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FEASIBILITY STUDY ON ORGANIZATION OF SUPPLY LINES FOR CASSAVA CHIPS

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ROOTS AND TUBER IMPROVEMENT PROGRAMME
MINISTRY OF FOOD AND AGRICULTURE
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EXECUTIVE SUMMARY

The study was carried out between September and October 2004. Actual fieldwork involved collection and review of available literature, stakeholder consultations, interviews with poultry farmers, feed milers, former chips exporter, cassava producers, cassava chips processors, researchers and development agencies, and policy makers. The study covered the Ashanti, Eastern, Central and Greater Accra Regions.

Cassava is the most cultivated food crop in Ghana, estimated to be cultivated by 90 percent of the rural households. Cassava has been processed into different forms for food and industrial use but to a lesser extend into chips for animal feed. The implementation of the RTIP has increased the production of cassava and new and profitable end uses must be found. Cultivation is largely for domestic needs and for the local market until the PSI on cassava came on board. It costs around ¢1,600,000 per acre to cultivate. The aim of the study is to assess the feasibility of organizing the supply lines for cassava chips.

The existence of a reliable supply of fresh roots at a competitive cost will be a factor determining the viability of any alternative cassava processing operation. The ability of farmers to gain access to other markets for their produce will be a major factor influencing the supply of cassava for a particular processing end use. Generally, price of fresh cassava are likely to be more attractive than those that a processing enterprise could afford.

A study by Day *et al* (1996) show that the price T&CG paid for dried chips at a collection point close to the farms was ¢2,600 per 91 kg unit, which they considered as farm gate prices compared to the wholesale prices in excess of ¢5,000 for the same weight. The price paid by T&CG for chips is not strictly equivalent to farm gate price for cassava since farmers also incurred costs associated with chipping and drying. The wholesale prices on the other hand also reflect transport and marketing costs incurred between the farm and the wholesale market.

In summary, the supply of cassava for processing into chips will depend on:

- Ease of access to fresh marketing channels;
- Ease of access to other processing outlets, e.g. *gari, kokonte, agbelima* etc;
- Other competing uses, e.g. as food security reserve;
- Transport links in the cassava producing area;
- Varieties of cassava available, e.g. for human or for other uses;
- Staple status of cassava in the area; and
- Seasonality, transportation difficulties, harvesting difficulties, drying operations, and overall seasonality of agricultural production processes. Seasonality in competing uses of cassava.

Organization of cassava supply for a processing operation would have to take issues affecting availability of steady supply and predictable flow into consideration. In fact, new end uses of cassava must be integrated into existing production and marketing system. Additional production must be encouraged to serve the new use and income source.

Experiences of Pioneers:

Traders and Exporters

Vehicle hiring from urban centres imposes a high search and delay (transaction) cost on the operations of the firm. During the cocoa season, the competition for trucks becomes even keener raising hiring cost. Investing in own vehicle require a high capital requirement which ploughed back profit could not meet. In addition, own trucks are associated with under capacity utilization as the chipping operation lasts eight months in a year, and high maintenance cost. Borrowing from financial institutions is an option for the purchase of own trucks, but it is not preferred due to the high collateral requirements and interest rate charges. Lending rate on investment loans is about 35 percent per annum 2004, Barclays Bank prices. A head of articulated truck is estimated at ¢1.2 billion (T&CG, September 2004 prices).

One particular constraint experienced by T&CG relates to transportation especially between the field and the assembly point. Most of the transportation at this level takes place by head loading.

Another issue of concern is technical options for drying to improve the quality and consistency of chips and intercropping to maintain soil fertility and yields, which can be demonstrated to farmers. These lessons are vital pointers for the development of proposed cassava processing models.

Advancing monies to farmers in lieu of future purchase sometimes resulted in breaches of contract. Farmers may sell fresh cassava to other processors such as *gari* and *kokonte* producers when the relative price for these products increases, decreasing the relative price of chips.

Low world market prices meant that the domestic producer price levels could not be sustained leading to shut down of operations in 2000.

Competition faced from other cassava products in terms of price. Surge in demand for other cassava-based production from the West African sub-region caused diversion of fresh cassava to the production of other products at the expense of chips.

Credit delivery is an area T&CG recommends further innovation in service provision to farmer processors. The scheme is for the chips traders, farmers and the financial institutions to work together instead of the trader pre-financing farmers' inputs. The financial institutions provide credit to farmers, the farmers produce chips and sell to the trader, and the trader makes payments on behalf of the farmers to the financial institution. At the same time the trader and the extension services of MoFA provide support to group formation and development. Experience of T&CG show that huge sums of money are needed to purchase chips from farmers and therefore the need for financial support from the financial institutions (see cash flow Tables 5.4 and 5.5) to the chips trader.

Chip demand follows seasonal variation and also cyclical movements, making some facilities to lie idle, while maintenance cost is incurred.

Production of Cassava

The highest cassava producing areas in the regions identified for the study are: Ejura-Sekyere-Dumase and Sekyere West District in the Ashanti Region, Assin District in the Central Region; and Akwapim North District in the Eastern Regions. The best locations for drying chips are areas with relatively long and intensive periods of sunshine, especially the transitional belt and the north, though drying can satisfactory be done in the locations visited during the survey for the study. Existing literature and our own field visits confirmed that areas of least alternate market for cassava are the transitional zone and the northern part of the Volta region. Cassava being a bulky low value commodity can only be transported over short distances (less than 40 km). Therefore processing should be as close to cassava production point as possible. The delivery price of chips acceptable to mills and poultry farmers at factory gate include transportation cost from purchasing at farmers location to the delivery points which is half the price of maize or less.

T&CG staff indicated that the most successful areas for producing cassava chips for their company during the peak activity period was in the middle belt/transitional zone from Atebubu to Kwame Danso, Bamboi, Nkwanta, Damankrom, Paramboi, Wenchi to Bongase, Banda Ahenkro, Manji, Brahie, the Damongo stretch from Fufunsu to Sawla, Nipala, Banjuala, Salaga, Nonto and Nolonto. The reason given was that, the level of human consumption of cassava in these areas is very low. In the absence of other market outlets in these areas the price of the fresh produce remains low and the 'surplus' production is available for processing into chips. Even including the cost of transporting cassava chips from these distant areas to the port in Tema, the company found it cheaper to buy and transport chips from these areas than to buy from nearer locations to Tema like Awutu where cassava is consumed extensively and therefore has a higher price. It is therefore important that the location for setting up a cassava chips processing plant is selected carefully taking all important factors into consideration especially the availability and cost of cassava roots.

Organization of Farmers

Small scale processes using simple technology (knives and sun drying on mats or patios) suited to village level enterprises have the advantage of being located very close to the production sites of fresh cassava. This reduces the transportation costs associated with the movement of large volumes of relatively low value raw material. Product quality assurance, however, is more difficult at the farmer level and the scope for developing formal marketing arrangements much reduced. More formal marketing arrangements are necessary to effectively reduce transaction costs.

Centralised large scale processing of cassava into chips require large investment (fixed and working capital) and the development of sophisticated marketing systems to ensure a continuous and reliable supply of cassava for processing, in order to miximize the utilization of capital equipment and other resources. In addition, transport cost associated with the supply of cassava are high proportions of operating costs. Therefore, attempts to reduce these operating costs will give rise to the development of some form of estate production of cassava, possibly leading to reduced benefits flow to farmers who are targets of poverty reduction actions.

T&CG experimented on a centralised processing of chip system but finally settled on the system where smallholder cassava producers carried out production and processing on a decentralised basis. T&CG concentrated on the role of organizing and coordinating marketing services. Under the guidance of T&CG, farmers were encouraged to form groups for the purpose of relating with T&CG. It is the view of T&CG staff that this method of organization is more flexible since farmers are able to respond more quickly and cost-effectively to changing weather conditions that affect harvesting and drying operations than a large-scale, capital-intensive processing operation.

The economic size of chips to be assembled at a location for lifting from T&CG experience is 25 MT at any point in time. Experience has shown that farmer groups have been effective when membership average 10 persons. It is proposed that 20 of such groups could be formed in each district. In fact, there can be more than one group in a village and must be self-select. Each farmer is expected to cultivate one acre (0.4 ha) of cassava farm with an average yield of 8 MT for chip production. Again experience has shown that 1.5 MT of fresh cassava yields 1 MT of chips. Therefore each farmer is expected to produce 5.33 MT per annum and each group would produce 53.3 MT per annum. Based on the fact that 20 groups will be formed in a district, the district is expected to produce 1,066 MT per annum. If production is organized in 6 districts (2 districts in each of the chosen regions), then a total volume of 6,396 MT would be available per annum. This means that from the pilot 533 MT of chips can be supplied per month from the pilot.

Of the farmers contacted during the survey, 91 percent were willing to participate based on the following conditions: chip price should not be less than half equivalent weight maize price, sustainable purchase of the chips, and price negotiated with the group before the actual purchase period.

Quality Specification
No clearly defined quality standards are available for chips to be used in feed production in Ghana. However, GAFCO and other poultry farmers producing their own feed prefer white, low moisture (bristle), no mould and low cyanide cassava chips. More scientific study is needed to establish standards for chips to be used in animal feed formulation.

Cost of Production
Cost of cassava chip production is dependent on the method of cassava production, the chipping method used and the method of drying. The traditional method of production is about uniform but cassava yield vary from area to area depending on cassava varieties planted and the climatic conditions. The least cost of chips production is when it is done on the farm following defined protocol. Raising the yield per area per time is the best opportunity to reduce cost of production. Evidence available is that cassava production in pure stand for the fresh market is more profitable than when intercropped with maize.

Marketing Chain and Pricing of Cassava Chips
Monthly national average maize and cassava prices graphed for the past five years showed a similar trend movement for the two commodities over the period. It was

also estimated that the correlation coefficient between maize and cassava prices over the period January 1998 and May 2003 is 0.91. This implies that as maize price rise cassava price also rise and fall when maize price falls.

The maize-cassava price ratios calculated for the period January 1998 to May 2003 indicates the average price ratio of 2.1 and with a minimum and maximum values of 1.3 and 3.9 respectively. In 2003, the monthly maize-cassava price ratio remained stable around the five years period average of 2.1. However, there is no clear pattern emerging in the seasonal variations in the maize-cassava price ratios. Within the year, the highest price ratios are clustered around January, February, July and August.

It is estimated that 1.5 kg of fresh cassava will yield 1 kg of cassava chips for animal feed (no peeling is required). Therefore, the value of fresh cassava in cassava chips production is equivalent to 71 percent of the maize price. This means to use cassava chips as maize substitute, the other production costs (to produce maize equivalent product) must be less than 29 percent of the maize price. It is common knowledge among researchers and practitioners in the poultry industry that cassava chips is not a one to one substitute for maize. The nutrient compositions of maize and cassava chips differ. As such, the value of cassava to be used in chip preparation should be lower than its value when it is sold in the fresh form.

Agronomic Aspects

Cassava chips production for use as animal feed does not require the peeling of the fresh cassava roots. Therefore, the thickness of cassava skin is not a problem. Rather cassava varieties that are early maturing and high yielding are required to reduce cost of production.

Chipping and Drying Technology

There are several combinations of technical packages that can be adopted. They include:

1. Using manual chipping (cutlass and knives), drying on mats and bagging with plastic bags - C1/D1/B:
2. Using manual chipping (cutlass and knives), drying on raised racks and bagging with plastic bags C1/D2/B:
3. Using manual chipping (cutlass and knives), drying on patios and bagging with plastic bags - C1/D3/B:
4. Using machine chipping, drying on mats and bagging with plastic bags – C2/D1/B:
5. Using machine chipping, drying on raised racks and bagging with plastic bags – C2/D2/B:
6. Using machine chipping, drying on patios and bagging with plastic bags – C2/D3/B:

Investment cost increases from option 1 to option 6. Most of the farmers contacted have had no experience using chipping machines. Those who had produced *Kokonte* used manual peeling and chipping.

The first three drying options are effective and efficient. However, their use will depend on the ability of the farmer to finance the cost involved. Solar driers are not considered because of their cost, the limited scale, and their high rate of replacement. It is also import dependent since the appropriate plastic sheets are not produced in Ghana.

Construction of Drying Facilities

The only drying facility considered suitable for use under Ghanaian conditions that need construction is the cement concrete patios. A 10 m^2 patio would cost about Five Million Cedis (¢5,000,000). The amount excludes the value of the land on which the construction is made. The raised platforms can be constructed using local materials and or purchased rubber mats for the drying surfaces. The major constraint associated with the construction of the patio and possibly the rubber mats is the cost and finance required. Farmers may
not be able or willing to invest in these.

Research, Extension and Training Needs:

Farmers Producing Cassava for Chips

When the cassava crop has matured the traditional system of manual harvesting is recommended since no suitable mechanical harvester is available for cassava. The reason for manual harvesting is that unless and until cassava planting is done on ridges, it will be difficult to harvest the crop mechanically without damaging the matured cassava roots.

To ensure continuous processing of cassava into chips, planting must be staggered over the year. That is planting should be planned for four specific periods during the year. This also implies that a quarter of the total land area required to be planted in a year to supply sufficient cassava for processing into chips must be planted every quarter. Every farmer participating in the pilot must do this. Alternatively, the farmers will have to be divided into four groups with each group planting an agreed farm area of cassava in only a specific quarter in the year. In this manner, adequate cassava would be available for processing to meet the demand from traders and feed mills. The success of this approach will depend on effective coordination and training of the key players by MoFA staff (RTIP).

To ensure quality production T&CG provided a form of extension service through their district level staff. The staffs were active in organizing farmers, arranging meetings and demonstrating the process of chipping and drying. The company also developed a loose set of criteria for investment in new areas including, the willingness of farmers to share part of the risk through cooperatives or private companies, and the ability to generate a minimum quantity of marketable cassava (usually a minimum of one 25 MT truckload per month). One primary concern expressed by farmers is the sustainability of the outlet for their crop in future years.

Farmers Producing Chips and Chips Producers

Farmer groups and factory chips producer need extension support to train them in appropriate size of the chip, the drying processes to facilitate drying and also avoid contamination of the dry chips. Extension is needed in the proper packaging and storage of chips until traders purchase them.

The use of chipping machines speeds up the cassava chipping process. However, the chipped cassava using machines stick together during drying. Therefore, without regular turning, which the farmers found tedious, the chips become mouldy. It is necessary that a more appropriate and efficient designs of chipping machines are developed and tested under the pilot with the support of the engineering faculties of the Universities and Food Research Institute.

Feed Mills and Feed Production

In order to control bacteria infections in cassava chips Sydals Farms Ltd. successfully used an extruding machine. The company purchased cassava chips from T&CG and after milling passed the flour through a dry extruder. During extrusion, the flour was heated to a temperature of 140 ^{o}C, which practically rendered it sterile. Heating at this temperature for a few minutes destroys nearly all micro-organisms including sporeformers and their spores. During extrusion, the flour is cooked and the starch gelatinised thereby improving the palatability of the feed for the birds. Also, gelatinisation of the starch also improved utilisation of the cassava flour by the birds, since raw cassava flour tends to stick to the upper section of the mouth of the birds. It was further noted that extruding or cooking cassava flour at 140 ^{o}C have a pronounced effect on the content of aflatoxin and other mycotoxins.

In the use of cassava chips in feed formulation, collaborative research effort is needed between feed millers and poultry farmers on one hand and the relevant agricultural departments of the universities and the Animal Research Institute on the other hand. The feed mills have the requisite know-how and experience in the formulation of feed using maize, but in substituting part of the maize with cassava flour, the protein content of the maize replaced from the feed has to be compensated for. It is recommended by a poultry farmer that dried cassava leaves are also incorporated into the feed since maize has a protein content of between 11 percent and 14 percent, cassava roots 1-3 percent and cassava leaves 7 percent on fresh weight basis. Cassava leaves are also rich in minerals, vitamins and all the essential amino acids except methionine and phenylalanine. The amino acid profile of the maize and cassava proteins will have to be taken into consideration and the necessary compensation made.

So far SYDALS Farms has been satisfied with the use of cassava flour in poultry feed and has the necessary know-how and experience in the formulation of feed in which part of the maize is substituted with cassava flour and deficiencies compensated for with incorporation of full fat soya meal. Assistance could be sought in sharing this knowledge and experience from the company.

Profitability Analysis of Production and Marketing of Chips

The Net Present Value (NPV) of both the centralised and decentralised production models yielded positive ¢1,075,890,034 and ¢2,457,730,506 respectively at 20 percent discount rate and a life of 10 years.

Sensitivity analysis conducted show that the financial performance is stable with regards to 14 percent increase in cassava price, increase in the discount rate from 20 to 27 percent, and a 16 percent decline in chip price from ¢60,000 to ¢50,000 per 50 kgs.

Recommendations:

Production of Cassava

The focus on cassava production should first be to lower the cost of production through yield increases to increase returns per unit area. The measures should include the continuous supply of improved and high yielding planting materials especially for the areas identified for animal feed and cassava chips production. Training of farmers to improve agronomic and crop husbandry practices is highly recommended as an effective way of reducing unit cost of production on sustainable basis.

Planting of cassava must be planned and coordinated to ensure harvesting, processing and supply of chips is continuous throughout the year. This will involve planning with the farmers (groups) and the chips traders and an agreement reached between all stakeholders.

Experience of T&CG concerning transportation between the field and the assemble point is that chips is transported by head loading. This is due to the absences of road infrastructure for even tractors. It is recommended that the District Assemblies focus attention on the provision of the feeder roads in these high potential areas.

It is recommended that the pilot production be located in districts not only producing large quantities of cassava but also experiencing relatively lower fresh cassava price. The potential areas are the transitional zones and the northern segment of the Volta Region with improved trunk roads.

Organization of Farmers

Small-scale processors using simple technology (knives and sun drying on mats or patios) suit village level production and have the advantage of being located very close to the production site of fresh cassava. Farmers must be encouraged to form self-select groups of between 8 and 12 people. Each farmer should cultivate at least 0.4 ha for chips production and a minimum of 20 farmer groups must be formed in each district. Each farmer in a group should be assigned a specified quantity of cassava chips to produced in a month, which should be a percentage of what is assigned to his or her group for the month.

Quality Specification

No clearly defined cassava chips quality standards for animal feed formulation exist in the industry. It is recommended that the industry stakeholders (feed millers, poultry farmers associations and researchers) join forces with the Ghana Standards Board to develop standards for cassava chips. This will build users confidence and improve acceptability.

Cost of Production

There is a need to generate a credible cassava based crop budget for the selected areas that can be used by extension officers to demonstrate to farmers that cassava farming and chip production is profitable. Similarly, the cost of producing chips at the farm level is based on information provided by farmers. It is recommended that under the pilot project effort is made to estimate accurately the cost of producing chips at the farm level in selected areas and also the private individual factory level. This should be a collaborative effort between the farmers, Extension officers of MoFA and Departments of Agricultural Economics and Agribusiness of the University of Ghana.

Monitoring of Prices

To understand the relationships between commodities and products, it is recommended that during the pilot, RTIP staff monitor and document prices of fresh cassava, chips, *gari, agbelima*, and maize prices at farm gate, wholesale and factory gate prices to inform price negotiation and price setting.

Chipping and Drying Technology

The chipping and drying technologies recommended is based on the view that chips production is to benefit the small-scale farmers. The three first options combining manual chipping- cutlasses and knives and drying technology – mats raised racks and patios. Chipping machines must be redesigned to make them user friendly in the rural setting for adoption.

Construction of Drying Facilities

Given the intended use of the drying facilities, the patios appear the most suitable in terms of durability. However, given the cost involved in construction, the farmers may have to be assisted with credit from RTIP for their construction. The cost of the other drying materials must also be supported with a credit facility from the project as incentive.

Research, Extension and Training

The agronomy, budgeting and coordination of activities of the farmers will need the support of MoFA staff (RTIP) to achieve desired targets. MoFA may also act as liaison between the farmers and the potential trader in terms of organizing meetings, negotiating prices and volumes and monitoring production to ensure that quality chips are delivered and disappointments eliminate.

Extension staff must themselves be trained in the best method for the production, drying, appropriate packaging and storage of cassava chips in order to facilitate the transfer of knowledge and skills for farmers. It should not be assumed that this would happen.

Although a holistic approach to the quality control of cassava chips from farm to the delivery point at the factory gate will be pursued, the use of extruding machine is highly recommended in order to eliminate nearly all micro-organisms including sporeformers and their spores and also improve the utilisation of the cassava flour by birds.

It is also recommended that, collaborative research effort is recommended between feed millers and poultry farmers on one hand, the relevant agricultural departments of the universities and the Animal Research Institute on the other hand in the use of cassava chips in feed formulation needs to be strengthened. This will ensure the development of the right formula for different classes and ages of domestic animals.

A starting point can be to use the formula for Sydals Farms if they would be willing to share their experience with others.

It is further recommended that all the stakeholders (farmers, MoFA staff, traders, feed millers, poultry farmers, researchers and the District Assembly) work together to establish a Hazard analysis critical control point (HACCP) system for feed produced from cassava chips.

ACRONYMS

COSCA	COLLABORATIVE STUDY OF CASSAVA IN AFRICA
DA	DISTRICT ASSEMBLY
DADU	DISTRICT AGRICULTURAL DEVELOPMENT UNITS
DfID	DEPARTMENT FOR INTERNATIONAL DEVELOPMENT
GAFCO	GHANA AGRO-FOODS COMPANY
GSS	GHANA STATISTICAL SERVICE
HACCP	HAZARD ANALYSIS CRITICAL CONTROL POINT
IFAD	INTERNATIONAL FUND FOR AGRICULTURAL DEVELOPMENT
KNUST	KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
MoFA	MINISTRY OF FOOD AND AGRICULTURE
ODI	OVERSEAS DEVELOPMENT INSTITUTION
RTIP	ROOT AND TUBER IMPROVEMENT PROGRAMME
T&CG	TRANSPORT AND COMMODITY GENERAL

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CHAPTER ONE

1 INTRODUCTION

1.1 Background

Most of the cassava produced in Ghana is consumed locally in various forms. COSCA studies estimated that 50 percent of the cassava is processed into various products while the rest is either eaten raw or cooked and eaten at home in various forms (Nweke *et al*, 1999). Only a small percentage of cassava production is processed and used in non-food applications. Although there is no documentation on the amount of cassava going into non-food sectors, there are a number of plywood and paper converting companies that are using cassava flour or starch in processing their products. The amounts being used are small compared to national production, but there is scope of expansion for industrial usage.

According to Ministry of Food and Agriculture, out of the 9,730,000MT of cassava produced in 2002, 6,810,000 MT (70%) were available for human consumption of which the estimated national consumption demand was 2,940,000 MT (30.2%) leaving a surplus of 3,870,000 MT (39.8%) (MoFA Facts and Figures, Sept. 2003). Increased usage of cassava in the industrial sector is therefore not likely to threaten food security of the producing households, but rather enhance their income levels. Programmes designed to expand the utilization capacity of cassava is therefore called for.

The Root and Tuber Improvement Programme (RTIP)[1] was designed with the objective to enhance food security and improve the income of resource-poor farmers by facilitating access to new but proven locally adapted technologies for the root and tuber crops (cassava, cocoyam, sweet potatoes, and yam). This is in line with Ghana's poverty reduction strategy in terms of reducing rural poverty.

The programme is being implemented through six components, namely:

- Planting material multiplication and distribution,
- Integrated Pest Management,
- Adaptive Research,
- Community Support and Mobilization,
- Post-Production and Marketing, and
- Programme Management and Co-ordination

The focus of the programme has been on improving access of farmers to improved planting materials of the target crops, especially cassava and sweet potato. Through the activities of the RTIP programme, 720,000 resource-poor farmers are expected to access planting materials of the improved cassava and sweet potato varieties by the end of the six-year programme period, which span January 1999 to December 2004.

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[1] Funding is by IFAD

The targeted beneficiaries, defined as resource-poor farmers in the rural areas who cultivate not more than 1.2 ha of land, have no or low access to other production inputs, capital and technology. Women constitute a special target group. Increasing numbers of farmers are adopting improved root and tuber technologies, especially cassava. This is evidenced by the increase in the number of adopting farmers of improved cassava technologies from 33,294 farmers in December 2001 to 159,854 (380 percent increase) in December 2002 and again to 343,949 farmers (115 percent increase) in December 2003.

The promotion of improved cassava varieties over the past five years and the significant adoption has resulted in reported gluts in parts of the country, resulting in continuous decline in cassava prices since 2002 (MoFA, 2003). To address this declining price issue and other post-harvest issues for cassava and other root and tuber crops, RTIP is considering a number of approaches to create alternative marketing outlets to absorb excess production from farmers, thereby increasing their income. One approach under consideration is the promotion of the commercial and industrial use of cassava chips in the production of animal (specifically poultry) feed on pilot basis.

To better inform the RTIP Programme Co-ordinating Office (PCO) as to which approach to adopt, a study is needed to evaluate the feasibility of the pilot commercial production of cassava chips for use in the industrial production of animal feed. The study involves an extensive review of literature on the production of cassava chips and use in the production of animal feed, and programme reports. It carried out interviews with producers, feed millers and other industrial users of cassava chips and exporters.

1.2 Terms of Reference for the Study

1.2.1 Objective of study

The objective of the study is to prepare a pilot project to organize farmers to deliver good quality cassava chips each month to an industrial user (feed mill) for the production of animal feed.

The specific objectives of the study include: to

1. Identify the constraints and lessons learned from exporters, producers and users of cassava chips in the nineties;
2. Provide detailed plan for cassava chip production and marketing;
3. Determine the inputs required to operate the pilot plant and assess their viability
4. Define responsibilities and cost implications of the key stakeholders in the running of the pilot plant;
5. Identify the need for additional testing of equipment for farmer level production of cassava chips
6. Establish cost of farmer level production of cassava chips, construction of drying facilities, chipping machines and small equipment used in drying cassava;
7. Assess the demand for cassava chips of the feed millers;

8. Assess and compare the price competitiveness of cassava and maize over the past five years and establish the acceptable price ratios for the two crops that will make cassava competitive and attractive to feed millers;
9. Identify acceptable quality specification in the use of cassava chips for the production of animal feed; and Identify the training, extension and research needs to support the production and marketing of cassava chips for feed mill; and
10. Recommend appropriate equipment for farm level cassava chips production, least cost production methods, how to bring down cost of production and harvesting, enhance the competitiveness of cassava and the use of quality specifications by both producers and users, and appropriate location for the pilot plants.
11. Recommend appropriate equipment for the farmer level production of cassava chips,
12. Recommend least cost production methods, how to bring down cost of production and harvesting, enhance the price competitiveness of cassava and the use of quality specifications by both producers and users, and
13. Recommend appropriate locations for the pilot plants.

