CENTRALIZED GRAIN STORAGE IN GHANA: A FEASIBILITY ANALYSIS

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CENTRALIZED GRAIN STORAGE IN GHANA: A

FEASIBILITY ANALYSIS

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ABSTRACT:

The focus of this analysis is to determine the feasibility of developing a centralized grain storage facility in the Ejura-Sekyedumase district of the Ashanti Region of Ghana,West Africa. This district is known for its production capacity and is considered the "corn basket" of the Ashanti Region. Maize producers in the Ejura-Sekyedumase district face the perpetual cycle of postharvest losses largely due to ineffective grain storage practices. Currently, aflotoxin producing organisms, grain borers, mold, and maize weevils often invade grain stored in the district. These infestations lead to quality and quantity losses. The value of grain storage in the Ejura-Sekyedumase district, to a market driven producer, is a function of price seasonality, value loss prevention, capital, and opportunity cost. A properly constructed grain storage system can effectively reduce grain storage pests and losses and thereby increase potential revenues. However, to be sustainable, storage systems require that they be profitable for producers. This study builds on previous grain storage research providing a model for the construction of economically viable grain storage systems in the Ejura-Sekyedumase district of the Ashanti Region, Ghana.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

Based on current growth rates, the world population is projected to double from more than 6 billion to more than 12 billion in less than 50 years (Mataruka, 2009). Population and consumption growth means that the demand for food will increase for at least another 40 years. As a result, a global strategy is needed to insure food security. Food production has increased in the past half-century, yet more than one in seven people today still lacks access to sufficient protein and energy in their diet, and. even more suffer from chronic hunger and malnourishment (Godfray, Beddington et al., 2010). Food producers are expected to meet the challenge of producing enough to feed the growing population.

One way to feed more people is to reduce postharvest waste. Corn (maize) is a staple food in most African countries, and serves as a strategic grain. Producers in developing countries often struggle to preserve and secure food after harvest. This is largely due to inefficient drying and storage facilities. Many producers in developing countries are small-scale famers who lack access to advanced agricultural machinery that will reduce labor and increase production. Small-scale Ghanaian maize producers tend to act collectively or form cooperatives to help tackle some of the social and economic problems they face. Cooperatives range from informal information networking to legal entities. Nso Nyame Ye Women's Cooperative (NNYWC) in the Ejura-Sekyedumase district of the Ashanti Region of Ghana faces the problem of postharvest losses. Maize harvested in the Ejura- Sekyedumase district of the Ashanti Region in Ghana is traditionally dried in open areas. Farmers spread grain on the side of the road or in an open field leading to pest infestation, mold, aflatoxin, and reduced quality and quantity.

Inefficient grain storage practices increase the level of postharvest loss and contribute to the perpetuating cycle of food insecurity in the Ejura-Sekyedumase district.

Objectives of Study

The objective of this study is to determine the economic feasibility of constructing and operating a grain storage facility in the Ejura-Sekyedumase district of the Ashanti Region of Ghana. If a centralized grain storage facility can prove to be economically viable then investing in the grain storage facility will be considered feasible. The objective will be fulfilled by: (1) determining the kind of grain storage facility that might be economically viable in the Ejura- Sekyedumase district; (2) determining the cost of the centralized grain storage; (3) determine the profitability of grain storage; (4) determining the minimum scale, volume of production requirement for a profitable enterprise; and (5) estimating the supply of corn in the Ashanti Region and determining the required storage capacity for the Nso Nyame Ye Women's cooperative. In completing these objectives, a model will be developed to estimate potential earnings over a ten year period. The model will be constructed using numbers derived from the Nso Nyame Ye Women's cooperative action plan and include assumptions that will be based on project estimates consistent with previous research conducted with regard to grain storage enterprises.