1.3 Scope of Work

The scope of the study was intended to include the following aspects, among others. Lessons learned from past experience in the cassava chip production and marketing chain during the 1990s:

Major constraints and challenges

(1) of exporters on the organization of farmers groups, tested chipping and drying technologies, organized supply lines,
(2) in the utilization of cassava chips on adequacy, timeliness and quality of supply,
(3) of individuals or groups already in the drying of cassava chips, and
(4) explore reasons for continued use of traditional chipping and drying methods.

Production of cassava

Highest cassava producing districts, location of good drying facilities, districts where farmers' access to alternative market sources for cassava is poor (i.e. Low price of chips), distance and transport costs and their acceptability to buyers.

Organization of Farmers:

Number of groups required, organization of groups required, production capacity of groups in cassava chips, recommended capacity per group of cassava chips per month, Willingness of farmers to participate in pilot scheme (i.e. farmers' willingness and ability to expand production to meet volumes required and accept the market price).

Quality Specifications:

Determine acceptable quality specifications of cassava chips for livestock feed (colour, moisture, starch, crude fibre, cyanide, etc.) by clients and farmers, and willingness of farmers to participate in pilot scheme at hypothesized price levels and quality.

Cost of production:

Cost of cassava chip production, identify least cost production methods, and analyse how to reduce cost of production and harvesting in the medium term.

Marketing chain and Pricing of Cassava Chips:

Establish the price trends and seasonal fluctuations for cassava relative to maize for the last five years, determine price ratios of cassava to maize, competitive prices of cassava relative to maize, and determine competitive price for cassava to be attractive to feed millers.

Agronomic Aspects:

Identify varieties with thin skin to speed up or reduce drudgery of peeling, and identify sources of supply of varieties with thin skin.

Chipping and drying Technologies:

Identify and assess performance of available chipping methods and technologies, awareness and knowledge of farmers of improved chipping methods and their attitude towards these, assess the need for additional testing of available chipping and drying technologies, recommend appropriate method and technology with respect to chipping machines or chipping and hand using knives, and recommend appropriate methods and technology for the drying of chips.

Construction of Drying Facilities:

Develop a plan and budget for the construction of drying facilities, develop a plan and budget for the procurement/purchase of chipping machines and equipment for drying cassava, and spell out the constraints and challenges associated with the plan.

Research, Extension and training needs:

Collate information on existing research work in production, utilization and marketing of cassava chips, and assess the training needs of farmers, users and MOFA staff.

Location of Study:

The study was to be conducted in two (2) selected districts in each of Ashanti, Central and Greater Accra Regions.

1.4 Organization of study

The study is organized into seven chapters. Chapter one provides the background, terms of reference, scope of work, and the organization of the report. Methodology used in this study covering sources of data and analysis, and how the data collection was conducted, and limitations of the study are presented in chapter two. Constraints and lessons learned in cassava chip production and utilisation from pioneers in the industry, policy makers and researchers are discussed in chapter three. Chapter four presents a discussion on planning for cassava chip production and marketing. Specifically, what is required for best practice and what is available for take off.

Contained in chapter five is discussion on the pilot plant. It covers stakeholders and their responsibilities, the benefit-cost analysis, sensitivity analysis of the pilot, potential locations of the pilot plants and farmer level organization required. Recommendations for appropriate equipment and methods for industry stakeholders are presented in chapter six. The final chapter, chapter seven provides a summary, conclusions and recommendations on the study.

CHAPTER TWO

2. METHODOLOGY

2.1 Introduction

This section describes the methodology employed in achieving each specific objective of the study. First, the theoretical framework within which data is collected and analysed is described. Then, the sources of data and method of data collection are examined. Finally, the analytical method is presented and the livelihood of small holders in cassava production described.

2.2 Theoretical Framework

Every society is made up of people whose major objective is to sustain a living. The people whether male or female, young or old, select methods or strategies that would aid the development of assets (see Box 1) in order to achieve sustainable outcomes. These strategies are either facilitated or constrained by policies, institutions and processes on the one hand, and by the external environment (or vulnerability factors such as drought, sickness, conflict, etc) on the other (Assuming-Brempong *et al*, 2004) (see also Figure 2.1).

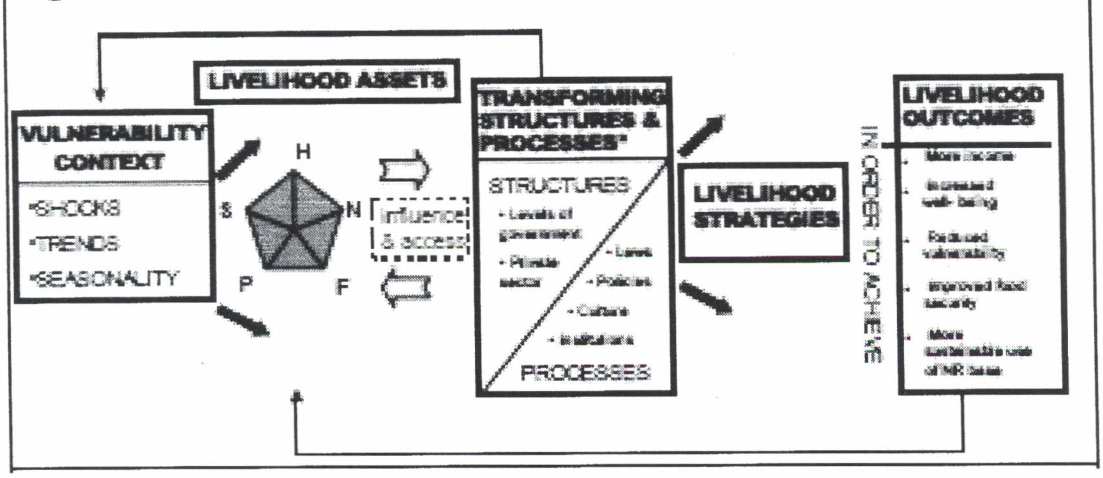
The general indication is that there are both controllable and uncontrollable factors influencing the selection of sustainable strategies. The controllable factors are internally generated and concern some personal characteristics of the people themselves. The uncontrollable factors are externally generated and relate to the risks, shocks and interventionists' processes and institutions. Interventions such as the introduction of cassava chip processing and utilization into the farming system or an industry is considered as process that should create opportunity for reduced dependence on maize as the only carbohydrate energy source for poultry feed, diversification of farm income generating activity, and possible reduction in cost of producing feed for poultry.

Box 1: Types of Assets that Contribute to Livelihoods

Assets	**Accessibility differs for and between individuals & households; some assets will be held at the community level.**
Natural	Natural resources (e.g. land, water, wildlife, biodiversity, environmental resources).
Physical	Production equipment (e.g. hoe, plough); basic infrastructure (e.g. shelter, transport, water, energy, communications).
Financial	Savings, credit, remittances, pensions.
Human	Skills, knowledge, health, ability to labour.
Social	Networks, membership of groups, relationships of trust, access to wider institutions of society

Source: **Carney D.** (1999) Approaches to Sustainable Livelihoods for the Rural Poor, ODI Poverty Briefing No. 2.

Figure 2.1: DfID's Sustainable Livelihood Framework



Source: Carney, 1999.

Whether farmers or some strategic investors will produce cassava chips would depend on the position of male and female farmers at the point of entry. Again the ability of feed millers to incorporate cassava chips, as a feed ingredient will depend on some perception they have of the product. In deed, whatever would constrain economic agents from adopting cassava chip on a sustainable basis should be related to some socio-economic characteristics of theirs, some technical attributes of the product and some institutional factors. Some of the important socio-economic factors analysed in adoption studies are age, sex and education (Badu-Forson, 1999); technical factors should include its economic advantage (due to saved cost or value added), ease of use or compatibility to old practice (Egyir, 2003); and the institutional factors concern the availability of markets (both input and output along the value chain), information and extension services and a favourable macro economy.

It is expected, that where input markets are well developed and there is adequate output markets, cassava farmers will diversify into off farm activities and adopt cassava chip production on a sustainable basis. Many cassava-farming systems in Ghana have incorporated processed product production as an off-season activity. Again, if poultry production depends on cassava-based diets and they would perform as expected (adequate laying and weight gain at time of sale), then poultry farmers would sustain their purchase or preparation of such products.

Therefore we need to understand the characteristics of the major stakeholders in the cassava chip chain (production to utilization) by observing current and past behaviour. The data collection process is informed by this understanding.

2.3 Sources of Data

Information used in the analysis of the study's objectives was obtained from both secondary and primary sources. Review of relevant theoretical and empirical literature was the major source of secondary data. Time series data on cassava production was obtained from the Ministry of Food and Agriculture (Appendix 2.1).

A desk review of literature was done to document what scientific research has been carried out by researchers and students in Ghana on cassava production and marketing, chip production, chip use in the livestock industry in general and the poultry sub sector in particular. A search on the World Wide Web also provided information on best practices in cassava chip production and use.

Primary data collection included rapid appraisals and sample surveys of stakeholders in the chip production and utilization chain, in four selected regions of Ghana. A case study of poultry farmers was studied. Other livestock producers such as swine, sheep and goats that could be potential users were not studied

2.3.1 Selection of study area

The study was carried out in the Greater Accra, Central, Ashanti and Eastern regions. The regions were suggested by the RTIP Secretariat and justified on the basis of association with major production of cassava, cassava chips or other products of cassava, poultry production, feed milling or poultry consuming population. For instance, although Greater Accra Region is not a major cassava growing area, it has the highest number of poultry farmers and feed millers and the highest population of consumers of poultry and cassava products in Ghana (Table 2.1).

Table 2.1: Selection of study area

Selection criteria	Region			
	Greater Accra	Ashanti	Central	Eastern
Cassava production	Low	High	High	High
Chip production	Not known	Known	Not known	Known
Feed miller numbers	High	Medium	Low	Low
Poultry farmer numbers	High	High	Medium	Medium
Consumer population	High	High	Medium	Medium

Source: Survey data

The Ashanti region is both a major producer of poultry products and cassava. *Gari* and *Kokonte* are major processed products associated with the region. It is also nearer to the Brong Ahafo region, which was the major producing area of cassava chips for export in the 1990's. The Eastern region is a major producer of cassava and cassava products and has been associated with the history of cassava chip exports in Ghana. Kwamoso is a village in the Eastern Region where cassava chipping for export was first experimented by the Transport and Commodities General Ltd. The Central Region is a major cassava producing area. In recent times, a Starch processing factory (Awutu Starch Company – ASCO) has been located in one of the districts bordering Greater Accra, under the President's Special Initiative (PSI) on cassava. The village is near Bawjiase in the Awutu Efutu Senya District.

Selection of villages and respondents

The villages selected for the sample survey of cassava producers were all major growing areas in the districts (Table 2.2). Assin Aworoso is a cocoa growing village whiles the villages in the Akwapim North District are maize areas and those in Sekyere West and Ejura-Sekye-Odumase are maize and yam growing villages. In all the villages cassava was regarded an intercropped plant, and a major staple. The survey of poultry farmers and feed millers was based on a snowballing procedure, which allows the first respondent to point to others in the industry for possible contact. Thus only farmers and millers who were at post at the time of visit were interviewed. Representatives of the Transport and Commodities General Limited and the Ghana Allied Foods Company were also interviewed as pioneers in chips export and feed milling using chips respectively. The Executive Secretaries of the Ghana National Poultry Farmers Association and the Feed Millers Association were also interviewed.

2.3.2 Interview Procedure

The feed millers cum poultry farmers were interviewed on their farms. Here either owners or representatives (managers or supervisors) were questioned with the aid of an interview guide. Major questions bothered on experience in the business, knowledge and use of cassava chips, willingness to participate in pilot project among others (see Appendix 2.2). The cassava producers and chip processors were interviewed in their homes with the aid of a structured questionnaire. Apart from the socio economic background, farmers were questioned about their experiences with cassava chips, group work, other cassava processed products, capacity and willingness to participate in pilot among others (see Appendix 2.3).

To understand the farming system of the survey areas, group discussions were employed to examine the process of cassava production and marketing of fresh and processed products. Seasonal Calendars and Daily Activity Clocks were designed to establish the place of cassava in the farming system and the gender roles in cassava production and marketing.

Others, including representatives of T&CG, GAFCO, Researchers and the Associations were interviewed in their offices in a conversational procedure, highlighting on the history, processes, quality control and constraints in cassava chip production and utilization in Ghana.

Table 2.2: Selection of villages and respondents

Category	Region	District	Village/Town	Respondents
Cassava producers	Ashanti	Sekyere West Ejura-Sekyere-Dumase	Bobin Hiawonwu Dromankuma	42
	Central	Assin	Aworoso Camp Five	34
	Eastern	Akwapim North	Kwamoso Adawso Pratu, etc	56
	Total			**132**
Cassava chip processors (High quality cassava for food and wood)	Central	Cape Coast	Cape Coast	1
	Eastern	Akwapim North	Akropong area	2
	Total			**3**
Poultry farmers	Greater Accra	Tema AMA	Fafraha Ashaimang Ajei Kojo Kpong Nungua	1 5 3 3 1
	Ashanti	Ejura-Sekere-Dumase Akropong	Ejura Akropong	2 3
	Central	Cape Coast Assin Gomoa Agona Ewutu	Cape Coast Fosu Manso Swedru Bawdjiase Pomadze	3 1 2 3 1 1
	Total			**29**
Feed millers	Greater Accra	Tema	Adenta Ashaimang Ajei Kojo	1 3 3
	Ashanti	KMA	Kumasi	5
	Central	Gomoa	Manso	2
		Ewutu	Pomadze Bawdjiase	1 1
		Cape Coast	Cape Coast	1
	Total			**17**
T&CG	Greater Accra	Tema	Tema	2
GAFCO	Greater Accra	Tema	Tema	2
Researchers	Greater Accra	AMA	Legon	1
	Central	Cape Coast	Cape Coast	3

Source: Survey data, September 2004

2.4 Method of Data Analysis

The objective of the study is to prepare a pilot project to organize farmers in order to deliver good quality cassava chips each month to an industrial user (feed mill) for the production of animal feed (poultry). In order to analyse the specific objective the following tools and models were employed:

1. **Identification of constraints and lessons:** Conclusions are drawn from interactions, interviews and sample surveys of exporters, producers and users of cassava chips in the nineties; rankings were made based on weights by frequency counts and percentages. Constraints are any factors that limit the access to or use of the product. Lessons learnt on opportunities, challenges and constraints are documented.

2. **Plan for cassava chip production and marketing**: This is modelled on a flow analytical framework (see chapter four pg 35). In identifying the detailed plan for chip production and marketing a structural (organisation and functions) analysis of the economic environment was made. First the broad objective of producing quality cassava chip for industrial poultry feed millers was identified. Then the potential stakeholders in the production, distribution and utilization chain were modelled in a flow chart (Figure 4.1). The expected capacity of each key stakeholder in contributing to the achievement of specified objective is indicated. The challenges emerging and the institutional support needs for a sustainable project are then examined.

3. **Input determination**: This is based on whether inputs are fixed or variable assets. Fixed assets include plant and machinery that are used up over a longer period of time. Variable inputs have short-term usage; their levels change whenever the level of output changes. The inputs may also be categorised as human resources, capital resources and natural resources. The capacity of human resources required is based on knowledge and equipment management of plant components. The viability of the enterprises are assessed based on the Net Present Value of the operations using discounted flow methods.

4. **Expected responsibilities, cost implications and benefits of all the key stakeholders in the running of the pilot plant**: A matrix approach is used to map the stakeholders (including researchers, farmers, strategic processors, feed millers, poultry farmers and traders -wholesalers and retailers of cassava chips and feed) to the responsibilities and cost. Stakeholder mapping and role identification is based on both information from literature and stakeholders themselves. In a typical snowballing fashion each stakeholder interviewed is made to identify other stakeholders and their role. The cost and benefit implications of their responsibilities are analysed from both the market (monetary) value and social value perspectives.

5. **The need for additional testing of the equipment for farmer level production of cassava chips**: This is established by comparing the chipping machines introduced earlier in the 1990s to what is appropriate, measured by best practice appropriate to stakeholders.

6. **The cost of production and harvesting**: The cost is established through consensus building during focus group discussions at the village level. The cost of chipping is imputed by adding depreciation value of chipping machine to running cost per tonne per year. The cost of construction of drying facilities, chipping machines and small equipment used in drying cassava is established at manufacture level (ITTU) and compared to market value.

7. **The demand for cassava chips of the feed millers:** This is established from a willingness to pay analysis (WTP). The WTP for cassava chips depends on the unit price of chips, the availability of technology for milling, the availability and unit price of close substitutes (such as maize), the availability and price per unit of complementary products (such as soy bean), and the income (or wealth status of millers. Hence, WTP = F (P_c,, T, P_M, P_s,, W) where Pc = price of chips, T = technology, Pm = price of maize, Ps = price of protein source (soy), w = wealth status of poultry farmer. Since the number of feed millers interviewed was minimum (17) none of the appropriate econometric models could be employed. Instead, conclusions are based on descriptions of the weights by frequency of the various independent factors.

8. **The price competitiveness of cassava and maize over the past five years**: The comparison is made using trend lines employing monthly national wholesale price data from 1998 to 2003. The acceptable price ratios for the two crops that will make cassava competitive and attractive to feed millers were then established by deduction. Partial budget analysis is employed to establish the profitability of replacing part of maize-based meal with cassava-based meal.

9. **The identification of acceptable quality specifications in the use of cassava chips for the production of animal feed**: This is made through best practice and farmer preference spelt out during interviews. Best practice indicators include criterion for chipping, drying, handling, composition, coloration, packaging, storage and complements

10. **The training, extension and research needs to support the production and marketing of cassava chips for the feed mill**: This is identified from spelt out needs of respondents during interactions and interviews and lessons drawn from past practitioners. Needs concern knowledge on the quality specifications, tools and equipment for research and logistics among others.

11. **Recommendations** are based on best practices, constraints, challenges and opportunities. An appropriate location for a plant is central to major cassava-producing areas, feed millers and poultry farmers. In this location the benefit/cost ratio for the plant would be greater than one. The appropriate equipment and methods of selection are based on best practice in other countries, availability in Ghana and indexed to the livelihood of different groups of cassava farmers, processors and users of cassava chips in Ghana.

2.5 The Livelihood of Cassava Producers in Ghana

The major asset needs of cassava producers are natural, human, physical, financial and social resources. Generally, cassava producers are typically smallholder farmers found mainly in the forest, transition, coastal savannah and guinea savannah agro-ecological zones of Ghana. Survey data shows that they include adult male and female farmers between the ages of 19 and 79; the majority (58%) were more than 40 years old (Table 2.3), a major challenge for a farming system that is dependent on less sophisticated machinery. Although there appears to be many more male farmers than females, the general indication is that both are important in cassava growing. There is gender division of labour at household and farm levels and both complement each other. Since males are heads of households they are likely to lead discussions concerning productive decisions and interventions.

Another major human resource element is formal education. Many farmers in Ghana are illiterate. In the survey, about 45 percent of the respondents were categorized as illiterate (since they have had no or less than 10 years of formal schooling). As has been the general case, there were fewer female literates, and they also had lower level of education. Although the labour market is developed, family labour is still important in cassava farming systems. It is therefore not surprising that the average household size was 8, larger than the national mean of 5 in year 2000 (GSS, 2001)[2].

Cassava farmers may hold large acreages of land but may put less than 5 acres under cassava cultivation[3]. In the survey, about 87 percent of all respondents held less than 5 acres of cassava land. In general, women appeared to hold smaller farms than men. During group discussions it became apparent that, the physically challenging nature of farming, coupled with low capital base for financing hired labour and distant locations of farms contributed to the low farm sizes of women. In Southern Ghana, the land markets are well developed and any body (irrespective of sex) with adequate capital could hire (or lease) land. In cocoa villages (e.g. Assin Aworoso) cassava is one of the food crops cultivated during the initial stages of establishing the farm. In yam farming villages, cassava is used to stake yam. Yam is almost a reserve crop for men, again due to the physically challenging nature of its cultivation. Maize is also mainly intercropped with cassava. Therefore, if males have larger acreages of maize, cocoa and yam land, they would have large acreages of cassava land. Large size is more indicative of ability to expand economic land than by social acquisition status.

Cassava is a staple food in Southern Ghana and farmers hardly add value to the raw product. Most prefer to sell the fresh root than other processed products. This is probably due to the fact that fresh cassava is used to prepare *fufu,* the most preferred meal among Southern populations. Of the processed product *gari* has the longest shelf life and is the most preferred alternative. Only 3 (2%) farmers were producing cassava chips (peeled) at the time of survey. The product was for the bakery rather than the feed market. Interestingly, knowledge of chips as an alternative product for poultry feed was not wide spread among farmers although most farmers (95%) believed that high quality product is needed for the feed industry.

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[2] We note that not all household members are available as labourers on the farm all the time. Some may be absentee members, others may be students or adult dependants (physically challenged).

[3] In the survey only two farmers had more than 10 acres of cassava farm. These were plots used to multiply improved varieties of cassava introduced by RTIP in 2002.

Table 2.3: Selected characteristics of cassava producer respondents

Character	Male		Female		All	
	Frequency	%	Frequency	%	Frequency	%
Age						
≤40 years	39	28.68	18	13.23	57	42
>40 years	59	39.38	20	14.71	79	58
Mean		45.5		44.7		45.3
Standard deviation		12.8		9.5		11.1
Education						
≤10 years	40	41	26	68	66	49
>10 years	58	59	12	32	70	51
Mean		7.5		5.1		7.08
Standard deviation		5.2		5.3		5.38
Household size						
≤4	12	12	8	27	20	15
>4	86	88	30	73	116	85
Mean						7.7
Standard deviation						3.8
Total land size						
≤4 acres	13	13	10	26	23	17
>4 acres	85	87	28	74	113	83
Mean		33.2		11.2		22.1
Standard deviation		99.2		13.7		56.5
Cassava farm size						
≥4 acres	84	86	34	89	118	87
<4 acres	14	14	4	11	18	13
Mean		5.1		2.6		3.9
Standard deviation		20.7		3.5		21.0

Group member? Yes	58 40	59 41	17 20	46 54	75 61	55 65
No *mode*	Yes		No		No	

Reason for being in group[4]:	Frequency	%
Market access	16	21
Credit access	10	13
External support	16	121
Mutual assistance	12	16
Just to belong to a group	9	12
Others	12	16
Cassava product sold[4]:	Frequency	%
Fresh	109	80
Gari	61	45
Agbelema	31	23
Kokonte	30	22
Chip	3	2
Experience with cassava chips	Frequency	%
Use	3	0.2
Knowledge	30	22
Nil	106	78
Perception of chip quality for feed		%
Comparable to human	130	95
Indifferent	6	5
Willingness to participate in pilot?	Frequency	%
Yes	125	91
No	11	9

[4] Counts are multiple cases

Social grouping and association is a thriving phenomenon but cooperation for economic activity is not well developed. In the survey about 55 percent of respondents claimed they had ever been part of a group; males were more likely to be in a group than females. Indeed, most of the respondents admitted that where their expectations in terms of improved product market access and financial aid is not met they become apathetic and allow the group to disintegrate. In Assin Fosu for instance, the Poultry Farmers Association is reorganized every five years "due to the perceived minimum economic benefits that accrue to individual farmers'. Information from the Department of Cooperatives indicate that agricultural cooperative organizations is going through serious challenges especially in the Greater Accra and Northern Regions (see Appendix 2.4).

Some cassava farmers trade in non-staple and non-food items or are temporary labourers in other people's farms. Only a few farmers are in permanent wage employment in other fields (non-agricultural sector) as masons, carpenters, blacksmiths, miners of precious minerals, salt winners and stone quarrying. Farm income is characterised by seasonal variation; this has contributed to the low capital accumulation of farmers. Most cassava farmers may be categorized as resource poor because they are unable to satisfy their community commitments and may not be able to adequately feed their families all year round. In some cases, some of them become welfare-dependent during some periods of the year especially, during the lean season. And without assistance they may not be able to take advantage of projects that target them (i.e. there is need for pro-poor project).

For example, without credit component, they may not be able to pay for machine hire even at subsidized prices. Such farmers are usually risk averse and therefore the least likely to respond to policies that do not factor in their exposure to risk. The poor are mostly disengaged from the market, so they are more likely to be unable to participate in a process that requires intensification and therefore use of more purchased inputs. This group lacks the capacity to look for markets so any new project that requires the development of new markets must assist in such development for a long time. Many of them are in remote areas with minimum access to physical infrastructure such as processing machines, good roads and well-developed markets. Therefore though the willingness to participate in the pilot project by farmers is high most of them are prepared to start with less than 1 metric tonne per month (or 12 Mt/annum).

2.6 Limitations

Not all aspects of the intended scope of the study could be achieved. For instance, since no cassava chip producer was encountered "the reasons for continued use of traditional chipping and drying methods" became a non-issue. Again the location of good drying facilities could not be identified.

The analysis of least cost production methods, and how to reduce cost of production and harvesting in the medium term could not be carried out due to lack of consistent time series data. The least cost combination is determined by evaluating the total cost function subject to output constraints.

The Identification of varieties with thin skin to speed up or reduce drudgery of peeling, and identify sources of supply of varieties with thin skin was a non-issue since the cassava chips is unpeeled.

CHAPTER THREE

3. CONSTRAINTS TO CASSAVA CHIP PRODUCTION AND MARKETING

3.1 Introduction

In this section the experiences of pioneer stakeholders in cassava business, research and policy implementation are examined to draw out lessons from the processes and activities carried out and any constraints encountered. The stakeholders in business are the exporters of chips, poultry feed millers, poultry farmers and cassava chip farmers/processors. Stakeholders in research include scientific researchers, lecturers and students who have ever researched and written on the subject. Policymakers include personnel of government's Ministries, Departments and Agencies who aid the formulation of policy objectives, strategies and rules of implementation.

3.2 What do the Pioneer Exporters Say?

The Transport and Commodity General Limited (T&CG) and the Ghana Food Company Limited (GAFCO) were the two firms whose experiences were shared. While T&CG stayed in the cassava chip export business for seven years (1993 – 2000), GAFCO only lasted a year (1996 – 1997). Therefore most of the conclusions drawn are based on T&CG experience. The process of cassava chip export has four major components: farmer organization, raw material (cassava) production, cassava processing into chips and purchasing and preparation of chips for shipment.

Farmer organization:
Ensuing sustainable supply requires that the production base be secured all the time. The group approach to cassava chip marketing was thus encouraged from the very beginning, though production remained at the individual level. In each community, interested farmers were made to form self select groups of 7 to 15 persons. The groups were ethnic or kin based but it was always gender and age neutral, in that women and men, young and old belonged to a group. Such groups were given training in the agronomy, pest management and post harvest handling of cassava. The Ministry of Food and Agriculture's Extension Services Directorate organized the training based on information developed by researchers and importer specification manuals. Such information is always subjected to local content and language. In addition to free information, T&CG also advanced monies to farmers in lieu of future purchases. Hire purchase of some consumer goods was also encouraged, through pre-finance by T&CG. The cassava producers were mainly Kokomba and Akan speaking tribes located in the Northern Volta and Brong Ahafo Regions. Many of the farmers were already familiar with group work since they practice *Nnoboa* system where labour is reciprocated on farms for major farm activities such as weeding, planting and harvesting. What was not well developed in the group organization was the economic element of cooperation where farmers pool resources other than labour (such as funds) for common savings to improve thrift and credit acquisition

Cassava production:
Generally, the farmers in cassava chip processing were yam/cassava intercrop producers who were cultivating the local varieties for the fresh cassava, *gari* and *kokonte* markets. To boost the production of cassava by encouraging mono cropping

and diversification into cassava chips production, new early maturing (bulking) varieties of cassava were introduced into the farming system. This implied that cassava was harvested earlier and presented in a form that was relatively advantageous for chip and not for the fresh market. In this way, when the harvesting period is delayed, the roots became fibrous, reducing the expected weight of chips.

Cassava processing into chips:

Though processing of chips as an animal feed is a new economic activity, the process is similar to *kokonte* (peeled chip) processing for consumption at household level. The difference is that unpeeled roots were chipped in approximately uniform sizes and sun dried for between 3 - 7 days depending on the mode of chipping. Chipping machines were supplied by T&CG Ltd. for chipping. Machine chipped products dried faster than the manually chipped ones. However, farmers preferred to process manually because the machine was not always available, it required extra cost of fuel and maintenance and extra attention during drying of chips since the chipped cassava stick together. An experienced manual farmer/processor could chip 1.5 metric tonnes of cassava per day and require one (1) labourer to attend to the drying. A good machine may chip 3.5 metric tones per day and require four (4) labourers to attend to the drying. The manual process involved cutting unwashed and unpeeled fresh cassava with cutlass on wooden platforms. It was learnt that sand particles of fresh cassava fall off by the end of the drying period of chips, so there is no need to wash the roots prior to chipping or drying.

To ensure high quality chips, drying was done on elevated mats in open spaces at home or on the farm. What this meant was that additional inputs (polythene sheets and man hours), were needed during the rainy season to protect the product from the weather. During the Hamattan period (January –March) drying takes 3 to 4 days. During the raining period drying is done at home and it lasts between 6 and 7 days.

Each tractor load of fresh cassava, equivalent to 6-8 metric tonnes could be processed into 71 bags of chips. Each bag weighs 65 kilograms. Thus, each tractor load of fresh cassava was processed into approximately 4.6 metric tonnes of cassava chips.

Purchasing practices:

When farmers stocks are ready Purchasing Clerks from T&CG inspect the chips before packaging. Sometimes when there are large volumes, farmers are made to package without prior inspection. To circumvent the problems of adulteration an Agency system was introduced. Some farmers were made hired agents to monitor and buy quality chips on behalf of the company. For the pilot a trusted JSS teacher could be hired as a buying agent to eliminated any conflict of interest that may arise in the use of farmers.

In the Nkwanta District in the Volta Region for instance, T&CG staff reported purchases always exceeded 100 metric tonnes per week. A maximum level of 400 metric tones per week was achieved during the dry season. The purchasing calendar starts in early October and ends in May the following year. In 1999 a 62 kg bag of cassava chips was purchased at ¢6,000.00 (US$3.00) per bag each

Preparation for shipment and shipment: Pre-shipment preparation require movement of purchased stock to district depots for onward stocking at a central warehouse in Tema (Greater Accra region (Figure 3.1). Here, quality analysis was made to ensure that the required quality specifications of importers were met.

Quality cassava chip is pure white, crisp and non-perforated. There was intermittent fumigation exercise before stocks were moved to the harbour at Tema in the Greater Accra Region for shipment.

Usually articulated trucks (flat body, container or sided) were used to transport the stock. These vehicles were hired from the urban centres and taken to the rural depots. Apart from road transport, the Volta Lake Transport was also used to transport stocks from the Volta region. At the harbour pre-shipment inspection was undertaken by SGS before loading unto the ship. About 300 metric tonnes of chips could be shipped in three days. During the period of operation, there was growth (Table 3.1). In 1998 the company contributed more than 90 percent of total export of 25,000 metric tonnes from Ghana (Suleman, 2000).

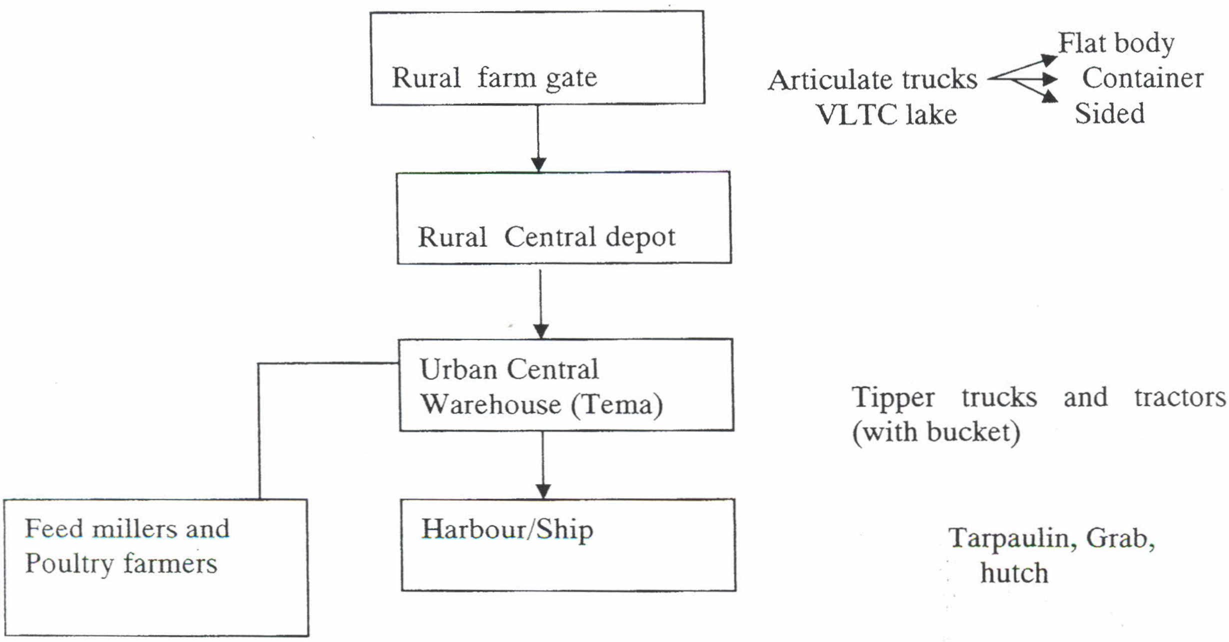
Table 3.1: Supply of cassava chips by Transport and Commodity General (T&CG) Ltd., 1994-1998

Year	Farm - gate Price (US$/MT)	Fob Price (Tema Port; US$/Mt)	Quantity (Tonnes)
1994	43 - 50	100	2,370
1995	43 - 50	100	3,300
1996	43 - 50	70	19,725
1997	43 - 50	70	19,725
1998	40	65	22,780

Source: T&CG, 2000

However, it appears that due to decreasing world prices the domestic prices offered to farmers also fell consistently from 1997. The exporter received payment fourteen days after shipment. All rejected products were sold to local feed millers such as GAFCO, Sydals Farms Ltd., and poultry farmers in the Central and Ashanti Regions at ¢1500.00 per 50Kg bag (or ¢300,000 per metric tonne) which translates to US$10.00/bag only, far lower than the purchase price.

Figure 3.1: Channel of movement for cassava chips by T&CG, 1999



Source: Survey data.

Constraints faced by T&CG

1. Vehicle hiring from urban centres imposes a high search and delay (transaction) cost on the operations of the firm. During the cocoa season, the competition for trucks becomes even keener raising hiring cost. Investing in own vehicle requires a high capital requirement, which ploughed back profit could not meet. In addition own trucks is associated with under capacity utilization as the chipping operation lasts eight months, and high maintenance cost. Borrowing from financial institutions is an option, but it is not preferred due to the high collateral requirements and interest rate charges. Lending rate on investment loans is about 35 percent per annum 2004, Barclays Bank prices. A head of articulated truck is estimated at ¢1.2 billion (T&CG, September 2004 prices).
2. Advancing monies to farmers in lieu of future purchase sometimes resulted in breaches of contract. Farmers may sell fresh cassava to other processors such as *gari* and *kokonte* producers when the relative price for these products increases, decreasing the relative price of chips.
3. Chip demand follows seasonal variation and also cyclical movements, making some facilities to lie idle, while covering maintenance cost.
4. Lack of adequate and modern port facilities lowers competitiveness in an industry where other exporting countries have the opportunity to use high technology. In Thailand for instance, chips are drawn over conveyor belts from port quay to ship.
5. Low world market prices meant that the domestic producer price levels could not be sustained leading to shut down in 2000.
6. Motivating farmer groups with subsidies on inputs and consumer goods is unsustainable with increasing price levels.
7. Competition faced from other cassava products in terms of price. Surge in demand for other cassava-based production from West African sub-region.

Lessons

1. Farmers' decisions are based on relative prices of competing cassava products;
2. Apart from price, quality assurance is the only way to win in business;
3. Quality assurance should be total along the supply chain.

3.3 What do the Pioneers in Poultry Farming Say?

Many of the poultry farms in operation today have been in existence for over a decade yet only two responding farms have ever experimented with cassava chips (unpeeled and sun dried). One farmer is experimenting with peeled cassava chips and six other farms had experimented with *konkonte*, peeled fire dried or sun dried chips (Table 3.2).

Sydals Farms Ltd had the opportunity to experiment with cassava chips in 1998 when
24
T & CG could not export a batch of its stock. With access to an Extruder, soya beans and low priced chips, it could undertake several experiments on its own until it settled for 20 percent replacement for maize in finisher broilers' feed. However, adoption ceased in 2001 due to unavailability from the cheap supply source (T & CG has suspended

Table 3.2: Experience of poultry farmers with cassava chips as feed ingredient

Name of farm	Years in operation	Cassava product used	Source of product	Success story ?
Sydals	33	Chip (unpeeled)	T&CG	Yes
Job Experiment	24	*Kokonte* /chip	Market/T&CG	Yes
Fafraha	24	Kokonte	Market	No
AgriVision	22	*Kokonte*	Market	No
Esi	28	Chip (peeled)	Own	Yes
Nketia	5	*Kokonte*	Market	No
Mensah	20	*Kokonte*	Market	No
Toppman	5	*Kokonte*	Market	No
Others (22 farms)	5-37	None	NA	NA

Source: Survey data, September 2004

operation). During operation, it was realized that the farm needed to purchase 3 - 4.5 metric tonnes every 5 weeks and applied at 10 percent feed formulation (40% cassava + 60% Soya by weight = 10% of feed formula). This mixture was 'branded' CASSOY.

Major problems encountered during experimentation included:

- Poor palatability, which retards intake,
- Micro organisms (bacteria and fungi) infested chips due to poor quality,
- Heat generated by Extruder could manage mycrotoxins easily but not fungi,
- High cost of imported Soya meal (full fat Soya) from USA or UK,
- Waste of time palletising what was available,
- Possible environmental consequence, due to pollution by powdered milled cassava – may be solved by adjusting engineering parts of the machine,
- Experiment cost was too high,
- Farmers learn experientially – so market acceptability of CASSOY was low,
- The insect larger grain borer attacks cassava chips in store,
- Low capacity utilisation of extruder,
- Energy level of maize is higher at 3,400cal/kg compared to that for cassava which is 2915 cal/kg of energy

Job Experimental Farms Ltd. uses *konkonte* during the lean season when maize prices become about double but cautions that to achieve a high standard of performance the diet must be fortified with cassava leaves and palm oil. Esi Farms also fortified her poultry feed with *Leucenia* leaves and palm oil and uses this cassava-based diet all year round.

Fafraha Prison Camp Farms used *kokonte,* at 20 percent replacement for maize from 1996 to 1998. Due to poor bird (broilers and layers) performance usage was discontinued. Poor quality chips and lack of adequate protein complements were the major reasons for the poor performance. Nketia Farms in Kumasi used *kokonte* in 1999/2000 but also discontinued use due to poor laying performance of birds. The following farms, Topman, Mensah and AgriVision also discontinued the use of *kokonte* due to poor quality product from the market which affected bird performance. Others who raise Cockerels in semi extensive system have used *gari waste* and cooked cassava waste with some success.

Of those who have never used cassava-based feed, more than 50 percent have learnt of the possibility from other farmers and through seminars. Indeed most (66%) of the respondents expressed their willingness to participate in the pilot project.

Constraints

1. Possibility of not achieving required palatability, health and weight when cassava is used.
2. Lack of consistent supply of low priced chips.
3. Lack of good quality product in the market

Lessons

1. The experimentation cost is high especially when good quality product and high protein supplementation is to be assured.
2. Cassava leaves can increase the utilization of cassava chips.

3.4 What do the Pioneer Feed Millers Say?

The Ghana Feed Millers Association has estimated that there are 16 commercial feed mills in Ghana; about 70 percent of these are in Accra. A few of these Mills in the Greater Accra and Ashanti Regions were visited. The observations of GAFCO, the Central Feed Mill Ltd., AGRICARE Ltd.and Ashaiman Timber Market Mill informed the conclusions of this study.

Apart from GAFCO none of the feed mills visited had ever used the unpeeled cassava chips before. The Ashaiman Timber Market mill had milled *Konkonte* for individuals who requested it. GAFCO was incorporated in 1995 and had opportunity to experiment with cassava chip as an export product and as a feed ingredient. Due to increases in maize prices it decided to practice what personnel responsible for the feed mill knew from literature and interactions at seminars. GAFCO purchased the raw materials from farmers and the T&CG Ltd. It experimented with 20 percent replacement for maize in original feed and realized that the cost of producing feed was lower.

However, complaints from clients (poultry farmers) drew the attention of GAFCO to possible feed composition problems. Farmers complained of high veterinary costs due to problems of diarrhoea, loss of appetite and high mortality of young birds. Scientific investigations in Germany discovered that feed was contaminated with *enteric bacteria*. Further investigations concerning processing and handling showed that quality assurance was not total. Cassava is produced on scattered farms with little or no supervision from harvesting through chipping, drying, bagging, haulage and storage.

In 1998 the use of cassava chip as a feed ingredient was terminated. Indeed the Timber Market mill operators have also observed the low demand for cassava milling services in recent times.

The general indication is that if any experimentation would be done again there will be the need for Scientists to establish the correct percentage replacement of maize with high quality cassava chips. Farmers ought to be trained properly (based on a prepared protocol for cassava chips), probably with the aid of Non-Governmental Organisations and government's extension agents. In this way many Feed Mills will be prepared to experiment again. GAFCO may re-start with a request of 100-200 metric tonnes per month.

Constraints

1. Lack of total quality assurance for cassava chip processing and transportation;
2. Irregular supply of cassava chips;
3. Low demand from poultry farmers

Lessons

1. The hazard analysis and critical control points ought to be established (see Appendix 5 for example of HACCP plan).
2. Feed Millers are also looking for low cost carbohydrate sources, but must be of reliable supply and quality
3. Sustainable use of cassava chip by Feed Millers is strictly dependent on customer satisfaction

3.4 What do the Pioneer Farmer-Processors say?

All the pioneer farmer processors of cassava chips are in the Brong Ahafo and Volta regions with few in the Eastern Region. Thus survey results of earlier research by Al-Hassan and Egyir, in 1998 have been analysed to inform the conclusions of this study (Al-Hassan and Egyir, 2002). In Atebubu (Brong Ahafo Region) for instance, the processors included small and large - scale farmers with farm sizes of between 1.2 ha (2.88 acres) and 16 ha (38.4 acres) In terms of chip production in a season, farmers were grouped as shown in Table 3.3; some farmers in the large-scale category could chip up to 900 bags per season.

Chip production is an individual income-generating activity. Farmers used family labour or hired labour for harvesting, but they usually did not hire labour for chipping; some large - scale farmers hired labour for chipping on share terms similar to those for processing *kokonte*. There was no use of reciprocal labour in chipping; the chippers' association in Atebubu district did not engage in communal chip production.

Table 3.3 Chips output by farmer category

Category	Seasonal Output (52 kg bag	Proportion of Farmers
Small-Scale	1 – 5	20
Medium-Scale	5 – 15	50
Large	15 and above	30

Source: TCG Area Office Atebubu

Chips were processed manually and by machine. T&CG had 31 chipping machines, available for use by farmers although it was estimated that 90 percent of farmers did manual chipping. Most farmers preferred to chip manually by hand because the chips were easier to dry and perceived hand chipping to give higher yields. The chipping machine produced small chips, which required more careful drying and became powdery more easily. Only large-scale farmers used the chipping machines. More farmers opted for machine chipping at the beginning of the farming season, when demand for farm labour was at a peak. Processing *kokonte* is hard work, which was why farmers hired labour for it. Processing chips was much easier and could be done casually by farmers in their free time.

An estimated 40 percent of chip processors were women. Before the advent of the cassava chip market in Atebubu, men donated their cassava fields (after yam harvest) to women to process the crop into *kokonte.* One woman commented: "since cassava became valuable and cassava is fully integrated into the cropping system, men's attitudes have changed with regards to the disposal of their crop; the result is that women themselves are now growing cassava. There is no problem of access to land; the only problem that farmers face is the high cost of labour".

Farmers tended to grow only varieties with high dry - matter content for chipping. Most of the local cassava varieties mature in a year, but there is one that matures later and can remain unharvested for about three years. This variety gives farmers the flexibility of chipping at any time during the year. It was only during the 1997 cropping season that one of the varieties released by the Crops Research Institute was introduced for testing by few farmers in the district. The results have not been documented.

Constraints faced by farmers

1. High cost of labour
2. High costs of chipping machine use
3. High economic and social costs associated with the use of chipping machine.

Lessons

1. Cassava chip is an alternative product that could be incorporated in the cassava farming system in Ghana
2. Cassava chip enterprise is labour intensive and therefore has high employment-generating opportunities. Service providers such as harvesters, chippers, transporters and wholesale purchasers could be employed.

3.6. What do the Policy Makers Say?

The Ministry of Food and Agriculture (MoFA) and the Ministry of Trade and Industry/President's Special Initiative (MOTI/PSI) champion policy making in cassava production and trade. In order to achieve the overall national objectives, comprehensive policies, and projects to support growth and poverty reduction over a three year period (2003-2005) has been put in a framework of Ghana Poverty Reduction Strategy (GPRS, 2003). Modernisation of agriculture based on rural development is one of the medium term priorities, which has led to the preparation of a Food and Agriculture Sector Development Programme (FASDEP). Root and tuber development has been highlighted. Since year 2001, statistics indicate a surplus of about 6 million metric tonnes for starchy staples. So, for these crops, emphasis is on value addition and export promotion (MoFA, 2002). For cassava a surplus of 3,870,000 metric tonnes was obtained after meeting human consumption needs in 2002 (MoFA, 2003).

Cassava's great potential for development has been recognized. It is a major component of most Ghanaian dishes. Cassava is consumed fresh as well as in many processed forms. Currently, it is exported in the form of chips and grits (*gari*). The production level as at 2002 was about 9.7 million metric tonnes. An estimated 1.55 million farm households cropping 726,000 hectares cultivate the crop. Prevailing yields are 11.8 Mt/Ha although 28 metric tonnes are achievable (MoFA, 2003).

The policy thrust is therefore, to increase production through increased productivity and area expansion especially on marginal lands. In addition, varietal improvement including storability of planting material, value addition (e.g., use of cassava powder in composite flour for bread and other confectionery) and marketing is being pursued. Cassava chip production for the animal feed industry is the current focus.

Constraints faced by policy makers

1. Low budgetary support of MoFA extension agents to distribute cassava planting materials nationwide to boost production base.
2. Limited number of training personnel to train processors to diversify processing enterprises.

Lessons

To sustain the diversification of cassava processed products access to markets must be improved.

3.7 What do the Pioneer Researchers Say?

The researcher information was obtained from diverse sources (Table 3.4). Whilst the lecturer /researchers were interviewed in their offices, students works were reviewed and conclusions drawn without further probing.

The researchers say that processed cassava increases the utilization of the product by living beings, both humans and animals (Edwards et al, 1981). Washing, chopping, sun-drying and grinding can cause a reduction in the HCN content of cassava by at least 30%. When cassava is used as part of the energy source in poultry rations, it may be necessary to add a rich source of riboflavin in the diet.

Different categories of birds, starters, growers, finishers require different replacement levels of the cassava chips. Whole cassava meal can replace maize as an energy source at between 20 percent and 32 percent in broiler finisher diets with superior weight gains and better feed conversion efficiency. High performance requires that protein sources be improved (add a rich source of protein especially riboflavin) since cassava has about 2 percent protein contents. Again since the rate of multiplication of insects (such as *A*.

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Cassava is a staple food in Ghana; there is a general increase in the demand for cassava when there is rapid population growth. Chipping machines are available in Ghana and the Sub-region; return on investment is higher with low cost cassava and high world market prices.

Constraints

1. Lower maize prices discourage the use of cassava as a feed (ingredient) component.
2. Higher fresh cassava price in certain locations discourage its use as poultry feed ingredient.
3. Lack of well-developed supply chain and quality management that ensure accessibility to all complementary inputs on a sustainable basis may discourage sustainable utilization.
4. Dependence on sun drying alone would limit the production period and increase storage cost if supply is to be all year round

Lessons.

1. Cassava chips research is required to establish specific varieties, specific rate of substitution of maize for cassava for different types of poultry, and hazard control points between harvesting of fresh cassava and utilization of cassava-based feed by poultry birds.

Table 3.4: Sources of research information on cassava chips as a potential feed ingredient

Location	Researcher	Comment
University of Cape Coast	Dr. Fishan	Technology Village Director knows about past attempts at research and other Researchers in Ghana.
University of Cape Coast	Dr. Tetteh	Animal Science Department and RTIP Southern sector coordinator knows about attempts at research and other Researchers. Cautions about the challenges in the supply chain service development
University of Ghana	Dr. Amaning-Kwarteng	Animal Nutritionist: knows about past researches of colleagues in Legon and KNUST. Believes cassava is only a second best alternative to maize if not a last resort.
University of Ghana	Prof. Obeng-Ofori	Crop Science Department: knows of research into improved varieties for processed products by other colleagues in KNUST & CRI, student research in genetic diversity in cassava cultivars in Ghana and research on insect attack on cassava chips.
Savanna Agricultural Research Institute)	Cecil Osei	Researcher working on new early bulking varieties for processed products in the Northern Savannah zone.
University of Ghana	Edward Obuobi (Student, 1974)	"Cassava as energy source in broiler ration": When cassava is used as part of the energy source in poultry rations, it may be necessary to add a rich source of riboflavin in the diet. Ground sun-dried cassava with peels can conveniently replace maize as energy source up to 20% in broiler ration. Profitable to use especially between February and April.
University of Ghana	Ayekpa, J. T (1997)	"Effect of replacing maize with whole cassava meal and Brewers' spent grain (BSG) on live performance of broilers" concludes that different percentages are required for different categories of broilers. No adverse effects expected.
University of Ghana	Eduku, Akpa (1994)	"A comparison of the development of the coffee bean weevil, *Araecercus fasciculatus* (De Geer) (Coleoptera, Anthribidae) on cassava chips and cocoa beans". Established the suitability of cassava chips and cocoa beans for the development of *A. Fasciculatus*. High moisture content of chips increased the longevity of the adult weevil and the damage caused by the insect. Quality require chipping in small sizes, through drying and storage in polythene sacks.
University of Ghana	Benson, Emmanuel (2002)	"Economic analysis of cassava demand in Ghana (1970-2002)". Population increases result in increased demand for fresh cassava. Other factors of demand were own price, price of yam, plantain and income.
University of Ghana	Adjei, E. K (1997)	"An economic evaluation of an International Institute of Tropical Agric designed manually operated chipping machine". Good financial returns may be realized from machine chips' in areas where the unit price of fresh cassava is low. -Eastern and Brong Ahafo
University of Ghana	Suleman, M. A (2000)	World cassava chip trade and its implications for Ghana's cassava chip exports (1978-1998). Growth in Ghana's chip industry is contingent on government's intervention programme. Own price of cassava chip in the most important determinant of demand in the EU.

2. Both an assured market for chips and fresh cassava production base is required.

Factors affecting supply of cassava for processing

The existence of a reliable supply of fresh roots at a competitive cost will be a factor determining the viability of any alternative cassava processing operation. A number of factors are likely to affect the supply of raw cassava for processing. The ability of farmers to gain access to other markets for their produce will be a major factor influencing the supply of cassava for a particular processing end use. Generally, price of fresh cassava are likely to be more attractive than those that a processing enterprise could afford.

A study by Day et al (1996) show that the price T&CG paid for dried chips at a collection point close to the farms was ¢2,600 per 91 kg unit, which they considered farm gate prices compared to the wholesale prices in excess of ¢5,000 per the same weight. The price paid by T&CG for chips is not strictly equivalent to farmgate price for cassava since farmers also incurred costs associated with chipping and drying. The wholesale prices on the other hand reflect transport and marketing cost incurred between the farm and the wholesale market.

In summary, the supply of cassava for processing will depend on:

- Ease of access for fresh marketing channels;
- Ease of access to other processing outlets, e.g. gari, kokonte, agbelima etc;
- Other competing uses, e.g. as food security reserve;
- Transport links in the cassava producing area;
- Varieties of cassava available, e.g. for human or for other uses; and
- Seasonality transportation difficulties, harvesting difficulties, drying operations, and overall seasonality of agricultural production processes. Seasonality in competing uses of cassava.

Organization of cassava supply for a processing operation will have to take issues affecting availability, steady supply and predictable flows into consideration. In fact, new end uses of cassava must be integrated with existing production and marketing system. Additional production must be encouraged to serve the new use and income source.

Marketing arrangement of cassava for processing

T&CG experimented initially on a centralised system for processing of chips. The company, however finally settled on the decentralised system where smallholder cassava producers carried out production and processing. T&CG concentrated on the role of organizing and coordinating marketing services. Under the guidance of T&CG, farmers were encouraged to form groups for the purpose of relating with T&CG. It is the view of T&CG staff that this method of organization is more flexible since farmers are able to respond more quickly and cost-effectively to changing

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Brickmann, W. L. (undated), Poultry production in Tropical areas. Tropical Animal Production.+

weather conditions that affect harvesting and drying operations than a large-scale, capital-intensive processing operation.