Benefits of Study

This study will be useful to potential agribusiness investors, the ministry of agriculture, and other governmental agencies interested in agriculture development projects. For individuals interested in opening a grain storage facility and grain processing plants this business model will assist in answering questions about potential profitability, net present value, benefit cost ratio, rate of return and break even period. These factors are essential in determining if opening and operating a grain storage facility is profitable. Intuitively, anyone interested in a business venture would prefer to maximize profit and understand cash flow. This study will be beneficial to famers both directly and in-directly in assisting them in understanding the importance of implementing proper post harvest practices and the impact of this practice on their bottom line.

CHAPTER II

REVIEW OF LITERATURE

Grain quality is important for producer's profitability. Therefore, the proper post-harvest storage system must maintain and/or improve grain quality. Grain companies understand this and invest in technologies that maintain the quality of their grain from harvest to purchase. However, in most developing countries, like Ghana, grain production is in the hands of small-scale producers who lack access to modern farm technologies and facilities. This means producers are forced to store their grain in their homes or on their farms. The grain is often stored in unsuitable conditions under fluctuating temperatures and humid conditions. Poorly stored grain will ultimately result in reduced grain quality as well as reduced weight.

Maize producers in Sub-Saharan Africa have been challenged for centuries by post-harvest losses from insect infestation, molds, and rodents. Small scale farmers are the most vulnerable because the lack of knowledge and capital needed to invest in proper storage technology. According to Jones el al. (2011), "escalating post-harvest maize grain losses in Sub-Saharan Africa have reached the highest level in recent history with the accidental introduction of the storage pest *Prostephanus truncatus*, or Larger Grain Borer (LGB), into Eastern and Western African in the late 1970s and early 1980s" (Jones, Alexander et al., 2011).

Grain Storage History

Komlos and Landes (1991) explained the controversy over the nature of grain storage in medieval Europe that was initiated with a thesis by (McCloskey and Nash, 1984). McCloskey and Nash were challenged by Fenoaltea (1984) who created an argument about the economics of grain storage. Moreover, according to Komlos and Landes (1991) the concept of grain storage was brought forth by lucid risk-adverse farmers who wanted to insure against inadequate harvest as well as the prevention of starvation. “Fenoaltea suggested a less costly form of self insurance, namely storage. He argued that grain inventories were, in fact, considerable already in the middle ages, and holding such stores was a less expensive way of insuring against disasters than scattering” (Komlos and Landes, 1991).

McClosky and Nash (1984) suggest that grain storage systems were irrelevant in the medieval world because they were costly and the interest rates were too high and the scattering of fields was preferable over storage as a form of insurance. Fenoaltea was unconvinced and further explained “McCloskey and Nash suggest that grain storage was a form of investment; consequently farmers would have kept stocks only to the extent that they were economically warranted. Grain would have been stored if doing so would have covered the cost of the barn and the guards, the depreciation of the grain, and the opportunity cost of the funds invested”(Jones, Alexander et al., 2011).

Moreover, it is explained that due to high interest rates, storage was uneconomical in the middle age, causing producers to “live from hand to mouth” (McCloskey and Nash, 1984). The same is true today in developing countries, small-scale famers lack the capital needed to construct grain storage that could provide insurance against starvation as well as economic freedom. Grain stocks serve as a form of savings and investment for producers, giving them the opportunity to purchase needed inputs and equipment to increase production. Thus, grain stocks serve as both a form of investment and as a means to manage food security.

There is a commonality between medieval Europe and today's developing countries. In most developing countries the average producer is a subsistence farmer whose total production and profits are often low. Producers in developing countries often cling to every bushel of grain, and sell the surpluses after feeding their families. The relationship between grain storage and interest rate is a foreign concept to most producers in developing countries. These farmers have difficulties storing their grain; even storing enough for personal consumption. The conversion of grain stocks into an investment opportunity or a financial instrument is not a familiar concept to many subsistence farmers in Ghana. If farmers in Ghana were able to sell and buy grain at will and internally use the funds obtained to make profitable investments they could increase their living standards, improve agricultural practices, and create financial institutions for farmers.

Grain Storage in Medieval England

The concept of grain storage dates back to the Medieval England as explained by McCloskey and Nash (1984). The authors explained the economy of grain storage to be a simple kind of insurance that could substitute for scattering. Moreover, there is a correlation between storage cost and the existing interest rate in the grain market because storage is viewed as an investment. Stored grain over a period of time must cover the cost of the shed and security, depreciation of grain as well as the opportunity cost (rate of interest) of funds invested. The authors further explained that, in the medieval ages, storage was neglected. (McCloskey and Nash, 1984). because “medieval Europe did not know how to store grain or accumulate reserves”(Komlos and Landes, 1991). Stefano Fenoaltea attempted to illustrate the estimate of carryover grain in dimensions of monastic barns. He estimated that “the monastic barns alone could hold enough grain to feed England’s human population for over a year and half” (McCloskey, 2001).

McCloskey and Nash (1984) disagreed because they felt that Fenoaltea did not consider storage of seed. The correct estimation was suggested to be “barn capacity = consumption + seed + carryover” (McCloskey and Nash, 1984). McCloskey and Nash further explained why storage of grains for food was not common in that it was expensive. “The cost of storing a bushel of wheat is the cost of the barn per bushel plus the loss in value of that grain rotting in storage plus the expected percentage loss of capital value due to falls in the price per bushel plus the opportunity cost of the interest forgone on the sum expended on the bushel”(McCloskey and Nash, 1984).

Examples of grain storage in countries with weather and economy similar to Ghana

Adda et.al. (2002) conducted large-scale experiments in maize storage in Togo. Togo borders Ghana and has similar environmental conditions. The authors explained that post-harvest losses experienced in Togo (West Africa) are largely caused by pests such as the weevil *Sitopphilus zeamais* and Anagoumois. They further explained that famers in Ghana, as in Togo, have been introduced to alternative chemical interventions as the means to help solve pest problems. However, due to economic constraints, the strategies have not been adopted in several West African countries. Misuse of the chemical intervention strategy poses a health hazards for famers and their families and high death rates associated with misuse and over-application have been reported in Benin. Despite the introduction of the chemical strategy, larger grain borer infestations in rural maize stores are still a problem for small-scale farmers.

Integrated control techniques using natural enemies to reduce pest infestations in maize stores were also introduced. The techniques include removing visually damaged maize cobs prior to the storage of early harvested maize. The authors concluded that non-chemical stored product protection is a feasible alternative for Togo (Adda, Borgemeister et al., 2002). The Adda et. al. research further discusses the influence of storage practices on aflatoxin contamination in maize with a focus on Benin, West Africa. The study explains the difference in grain storage units in the Southern and Northern regions of Benin. Southern storage units were constructed from plant-based materials, while the Northern region of Benin had storage facilities built from clay. Lack of capital for small-scale farmers makes them vulnerable to different post harvest problems. Small-scale farmers often leave maize on the floor in a corner of a room or the courtyard, where maize has immediate contact with the floor, increasing the risk of *Aspergillus* and other fungal developments, making products inedible and decreasing the quality and market price, and contributing to food insecurity. Small-scale famers do not react to storage problems or treatments as the solution to reduce pest invitation in grain as commercial insecticides and traditional protectants like leaves, pepper, and ash mixed with sand or smoke are costly and time consuming without a guarantee of success (Hell, Cardwell et al., 2000).

In a presentation at the 3rd African Association of Agricultural Economists (AAAE), (James, Adda et al., 2007) provided an insight on grain storage losses and the effects on food security in developing countries. Grain storage helps even out fluctuations in the market supply of maize from one season to another. Although the importance of grain storage is recognized, the impact of stored product is undermined by destructive storage pests like the weevil and larger grain borer (LGB). As an illustration, the authors indicated that the impact of LGB occurred in Togo in 1984, causing grain loss of up to 30.2% after six months (Adda, Borgemeister et al., 2002). The authors report that in Benin, the percentage of stored maize lost was approximately 23%, while in Tanzania the estimated loss was 34% and in some extreme cases, 70-80% of the maize grain was damaged, making the grain unfit for the market and consumption . Although, small-scale farmers experience post harvest loss due to pest infestation, modern technology can help minimize the effect of molds, insects, and rats from damaging stored commodities such as maize, and therefore can reduce the chance of high food prices.