Marketing is perceived as the most important constraint facing cassava farmers: the fresh cassava market is difficult to access, is risky and unpredictable. Lack of markets prevents farmers from harvesting their cassava in a timely manner and tie up land under cassava for long periods. Cassava processing is considered the key to enhance the marketing opportunities for farmers, and in the provision of production credit to farmers. Another constraint perceived by farmers is accessibility to chipping and drying facilities. These are not difficult to address since they involve reasonable costs.

To ensure quality production T&CG provided a form of extension service through their district level staff. T&CG staffs were active in organizing farmers, arranging meetings and demonstrating the process of chipping and drying. Mechanised slicers were used by T&CG with mobile groups camping and undertaking chipping and drying in different areas initially, but later encouraged farmers to chip by hand since this provided cost savings over the mechanical methods and better quality chips. The company also developed a loose set of criteria for investment in new areas including, the willingness of farmers to share part of the risk through cooperatives or private companies, and the ability to generate a minimum quantity of marketable cassava (usually a minimum of one 25 MT truckload per month).

Payment for chips was made according to a pre-agreed fixed price and usually made direct to farmers within one week of delivery. Farmers, it was reported, valued the guaranteed nature of the outlet, the ease with which this market outlet can be accessed compared to other market outlets, and the relatively quicker payments. One primary concern expressed by farmers is the sustainability of the outlet for their crop in future years.

Credit delivery is an area T&CG recommend further innovation in service provision to farmer processors. The scheme is for the chip trader, farmers and the financial institutions to work together. The financial institutions provide credit to farmers, the farmers produce chips and sell to the trader, and the trader makes payments on behalf of the farmers to the financial institution. At the same time the trader and the extension services of MoFA provide support to group formation and development. Experience of T&CG show that huge sums of money are needed to purchase chips from farmers and therefore the need for financial support from the financial institutions (see cash flow table) to the chips trader.

One particular constraint experienced by T&CG relates to transportation especially between the field and the assembly point. Most of the transportation at this level takes place by head loading. Another issue of concern is technical options in drying to improve the quality and consistency of chips and the intercropping to maintain soil fertility and yields, which can be demonstrated to farmers. These lessons are vital pointers for the development of proposed cassava processing models.

Scale and organization of chips production

Small scale processes using simple technology (knives and sun drying in mats or patios) suited to village level enterprises have the advantage of being located very close to the production sites of fresh cassava. This reduces the transportation costs associated with the movement of large volumes of relatively low value raw material. Product quality assurance, however, is more difficult at the farmer level and the scope for developing formal marketing arrangements much reduced. More formal marketing arrangements are necessary to effectively reduce transaction costs.

Centralised large scale processing of cassava into chips require large investment (fixed and working capital) and the development of sophisticated marketing systems to ensure a continuous and reliable supply of cassava for processing, in order to maximise the utilization of capital equipment and other resources. In addition, transport cost associated with the supply of cassava constitutes a high proportion of operating costs. Therefore, attempts to reduce these operating costs will give rise to the development of some form of estate production of cassava, possibly leading to reduced benefits flow to farmers who are targets of poverty reduction actions.

CHAPTER FOUR

4. PLANNING FOR CASSAVA CHIPS PRODUCTION AND MARKETING

4.1 Introduction

In this section, what is required for best practice in cassava chip production and marketing in Ghana is discussed. Then two alternative models, the centralised and decentralised systems of chipping enterprises are examined. The economic and technical resources, quality assurance and institutional support requirements are also discussed. Finally, information on the current status of cassava production and processing is examined to inform how the take-off of the pilot should be directed.

4.2 What is Required for Best Practice (The Model for Pilot Cassava Chips Production and Marketing)

The proposed model for the pilot organisation of supply of cassava chips to feed mills is based on the successful model operated by T&CG; the most successful and experienced company that spearheaded the export of cassava chips in the second half of the 1990. T&CG tried various models including pilot production of the chips by the company itself and finally settled on organizing farmers in various localities to produce cassava chips either on the farm or in the village for purchase, bulking and transportation by T&CG staff.

To augment the protein level of cassava chips incorporation of cassava leaves as suggested by Job Experimental could be tested.
Therefore based on the T&CG and Job Experimental best practice the proposed model for pilot cassava chips production and marketing shall have three main components or operators namely:

i. *Production of cassava chips (two models)*:

   a. In a decentralised system, farmers and cassava processors belonging to a group that will be responsible for the production of the chips and dried cassava leaves. Each farmer or processor will process his own cassava into chips but with the assistance of the rest of the group who sell in bulk to a buying company.

   b. In a centralised system, processing of cassava roots into chips will be done by a group at a location in the village, i.e. a pilot plant. The group will purchase the cassava roots and own the chips produced.

ii. *Purchase and distribution of cassava chips*: A purchaser or wholesaler of cassava chips in a district or a zone will be responsible for the purchase of cassava chips from the farmers and processors, and transportation and selling of the chips to feed mills and/or poultry farms.

iii. *Production of feed*: Feed mill and/or poultry farms that will incorporate the cassava chips and dried leaves into animal feed.

4.2.1 Production of cassava chips and dried leaves

In the decentralised system (Figure 4.1):

a. Cassava roots will be transformed into chips by farmers belonging to a group on the farmer's own farm or in the village.
b. Conversion of the roots into chips will involve manual slicing of the cassava roots (after washing) into thin slices which will facilitate drying. Drying should be accomplished within three days.
c. Slicing of the washed roots may also be carried out using a mechanical slicer supplied by RTIP.
d. Harvesting of cassava and manual slicing will be carried out by the group for the individual farmer on a group-help or 'nnoboa' basis. Thus, the group will alternate from farm to farm to slice cassava for individual members of the group until each member has been served. Slicing groups may be carried out at sub-groups level within the group where this is feasible.
e. Drying of cassava chips and leave either on the farm or in the village will be carried out using any of the following facilities:
a. raised drying racks/platform (similar to the drying racks used for cocoa)
b. concrete patio.
c. cleared areas on the farm covered with plastic woven mats.
d. solar dryer.

f. Chips will be covered with plastic sheets when it begins to rain.
g. If analysis shows that dried whole leaves contain high levels of cyanide, then leaves will be chopped before drying to facilitate detoxification by release of endogenous enzymes in the leaves.
h. Dried chips and leaves will be packed into jute or plastic sacks and carried to the house.

In the centralised system (Figure 4.2):

1. A pilot plant facility shall be established in the village for the production of cassava chips by RTIP. The facility will consist of a shed or processing hall in which a chipping machine will be installed. Drying patios will also be constructed around the shed to be used for drying cassava chips. The whole area shall be fenced to prevent animals having access to the drying chips.
2. The plant will be operated by the group identified or formed by RTIP.

Figure 4.1 Schematic framework for the pilot production and marketing of cassava chips – the decentralised system or model

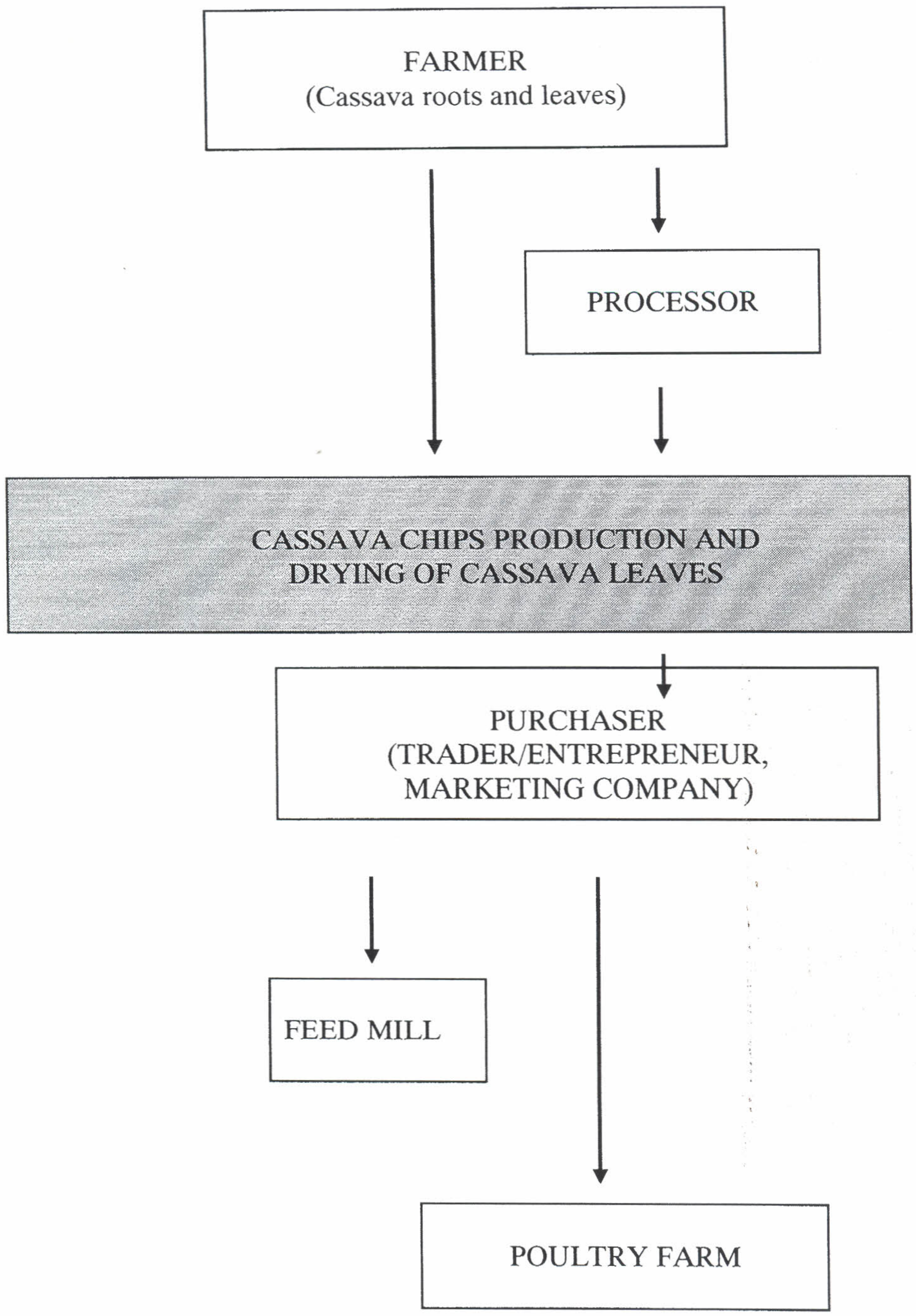
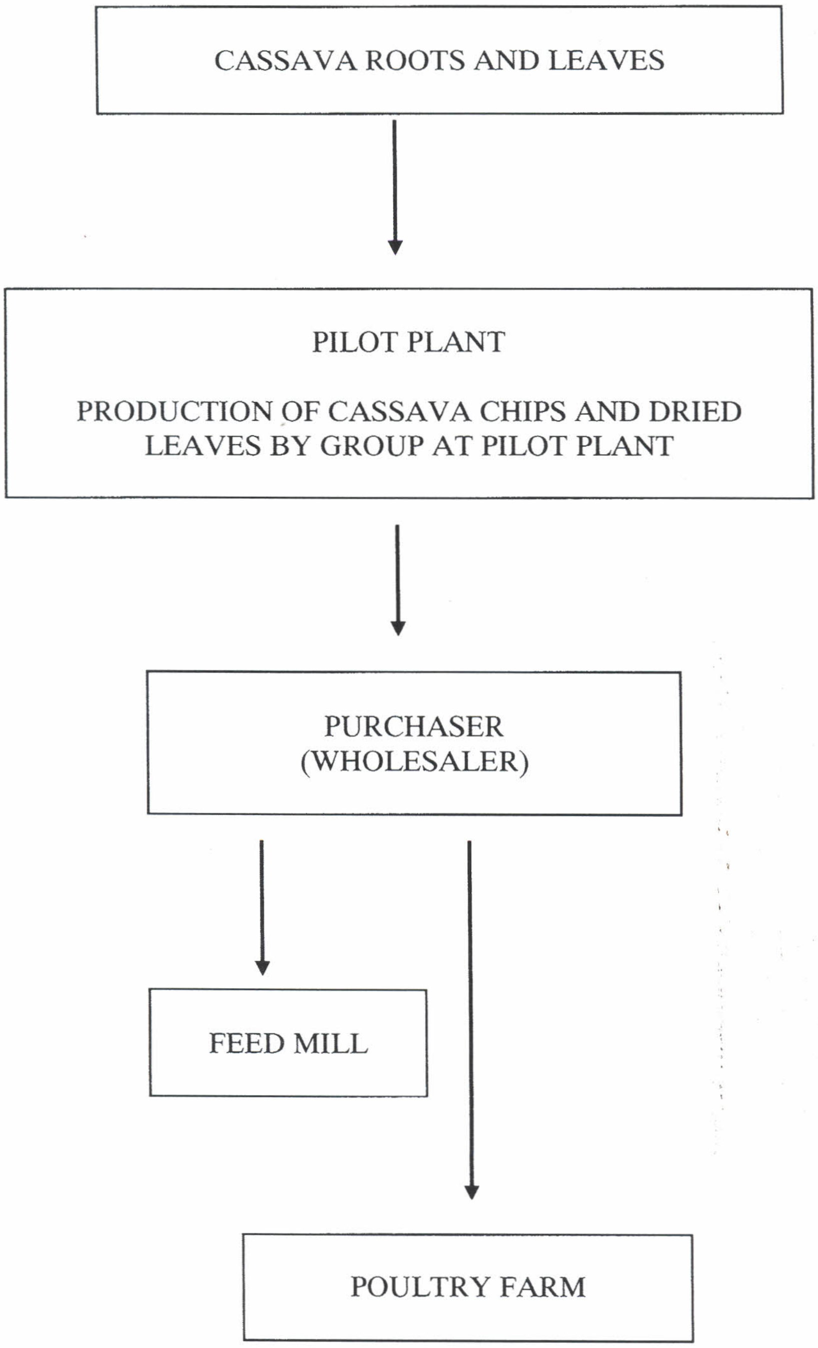


Figure 4.2: Schematic framework for the pilot production and marketing of cassava chips – the centralised system or model



3. The group will purchase cassava roots from members of the groups and also from other farmers in the vicinity and carry out group processing at the pilot plant.
4. The cassava roots will be washed and chipped by a chipping machine or manually by members of the group.
5. The chips and cassava leaves will be dried on the patios and packed into jute or plastic sacks and sold to a wholesaler by the group.

4.2.2 Purchase, bulking, and transportation of cassava chips and dried leaves

1. On purchase day (a prearranged day), the chips purchaser or wholesaler will inspect each farmer's produce for quality and buy the chips according to weight, i.e. number of sacks based on a previously agreed price.
2. On purchase day, chips purchaser will buy dried cassava leaves also by weight, i.e. number of bags based on a previously agreed price.
3. The purchaser shall have an appropriate place for the holding/temporary storage of cassava chips and leaves in the village or within a suitable radius to enable him bulk his purchases for transportation to the feed miller.
4. The purchaser may be an individual (male or female), a businessman, a group, or a company with suitable resources to enable it carry out the required tasks efficiently. It will be an advantage for the purchaser to own a truck or trucks, but this shall not be a necessary requirement since the purchaser may hire such services if he has adequate resources. The purchaser is a key player in the model since he provides a direct market to the farmers who are the concern of RTIP. RTIP should therefore provide suitable support to the purchaser to enable him carry out his function otherwise the model cannot be operated and sustained.

4.2.3 Production and marketing of feed

1. The purchaser shall sell the cassava chips and dried leaves to feed mills and/or poultry farms that prepare their own feed. To eliminate problems of microbial contamination of feed, the feed mill shall have a facility for giving the pulverized chips a suitable heat treatment that shall eliminate any bacterial load in the chips, for example through the use of an extruder or a pelleting machine which sufficiently heats the cassava flour to reduce the bacterial load.
2. Feed millers shall formulate their own feed and shall incorporate both the cassava chips and dried cassava leaves into the feed.

4.2.4 Technical assistance

1. The relevant research institutions, university departments and MoFA shall provide technical assistance to chips producers and purchasers with respect to technology and quality assessment and also backstopping to the feed mills.

4.3 Economic and Technical Resources Required for Best Practice

The equipment and facilities needed by various actors in the processing chain and their costs are presented in Table 4.1.

Table: 4.1 Technical and economic resource per metric tonne of cassava chip

Agent	Resources		
	Technical	Economic	
		Item	Unit Cost (¢)
Farmer and processors	Chipping	Cutlasses/Knives (C1)	20,000
		Chipping machine (C2)	7,000,000
		Water tank	1,500,000
		Engine (C2)	3,700,000
	Drying	Patio (D3)	5,000,000
		Raised racks (D2)	1,500,000
		Plastic mats (D1)	350,000
		Rakes	10,000
		Plastic sheets	120,000
	Bagging and storage	Plastics or jute sacks (B)	10,000
		Storage space	
	Planting	Planting material (cassava sticks)	20,000
Purchaser/Wholesaler	Bagging	Plastics or jute sacks	10,000
		Warehouse	125,000,000
		Truck	1,000,000,000
		Hired truck	Variable
		Weighing scale	6,000,000
Feed miller/poultry farmer	Milling and blending	Weighing scale	6,000,000
		Hammer mill	16,500,000
		Extruder/pelleting machine	
		Mixer/filler machine	

Source: Survey data, September 2004

There are several combinations of technical packages that can be adopted (Table 4.2). The options for the three major activities include:

1. Using manual chipping (cutlass and knives), drying on mats and bagging with plastic bags - C1/D1/B:
2. Using manual chipping (cutlass and knives), drying on raised racks and bagging with plastic bags C1/D2/B:
3. Using manual chipping (cutlass and knives), drying on patios and bagging with plastic bags - C1/D3/B:
4. Using machine chipping, drying on mats and bagging with plastic bags – C2/D1/B:
5. Using machine chipping, drying on raised racks and bagging with plastic bags – C2/D2/B:

6. Using machine chipping, drying on patios and bagging with plastic bags – C2/D3/B:

Table 4.2: Combinations of technical packages that can be adopted

Activity	Technology/requirements		
Chipping	Cutlasses/knives (C1)		Chipping machine (C2)
Drying	Plastic mats (D1)	Raised racks (D2)	Patio (D3)
Bagging	Jute /plastic bags (B)		

4.4 Quality Assurance and Specifications

To ensure production of good quality of cassava chips, production groups will be trained in the implementation and maintenance of appropriate quality system, which will be based on the principles of Hazard Analysis Critical Control Point (HACCP) and Good Manufacturing Practices. Such a quality system will have to be very rudimentary so that it can be appreciated and applied by the farmers and processors without having to resort to any sophisticated procedures. This is important because the literacy rate of the farmers surveyed was low. Indices for assuring quality should be based on observable parameters which can be assessed by physical examination such as appearance (mouldiness), colour, brittleness, hand feel, biting feel. Producers/groups will also have to keep records on day of harvest, day of processing, drying period, rainfall during drying period and what was done during rain, length of storage before marketing, etc.

4.5 Institutional Support

Various stake holders will play their part to ensure the success of pilot production and marketing of cassava chips by groups to feed mills and/or poultry farms for incorporation into poultry feed.

4.5.1 Production of cassava chips

RTIP will provide financial assistance to enable identified groups undertake pilot scale production of cassava chips. Implements and equipment needed to start operations as identified above will initially be provided by RTIP to the groups. These include chipping machine, plastic mats, rakes, plastic sheets and sacks. RTIP will construct patios in the villages for the groups to use for drying chips. With respect to chipping machines, RTIP will initially provide mobile chipping machines in the production areas but RTIP will retain ownership of these chippers. With time the groups and individual farmers will be encouraged to purchase these machines.

4.5.2 Quality of chips and quality specifications

No clearly defined quality standards are available for chips to be used in feed production in Ghana. However, GAFCO and other poultry farmers producing their own feed prefer white, low moisture (bristle), no mould and low cyanide cassava chips.

The appropriate quality system for the production of cassava chips by the groups, which will be based on Good Manufacturing Practices and the principles of Hazard Analysis Critical Control Point[6] will be developed by the Food Research Institute and the Biochemistry Department of the Kwame Nkrumah University of Science and Technology. The scientists will train the groups, extension officers of MoFA and purchasers in the implementation and maintenance of the rudimentary quality system. Extension officers will be responsible for ensuring that the groups operate the quality system. In deed about 91 percent of the study respondents expressed their willingness to participate in the pilot. (see Table 2.3)

Chips produced in different areas will also be sampled at suitable intervals and sent to the Food Research Institute for determination of moisture, mould counts, identification of moulds, determination of aflatoxins and other mycotoxins, and cyanogenic potential of samples. The results will be used to assess the suitability of the chips production procedure and corrective and preventive actions taken when found necessary.

4.5.3 Extension and supervision

The Ministry of Food and Agriculture extension staff in the district will be responsible for supervising and monitoring the production of cassava chips in the various zones of the district. The extension staff will also gather information on chips production, chips availability, etc and such information will be made available at the District Agricultural Development Units (DADUs) for purchasers/ buying companies. DADUs will also make the information available to the Programme Coordinating Office of RTIP who will relay the information to purchasers, buying companies, feed mills and poultry farms.

4.5.4 Feed formulation and research

The Animal Science Departments of the universities, the Animal Research Institute and other relevant institutions will assist feed mills and poultry farms to develop formulations for different types of poultry feed based on cassava chips and leaves. The academic and research institutions will collaborate with poultry farms to carry out research studies to assess the effect of the feed and different formulations on the birds. Such research will be funded by RTIP.

4.6 What is Available for Take-off

The potential demand for cassava chips as a feed component has been established. In addition, farmer level processing activities have been described to determine the similarities and differences between what cassava processing activities farmers know and practice and what new practice is to be learnt. Then the status of maize as the used input for feed formulation is also described.

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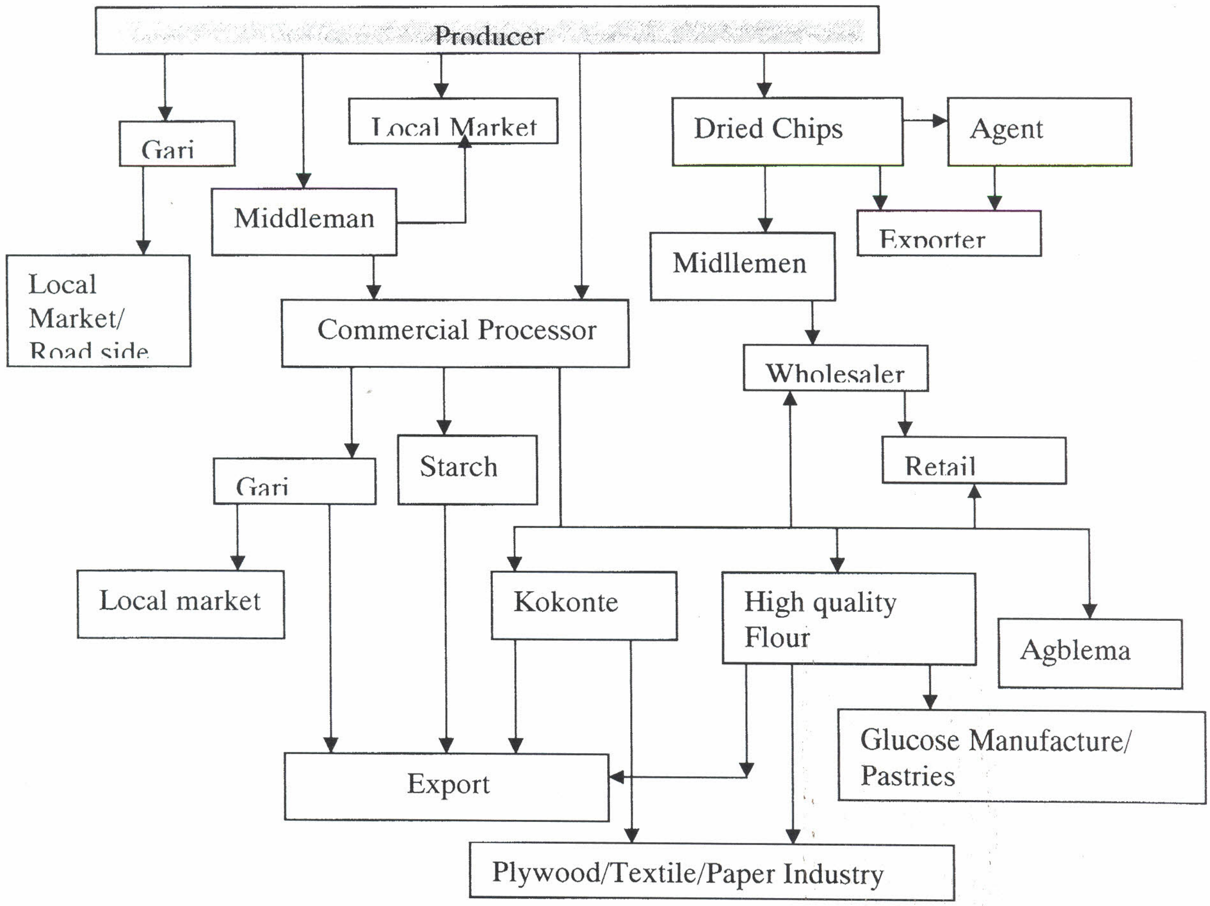
[6] see Appendix 4.1.

Figure 4.3: Cassava Value Chain



Source: Mbwika, J. M. and W. Amoa-Awua (2003) Upgrading the productivity and competitiveness of the cassava industry.

4.6.1 Potential demand for cassava chips

Cassava chips is recognized as a component of the cassava value chain (Figure 4.3). Traditional cassava processing technologies have been developed over the years to overcome the problem of poor storability of cassava. Processing adds to the shelf life of cassava and presents cassava in more convenient form for preparation, while at the same time increasing the variety of ways in which it is consumed. The main cassava processed products in Ghana are *Gari, Agbelima, Kokonte and Akyeke*. *Gari* is the most widely processed product across the country and is also the most traded cassava product. Both traditional and modern cassava processing technologies are being practiced. Traditional processing technologies are being replaced with more efficient technologies including the use of motorized graters, screw press, gari roasting stoves and dryers.

Gari: This is the most popular form into which cassava is processed. Peeled cassava roots are grated and packed into woven polythene sacks and allowed to ferment spontaneously for 2 to 4 days. During fermentation weights are placed on top of the bags to slowly dewater the mash. Alternatively the cassava mash is dewatered mechanically using a screw press. The fermented dewatered mash is sieved to break up the cake and fibre strands removed. The granulated dough is roasted in an open pan. During roasting the granules gelatinize and are cooked into gari.