Storage technologies such as actellic super, super grain bags and metal silos are available in the market, but small scale farmers have not adopted these new technologies because little is known about the technology or its economic advantage. Importantly, these technologies are expensive and famers in developing countries lack the capital to invest in such innovations. Moreover, small-scale famers lack the financial capacity to own such innovations and the ability to adopt and use it in their circumstances (James, Adda et al., 2007) . An evaluation of storage techniques and trends in developing countries was explained in a Food and Agriculture Organization of the United Nations (FAO) bulletin in 1994 explaining the cost, risk and benefits to famers. Prior to the construction of grain storage facilities in a developing country a needs assessment is necessary to understand where grain storage fits into the farming community. Knowing that the "storage will only be attractive to farmers, traders or governments if the perceived benefits substantially outweigh the cost. Technical superiority is generally insufficient (although it can be attractive for its prestige value), and farmers and traders are likely to tolerate high storage losses before undertaking complex or expensive changes to their storage system" (Proctor, 1994).

To help reduce post harvest loss and invest in innovations that will minimize waste, formation of agricultural cooperatives might be beneficial to small-scale farmers in Ghana. Cooperatives in developing countries such as Ghana are not as profitable as those in the United States. Cocoa is the largest exported and most profitable commodity in Ghana. Should Ghana have successful profitable agricultural cocoa cooperatives, producers will be able to gain confidence in the formation of other community based cooperatives. (Cazzuffi and Moradi, 2010) evaluated why cooperatives fail by studying Ghanaian cocoa producers. Cooperatives represent an effective institution for solving problems faced by small farmers. Small-scale farmers often form cooperatives to undertake a new market, to achieve better prices in the existing market, to provide access to capital, and knowledge sharing. Another important reason for cooperative formation is that economies of scale that can be obtained. (Coulter and Onumah, 2002) presented a study of Ghana and Zambia that examined the role of third party warehousing services as a means to enhance African agriculture. Furthermore, the authors explained that high profits could be earned from intra-seasonal storage of grains in both Ghana and Zambia. Establishment of public warehousing services is difficult in grain producing areas due to the risk of low capacity utilization. In general "warehousing services are normally most developed in port areas, involving both bonded and non-bounded cargo entering international trade. Warehousing skills developed in this environment are largely transferable to up-country storage situations, and while the latter have tended to be a preserve for enterprises, port or urban warehousing concerns may get involved in the future” (Coulter, Sondhi et al., 2000). Moreover, Coulter et. al. (2002) point out that “most of Ghana’s trade is carried out by a myriad of small informal traders, each of them moving an insignificant portion of the crop. No Ghanaian grain trader markets as much as 10,000 tones of domestic grain a year”.

Profitability of Maize Storage Techniques in Kwara State, Nigeria

Maize is a key staple food in Ghana, consumed in various forms by virtually every household in Ghana. In Ghana and most of Africa, the maize grain is stored for both seed and food. Nigeria, another West African country in close proximity to Ghana, has climatic and growing conditions that are similar to those of Ghana. And, Nigeria’s storage systems are the mostly local aboriginal structures as they are in Ghana. (Adetunji, 2009) explains the grain storage structures in Nigeria:

> “They are constructed from a wide variety of locally available materials such as paddy straw, split bamboo, reeds, mud, timber, bricks, etc. Most of these structures were not found to be suitable for storage of quality grains over a long period. People who became involved in grain storage were the peasant farmers who produced the grains mostly in small quantities all over the country and usually disposed of them soon after harvest or stored some for household consumption”.