Agbelima: This is a sour cassava meal which is produced by grating peeled cassava roots together with a traditional cassava dough inoculum called *kudeme*. The grated mash is packed into polythene sacks and left for 2 to 3 days to ferment, whilst weights are placed on top of the sacks to partially dewater the mash during fermentation. The sour meal is cooked mixed with fermented maize meal in varying proportions into *banku* or *akple* which are stiff porridges eaten with a stew or soup.

Kokonte: Cassava roots are peeled and chopped into chips which are sundried. During the drying process the chips attain some level of fermentation. The dried chips are then pounded or milled into flour. In the Upper West Region where higher cyanide containing cassava varieties are processed into *kokonte*, a modified procedure is used to facilitate detoxification of the cassava roots. The cassava chunks are fermented for a few days submerged in water before they are sundried and milled into flour.

Akyeke: This is a steamed sour granulated product, which is produced by grating peeled cassava roots together with a traditional inoculum. The mash is packed into polythene sacks and allowed to ferment for 5-7 days. Water is added to the fermented meal and screened to decolourise the meal and also remove some amount of starch. It is then dewatered using a screw press and screened again to retain the larger granules, which are sundried and steamed to obtain *akyeke*.

Starch: Traditionally, cassava starch is produced by grating peeled roots and manually extracting the mash with water to obtain a starch slurry. This is strained with a cloth and allowed to settle. After sedimentation and decantation, the starch sediment is washed or ground with water and allowed to settle again. Washing is repeated until a white starch is obtained. The purified starch is then dried.

Cassava starch is the only product currently being processed on a large scale in Ghana using the state of the art technology. The Ayensu Starch Co. (ASCO) has a processing capacity of 22,000 Mt of starch per year and the plant consists of a peeler, washer, raspers, centrifuges, hydro-cyclones, vacuum filters, a boiler for steam generation and dryers and packing machine. The process involves peeling, washing, chopping and rasping to expose starch grains. Copious volumes of water are added to the mass and the starch is concentrated, refined, de-watered, dried, cooled and bagged. All the operations are automated.

Tapioca: This is gelatinized cassava starch which is cooked into a thin porridge and eaten with milk and sugar added. Fresh cassava starch is partially dried and sifted with a cane sieve. The sifted starch is roasted until it gelatinizes.

High Quality Cassava Flour (HQCF): This is unfermented cassava flour produced on small scale for use as composite flour in baking. Cassava roots are peeled washed and grated. The grated mash is dewatered in a screw press and the granules dehydrated by mechanical or sundrying. The product has to be dried within a day to avoid fermentation and is milled into flour. HQCF can also be used as glue extender in the textile and plywood industries.

Glucose: Glucose or maltose syrup is currently being produced commercially by a small-scale manufacturer from cassava roots. Cassava starch or HQCF is hydrolysed using malted rice as a source of hydrolyzing enzymes. The product is filtered and concentrated into a syrup.

Recently, the potential demand for cassava chips compared to other products was estimated at 45,000 metric tones at a value of US$ 6.56 million in (Table 4.3).

Table 4.3: Estimated annual demand for various cassava products by industry

Industry	Estimated demand (MT)	Estimated value ($)
Cassava chips for feed	45,000	6,525,000
Cassava grits for brewery	5,800	841,000
HQCF for bakery products	55,000	16,500,000
HQCF for adhesives	15,000	4,800,000
HQCF for alcohol	23,000	7,360,000
HQCF for glucose	110	32,000

Estimates of animal feed requirements indicate that up to 20 percent of the maize content of poultry feed (on average 50 percent of the feed is maize) can safely be replaced with cassava chips. Of the poultry farmers visited during field data collection for this study almost all indicated they are prepared to use cassava chips in the feed formulation provided regular supply and reliable quality can be assured. In fact, the poultry farmers are prepared to experiment with between 5 –10 percent of the birds feeding them with cassava chips blended feed.

Generally, about 60 percent or more of the birds kept by the poultry industry in Ghana are layers. From statistics available up to year 2002, poultry population was about 24,251,000 (MoFA, 2003). Discussions with the poultry farms visited revealed that the industry may have grown by 10 percent per annum in the past two years. It can be estimated that about 17,606,280 layers and 11,737,520 broilers would be raised in Ghana in 2004. The feeding rate per bird for one layer in a year is 49.17 kilogrammes of feed and the feeding rate for one broiler for nine weeks (the average selling age of boilers) average 3 kilogrammes for the period. Based on this information total feed required a year would average 936,124 MT (865,700 MT for layers and 70,424 MT for broilers). Since 50 percent of the feed on average is maize, and about 20 percent of the maize component can safely be replaced with cassava chips, then there is a **potential demand of 93,612 MT of cassava chips** (20 percent of 468,062 MT of maize).

We note that this potential demand is determined by variables such as (in order of importance), quality of cassava chips, own price of cassava chips, price of maize, price of fresh cassava, price of *kokonte*, price of *gari*, cost of other protein supplements and consistent supply of chips.

4.6.2 Production and processing of cassava

1. Farmer level production

Cassava chips production covers the cost of fresh cassava production and then the chips production. Data collected from farmers and also from secondary sources (MoFA, 2002) indicate that the cost of fresh cassava production varies from ecological zone to ecological zone and also from the method of production within the same ecological zone.

In this study, results from the coastal savannah and forest zones where the field study was carried out indicated that, cassava production is mostly done either as pure stand or mixed cropping with maize. Where it is intercropped with maize, the maize is first planted and later inter planted with cassava. Given the shorter growing period for maize, it is the first crop to be harvested. The cassava plant is left to stand for a year or more before harvesting. The pure stand of cassava is also harvested when it is a year old or more. Crop budgets estimated for cassava pure stand and cassava-maize mixed crop from data collected from the farmers show the pure stand of cassava is more profitable to the farmers than the maize-cassava mixed system (Tables 4.4 and 4.5). The return on investment for the pure cassava stand crop estimated was 77.2 percent, which is a net revenue of ¢1,220,000 per acre (or 0.4 ha) for the Ashanti Region. On the other hand, returns on investment for the maize cassava mixed system for the Ashanti Region yielded 17.2 percent, which is about ¢308,000 net revenue. It must be recognised that since the cassava crop occupies the land for the rest of the year or more, only one maize crop can be harvested in a year from a given land

Kokonte production

During the field survey it came to light that some of the farmers had produced cassava chips in the form of *kokonte* for human consumption. This has been done mostly when the farmers have failed to sell the cassava in the fresh form. The knowledge for *kokonte* production farmers claimed was acquired from their parents through socialisation and training during family interaction. *Kokonte* is a stable product the

Table 4.4 Crop Budget for Cassava in the Forest Zone

Main Crop: **Cassava**		Ecological Zone: **Forest**	
Technology: Traditional		Land area: 1 acre	
Items/Activities	Q'ty of Resources	Unit Cost/Price (¢)	Total Cost (¢)
	Man-day/contract	Cost/man-day/contract	Per Acre
A. LABOUR INPUT			
1. Land clearing– depreciated over 20 yrs		1,500,000	75,000
2. Land preparation:			
- Slashing/burning	10	18,000	180,000
4. Planting/transplanting	5	20,000	100,000
5. Weeding 1st	7	20,000	140,000
2nd	6	20,000	120,000
Sub-total			**515,000**
8. Harvesting (number of persons per days)	10	20,000	200,000
9. Transportation produce	80	3,000	240,000
Sub-total			**440,000**
B. LAND RENT		**100,000**	**100,000**
C. VARIABLE INPUT Seed/planting materials	15	20,000	300,000
Sub-total			**300,000**
D. TOOLS & EQUIPMENT			
1. Cutlass	1	25,000	25,000
2. Hoe	1	20,000	20,000
3. Basket	5	6,000	30,000
4. Sack	15	10,000	150,000
Sub - total			**225,000**
E. TOTAL (A+B+C+D)			**1,580,000**
GRAND TOTAL COST			**1,580,000**
REVENUE			
Yield/ acre (MT)	8		
Price (¢) /unit of produce		350000	
Gross Revenue			**2,800,000**
Net Revenue			**1,220,000**
Return on Investment %			77.2

Source: Field survey data, September 2004

Table 4.5 Crop Budget for Maize/Cassava Farms in the Forest Zone

Main Crop: **Cassava**		Ecological Zone: **Forest**	
Technology: Traditional		Land area: 1 acre	
Items/Activities	Q'ty of Resources	Unit Cost/Price (¢)	Total Cost (¢)
	Man-day/contract	Cost/man-day/contract	Per Acre
A. LABOUR INPUT			
1. Land clearing– depreciated over 20 yrs		1,500,000	75,000
2. Land preparation:			
- Slashing/burning	10	18,000	180,000
3. Planting/transplanting	7	20,000	140,000
4. Weeding 1st	7	20,000	140,000
2nd	6	20,000	120,000
Sub-total			**655,000**
5. Harvesting (number of persons per days)	12	20,000	240,000
6. Dehusking	3	20,000	60,000
7. Shelling	3	20,000	60,000
8. Drying	3	20,000	60,000
9. Bagging	2	20,000	40,000
9. Transportation produce	44	3,000	132,000
Sub-total			**592,000**
B. LAND RENT		**100,000**	**100,000**
C. VARIABLE INPUT Seed/planting materials	9	20,000	180,000
Improved maize seed (kg)	5	10,000	50,000
Sub-total			**230,000**
D. TOOLS & EQUIPMENT			
1. Cutlass	1	25,000	25,000
2. Hoe	1	20,000	20,000
3. Basket	5	6,000	30,000
4. Sack	12	10,000	120,000
Sub - total			**195,000**
E. TOTAL (A+B+C+D)			**1,772,000**
GRAND TOTAL COST			**1,772,000**
REVENUE			
Yield/ acre (MT)	4		
Price (¢) /MT		350,000	
Gross Revenue from cassava			**1,400,000**
Yield/acre of maize in bags (100 kg)	4		
Price per bag of maize		170,000	**680,000**
Gross Revenue from maize			
Gross Revenue from acre			**2,080,000**
Net Revenue			**308,000**
Return on Investment %			**17.4**

Source: Field survey data, September 2004

2. Farmer level marketing

Cassava farmers and producers of *kokonte* chips sell their produce in the village to traders who visit to buy and/or carry them to the nearest big market for sale. The impression given during the field trip was that the farmers always got buyers for their produce. The fresh cassava is usually sold while still standing on the farm to traders who visit the village to buy the cassava. In this case, the harvesting is the responsibility of the buyer. Where farmers wish to sell fresh cassava in nearby large markets on market days, they harvest small quantities they and their families can headload to the village and transport this to the market. The revenue from the sale is normally for the purchase of small household items needed within the week or month of sales.

3. Processor level production

A few sole processors of cassava into *gari* were encountered during the field trip. Invariably, those who process cassava into *gari* also produce some of the cassava they use and buy the rest from other farmers. *Gari* production is done purely at the traditional level or some aspects of the process is mechanised, especially where large volumes are produced. The process involves receiving the fresh cassava at the processing plant and 51
peeling is done or the peeling is done on the farm and the peeled cassava transported to the processing point.

The peeled cassava goes through washing, grating (manual or mechanical), dewatering (traditional with stones or mechanical), sieving (manual), roasting (manual), spreading to cool (manual), bagging (manual) sealing of filled bags (manual or mechanical) and storage. The two most mechanised processes (grating and dewatering) speed up the production process and allow larger quantities to be produced within a short period.

It was observed that the peeling, washing, sieving, roasting, spreading to cool, sealing of filled bags when no carrying is required are activities mostly done by women and girls. On the other hand, the mechanical grating and dewatering, bagging and carrying for storage requiring physical input is done mainly by men.

4.6.3 Maize as the used input

Generally, maize is the main input used by livestock and poultry producers in formulating feed for their animals. It is only when maize is not available and prices are very high that alternative sources of inputs become important and are desired. It is established that about 50 percent of the formulated feed for poultry at least is made of maize. The maize supplies the energy needed and also provides about 14 percent of the protein and other amino acids that are essential for growth and performance. Thus, livestock farmers' first option for feed formulation is to use maize unless it is unavailable or not accessible.

Estimates are that of the total maize produced in the country of about 1,509,877 metric tonnes, about 31 percent is used by the livestock sector.

Post-production linkages of maize

Except in a few cases, there are no formal linkages between maize producers and the users of maize, especially in the livestock sector. No formal contracts are entered into for delivery of maize of specified quantities and quality. Rather, livestock producers buy from the open market or in a few cases, enter into agreements with maize merchants who deliver at farm gate at a specified price and quality. When for various reasons maize supply falls short and human demand is high and associated with high maize prices, these agreements are usually not honoured by the traders thereby creating problems for livestock farmers.

Thus, if a reliable alternative supply source can be established to take off some of the pressure and risk, it would be beneficial to the livestock sector. It is therefore not surprising that a high percentage of the poultry farmers contacted during the field survey were willing to participate in the pilot to use cassava chips to replace part of the maize required in feed formulation to assess its potential as a maize substitute.

CHAPTER FIVE

5. THE PILOT PROJECT

5.1 Introduction

In this chapter the various institutions and/ or agencies that have a stake in the pilot project are first examined to understand their role and interrelationships. Then the relationship between cassava and maize in the market are described using trend and ratio analysis. Next, the costs and benefits of the project under the centralized and decentralized models are analysed and finally the location of the project and mode of farmer organisation assessed.

5.2 Stakeholder Mapping

The various stakeholders who would play a role in the pilot project for cassava chips as a poultry feed component are identified at three levels: macro, meso and micro (Figure 5.1). The macro level stakeholders are the Researchers, the Ministry of Food and Agriculture (MoFA) and the Root and Tuber Improvement Programme (RTIP). The researchers would establish the quality protocols and the rate of substitutability. The MoFA would transfer the information and the RTIP would finance the project. While RTIP-MoFA may have direct links with all the other stakeholders, the Research team would only deal with MoFA staff. Occasionally the research team may do a briefing for all stakeholders at a workshop.

The meso level stakeholders include wholesalers of cassava chips, transporters, feed millers, and poultry farmers located at the regional and district capitals. These would need the support of the RTIP and MoFA (a decentralised department of the district assembly) in the handling and delivery of high quality chips. At the district level where other strategic processors of chips may be located strong links are expected among them, the feed millers and poultry farmers. District Assemblies will play a key role in identifying the other stakeholders who are operating in the district and ensure the successful implementation and sustainability of RTIP II in the district.

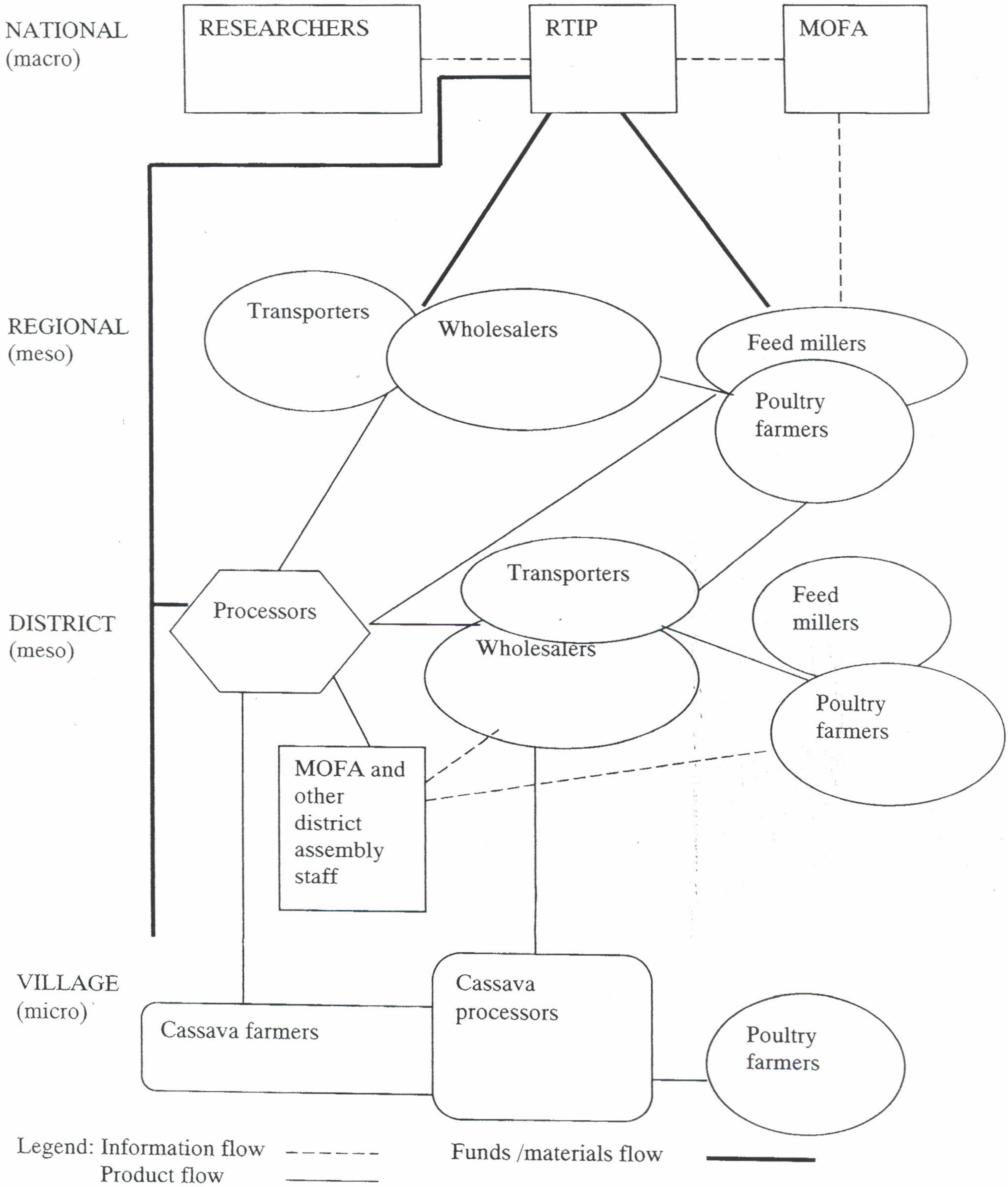
Cassava farmers and many of the processors would be located at the micro level in various villages. In other to ensure consistent flow of chips middlemen (wholesaler merchants and agents) located at all levels, need to forge close links with farmers.

5.3 Maize Versus Cassava Price Trends and Ratios

5.3.1 How are they correlated?

The monthly national average maize and cassava prices were analysed for the past five years. The real price series (1997 = 100) is for 100 kg bag of maize and 91 kgs bag of fresh cassava. The cassava prices were converted to 100 kgs bag prices. The graph shows a similar trend movement for the two commodities (Figure 5.2) over the period.

Figure 5.1 Stakeholder in pilot project and interrelationships



Another measure of the movement together of the two commodity prices is the estimation of the correlation coefficient. It is estimated that the correlation coefficient between maize and cassava prices over the period January 1998 and May 2003 is 0.91. This correlation coefficient value is high and shows the two prices move together in the same direction. This implies that as maize price rises cassava price also rises and falls when maize price falls. However, there is no clear pattern emerging in the seasonal variations in the maize-cassava price ratios. Within the year, the highest price ratios are clustered around January, February, July and August.

5.3.2 What is the maize-cassava price ratio

The maize-cassava price ratios were calculated for the period January 1998 to May 2003 for which monthly average national wholesale prices were available. The result indicates the average price ratio of 2.1 and with a minimum and maximum values of 1.3 and 3.9 respectively. In 2003, the maize-cassava price ratio has remained stable around the five years period average of 2.1. The monthly price ratio for the five years period is graphed as shown in Figure 5.3. It is estimated that 1.5 kg of fresh cassava will yield 1 kg of cassava chips for animal feed (no peeling is required). Therefore, the value of fresh cassava in cassava chips production is equivalent to 71 percent of the maize price[7]. This means to use cassava chips as maize substitute, the other production costs (to produce maize equivalent product) must be less than 29 percent of the maize price. It is common knowledge among researchers and practitioners in the poultry industry that cassava chips is not a one to one substitute for maize. The nutrient composition of maize and cassava chips differ (Table 5.1). The current varieties of maize have even higher protein content of 14 percent and energy levels of more than 2900 kilocalories.

It is recognised that the protein and fat levels in cassava chips compared to that in maize is woefully inadequate and must be compensated with other sources of protein. This also means increase cost and must be factored in the pricing of cassava chips. As such, the value of cassava to be used in chip preparation should have a lower value than what is sold in the fresh form.

5.4 The Cost-Benefit Analysis

Two chip production models: Centralised and Decentralised systems described earlier in this study are analysed in this section of the report.

5.4.1 Operating assumptions

Centralised System

It is expected that ten labourers and one supervisor would be needed at the chip-producing factory. Eight of the labourers will be engaged in chipping the cassava while the other two will be responsible for drying the chipped cassava on the patios.

Figure 5.2 Monthly Ave. Wholesale Price Trend , 1998 - 2003

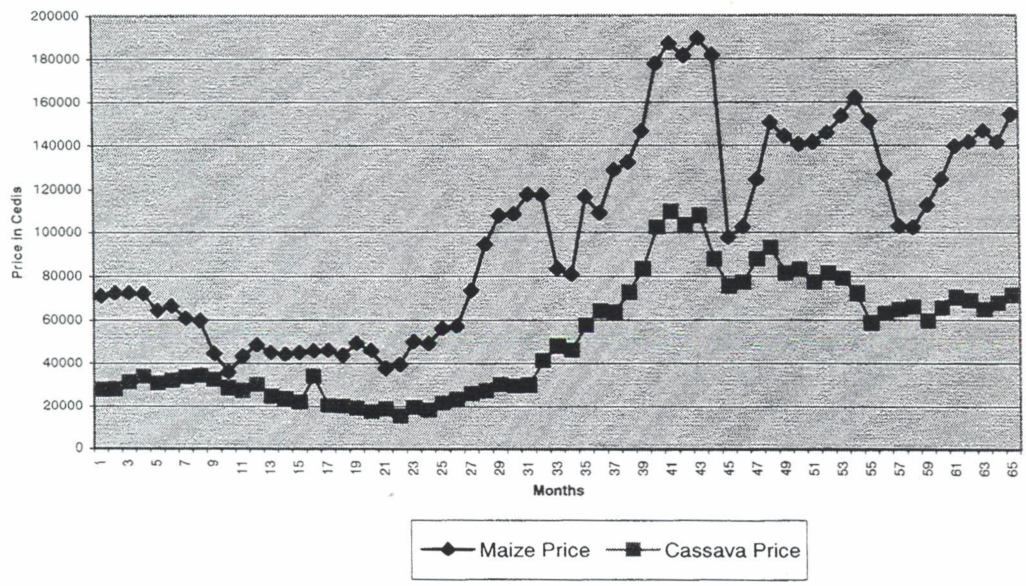


Figure 5.3 Maize-Cassava Price Ratio, 1998-2003

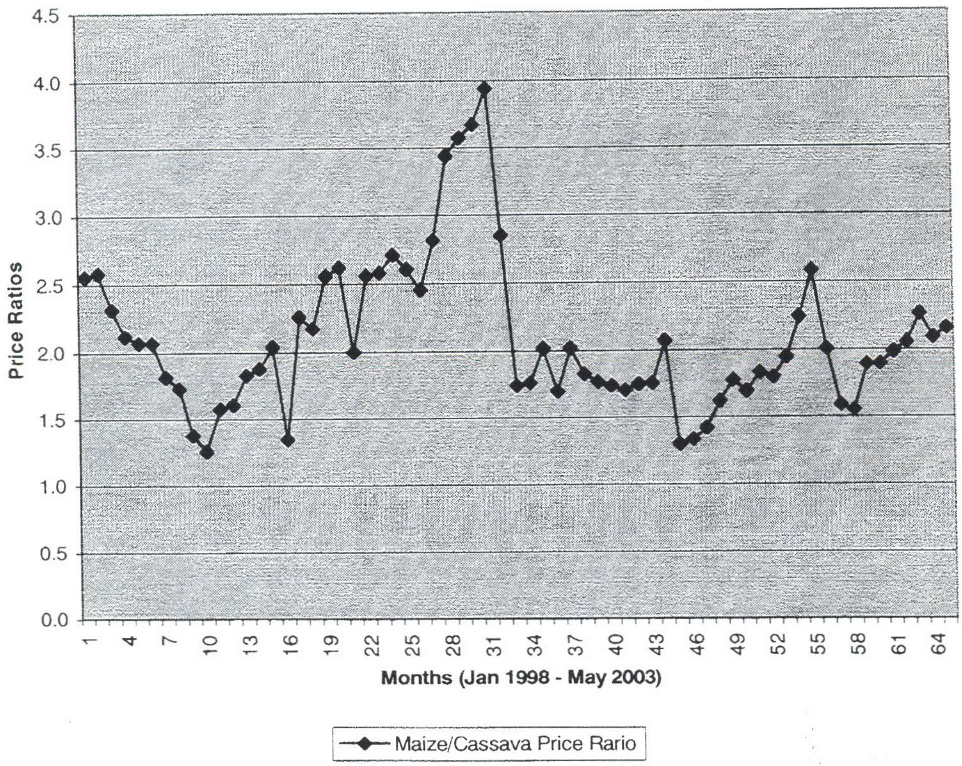


Table 5.1: Composition of Maize and Cassava in Terms of 100 Grams

Nutrient Composition	Maize	Cassava chips
Food (calories)	359	352
Energy (Kilocalories)	1,503	1474
Protein (g)	8.8	1.3
Fat (g)	3.9	0.4
Carbohydrate (g)	75.1	85.6
Fibre (g)	1.2	-
Calcium (mg)	45	50
Iron (mg)	8.4	1.4
Amino acid	Lysine	-

Source: Eyeson, E. E. and E. K. Ankrah, Composition of Foods Commonly Used in working at the rate of one metric tonne per person per day, 8 metric tonnes of fresh cassava would be processed in a day. The number of working days assumed in a month is 25 days making room for Sundays and other official public holidays. This implies that about 200MT of cassava would be processed in a month into chips. Working over seven months in the year (November to May of the following year) the total fresh cassava required for processing in the year and operating at full capacity is 1,400 MT.

In the first year the factory would operate at 60 percent capacity, second year of operation would be at 80 percent capacity and full capacity operation would start in the third year and continue to the tenth year. Direct input costs would increase proportionately with the increase in the level of production. Indirect costs on the other hand are fixed for the year of operation. No price increases are assumed in the projections.

Depreciation of fixed capital items was based on the straight-line method. The price of fresh cassava to be processed was based on ¢350,000 per metric tonne.

Decentralised System

The number of farmers in a group is assumed to average 10 and the number of groups expected in a district would be 20. Each farmer is expected to cultivate an average of two acres and devote one acre to producing cassava chips. Yield of cassava from an acre farm is estimated to be 8 MT. Therefore cassava available per year for chip production amount to 1,600 MT. It is estimated that 1.5 MT of fresh cassava is needed to produce 1 MT of chip for animal feed production. Thus, about 1,067 MT of cassava chips would be produced in a year.

It is anticipated that 60 percent of the projected farmers would produce in the first year. The percentage would increase to 80 percent in the second year and the projected target in the third year and beyond.

5.4.2 Investment cost estimates for cassava chips production

Centralised System

Fixed costs for cassava chips production in the centralised system include, land, factory building, electricity installation, water connection to the factory, water tank, construction of patios and plastic bowls and containers. Other costs will cover the cost of office equipment such as tables, chairs, kitchen stools, and stainless steel knives and office materials. It is estimated that the initial fixed capital cost would be ¢57,505,000. Based on assumptions of the depreciated values of these items, annual depreciation is estimated at ¢3,615,833 (Appendix 5.1).

Decentralised system

The fixed costs in the decentralized system are made up of the drying mats and the stainless steel knives/machetes. The amount of fixed investment is estimated at ¢750,000. The two items are depreciated over three years giving a depreciated value of fixed items amounting to ¢250,000 (Appendix 5.2).

5.4.3 Working capital requirement per month

Centralised System

Working capitals are consumable items needed for operation before any sales are made from production in the centralised system. Items in the category are fresh cassava, labour, transport, utilities, repair and maintenance, packaging materials and distribution costs. Six weeks operating costs of these items are estimated to be the working capital required valued at ¢136,862,430 (Table 5.3).

Decentralised System

No working capital (cash) is necessary in this system. Each farmer will use his/her cassava for processing and labour for chipping and drying would come from family sources and from neighbours on reciprocal basis. On the other hand, if labour from family and neighbours are unavailable, then the labour costs indicated in Table 5.3 will apply. In this case the farmers will require working capital of the stated amount.

5.4.4 Projected income statement for cassava chip production

Cost of operation in Centralised System

The cost of operation is made up of direct costs, indirect costs, depreciation and amortization. Direct costs amounted to ¢395,775,500.00, ¢499,695,500.00 and ¢600,655,500.00 in the first, second, and third years of operation respectively. The direct operating costs remain constant for the rest of the operating period. The indirect costs are fixed for the year and therefore remain constant for the period of operation except the transport cost that varied with the level of operation.

The estimated total operating costs for the first year of operation is ¢420,711,333.00 for the second years ¢541,431,333.00 and for third year and the rest of the period is ¢650,791,333.00. Operating profit for the first year of operation is ¢244,568,667. The net operating profit increases to ¢345,608,667 in the second year. Net operating profit in the third year of operation is estimated at ¢458,008,667 and remain the same for the rest of the period (Table 5.2).

Cost of operation in Decentralised System

It is estimated that the only direct payments would be for transport, knives and packaging materials. The cost of cassava and labour are imputed costs (Table 5.3).

5.4.5 Revenue from sales

Centralised System

The revenue estimate is from chips price and the quantity of chips to be produced. Revenue in year one, two, and three are ¢665,280,000, ¢887,040,000 and ¢1,108,800,000 respectively. From the third year to the tenth year the estimated revenue remain constant (Table 5.2).

Decentralised System

The price of chips is the same as that of the centralized system. Since the anticipated output of chips is greater, the revenue expected for year one, two and three are

Table 5.2 projected income and expenditure for centralised system (Amount in thousands of cedis)

Year	1	2	3	4	5	6	7	8	9	10
	60	80	100	100	100	100	100	100	100	100
Capacity utilization (%)	840	1120	1400	1400	1400	1400	1400	1400	1400	1400
MT of cassava processed/year	554.4	739.2	924	924	924	924	924	924	924	924
MT of chips produced/year	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Price of units of chips	665,280	887,040	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800
Revenue										
Cost of production	294,000	392,000	490,000	490,000	490,000	490,000	490,000	490,000	490,000	490,000
Raw materials (cassava)	48,750	48,750	48,750	48,750	48,750	48,750	48,750	48,750	48,750	48,750
Direct labour	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800	10,800
Electricity	335	335	335	335	335	335	335	335	335	335
Water	15,844	15,844	15,844	15,844	15,844	15,844	15,844	15,844	15,844	15,844
Health and safety	5,920	11,840	14,800	14,800	14,800	14,800	14,800	14,800	14,800	14,800
Packaging materials	20,127	20,127	20,127	20,127	20,127	20,127	20,127	20,127	20,127	20,127
Repair and maintenance	395,776	499,696	600,656	600,656	600,656	600,656	600,656	600,656	600,656	600,656
Sub total										
	16,800	33,600	42,000	42,000	42,000	42,000	42,000	42,000	42,000	42,000
Indirect cost	720	720	720	720	720	720	720	720	720	720
Transport	600	600	600	600	600	600	600	600	600	600
Bank charges	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Cleaning and hygiene	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Stationary										
Marketing and distribution	21,320	38,120	46,520	46,520	46,520	46,520	46,520	46,520	46,520	46,520
Sundry expenses										
Sub total	3,616	3,616	3,616	3,616	3,616	3,616	3,616	3,616	3,616	3,616
		0	0							
Depreciation	3,616	3,616	3,616	3,616	3,616	3,616	3,616	3,616	3,616	3,616
Amortization	420,711	541,431	650,791	650,791	650,791	650,791	650,791	650,791	650,791	650,791
Sub total	244,569	345,609	458,009	458,009	458,009	458,009	45,009	458,009	458,009	458,009
Total Cost of Operation	27,211	27,211	- 21,769	16,327	10,885	5,442	0			
Operating profit	0									
Interest expense										
Profit before tax	**217,357**	**318,397**	**436,240**	**441,682**	**447,124**	**452,566**	**458,009**	**458,009**	**458,009**	**458,009**
Tax@ in year 11	**217,357**	**535,754**	**971,994**	**1,413,676**	**1,860,800**	**2,313,366**	**2,771,375**	**3,229,384**	**3,687,392**	**4,145,401**
Net profit	758	732	704	704	704	704	704	704	704	704
Accumulated earning	15	15	14	14	14	14	14	14	14	14
Break-even price of chips/MT (₵)										
Break-even price/50kg bag (₵)										

Table 5.3-Projected Income and Expenditure Statement for Decentralized System (Amount in thousands of cedis)

Year	1	2	3	4	5	6	7	8	9	10
Capacity utilization (%)	60	80	100	100	100	100	100	100	100	100
MT of cassava processed/year	960	1280	1600	1600	1600	1600	1600	1600	1600	1600
MT of chip processed/year	633.6	844.8	1056	1056	1056	1056	1056	1056	1056	1056
Price of unit of chips	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Revenue	760,320	1,013,760	1,267,200	1,267,200	1,267,200	1,267,200	1,267,200	1,267,200	1,267,200	1,267,200
Cost of production										
Raw material (cassava)	336,000	448,000	560,000	560,000	560,000	560,000	560,000	560,000	560,000	560,000
Direct labour	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000
Packaging materials	8,880	11,840	14,800	14,800	14,800	14,800	14,800	14,800	14,800	14,800
Drying mats & knives	250	250	250	250	250	250	250	250	250	250
Transport	12,804	17,072	21,340	21,340	21,340	21,340	21,340	21,340	21,340	21,340
Total cost of operation	366,934	486,162	605,390	605,390	605,390	605,390	605,390	605,390	605,390	605,390
Operating profit	393,386	527,598	661,810	661,810	661,810	661,810	661,810	661,810	661,810	661,810
Tax@in year 11	0									
Net profit	393,386	527,598	661,810	661,810	661,810	661,810	661,810	661,810	661,810	661,810
Accumulated Earning	393,386	920,984	1,582,794	2,244,604	2,906,414	3,568,224	4,230,034	4,891,844	5,553,654	6,215,464
Net profit/acre	1,967	2,638	3,309	3,309	3,309	3,309	3,309	3,309	3,309	3,309
Break-even price of chippers/ MT	579	575	573	573	573	573	573	573	573	573
Break-even price per 501kgs bag	29	29	29	29	29	29	29	29	29	29

Source: Survey data 2004

Note: See Appendices 5.4, and 5.6 for raw data.

¢760,320,000, ¢1,013,760,000, ¢1,267,200,000 respectively. Similar to the centralized system the revenue remains constant till year ten (Table 5.3).

5.4.6 Net Present Value (NPV) for the Centralised and Decentralised Systems

Centralised System

The cash flow discounted at the discount rate of 20 percent yielded a Net Present Value (NPV) of ¢1,075,890,034 (Table 5.4). The payback period is estimated at 1year (Appendix 5.8).

Decentralised System

The cash flow discounted at the discount rate of 20 percent yielded a Net Present Value of ¢2,457,730,506 (Table 5.5).

5.5 The Sensitivity Analysis

The sensitivity analysis was performed lowering cassava chips price to 41.7 percent of the maize price (¢50,000/ 50kg bag) and also increasing the discount rate to 27 percent. Another sensitivity was tested with cassava price. The latter was increased to ¢400.000/MT from ¢350,000/ MT.

Centralized System

The chip price was lowered to 41.7 percent the maize price (¢50,000 per 50 kgs bag). The net profit was positive ¢106,477,226 in year one, ¢170,557,226 in year two and ¢251,439,515 in year three and beyond. Total equity was valued ¢2,534,627,573 in year ten. The cash flow discounted at 20 percent yielded a NPV of ¢497,028,143 and at 27 percent discount rate yielded NPV of ¢464,817,230. The Payback Period estimated for the two discount rates (20% and 27%) were 2 years.

When the fresh cassava price was increased to ¢400,00 per MT and all other prices kept constant, the net profit for years one, two and three were ¢175,367,226, ¢262,397,226, and 366,239,515 respectively. Total equity assets in year ten was ¢3,613,747,573. The cash flow discounted at 20 percent yielded NPV of ¢856,624,166 and at 27 percent discount rate the NPV was ¢800,656,706. The Payback Period for the two discount rates (20, and 27) was 2 years.

Decentralised System

The chip price was lowered to 41.7 percent of the maize price (¢50,000 per 50 kgs bag). The net profit was positive ¢266,660,000 in year one, ¢358,638,000 in year two and ¢450,610,000 in year three and beyond. The cash flow discounted at 20 percent yielded an NPV of ¢1,672,013,735 and at 27 percent discount rate yielded NPV of ¢1,314,168,064. When the fresh cassava price was increased to ¢400,00 per MT and all other prices kept constant, the net profit for years one, two and three were ¢345,386,000,

Table 5. 4 Projected cash flow statement for centralized system

Year	0	1	2	3	4	5	6	7	8	9	10
Sales operating cost	0	420711	541431	541431	541431	541431	541431	541431	541431	541431	541431
Other cost	0	27211	27211	21769	16326	10884	54428	0	0	0	0
Taxes on operation	0	0	0	0	0	0	0	0	0	0	0
Principal payment	0	0	0	27211	27211	27211	27211	27211	0	0	0
Capital investment	57,505										
Working capital	136,862										
Total cash out flow	194367	447922	568642	699771	69444329	688887	683445	678002	650791	650791	650791
Cash flow from operation	0	665,280	887,040	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800
Equity contribution	0										
Loan receipts	0										
Total cash in flow		665,280	887,040	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800
Net cash flow	194,367	217,357	318,397	409,028	414,472	419,912	425,354	430,797	458,009	458,009	458,009
Cumulative cash flow	194,367	22,989	341,387	750,415	1,164,885	1,584,798	2,010,153	2,440,950	2,898,959	3,356,968	3,814,976
Discount rate (20%)											
Discount cash flow	194,367	181,131	221,109	236,706	199,879	168,753	142,450	120,227			
Net present value (¢)	1,075,890,										
Discount rate (27%)	194,367	171,147	197,406	199,683	159,323	127,098	101,374	80,843	67,677	53,289	41,960
Net present Value (¢)											

Source: Survey data 2004

Table 5.5: Projected cash flow statement for decentralized system. Amount in thousands of cedis

Year	0	1	2	3	4	5	6	7	8	9	10
Sales operating cost	0	366,934	486,162	605,390	605,390	605,390	605,390	605,390	605,390	605,390	605,390
Total cash out flow	0	366,934	486,162	605,390	605,390	605,390	605,390	605,390	605,390	605,390	605,390
Cash flow from operation	0	760,320	1,013,760	1,267,200	1,267,200	1,267,200	1,267,200	1,267,200	1,267,200	1,267,200	1,267,200
Total cash in flow	-	760,320	1,013,760	1,267,200	1,267,200	1,267,200	1,267,200	1,267,200	1,267,200	1,267,200	1,267,200
Net cash flow	-	393,386	527,598	661,810	661,810	661,810	661,810	661,810	661,810	661,810	661,810
Cumulative cash flow	-	393,386	920,984	1,582,794	2,244,604	2,906,414	3,568,224	4,230,034	4,891,844	5,553,654	6,215,464
Discount cash flow (20%)		327,822	366,388	382,992	319,160	265,967	221,639	184,699	153,916	128,263	106,886
Net present value (20%)	2,457,731										
Discount cash flow (27%)	0	309,753	327,111	323,089	254,401	200,316	157,729	124,196	97,792	77,002	60,631
Net present value (27%)	1,932,019										

Source: Survey data 2004

¢463,598,000, and ¢581,819,000 respectively. The cash flow discounted at 20 percent yielded NPV of ¢2,160,110,517 and at 27 percent discount rate the NPV was ¢1,697,984,608 These analyses clearly show chip production under the two models are profitable and are not sensitive to cassava price, discount rates and chip price.

5.6 Location of Pilot Plants

The choices of the pilot locations are informed by the district trend in cassava production and the staple food of the people. Experience has revealed that producing cassava chips is best achieved in areas where cassava is not a staple food of the people. Again the planting conditions must be good for reasonable crop yield and the farmers should be looking for alternative sources of income. In addition to above factors, the closeness of the production sites to feed mills and high concentration of poultry farms (near Accra and Kumasi) will be an added advantage. The locations visited and recommended for consideration include: Ejura-Sekyere-Odumase District and Sekyere West Districts of the Ashanti region; Akwapin North District of the Eastern Region and Assin District of the Central Region. The Feed mills and the poultry farmers to participate in the pilot will be located in Kumasi (Ashanti Region), Assin Fosu (Central Region) and Accra (Greater Accra Region).

5.7 Farmer Level Organization

Centralised System

Farmers will be encouraged to form self-select groups to produce cassava for processing at a centralized location. This will allow for quality control supervision to meet quality standards required by the poultry industry. The farmers are expected to sell their cassava to the central processing plant to process the fresh cassava into chips. The plant will serve as market for farmers' fresh cassava while supplying quality cassava chips to feed mills and poultry farmers.

Decentralised System

Farmers will be encouraged to form self-select groups of cassava and chips producers. The group members would number 8-12. They will be organized along the 'Nnoboa" scheme for them to support the economic activities (especially cassava chip production) of members. They will be encouraged to support group members in uprooting cassava for processing and chipping cassava. They will sell in bulk to chip traders who in turn will sell the cassava chip to feed mills and poultry farmers.

The farmers and traders will be given training to enable them recognize good quality cassava chip and they will buy based on quality and weight. It is expected that RTIP will support the traders with weighing scale to facilitate the trading in chips.

Producing the cassava chips on the farm reduces the weight to be carried by the farmers to the village. However, there is the risk of the chip being affected by rainfall in the absence of the farmer. It may be necessary to cover the chip on the farm when leaving for the village. This will require the purchase of polypropylene sheets for covering the drying chips against rainfall.

CHAPTER SIX

6. Recommendations for Appropriate Equipment and Methods for the Production of Cassava Chips

6.1 Introduction

This section of the report presents the most appropriate equipment and methods for organizing the production and marketing of cassava chips from the farmer to the feed mills and poultry farmers.

6.2 Production of Fresh Cassava

Both small ($\leq$4 acres) and large (>4 acres) farmers would produce the fresh cassava. According to T&CG staff the best cassava planting material for chips production is the one that matures in 6 months. If the matured crop is not harvested beyond 9 months it turns fibrous and is not suitable for producing chips. When the cassava crop has matured the traditional system of manual harvesting is recommended since no suitable mechanical harvester is available for cassava. The reason for manual harvesting is that unless and until cassava planting is done on ridges, it will be difficult to harvest the crop mechanically without damaging the matured cassava roots.

To ensure continuous processing of cassava into chips, planting must be staggered over the year. That is planting should be planned for three specific period during the year. This also implies that a third of the total land area that must be planted in a year to supply sufficient cassava for processing into chips the whole year must be planted every three months except during the dry three months of December to February. Every farmer participating in the pilot must do this or the farmers must be divided into three groups based on area for each of the three groups. This way adequate cassava would be available for processing to meet the demand from traders and feed mills the whole year.

It is expected that most of the chipping and drying would be done on the farm and so the dried chips will be head-loaded to the village or tractor services would be used to haul the fresh cassava to the village for processing.

6.3 Production of Cassava Chips

Small Farmer

A small cassava farmer is here defined as a farmer who cultivates less than five acres of cassava farm. It is recommended that a small farmer who wants to process his/ her cassava roots into chips, should use very simple implements and basic processes for producing cassava chips. Processing of the cassava roots into chips may either be carried out on the farm or the roots carried to the village for processing into chips. The small farmer will use knives and cutlasses to manually slice harvested cassava roots. Due to the small volume of cassava roots handled, this will prove an efficient method for chipping. An experienced processor will be able to chip about 1.5 metric tonnes of cassava roots in a day as the team learnt during the survey. The small farmer

¢463,598,000, and ¢581,819,000 respectively. The cash flow discounted at 20 percent yielded NPV of ¢2,160,110,517 and at 27 percent discount rate the NPV was ¢1,697,984,608 These analyses clearly show chip production under the two models are profitable and are not sensitive to cassava price, discount rates and chip price.

5.6 Location of Pilot Plants

The choices of the pilot locations are informed by the district trend in cassava production and the staple food of the people. Experience has revealed that producing cassava chips is best achieved in areas where cassava is not a staple food of the people. Again the planting conditions must be good for reasonable crop yield and the farmers should be looking for alternative sources of income. In addition to above factors, the closeness of the production sites to feed mills and high concentration of poultry farms (near Accra and Kumasi) will be an added advantage. The locations visited and recommended for consideration include: Ejura-Sekyere-Odumase District and Sekyere West Districts of the Ashanti region; Akwapin North District of the Eastern Region and Assin District of the Central Region. The Feed mills and the poultry farmers to participate in the pilot will be located in Kumasi (Ashanti Region), Assin Fosu (Central Region) and Accra (Greater Accra Region).

5.7 Farmer Level Organization

Centralised System
Farmers will be encouraged to form self-select groups to produce cassava for processing at a centralized location. This will allow for quality control supervision to meet quality standards required by the poultry industry. The farmers are expected to sell their cassava to the central processing plant to process the fresh cassava into chips. The plant will serve as market for farmers' fresh cassava while supplying quality cassava chips to feed mills and poultry farmers.

Decentralised System
Farmers will be encouraged to form self-select groups of cassava and chips producers. The group members would number 8-12. They will be organized along the 'Nnoboa" scheme for them to support the economic activities (especially cassava chip production) of members. They will be encouraged to support group members in uprooting cassava for processing and chipping cassava. They will sell in bulk to chip traders who in turn will sell the cassava chip to feed mills and poultry farmers.

The farmers and traders will be given training to enable them recognize good quality cassava chip and they will buy based on quality and weight. It is expected that RTIP will support the traders with weighing scale to facilitate the trading in chips.

Producing the cassava chips on the farm reduces the weight to be carried by the farmers to the village. However, there is the risk of the chip being affected by rainfall in the absence of the farmer. It may be necessary to cover the chip on the farm when leaving for the village. This will require the purchase of polypropylene sheets for covering the drying chips against rainfall.

may also be able to employ the services of one or two other persons (facility members) to assist in the chipping of the cassava roots.

Plastic mats placed on cleared areas on the farm should be used for drying the small volumes of cassava chips on the farm. The chips should be spread thinly on the mats and occasionally turned using rakes to facilitate drying. If drying is to be carried out in the village, the chips should be placed on raised racks similar to that used for drying cocoa in villages. It is necessary to use the raised racks to avoid contamination by sheep and goats. If the small farmer prefers to use mats placed on the floor for drying the chips, then the area should be fenced off using cheap locally available materials such as palm fronts or split bamboo to exclude ruminants, poultry, and other animals from having access to the drying chips.

Chips either processed on the farm or in the village should be collected and packed into polyproplene or plastic sacks and stored in a well ventilated area in the house until they are purchased by a wholesaler.

Large Farmer

A large cassava farmer is here defined as a farmer who cultivates five acres or more of cassava farm. Due to the larger volumes of chips to be handled, it is desirable that the large farmer uses a chipping machine for processing the chips. The chipping machines supplied to farmers by T&CG could chip 1.2 tons of cassava in an hour. This may be carried out on the farm or in the village. However, if feasible, the farmer may employ several hands to manually chip the cassava roots. For drying of the chips, it is recommended that concrete patios constructed either on the farm or in the village are used. The use of patios will enable the drying of large volumes of chips to be carried out in smaller drying areas than on drying mats or raised racks since the patios retain heat making available slightly higher temperatures for drying the chips.

During drying, the chips have to be turned with rakes at regular intervals due to the thicker layer of chips on the patios. Also during the survey, the team was informed that chips sliced with a chipper had starchy surfaces causing the chips to stick together during drying. Therefore, without regular turning which farmers found tedious, the chips became mouldy. This together with the fact that farmers had to buy fuel for chippers supplied by T&CG discouraged farmers from using the chipping machines. It is recommended that other more appropriate and efficient designs of chipping machines should be developed by institutions such as the Food Research Institute and the Mechanical Engineering Department of Kwame Nkrumah University of Science and Technology (KNUST) to overcome this problem. Such chippers should be tested in the field during the pilot project.

Dried chips should be packed into polyproplene/plastic sacks and for the large farmer a warehouse should be constructed (or a room or rooms should be set aside) in the village to store the larger volumes of cassava chips until the wholesaler purchases them.

Cassava Chips Pilot Plant/Small Scale Cassava Chips Factory

The citing of a cassava chips pilot plant or small scale factory is very crucial because the plant will depend on cassava purchases from farmers in the vicinity of the plant. In the case of farmers producing cassava chips, most of the cassava roots utilised for the production of the chips will be the farmers own produce so chips production in most cases may be considered an extension of agronomic activities to reducing post harvest loss of their crop by processing into a shelf stable form (especially in localities where market for the fresh produce is saturated).

The survey team was told by T&CG staff that the most successful areas for producing cassava chips for their company during the peak activity period was in the middle belt/transitional zone from Atebubu to Kwame Danso, Bamboi, Nkwanta, Damankrom, Paramboi, Wenchi to Bongase, Banda Ahenkro, Manji, Brahie, the Damongo stretch from Fufunsu to Sawla, Nipala, Banjuala, Salaga, Nonto and Nolonto. The reason given was that not much cassava is eaten by human in these areas, so the fresh produce price is low and the 'surplus' production is available for processing into chips. Even including the cost of transporting cassava chips from these distant areas to the port in Tema, the company found it cheaper to buy and transport chips from these areas than to buy from nearer locations to Tema like Awutu where cassava is consumed extensively and therefore has a higher price. It is therefore important that the location for setting up a cassava chips processing plant is selected carefully taking all important factors into consideration especially the availability and cost of cassava roots.

A cassava chips pilot plant or small-scale factory needs to have a suitable structure to serve as a processing hall. This must be cited correctly taking into account factors such as electricity, water, disposal of waste material, and adequate space for erecting drying facilities such as patios and solar dryers. The space must be fenced to ward off animals and rodents. The processing hall must provide adequate space for receiving raw materials, installation of a chipping machine and a diesel engine, giving enough room for operating and cleaning the machines.

To ensure good microbiological quality of chips, the cassava roots must be washed before chipping. A washing tank should be erected for this purpose. After chipping, the roots should be spread out to dry on concrete patios and where available solar dryers. Solar dryers constructed locally use ordinary plastic sheets for enclosing the structure and such locally manufactured sheets tend to have a very short life span since they are not made purposely for solar drying. They are unable to withstand wind, rain and sunlight and have to be replaced after only a few months, which makes solar drying expensive.

For a pilot plant or a small scale factory which will rely on the use of solar dryers, the appropriate sheets for constructing solar dryers will have to be imported and such sheets made for solar dryers have a long life span and can last several years. Such solar dryers constructed using the right materials are ideal for producing good quality chips since drying will be accomplished within short periods because of the higher temperatures which can be generated in the solar dryers, e.g. over 50 ^{o}C yielding good quality chips. In the solar dryer, the chips are also protected from the environment; therefore, contamination from the external environment is reduced to a minimum.

After drying, the dried chips are packaged into plastic bags and placed in a warehouse until they are purchased by the wholesaler.

6.4 Feed Mills and Feed Production

We recall that in order to control bacteria infections in cassava chips Sydals Farms Ltd. successful used an extruding machine (see chapter 3). The company purchased cassava chips from T&CG and after milling passed the flour through a dry extruder. During extrusion, the f lour was heated to a temperature of 140 °C, which practically rendered it sterile. Heating to a temperature of 140 °C for a few minutes should be sufficient to destroy nearly all microorganisms including sporeformers and their spores. According to the manager, during extrusion, the flour was cooked and the starch gelatinised which improved the palatability of the feed to the birds. Also, gelatinisation of the starch also improved utilisation of the cassava flour by the birds, since raw cassava flour tends to stick to the upper section of the mouth of the birds. It should be noted here that extruding or cooking cassava flour at 140 °C is bound to have a pronounced effect on the content of aflatoxin and other mycotoxins which could be present due to the use of mouldy chips. Kpodo *et al* (1996) reported that cooking of maize dough into kenkey reduced the levels of aflatoxins B^1 and B^2 by 80 and 35 percent respectively and aflatoxin G_1 by about 80 percent whereas the effect on aflatoxin G_2 appeared to be less pronounced.