The same storage characteristics can be found among Ghanaian farmers. Lack of proper storage systems often lead farmers to dispose of their grains at harvest. Adetunji (2007) also explains the behavior of other grain producers that are involved in large-scale enterprises such as breweries, flourmills and consumer food industries. These industries always have grain silos nearby for short-term stocks (Adetunji, 2007). Government and other agriculture institutions also store grain for their purpose of selling to processing facilities. Moreover, three types of grain storage systems exist including: (i) local storage techniques at the domestic level (e.g., cribs, open field, platforms, roofs and fireplaces); (ii) semi-modern storage techniques at the domestic level (e.g., ventilated cribs, improved rhombus, and brick bins; and (iii) modern centralized storage at the commercial level (e.g., silos, warehouses). Farmers often make suitable storage decisions based on affordability (Adetunji, 2007). The Adetunji study illustrates that 38% of farmers use local storage systems, 31% did not store their maize, 21% used semi-modern techniques and 11% used modern storage techniques. Most Nigerian farmers store grain for household use – suggesting local storage is commonly used among grain producers and traders in Kwara State, Nigeria. However, modern storage systems (e.g., silos, and warehouses) were the best techniques based on the gross margin and rate of return (Adentunji, 2007).

Grain Storage in Ghana

Like many West African countries, small-scale farmers in Ghana face the problem of post harvest loss. Inefficient grain storage systems make harvested maize more susceptible to mold and insect infestation. Armah and Asante (2006) concluded that though Ghana is about 99% self-sufficient in domestic maize production, maize prices are high in the post-harvest season due to poor storage, distribution difficulties, and market demand. This contributes to increased poverty levels since many people in the rural areas do not have the purchasing power to buy maize in the post harvest season. Moreover, traditional maize storage systems in Ghana contribute to food insecurity (Armah and Asante, 2006). Inefficient technology and storage practices play a part in the maize price variability.

Reportedly, 78% of maize traders in Ghana indicated the need for a warehouse in the marketplace for maize storage purposes (Armah and Asante, 2006). Maize prices are generally low during the major harvest season (August- October) as farmers sell their output immediately after harvest. Maize prices are at the highest during the minor season (January to February). The length of storage of maize during the minor season influences maize availability in the country. Moreover, stored maize from the minor season is insufficient to eliminate the availability-gap or stabilize maize prices in the post-harvest season.

There is a direct correlation between inadequate maize storage in the post-harvest season and food insecurity in Ghana. Armah and Asante (2006) stated, “there is no standard method for appraising the efficiencies of the traditional maize-storage systems”. Developing countries such as Ghana lack the institutions, resources, and policy needed to regulate and appraise agriculture commodities, as they often do not support farmers. Different organizations and strategies, such as the Ghana Food Distribution Corporation's (GFDC) Cocoa Marketing Board (CMB) and Action Aid, establish warehouse and silo projects to promote maize storage and stabilize maize prices. Many of these projects are now idle and rusting.

Armah and Asante (2006) relied on socioeconomic and behavior characteristics of farmers to understand the factors influencing grain storage decisions in the Ghanaian maize industry, to overcome maize shortages in the country and to reduce high grain prices by providing storage policies. This task was difficult since many famers kept minimal or no farming and marketing records. The authors used an integration of direct and indirect analysis to cross check ineffectiveness of current maize storage facilities. Evaluation of traditional maize storage cribs was considered by assuming a perfectly competitive market that utilized the temporal pricing model of (Tomek, 2000) to appraise storage opportunities. The empirical results suggested 38% of producers store maize until the post-harvest season, while 58% indicate selling their maize immediately after harvest. Further analysis suggested that maize stored until the post-harvest season is from the minor season (February) and sold between May and July (Armah and Asante, 2006). Moreover, the authors explained that 72% of the farmers and traders interviewed were aware of market prices, yet sell their maize immediately after harvest to meet cash needs, while 42% indicate storing until the post-harvest season to sell for high future prices and less than 50% of farmers owned a storage barn or crib. The authors concluded that "maize prices are at their highest in the post-harvest season suggesting that maize storage is inadequate and that there is poor maize security to storage relationship". Producers often sell their maize immediately after harvest to meet cash needs because of the general capital shortage for producers. Overall, results of the study indicate that there is an opportunity for long-term grain storage systems.