In the survey of feed mills and poultry farms, it was realised that the most important operations in the production of feed are milling and preparation of ingredients, formulation of the feed, mixing and bagging of the feed. In the use of cassava chips in feed formulation, assistance should be sought by feed millers and poultry farmers from the relevant agricultural departments of the universities and the Animal Research Institute. The feed mills have the requisite experience in the formulation of feed using maize, but in substituting part of the maize with cassava flour, the protein content of the maize removed from the feed has to be compensated for, that is why it is recommended that dried cassava leaves are also incorporated into the feed since maize has a protein content of between 11 and 14, cassava roots 1-3 percent and cassava leaves 7 percent on fresh weight basis. Cassava leaves are also rich in minerals, vitamins and all the essential amino acids except methionine and phenylalanine. The amino acid profile of the maize and cassava proteins will have to be taken into consideration and the necessary compensation made. So far Sydals Farm has been satisfied with the use of cassava flour in poultry feed and has the necessary experience in the formulation of feed in which part of the maize is substituted with cassava flour and deficiencies compensated for with incorporation of full fat soya meal and assistance could be sought from that company.

Based on the experiences of using cassava flour in feed by GAFCO and Sydals Farm, it is recommended that any feed mill or poultry farm incorporating cassava chips into feed should include the operation of extruding in the production line or any suitable operation which will give a sufficient heat treatment to the feed in order to destroy any enteric pathogens present in the feed. It should be emphasised that in the absence of an extruder or a heating process in the preparation of the feed, the problem of microbial contamination of cassava chips can be eliminated by modifying the process of producing cassava grits.

Finally it will be advantageous for feed mills and poultry farms to pellet their feed before it is fed to poultry. This will improve utilisation of the feed. For this purpose, the feed mill or poultry farm should preferably have a pelleting machine.

CHAPTER SEVEN

7. Summary, Conclusion and Recommendations

7.1 Introduction

The final chapter presents summary of finding during the study and conclusions drawn to inform the recommendation made for consideration in setting up the proposed pilot in producing and marketing cassava chips.

7.2 Summary and Conclusions

The existence of a reliable supply of fresh roots at a competitive cost will be a factor determining the viability of any alternative cassava processing operation. A number of factors are likely to affect the supply of raw cassava for processing. The ability of farmers to gain access to other markets for their produce will be a major factor influencing the supply of cassava for a particular processing end use. Generally, price of fresh cassava are likely to be more attractive than those that a processing enterprise could afford.

A study by Day et al (1996) show that the price T&CG paid for dried chips at a collection point close to the farms was ¢2,600 per 91 kg unit, which they considered farm gate prices as compared to the wholesale prices in excess of ¢5,000 per the same weight. The price paid by T&CG for chips was not strictly equivalent to farmgate price for cassava since farmers also incurred costs associated with chipping and drying. The wholesale prices on the other hand also reflect transport and marketing cost incurred between the farm and the wholesale market.

In summary, the supply of cassava for processing will depend on:

- Ease of access for fresh marketing channels;
- Ease of access to other processing outlets, e.g. gari, kokonte, agbelima etc;
- Other competing uses, e.g. as food security reserve;
- Transport links in the cassava producing area;
- Varieties of cassava available, e.g. for human or for other uses;
- Staple status of cassava in the area; and
- Seasonality in transportation difficulties, harvesting difficulties, drying operations, and overall seasonality of agricultural production processes. Seasonality in competing uses of cassava.

Organization of cassava supply for a processing operation would have to take issues affecting availability of steady supply and predictable flow into consideration. In fact, new end uses of cassava must be integrated with existing production and marketing systems. Additional production must be encouraged to serve the new use and income source.

7.2.1 Major constraints and challenges

Exporter and Traders

1. The primary exporter of cassava chips in the late 1990s was Transport & Commodity General (T&CG). The company experienced several constraints in the operations including; vehicle hiring from urban centres, which imposed a high search and delay (transaction) cost on the operations of the firm. During the cocoa season, the competition for trucks became even keener raising hiring cost. Investing in own vehicle required a high capital requirement, which ploughed back profit could not meet. In addition, own trucks are associated with under capacity utilization as the chipping operation lasts eight months in a year, and high maintenance cost. Borrowing from financial institutions was an option for the purchase of own trucks, but it was not preferred due to the high collateral requirements and interest rate charges. Lending rate on investment loans is about 35 percent per annum 2004, Barclays Bank prices. A head of articulated truck is estimated at ¢1.2 billion (T&CG, September 2004 prices).

2. One particular constraint experienced by T&CG related to transportation especially between the field and the assembly point. Most of the transportation at this level took place by head loading. Another issue of concern was the technical options in drying to improve the quality and consistency of chips and the intercropping to maintain soil fertility and yields, which can be demonstrated to farmers. These lessons are vital pointers for the development of proposed cassava processing models.

3. Advancing monies to farmers in lieu of future purchase sometimes resulted in breaches of contract. Farmers may sell fresh cassava to other processors such as *gari* and *kokonte* producers when the relative prices for these products increases, decreasing the relative price of chips.

4. Low world market prices meant that the domestic producer price levels could not be sustained by T&CG leading to shut down of operations in 2000.

5. Other constraints included competition faced from other cassava products in terms of price and surge in demand for other cassava-based production from West African sub-region caused diversion of fresh cassava to the production of other products at the expense of chips.

6. Credit delivery is an area T&CG recommend further innovation in service provision to farmer processors. The scheme is for the chip trader, farmers and the financial institutions to work together instead of the trader pre-financing farmers inputs. The financial institutions provide credit to farmers, the farmers produce chips and sell to the trader, and the trader makes payments on behalf of the farmers to the financial institution. At the same time the trader and the extension services of MoFA provide support to group formation and development. Experience of T&CG show that huge sums of money are needed to purchase chips from farmers and therefore the need for financial support

from the financial institutions (see cash flow Tables 5.4 and 5.5) to the chips trader.

7. Chip demand follows seasonal variation and also cyclical movements, making some facilities to lie idle, while maintenance cost is incurred.

8. Lack of adequate and modern port facilities lowers Ghana's competitiveness in an industry where other exporting countries have the opportunity to use high technology. In Thailand for instance, chips are drawn over conveyor belts from port quay to ship. In Ghana, it is done with the aid of forklift, which takes several extra days.

Poultry Farmers

- Possibility of not achieving required palatability, health and weight when cassava is used.
- Inconsistent supply of low priced chips.
- Lack of good quality product in the market
- High cost of research and development associated with using cassava chips in feed formulation

Feed Millers

- Lack of total quality assurance for cassava chip processing and transportation;
- Irregular supply of cassava chips
- Low demand of cassava chip feed from poultry farmers

Farmers

- Marketing is perceived as the most important constraint facing cassava farmers: the fresh market is difficult to access, is risky and unpredictable. Lack of markets prevents farmers from harvesting their cassava in a timely manner and tie up land under cassava for long periods. Cassava processing is considered the key to enhance the marketing opportunities for farmers, and in the provision of production credit to farmers.
- Another constraint perceived by farmers is accessibility to chipping and drying facilities. These are not difficult to address since they involve reasonable costs.
- High cost of labour for chipping and drying.
- High costs of chipping machine and operating cost.
- High economic and social costs associated with the use of chipping machine.

Policy Makers

- Low budgetary support for MoFA extension agents to distribute cassava planting materials nationwide to boost production base.
- Limited number of trainers to train processors to diversify processing enterprises.

Researchers

- Lower maize prices discourage the use of cassava as a feed (ingredient) component.
- Higher fresh cassava price in certain locations discourage its use as poultry feed ingredient.
- Lack of well-developed supply chain and quality management that ensure accessibility to all complementary inputs on a sustainable basis may discourage sustainable utilization.
- Dependence on sun drying alone would limit the production period and increase storage cost if supply is to be all year round.

7.2.2 Locations for production of cassava

Major cassava producing areas in the regions identified for the study are: Ejura-Sekyere-Dumase and Sekyere West District in the Ashanti Region, Assin District in the Central Region; and Akwapim North District in the Eastern Regions. The best locations for drying chips are areas with relatively long and intensive periods of sunshine, especially the transitional belt and the north, though drying can satisfactory be done in the locations visited during the survey for the study. Existing literature and our own field visits confirmed that areas of least alternate market for cassava are the transitional zone and the northern part of the Volta Region. Cassava being a bulky low value commodity must only be transported over short distances (less than 40 km) in the fresh form. Therefore processing should be as close to cassava production point as possible. The chips delivery price acceptable to mills and poultry farmers at factory gate include transportation cost from purchasing at farmers location to delivery, which is half the price of maize or less.

TC&G staff indicated that the most successful areas for producing cassava chips for their company during the peak activity period was in the middle belt/transitional zone from Atebubu to Kwame Danso, Bamboi, Nkwanta, Damankrom, Paramboi, Wenchi to Bongase, Banda Ahenkro, Manji, Brahie, the Damongo stretch from Fufunsu to Sawla, Nipala, Banjuala, Salaga, Nonto and Nolonto. The reason given was that, not much cassava is eaten as food in these areas, so the fresh produce price is low and the 'surplus' production is available for processing into chips. Even including the cost of transporting cassava chips from these distant areas to the port in Tema, the company found it cheaper to buy and transport chips from these areas than to buy from nearer location to Tema like Awutu where cassava is consumed extensively and therefore has a higher price. It is therefore important that the location for setting up a cassava chips processing plant is selected carefully taking all important factors into consideration especially the availability and cost of cassava roots.

7.2.3 Model for pilot cassava chips production and marketing

The proposed model for the pilot organisation of supply of cassava chips to feed mills is based on the successful model operated by TC&G; the most successful and experienced company that spearheaded the export of cassava chips in the second half of the 1990.
To augment the protein level of cassava chips, incorporation of cassava leaves as suggested by Job Experimental could be tested.

Therefore based on the T&CG and Job Experimental best practice, the proposed model for pilot cassava chips production and marketing shall have three main components or operators namely:

Production of cassava chips (two models):

a. In a decentralised system, farmers and cassava processors belonging to a group that will be responsible for the production of the chips and dried cassava leaves. Each farmer or processor will process his own cassava into chips but with the assistance of the rest of the group who sell in bulk to a buying company.
b. In a centralised system, a group or individual at a location in the village, i.e. a pilot plant, will do processing of cassava roots into chips. The group will purchase the cassava roots and own the chips produced.

Purchase and distribution of cassava chips: A purchaser or wholesaler of cassava chips in a district or a zone will be responsible for the purchase of cassava chips from the farmers and processors, and transportation and selling of the chips to feed mills and/or poultry farms.

Production of feed: Feed mill and/or poultry farms that will incorporate the cassava chips and dried leaves into animal feed.

7.2.4 Organization of farmers

Small scale processes using simple technology (knives and sun drying in mats or patios) suited to village level enterprises have the advantage of being located very close to the production sites of fresh cassava. This reduces the transportation costs associated with the movement of large volumes of relatively low value raw material. Product quality assurance, however, is more difficult at the farmer level and the scope for developing formal marketing arrangements much reduced. More formal marketing arrangements are necessary to effectively reduce transaction costs.

Centralised large scale processing of cassava into chips require large investment (fixed and working capital) and the development of sophisticated marketing systems to ensure a continuous and reliable supply of cassava for processing, in order to maximise the utilization of capital equipment and other resources. In addition, transport costs associated with the supply of cassava are high proportions of operating costs. Therefore, attempts to reduce these operating costs will give rise to the development of some form of estate production of cassava, possibly leading to reduced benefits flow to farmers who are targets of poverty reduction actions.

T&CG experimented on a centralised processing of chip system but finally settled on the system where smallholder cassava producers carried out production and processing in a decentralised basis. T&CG concentrated on the role of organizing and coordinating marketing services. Under the guidance of T&CG, farmers were encouraged to form groups for the purpose of relating with T&CG. It is the view of T&CG staff that this method of organization is more flexible since farmers are able to respond more quickly and cost-effectively to changing weather conditions that affect harvesting and drying operations than a large-scale, capital-intensive processing operation.

The economic size of chips to be assembled at a location from T&CG experience to be lifted is 25 MT. Experience has shown that farmer groups have been effective when membership average 10 persons. It is proposed that 20 of such groups could be formed in each district. In fact, there can be more than one group in a village and must be self-select. Each farmer is expected to cultivate one acre (0.4 ha) of cassava farm with an average yield of 8 MT for chips production. Again experience has shown that 1.5 MT of fresh cassava yields 1 MT of chips. Therefore each farmer is expected to produce 5.33 MT per annum and each group would produce 53.3 MT per annum. Based on the fact that 20 groups will be formed in a district, the district is expected to produce 1,066 MT of chips per annum. If production is organized in 6 districts (2 in each of the chosen regions), then a total of 6,396 MT would be available per annum. This means from the pilot 533 MT of chips can be supplied per month.

Of the farmers contacted during the survey, 91 percent were willing to participate based on the following conditions: chips price should not be less than half equivalent weight maize price, sustainable purchase of the chips, and price negotiated with the group before the actual purchase period.

7.2.4 Quality specification

No clearly defined quality standards are available for chips to be used in feed production in Ghana. However, GAFCO and other poultry farmers producing their own feed prefer white, low moisture (bristle), no mould and low cyanide cassava chips. More scientific study is needed to establish standards for chips to be used in animal feed formulation.

7.2.5 Cost of production

Cost of cassava chips production is dependent on the method of cassava production, the chipping method used and the method of drying. The traditional method of production is about uniform but cassava yield vary from area to area depending of cassava varieties planted and the climatic conditions. The least cost of chips production is when it is done on the farm following defined protocol. Raising the yield per area per time is the best opportunity to reduce cost of production. Evidence available is cassava production in pure stand for the fresh market is more profitable than when intercropped with maize.

7.2.6 Marketing chain and pricing of cassava chips

Monthly national average maize and cassava prices graphed for the past five years showed a similar trend movement for the two commodities over the period. It was also estimated that the correlation coefficient between maize and cassava prices over the period January 1998 and May 2003 is 0.91. This implies that as maize price rise cassava price also rise and fall when maize price fall.

The maize-cassava price ratios calculated for the period January 1998 to May 2003 indicates the average price ratio of 2.1 and with a minimum and maximum values of 1.3 and 3.9 respectively. In 2003, the monthly maize-cassava price ratio remained stable around the five years period average of 2.1. However, there is no clear pattern

emerging in the seasonal variations in the maize-cassava price ratios. Within the year, the highest price ratios are clustered around January, February, July and August.
It is estimated that 1.5 kg of fresh cassava will yield 1 kg of cassava chips for animal feed (no peeling is required). Therefore, the value of fresh cassava in cassava chips production is equivalent to 71 percent of the maize price. This means to use cassava chips as maize substitute, the other production costs (to produce maize equivalent product) must be less than 29 percent of the maize price. It is common knowledge among researchers and practitioners in the poultry industry that cassava chips is not a one to one substitute for maize. The nutrient compositions of maize and cassava chips differ. As such, the value of cassava to be used in chip preparation should have a lower value than what is sold in the fresh form.

7.2.7 Agronomic aspects

Cassava for chips production to feed animal need no peeling. Therefore, the thickness of cassava skin is not a problem. Rather cassava varieties that are early maturing and high yielding are required to reduce cost of production.

7.2.8 Chipping and drying technology

The equipment and facilities needed by various actors in the processing chain and their costs are presented in the table below

There are several combinations of technical packages that can be adopted. The options for the three major activities include:

1. Using manual chipping (cutlass and knives), drying on mats and bagging with plastic bags;
2. Using manual chipping (cutlass and knives), drying on raised racks and bagging with plastic bags;
3. Using manual chipping (cutlass and knives), drying on patios and bagging with plastic bags;
4. Using machine chipping, drying on mats and bagging with plastic bags;
5. Using machine chipping, drying on raised racks and bagging with plastic bags;
6. Using machine chipping, drying on patios and bagging with plastic bags.

Investment cost increases from option 1 to option 6. Most of the farmers contacted have had no experience using chipping machines. Those who had produced *Kokonte* used manual peeling and chipping.

The three drying options are effective and efficient. However, their use will depend on the ability of the farmer to finance the cost involved. Solar driers are not considered because of cost, the limited scale, and their high rate of replacement. It is also import dependent since the appropriate plastic sheets are not produced in Ghana.

7.2.9 Construction of drying facilities

The only drying facility considered suitable for use under Ghanaian conditions and need construction is the cement concrete patios. A 10 m^2 patio would cost about five Million Cedis (¢5,000,000). The amount excludes the value of the land on which the

Technical and economic resource per metric tonne of cassava chip

Stakeholders	Resources		
	Technical	Economic	
		Item	Unit Cost (¢)
Farmer and processors	Chipping	Cutlasses/ Knives (C1)	20,000
		Chipping machine (C2)	7,000,000
		Water tank	1,500,000
		Engine (C2)	3,700,000
	Drying	Patio (D3)	5,000,000
		Raised racks (D2)	1,500,000
		Plastic mats (D1)	350,000
		Rakes	10,000
		Plastic sheets	120,000
	Bagging and storage	Plastics or jute sacks (B)	10,000
		Storage space	
	Planting	Planting material (cassava sticks)	20,000
Purchaser/Wholesaler	Bagging and storage	Plastics or jute sacks	10,000
		Warehouse	125,000,000
		Truck	1,000,000,000
		Hired truck	Variable
		Weighing scale	6,000,000
Feed miller/poultry farmer	Milling and blending	Weighing scale	6,000,000
		Hammer mill	16,500,000
		Extruder/pelleting machine	-
		Mixer/filler machine	-

Source: Survey data, September 2004

construction is made. The raised platforms can be constructed using local materials or the drying surface being purchased rubber mats. The major constraint associated with the construction of the patio and possibly the rubber mats is the cost and finance required. Farmers may not be able or willing to invest in these.

7.2.10 Research, extension and training needs.

Farmers Producing Cassava for Chips

According to T&CG staff, after experimentation, the best cassava planting material for chips production is the one that matures in 6 months. If the matured crop is not harvested by 9 months it turns fibrous and is not suitable for producing chips. When the cassava crop has matured the traditional system of manual harvesting is recommended since no suitable mechanical harvester is available for cassava in the areas surveyed. The reason for manual harvesting is that unless and until cassava planting is done on ridges, it will be difficult to harvest the crop mechanically without damaging the matured cassava roots.

To ensure continuous processing of cassava into chips, planting must be staggered over the year. That is planting should be planned for four specific periods during the year. This also implies that a quarter of the total land area that must be planted in a year to supply sufficient cassava for processing into chips must be planted every quarter. This must be done by every farmer participating in the pilot or the farmers must be divided into four groups based on area for each of the four groups to plant cassava during a specific quarter of the year. This way adequate cassava would be available for processing to meet the demand from traders and feed mills. Coordination and training is needed to achieve this from MoFA staff (RTIP).

To ensure quality production T&CG provided a form of extension service through their district level staff. These staff were active in organizing farmers, arranging meetings and demonstrating the process of chipping and drying. Mechanised slicers were used by T&CG with mobile groups camping and undertaking chipping and drying in different areas initially, but later encouraged farmers to chip by hand since this provided cost savings over the mechanical methods and better quality chips. The company also developed a loose set of criteria for investment in new areas including, the willingness of farmers to share part of the risk through cooperatives or private companies, and the ability to generate a minimum quantity of marketable cassava (usually a minimum of one 25 MT truckload per month). One primary concern expressed by farmers is the sustainability of the outlet for their crop in future years.

Farmers Producing Chips and Chips Producers

Farmer groups and factory chips producers need extension support to train them appropriate in the size of the chip, the drying processes to facilitate drying and also avoid contamination of the dry chips. Extension is needed in the way chips must be packaged and stored until purchased by traders.

The use of chipping machines speeds up the cassava chipping process. However, the chipped cassava using machines stick together during drying. Therefore, without regular turning, which the farmers found tedious, the chips become mouldy. It is necessary that a more appropriate and efficient designs of chipping machines are developed and tested under the pilot with the support of the engineering firms, Engineering Faculties in our Universities and food Research Institute.

Feed Mills and Feed Production

In order to control bacteria infections in cassava chips Sydals Farms Ltd. successfully used an extruding machine. The company purchased cassava chips from T&CG and after milling passed the flour through a dry extruder. During extrusion, the flour was heated to a temperature of 140 ^{o}C, which practically rendered it sterile. Heating to a temperature of 140 ^{o}C for a few minutes should be sufficient to destroy nearly all micro-organisms including sporeformers and their spores. During extrusion, the flour is cooked and the starch gelatinised which improved the palatability of the feed to the birds. Also, gelatinisation of the starch also improved utilisation of the cassava flour by the birds, since raw cassava flour tends to stick to the upper section of the mouth of the birds. It was also noted that extruding or cooking cassava flour at 140 ^{o}C have a pronounced effect on the content of aflatoxin and other mycotoxins which could be present due to the use of mouldy chips.

In the use of cassava chips in feed formulation, collaborative research effort is needed between feed millers and poultry farmers on one hand and the relevant agricultural departments of the universities and the Animal Research Institute on the other. The feed mills have the requisite know-how and experience in the formulation of feed using maize, but in substituting part of the maize with cassava flour, the protein content of the maize removed from the feed has to be compensated for. It is recommended by a poultry farmer that dried cassava leaves are also incorporated into the feed since maize has a protein content of between 11 and 14, cassava roots 1-3 percent and cassava leaves 7 percent on fresh weight basis. Cassava leaves are also rich in minerals, vitamins and all the essential amino acids except methionine and phenylalanine. The amino acid profile of the maize and cassava proteins will have to be taken into consideration and the necessary compensation made.

So far Sydals Farm has been satisfied with the use of cassava flour in poultry feed and has the necessary know-how and experience in the formulation of feed in which part of the maize is substituted with cassava flour and deficiencies compensated for with incorporation of full fat soya meal. Assistance could be sought in sharing this knowledge and experience from the company.

7.2.11 Profitability analysis of production and marketing of chips

The Net Present Value (NPV) of both the centralised and decentralised production models yielded positive ¢1,075,890,034 and ¢2,457,730,506 respectively at 20 percent discount rate and a life of 10 years.

Sensitivity analysis conducted show that the financial performance is stable with regards to 14 percent increase in cassava price, increase in the discount rate from 20 to 27 percent, and a 16 percent decline in chip price from ¢60,000 to ¢50,000 per 50 kgs.

7.3. Recommendations:

7.3.1 Production of cassava

The focus on cassava production should first be to lower the cost of production through yield increases to increase returns per unit area. The measures should include the continuous supply of improved and high yielding planting materials especially for the areas identified for animal feed cassava chips production. Training of farmers to improve agronomic and crop husbandry practices is highly recommended as an effective way of reducing unit cost of production on sustainable basis.

Planting of cassava must be planned and coordinated to ensure that harvesting, processing and supply of chips is continuous throughout the year. This will involve planning with the farmers (groups) and the chips traders and an agreement reached between all stakeholders..

Experience of T&CG concerning transportation between the field and the assemble point is that chips is transported by head loading. This is due to the absences of road infrastructure for even tractors. It is recommended that the district assemblies focus attention on the provision of feeder roads in these high potential areas.

It is recommended that the pilot production be located in districts not only producing large quantities of cassava but also experiencing relatively lower fresh cassava price. The potential areas are the transitional zones and the northern segment of the Volta Region with improve trunk roads.

7.3.2 Model for pilot cassava chips production and marketing

The recommended model for the pilot organisation of supply of cassava chips to feed mills is based on the successful model operated by T&CG in the second half of the 1990.

The pilot cassava chips production and marketing shall have three main components or operators namely:

Production of cassava chips: A decentralised system of cassava chips production is recommended. Farmers and cassava processors belonging to a group will be responsible for the production of the chips and dried cassava leaves. Each farmer or processor will process his own cassava into chips and may be assisted by the rest of the group who sell in bulk to a buying company or individuals.

Purchase and distribution of cassava chips: A purchaser or wholesaler of cassava chips in a district or a zone will be responsible for the purchase of cassava chips from the farmers and processors, and transportation and selling of the chips to feed mills and/or poultry farms.

Production of feed: Feed mill and/or poultry farms that will incorporate the cassava chips and dried leaves into animal feed.

7.3.3 Organization of farmers

Small-scale processers using simple technology (knives and sun drying on mats or patios) suit village level production and have the advantage of being located very close to the production site of fresh cassava. Farmers must be encouraged to form self-select groups of between 8 and 12 people. Each farmer should cultivate at least 0.4 ha for chips production and a minimum of 20 farmer groups must be formed in each district. Each farmer in a group should be assigned a specified quantity of cassava chips to be produced in a month, which should be a percentage of what is assigned to his or her group for the month.

7.3.4 Quality specification

No clearly defined cassava chip quality standards for animal feed formulation exist in the industry. It is recommended that the industry stakeholders (feed millers, poultry farmers associations and researchers) join forces with the Ghana Standards Board to develop standards for cassava chips. This will build users confidence and improve acceptability.

7.3.5 Cost of production

There is a need to generate a credible cassava based crop budget for the selected areas that can be used by extension officers to demonstrate to farmers that cassava farming and chips production is profitable. Similarly, the cost of producing chips at the farm level is based on information provided by farmers. It is recommended that under the pilot, effort is made to estimate accurately the cost of producing chips at the farm level in selected areas and also the private individual factory level. This should be a collaborative effort between the farmers, Extension officers of MoFA and Departments of Agricultural Economics and Agribusiness of the University of Ghana.

7.3.6 Monitoring of prices

It understand the relationships between commodities and products, it is recommended that during the pilot RTIP staff monitor and document prices of fresh cassava, chips, gari, agbelima, maize prices at farm gate, wholesale and factory gate prices to inform price negotiation and price setting.

7.3.7 Chipping and drying technology

The chipping and drying technologies recommended is based on the view that chips production is to benefit the small-scale farmers. The three first options combining manual chipping- cutlasses and knives and drying technology – mats, raise racks and patios. Chipping machines must be redesigned to make them user friendly in the rural setting for adoption.

7.3.8 Construction of drying facilities

Given the use to which the drying facilities are to put, the patios appear the most suitable in terms of durability. However, given the cost involved in construction, the farmers may have to be assisted with credit from RTIP for their construction. The cost of the other drying materials must also be supported with a credit facility from the project as incentive.

7.3.9 Research, extension and training

The agronomy, budgeting and coordination of activities of the farmers will need the support of MoFA staff (RTIP) to achieve desired targets. MoFA may also act as liaison between the farmers and the potential traders in terms of organizing meeting, negotiating prices and volumes and monitoring production to ensure quality chips are delivered and eliminate disappointments.

Extension staff must themselves be trained in the way chips must be made to facilitate drying, drying of chips to avoid moulding, the way to package and store chips until it is purchased by traders in a good state. It should not be assumed it would happen.

To control bacterial infection in cassava, even though quality control from the farm to delivery at factory gate is expected to be holistic, we recommend the use of extruding machine. The extruder heats the milled chips to about 140 ^{o}C destroying nearly all microorganisms including sporeformers and their spores. During the extruding the flour is cooked and the starch gelatinised, which improves utilisation of the cassava flour by the birds.