The Role of Agriculture Cooperatives in Grain Storage Systems

An average machinery cost saving of 35% per acre for a small grain farm in Saskatchewan that jointly owned farm equipment with at least two other farmers instead of individual ownership (Long and Kenkel, 2007). Chambo (2009) from the Moshi University College of Co-operative and Business Studies in Moshi, Tanzania further explains agriculture cooperatives in Africa. Historically, agricultural marketing cooperatives have been the most popular mode linking developing countries with the rest of the world through exporting. Traditionally, small scale farmers form marketing based cooperatives that combine agricultural input supply and output marketing- that is critical in meeting the needs of small scale farmers' production requirements. Furthermore, Chambo (2009) explains:

> "In Tanzania, Kenya, Uganda, Ghana, and Nigeria, cooperatives were established to make coffee, cotton, cashew nuts and cocoa. The development of food marketing cooperatives was associated with post colonial governments, when they realized the organizational importance of the cooperative enterprise for the development of the whole country. It is historically obvious that the structure of traditional agricultural cooperatives is directly affected by the shocks of declining world market prices because; Africa has not changed its pattern of production and consumption" (Chambo, 2009).

Moreover, there is a division between financial institutions and agricultural cooperatives. Lack of capital and interest from financial institutions makes the agriculture cooperative movement in Africa unstable and disjointed and results in difficulties for Africans trying to solve many of their market problems. An investment from financial institutions could affect small-scale farmers' productivity and increase market access. Access to capital for small-scale farmers could improve rural development in terms of employment creation, rural market development and access to social services. Agricultural cooperatives may be an important component in rural development because of their ability to create employment for the rural community (Chambo, 2009).

The food crisis of the 1970s led to the formation of the Group for Assistance on Systems Relating to Grain After-Harvest (GASGA). Later known as the Global Postharvest Forum (PhAction), the group's main objective was to reduce postharvest loss. The largest initiative was the Prevention of Food Losses program of the 1980s and 1990s. PhAction fell apart in the early 2000s. Economically, one can argue that the increase in food prices in 2007 was also positive – though it presents a threat to food security, it created an opportunity for farmers to benefit from high food prices and increased demand. The recent food crisis depicts the need for action against postharvest loss.

Although, the advancement in farm equipment may help reduce labor costs and increase productivity, many farmers do not have the purchasing power needed to own this equipment. In a stable environment, farmers are able to form a cooperative to help minimize the cost of owning farm machinery. Farmers often have an understanding of equal access to the equipment and an agreement regarding repair costs.

(Carlberg, Ward et al., 2006) explained the success factors for new generation cooperatives. The success of new generation cooperatives lies in the planning, development, financing and cost of the organization. They noted that farms in the United States have a long tradition of cooperative behaviors. In 2002, there were 2.8 million members in 3,140 farmer cooperatives, created jobs for 166,000 people, and earned net incomes of over $3.1 billion with a net worth of $20 billon.

The most important reason for the formation of cooperatives is the economies of scale that famers are not able to realize individually. Carlberget al (2006), maintain that cooperatives, if organized correctly, can be highly profitable, boost employment and promote economic development. Agriculture cooperatives play a significant role in food security and rural development. (Long and Kenkel, 2007) explained the structural considerations for machinery cooperatives. Individual farm agricultural machinery ownership and operation are too costly, allowing producers in the United States to form machinery cooperatives enabling them to become more efficient by spreading the cost of the machinery across more producers and saving on labor expenses associated with maintenance. The authors also reported that machinery costs represent approximately 20-30% of the total production costs for corn and soybeans, making it necessary for small farmers to spread the equipment cost over increased acreage. Kenkel and Long (2006) explain that as in developing countries, small farm producers in the US lack capital investment for emerging farm technology that could increase production efficiency. By forming a cooperative small farm producers can alleviate the high cost of farm machinery.