In the use of cassava chips in feed formulation, collaborative research effort is recommended between feed millers and poultry farmers on one hand, the relevant agricultural departments of the universities and the Animal Research Institute in developing the right formula for different classes and ages of domestic animals. A starting point could be what Sydals Farms has achieved if they are willing to share it with others.

It is recommended that all the stakeholders (farmers, MoFA staff, traders, feed millers, poultry farmers, and researchers) work together to establish a Hazard Analysis Critical Control Point (HACCP) system for feed produced using cassava chips.

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APPENDIX

(Pages 95-115)

Table 2: **Ghana national Average wholesale prices of maize in local currency (cedis), 1970 - 2004**

COMMODITY	YEAR	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	AVG.
MAIZE 100KG BAG	1970	11	12	12	13	14	13	13	12	9	9	11	11	12
	1971	11	11	12	13	14	14	13	10	10	10	12	13	12
	1972	14	16	18	23	24	25	18	12	11	13	16	10	17
	1973	17	17	19	23	25	24	21	15	14	14	16	16	18
	1974	18	19	20	22	22	21	20	21	20	22	20	21	21
	1975	20	21	22	24	27	29	27	21	19	32	30	28	25
	1976	37	39	38	43	56	68	74	59	53	63	74	79	57
	1977	87	94	96	108	179	184	155	165	83	79	94	102	119
	1978	120	129	133	123	120	138	141	132	124	144	163	143	134
	1979	142	176	149	177	210	229	174	141	175	167	151	110	167
	1980	229	223	256	327	405	589	622	396	485	383	431	619	414
	1981	605	639	710	862	1015	1030	874	824	512	701	877	633	774
	1982	656	555	555	569	903	921	1027	794	731	844	962	1050	797
	1983	1442	3820	2878	5430	6842	7846	5258	2736	2129	2460	2426	3024	3858
	1984	3446	3288	3227	3755	3361	3161	2092	1390	955	1209	1078	1088	2338
	1985	1648	1512	1608	2083	2215	2198	2479	1974	1636	1865	2896	2342	2086
	1986	2583	2985	3407	3967	3865	4383	3725	2880	2420	2830	3248	3435	3311
	1987	3728	3760	4580	5256	6040	7870	5834	5221	4730	5406	5960	6259	5387
	1988	6151	7121	9035	9017	9847	9373	7783	4952	4397	4305	4971	5354	6859
	1989	5532	5857	6539	6745	6950	6067	5633	4691	3696	3777	4682	4877	5421
	1990	5243	5636	5952	7539	9469	10099	14104	10062	6974	6977	10597	10938	8633
	1991	10782	10856	11694	12758	11935	11509	10460	7250	6169	6397	6476	6928	9435
	1992	7801	8554	10077	11708	11996	12996	13119	9185	7600	7579	9654	10306	10048
	1993	11351	11715	11657	12594	13357	12807	12061	9962	8229	8586	10081	10461	11072
	1994	10890	11388	12527	13412	15547	16596	16642	13854	12094	12701	15206	15500	13863
	1995	20992	23043	26350	29638	30658	32972	28629	18787	15941	19095	24096	26300	24708
	1996	25505	26583	28019	28010	30213	36222	35293	34567	30198	35195	39019	44947	32814
	1997	51967	56263	61763	78737	77852	77500	72994	56811	48857	54720	64022	70424	64326
	1998	71000	72340	72590	72060	64344	66510	60770	59810	44534	36049	43214	48488	59309
	1999	45074	44271	45076	45785	46082	43818	49287	46020	37666	39433	50167	49159	45153
	2000	56140	57331	73567	94507	107994	108726	117888	117457	83546	81037	116648	109118	93663
	2001	129032	132424	146851	177704	187155	181484	189489	182000	97845	102700	124580	150690	150163
	2002	144488	140520	141575	146083	153736	162075	151494	127034	102985	102540	112837	124646	134168
	2003	139759	141910	146931	141650	154432	176314	172207	154361	129746	131777	149593	157704	149699
	2004	181431	173731	180837	191008									181752

Source; Ministry of Food and Agriculture, Accra Table 3

Table 3: Production of cassava in Ghana: 1970- 2003 (Figures in '000MT)

Year	Quantity	Year	Quantity
1970	2387.8	1987	2725.8
1971	2387.8	1988	3300.0
1972	2840.0	1989	3320.0
1973	2865.4	1990	2717.0
1974	3696.1	1991	5701.5
1975	2398.0	1992	5662.0
1976	1818.5	1993	5972.6
1977	2119.0	1994	6025.0
1978	2334.3	1995	6611.4
1979	2319.9	1996	7111.2
1980	2896.3	1997	6999.5
1981	2720.6	1998	7171.5
1982	1985.5	1999	7845.4
1983	1375.2	2000	8106.8
1984	4065.0	2001	8965.8
1985	3075.0	2002	9731.0
1986	2876.2	2003	10239.3

Source: Statistics, Research and Information Directorate (SRID), MoFA, March,2003

Table 4: Production of maize in Ghana: 1970- 2003 (Figures in '000MT)

Year	Quantity	Year	Quantity
1970	481.6	1987	597.7
1971	465.4	1988	600.0
1972	402.4	1989	715.0
1973	426.4	1990	553.0
1974	485.7	1991	931.5
1975	343.4	1992	730.6
1976	286.4	1993	960.9
1977	312.2	1994	939.9
1978	269.3	1995	1034.2
1979	308.6	1996	1007.6
1980	354.0	1997	996.0
1981	334.2	1998	1015.0
1982	264.3	1999	1014.5
1983	140.8	2000	1012.7
1984	574.0	2001	938.0
1985	395.0	2002	1400.0
1986	559.1	2003	1289.0

Source: Statistics, research and information directorate (SRID), Ministry of food and Agriculture-March, 2003

Table 5: Selected data on cassava products exported from Ghana

	January-December 2001				January-December 2002			
Product	No. of Exporters	Quantity (Metric tonnes)	Value in Dollars	% Contribution	No. of Exporters	Quantity (Metric tonnes)	Value in Dollars	% Contribution
Cassava Fresh/Dried	6	15.240	3,558.00	0.00%	2	1.033	322.20	0.00%
Poultry Feed	6	490.945	105,489.73	0.13%	4	2,159.820	129,475.32	0.15%
Cassava Flour/ dough	49	160.545	81,944.68	0.02%	48	244.746	89,659.06	0.02%
	January-December 2002				January-December 2003			
Product	No. of Exporters	Quantity (Metric tonnes)	Value in Dollars	% Contribution	No. of Exporters	Quantity (Metric tonnes)	Value in Dollars	% Contribution
Cassava Fresh/Dried	2	1.033	322.20	0.00%	6	11.932	4,108.00	0.00%
Cassava chips					1	555.140	11,853.00	0.01%

Source: Ghana Export Promotion Council, Accra, 2004.

Table 6: Livestock census: 1986 to1996

Year	Cattle	Sheep	Goats	Pigs	Poultry
1986	1,134,870	1,814,242	1,632,576	468,653	6,409,709
1987	1,169,837	1,988,522	1,900,876	533,845	8,214,086
1988	1,143,812	2,045,964	1,991,217	478,344	8,039,795
1989	1,136,421	2,211,922	2,363,624	558,604	8,787,127
1990	1,144,787	2,223,599	2,018,027	473,946	9,989,889
1991	1,194,633	2,162,340	2,194,372	453,877	10,572,472
1992	1,159,431	2,125,522	2,157,278	413,243	11,231,574
1993	1,168,640	2,224,974	2,124,529	408,134	12,169,523
1994	1,216,677	2,215,964	2,204,150	351,169	12,289,376
1995	1,122,730	2,010,147	2,155,938	365,339	13,082,552
1996	1,247,861	2,418,738	2,532,710	354,678	14,589,303

Source: Statistics, Research and Information Directorate (SRID), Ministry of food and Agriculture-March,2003

Table 7: Annual growth in livestock production (ten-year period: 1986-1996)

	Year	Cattle	Sheep	Goats	Pigs	Poultry
	1986					
	1987	3.1	9.6	16.4	13.9	28.2
	1988	-2.2	2..9	4.8	-10.4	-2.1
	1989	-0.6	8.1	18.7	16.8	9.3
	1990	0.7	0.5	-14.6	-15.2	13.7
	1991	4.4	-2.8	8.7	-4.2	5.8
	1992	-2.9	-2.7	-1.7	-9.0	6.2
	1993	0.8	4.7	-1.5	-1.2	8.4
	1994	4.1	-0.4	3.7	-14.0	1.0
	1995	-7.7	-9.3	-2.2	4.0	6.5
	1996	11.1	20.3	17.5	-2.9	11.5
Diff (1996-1986)/tot%	**10**	**10.7**	**32.0**	**49.8**	**-22.1**	**88.4**
Avg. annual growth (%)		**1.1**	**3.2**	**5.0**	**-2.2**	**8.8**

Source: Statistics, Research and Information Directorate (SRID), Ministry of food and Agriculture-March,2003

Table 8: Projected livestock population (for 1997– 2007).
Based on average growth rate of the previous decade (1986-1996)

Year	Cattle	Sheep	Goats	Pigs	Poultry
1997	1,261,191	2,496,111	2,658,925	346,830	15,878,781
1998	1,274,664	2,575,960	2,791,431	339,156	17,282,229
1999	1,288,280	2,658,363	2,930,539	331,652	18,809,722
2000	1,302,042	2,743,401	3,076,580	324,314	20,472,222
2001	1,315,951	2,831,160	3,229,899	317,138	22,281,662
2002	1,330,008	2,921,727	3,390,858	310,121	24,251,031
2003	1,344,216	3,015,190	3,559,838	303,259	26,394,462
2004	1,358,575	3,111,644	3,737,240	296,549	28,727,340
2005	1,373,088	3,211,183	3,923,482	289,987	31,266,411
2006	1,387,756	3,313,906	4,119,005	283,571	34,029,897
2007	1,402,581	3419,915	4,324,272	277,296	37,037,635

Source: Statistics, Research and Information Directorate (SRID), Ministry of food and Agriculture-March,2003

Appendix 2.2: Checklist for poultry farmers and feed millers

1. When established?
2. Production calendar
3. Capacity (installed)
4. Types of poultry
5. Experience with cassava chips utilisation
6. Sources of knowledge on cassava utilisation as feed for poultry
7. Feed production process
8. Sources of raw material (chips) – group, how organised, peeled
9. Participation in pilot
10. What will you commit to the trial?
11. Quality assurance
12. Financially whether good substitute
13. Constraints faced in using chips
14. If used and stopped, why?
15. Ratio of substitution between maize and chips
16. Number of birds raised per year by class
17. Cassava chips quality specification
18. Cassava varieties with thin cover
19. How much of the chips will you buy in a month/year?
20. How much will you pay for the chips
21. In which months of the year will you buy chips

Appendix 2.3: **Root and Tuber Improvement Programme, Ministry of Food and Agriculture (MoFA)**
(Cassava farmer/processor questionnaire)

Questionnaire No……………………. Date of interview ……………….2004
Town…………………….. District …………….. Region………………..
Name of Eumerator……………………… Name of respondent……………………..

A. Demographic Characteristics of Household

1. Gender of respondent: 1. Male 2. Female
2. Age of respondent :…………………..
3. Educational level off respondent (Number of years of formal schooling) _____
4. Household size: ……… male………….. Female …………………

B. Cassava Production

5. Size of cassava farm in acres? ______________________________
6. Size of total land holding? __________________________________
7. By how many acres can you expand your cassava farm? __________
8. Have you ever been a member of a farmers group? 1.Yes 2.No
9. What were your reasons for joining the group?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

10. In what form do you sell the cassava? 1. Fresh 2. Agbelima (dough) 3. Gari . Chips 5.Kokonte 6.Others_________________
11. For the cassava products specified, where are the markets?……………………..

Product	Current Market	Alternative market
Fresh		
Cassava dough		
Gari		
Chip		
Kokonte		
Others		

If you do not sell cassava chips, go to Q 38……………………………………

C. Lessons From Past Experience With Cassava Chip Production

12. Do you produce or ever produced cassava chips? 1. Yes 2. No (if no, go to Q 4
13. Did you produce or are producing the cassava chip in a group? 1. Yes 2. No
14. Is the group still in existence? 1. Yes 2. No
15. If yes, provide name of group ____________________ and number of members ___________
16. Describe cassava chipping method used?

....
....
....

17. Describe cassava-drying method to produce chips.
....
....
....

18. Reasons for continuing to use the traditional chipping method?
....
....
....

19. Reasons for using traditional drying methods?
....
....
....

20. Distance to market (km) and associated cost (¢)? ______________________

21. Acceptability of haulage cost to buyers? 1.Good 2. Fair 3. Bad

22. In which months of the year do you produce cassava chips?________________

23. How much of cassava chips (kg) did you produce in each of these months?
....
....
....

24. If you had a ready market for the chips, how much (kg) of the cassava chips can you produce in these favourable months in the year?
....
....

25.Why do you consider these months as suitable for producing cassava chips?
....
....

D. Quality Issues

26. Which of these qualities of chips are acceptable to buyers?

Colour______________________________

Size________________________________

Moisture level_________________________

Crude fibre___________________________

Cyanide level_______________________________

27. If you are to produce cassava chip with a standard quality specification and priced at ¢45,000 per 50 kg at farm gate, would you participate in the pilot?

1.Yes 2. No

E. Cost of Chip Production

28. Production cost per 50 kg

Items	Economic life	Units	Unit Price	Total cost
Labour Input				
Washing				
Chopping				
Transport				
Drying				
Sorting				
Bagging				
Subtotal				
Other Items				
Cassava				
Knives				
Tarpaulin				
Sacks				
Pans/bowls				
Patios				
Solar dryer				
Shredder/chipper				
Subtotal				
Total				

F. Other Issues

29. Variety of cassava used for chip production? ____________________

30. Do you know of any machine for chipping cassava? 1.Yes 2. No

31. What are some their advantages?

a. ____________________
b. ____________________
c. ____________________
d. ____________________
e. ____________________
f. ____________________

32. What are some of their disadvantages?

a. ____________________
b. ____________________
c. ____________________
d. ____________________
e. ____________________

f. ____

33.What cassava chip drying methods are available for drying the chip? 1. Sun drying on the ground 2. Sun drying on the street 3. Sun drying on patios 4 Using Solar dryers 5. Mechanical dryers 6. Electrical dryers 6 others

____

34. .Advantages and disadvantages of chipping and drying technologies?

Advantages	Chipping	Drying
a.	____________	____________
b.	____________	____________
c.	____________	____________
d.	____________	____________
e.	____________	____________

Disadvantages		
a.	____________	____________
b.	____________	____________
c.	____________	____________
d.	____________	____________
e.	____________	____________

35. Sources of water supply for washing and drinking?

1. Pipe borne water 2.Bore hole 3. well 4. River/stream

5. Dam/dugout 6. Others________________________________

36. Storage place after production of cassava chips before sale?____________

37. State the shortest and longest period (days) of storage of chips before it was sold? Shortest __________, Longest ______________________

38. Do you consider that buyers will accept the incorporation of cassava leaves into the chips? 1.Yes 2. No

39. Would you grow Soya bean if there is market for it? 1. Yes 2.No 3. Do not know.

40. Do you think feed for livestock must be handled with the same care as those for humans? 1. Yes 2. No

41. Do you think contamination of any of the ingredients used in feeding livestock could cause sickness or death? 1. Yes 2. No

42. Can mouldy chips be fed to livestock? 1. Yes 2. No

43. What is your source of knowledge for producing cassava chips?________

G. Willingness to participate in pilot

44. Are you willing to join a group to produce cassava chips for the market?
1.Yes 2. No

45.If you are not a cassava chip producer, what quantity in kilogramme's can you produce in a year? ________________. If you are already producing cassava chips, by how many kilograms will you increase production in a year?

____

46.How will you like to fix the price of chips for a stable market or buyer?

....

....

47. Name **three (3)** staples consumed by your household **in order of importance**. 1. Cassava....... 2. Cocoyam..... 3. Plantain.... 4. Yam......5. Taro.... 6. Maize..... 7.Rice.... 8. Sorghum/Millet...... Others.................

Appendix 2.4: Agricultural cooperatives in Ghana, January 2004

REGION	NUMBER
GREATER ACCRA	8
EASTERN	46
ASHANTI	95
BRONG AHAFO	48
CENTRAL	32
WESTERN	43
VOLTA	22
NORTHERN	14
UPPER EAST	11
UPPER WEST	8

Source: Department of Co-operatives, Accra, Ghana, 2004

Appendix 4.1: Hazard Analysis and Critical Control Points (HACCP) First Steps in the Development of a HACCP Plan

1. Assemble the HACCP team (in a small plant this may be one individual).
   This team should consist of individuals who have specific knowledge and expertise appropriate to the product and process. It is the team's responsibility to develop each component of the HACCP PLAN. The team should be multi disciplinary. These individual should have the knowledge and experience to correctly; (a) identify potential food safety hazards; (b) assign levels of severity and risk; (c) recommend controls, criteria, and procedures for monitoring and verification; (d) recommend appropriate corrective actions when a deviation occurs, (e) recommend research related to the HACCP plan if important information is not known; and (f) predict the success of the HACCP plan.

2. Describe the food and its distribution
   This consists of a full description of the food including the ingredients recipe or formulation. The method of distribution should be described along with information on whether the food is to be distributed frozen, refrigerated or shelf-stable. Considerations should also be given to the potential for abuse in the distribution channel and by consumers.

3. List of Ingredients, identify use and the consumers of the food/feed
   The intended use of the food should be based upon the normal use of the food by end users or consumers. The intended consumers here may be the general livestock population or a particular segment of the population, such as poultry.

4. Develop flow diagram
   The scope of the flow diagram must cover all the steps in the process, which are directly under the control of the establishment. In addition, the flow diagram can include steps in the food chain, which are before and after the processing that occurs in the establishment. For the sake of simplicity, the flow diagram should consist solely of words, not engineering drawings

5. Verify flow diagram
   The HACCP team should review the operation to verify the accuracy and completeness of the diagram. The diagram should be modified as necessary.

6. Conduct Hazard Analysis

Then you are ready to begin developing your HACCP plan though the seven principles of HACCP:

Principle One: Hazard Analysis

Conduct a hazard analysis. Prepare a list of steps in the process where significant hazards occur and describe the preventive measures.

Principle Two: CCP Determination

Identify the critical control points (CCPs) in the process. A CCP is one at which control can be applied and as a result a food safety hazard can be prevented, eliminated or reduced to an acceptable level. An example is the packaging material for chip transfer.

Principle Three: Critical Limit Determination

Establish critical limits for preventive measures associated with each identified CCP. Example: set the maximum or minimum value to which a physical, biological or chemical hazard must be controlled at a CCP.

Principle Four: Development of Monitoring Procedures

Establish CCP monitoring requirements. Establish procedures for using the results of monitoring to adjust the process and maintain control.

Principle Five: Development of Corrective Action Plans

Establish corrective action to be taken when monitoring indicates that there is a deviation from an established critical limit.

Principle Six: Development of Record Keeping Procedures

Establish effective record keeping procedures that document the HACCP system. Document that each CCP is under control and verify the adequacy of the HACCP plan.

Principle Seven: Development of Verification Procedures

Establish procedures for verification that the HACCP system is working correctly.

Appendix 5.1: Investment cost estimate for cassava chips production for

centalised system

	Quantity	Cedis (¢)	Life in Years	Annual Depreciation
A. Land building & equipment				
1.Land (ha)	0.4	5,000	50	100
2.Factory building		25,000	50	500
3.Electricity to factory		3,000	20	150
4.Water to factory		3,000	20	150
5.Water tank (1,500 litre		2,500	10	250
capacity)	2(10m	10,000	10	1,000
6.Construction of patios	x10m)	6,000	10	600
7.Weighing scale		1,000	4	250
8.Plastic bowls/aluminium		**55,500**		**3,000**
containers				
Sub total				
		400	5	80
B. Office equipment	1	5	2	2.5
1.Tables	10	200		200
2.Chairs		**1,605**		**483**
3.Kitchen stool				
4.office materials				
Sub total		400	**3**	133
	20			
C. Accessories		**57,505**		**3,616**
1.Stainless steel knives				
Total capital investment required		55,500		
Summary of total investment		1,605		
cost		400		
		57,505		
A. Factory building and related		Total working		

costs	Per month	capital		
B. Office equipment and	70,000	105,000		
furniture	4,775	7,258		
C. Accessories	4,000	6,080		
Total fixed capital	1,392	2,116		
investment	2,875	4,370		
	5,920	8,998		
Working capital required	2,000	3,040		
Cassava				
Labour		136,862		
Transport				
Utilities				
Repair and maintenance				
Packaging materials				
Distribution cost				
Working capital requirement				
for 1.5 months				

Source: survey data 2004

Appendix 5.2: Investment cost estimates for cassava chips production

A. Drying mats & knives	Quantity	Cedis(¢)	Life in Years	Annual Depreciation
1. Drying mats	10	350,000	3	116,667
2. Stainless steel knives	20	400,000	3	133,333
Sub total		750,000		250,000

Source: Survey data 2004

Appendix 5.3: Raw material requirement producing at full capacity in centralised system

Number of working hours/day	8
MT of cassava required/ hour	1
MT of cassava required/day	8
Number of working days/month	25
MT of cassava required/month	200
Number of working months	7
MT cassava required/year at full capacity	1400
Price of cassava/ mt	350,000

Value of fresh cassava/year	490,000,000.00

Source: 2004 survey data

Appendix 5.4: Raw material requirement producing at full capacity in decentralised system

Number of farmers in the group	20
Number of groups in a district	10
Number of farmers	200
Cassava supply/farmer	8
MT of cassava required per year	1600
MT of chips/ year	1067
Price of cassava per mt	350,000
Value of fresh cassava/year	560,000,000.00
MT of cassava/month	229
MT of cassava chips/month	152

Source: 2004 survey data

Appendix 5.5 Estimation of operating costs in cedis for centralised system

Personnel	Number	Salary per Month	Total salary per month	Total per year
Direct labour				
Supervisor	12	500,000	500,000	
Chipper operators	1	375,000	3,375,000	6,000,000
Labourers	9	450,000	900,000	33,750,000
Sub total	2		4,775,000	9,000,000
				48,750,000
Add 32.5% for medical expenses Social security, and others			1,551,875	15,843,750
Total personnel cost			**6,326,875**	**64,593,750**

Utilities and others				
Electricity	12	30	1,350,000	10,800,000
Water	25	25	41,875	335,000
Packaging materials	7400	2,000	14,800,000	14,800,000
Repair & maintenance			2,875,250	20,126,750
Sub total				46,061,750
Indirect cost				
Transport	200	20,000	4,000,000	28,000,000
Bank charges			60,000	720,000
Cleaning and hygiene			50,000	600,000
Stationary			100,000	1,200,000
Marketing and distribution				2,000,000
Sundry expenses				
				32,520,000

Source: Survey data 2004

Appendix 5.6 Estimation of operating costs in cedis for decentralised system

Personnel	Number	Salary per Month	Total salary per month	Total per year
Labourers	2	450,000	900,000	9,000,000
Sub total			900,000	9,000,000
Utilities and others				
Packaging materials	7400	2,000	14,800,000	14,800,000
Sub total				14,800,000
Indirect cost				
Transport	162	20,000	3,048,571	21,340,000
Sub total				21,340,000

Source: Survey data 2004

Appendix 5.7 Projected balance sheet for centralised system (thousands of cedis)

Years	0	1	2	3	4	5	6	7	8	9	10
Assets											
Accumulated cash	3,1862	217,357	535,754	971,994	1,413,676	1,860,800	2,313,366	2,771,375	3,229,384	3,687,392	4,145,401
Inventory	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000
Accounts receivable	0	0	0	0	0	0	0				
Current assets	136,862	322,357	640,754	1,076,994	1,518,676	1,965,800	2,418,366	2,876,375	3,334,384	3,792,392	4,250,401
Building & equipment	57,505	57,505	53,889	50,273	46,658	43,042	39,426	35,810	32,194	28,578	24,963
Less accumulated Depreciation	0	-3,616	-3,616	-3,616	-3,616	-3,616	-3,616	-3,616	-3,616	-3,616	-3,616
Fixed assets	57,505	53,889	50,273	4,658	43,042	39,426	35,810	32,194	28,578	24,963	21,347
Total assets	194,367	376,246	691,028	1123651	1,561,717	2,005,226	2,456,176	2,908,569	33,629,621	3,817,355	4,271,748
Current liabilities Accounts payable	0	0	0	27,211,440	27,211,440	27,211,440	27,211,440	27,211,440	0	0	0
Total asset Less current liabilities	194,367	376,246	691,028	1,096,440	1,534,506	1,978,014	2,426,965	2,881,358	3,362,962	3,817,355	4,271,748
Financed by **Equity** Common Stocks	583,102	240,189	554,971	987,594	1,452,872	1,923,591	2,399,753	2,881,358	3,362,962	3,817,355	4,271,748
	0										
Retained earnings	583,102	240,189	554,971	987,594	1,452,872	1,923,591	2,399,754	288,1358	3,362,962	3,817,355	4,271,748
Total equity	136,057	136,057	136,057	108,846	81,634	54,423	27,211	0	0	0	0
Loans (debenture)											
Total equity & long term loan	194,367	376,246	69,028	109,6440	1,534,506	1978,014	2426,965	2,881,358	3,362,962	3,817,355	4,271,748

Source: survey data 2004

Appendix 5.8 Estimated Payback period for centralised system

Year	0	1	2	3	4	5	6	7	8	9	10
Initial											
investment	57,505										
Fixed											
assets											
Initial	136,862										
working	0	665,280	887,040	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800	1,108,800
capital	0	420,711	541,431	650,791	650,791	650,791	650,791	650,791	650,791	650,791	650,791
Sales	0	0	0	0	0	0	0	0	0	0	0
Operating											
costs	-	244,569	345,609	458,009	458,009	458,009	458,009	458,009	458,009	458,009	458,009
Tax	194,367										
	0.2										
Net cash		203,807	240,006	265,051	220,876	184,063	153,386	127,822	106,518	88,765	73,971
flow	-										
Discount	194,367										
rate											
Discounted		9,440	249,446	514,497	725,373	919,437	1,072,823	1,200,645	1,037,163	1,395,928	1,469,899
net cash											
flow	-										
	194,367	192,574	214,278	223,595	176,059	138,629	109,157	85,950	67,677	53,289	41,960
	1 year										
Cumulative		- 1,794	212,484	436,079	612,139	750,768	859,925	945,875	1,013,553	1,066,842	1,108,802
disc. Cash	-										
flow	194,367										
Pay-back-											
period	-										
Discounted	194,367										
cash flow											