Role of Grain Drying

Drying grain to a moisture content which will allow long term storage is an essential component of a storage system. For corn tolerable moisture content ranges from 13% to 15.5% storage moisture. The current method for drying grain in the Ejura – Sekyereduamase district is to spread corn out in an open area on the field or on concrete close to the road. The most common drying system explained by (Jayas and White, 2003) is the controlled drying system consisting of fans at the base of a granary, blowing air under stored grain. (Rausser, Perloff et al., 1985) point out that an economic efficiency for drying and storage technologies in the Ejura- Sekyedumase district of the Ashanti Region of Ghana is needed to evaluate the cost, benefit, and efficiency for the construction of a grain storage facility. A needs assessment was completed in the district in 2010. However, an evaluation of the grain storage economic efficiency is still needed.

Solar Heat for Grain Drying

Modern solar grain dryers offer a potential alternative for small-scale famers in the Ejura- Sekyedumase district of the Ashanti Region of Ghana. (Tayeb, 1986) explained, "for safe, long-term storage of agricultural produce, maximum moisture content has been determined (known as the sage storage moisture content), below which produce can be store for a definite duration without the possibility of spoilage at ambient temperatures". The use of solar energy is considered an option to replace sun drying for crops; however, alternate drying methods will be needed during the rainy season in Ghana when there is reduced sunshine. Tayeb (1986) further described the design of the rotary dryer, explaining that wet grain enters at one end of the cylinder, and dry material discharges at the other end. The economics of solar drying indicate the cost of a solar dryer is offset by the saving of at least 50% in fan and power costs. Since drying can be done rapidly, this may result in reduced fuel costs if solar heat is used instead of fuel heat. In conclusion, Taybe (2006) noted that for the required levels of heat needed to dry grain, the solar rotary dryer is an inexpensive and efficient method.

Solar energy could be beneficial in Ghana (Sub-Saharan Africa) because it is fairly hot during the day and the energy can be harnessed and used for the storage facility. "The machine shed roof and sidewall collector can produce about 2,000,000 Btu/day in the fall in Lincoln, NE. A high temperature dryer might use 50,000,000 Btu/day to dry 10 pints of moisture from 3,000 bu/day. The collector could replace about 4% of the purchased energy, or about 24 gal/day of LP" (Spillman, Bern et al., 1980). The solar drying system was not modeled in the feasibility analysis but it could represent an attractive alternative.

Types of Grain Storage

Often traditional farms/villages in most African countries have developed their own techniques of post harvest storage. In Ghana the temporary storage method includes, aerial storage, storage on the ground, and open timber platforms, while the long-term storage methods include storage baskets (cribs), calabashes (pots), jars, solid wall bins, underground storage, and warehouse systems. The safest and most financially profitable method appears to be the warehouse storage system. Unfortunately, many farmers are unable to afford the construction of their own warehouse system. Cooperatives also find it difficult to establish adequate capital to secure a warehouse storage system. The warehouse storage system is becoming a profitable venture. During my visit to the Ejura-Sekyedumase district in 2011, the Pan Africa Food Bank had initiated a warehouse storage system. Space in the facility is rented out to producers in the area. Farmers in the Ejura-Sekyedumase district are unable to afford the storage rates charged by the facility.

According to the Ghana shippers' authority, traditionally there are four main types of warehouses in Ghana: State Warehouses, Government Warehouses, Private Bonded Warehouses, and Public Warehouses. The grain warehouse storage systems in Ghana are usually constructed from cement blocks similar to the walls of a house. (Coulter and Onumah, 2002) explain the warehouse receipts system in Africa as "documents issued by warehouse operators as evidence that specified commodities of stated quantity and quality have been deposited at particular locations by named depositors" (Coulter, Sondhi et al., 2000). Depositors are often producers, traders, processors or farm workers.

The warehouse operators hold the grain stock as security for a loan or trade. However, there are various limitations to this warehouse storage system. (Coulter and Onumah, 2002) explained, "users tend to be large operators, who own or can rent entire warehouses or silos, and can afford fees costing thousands of dollars (US) per month. Warehouse storage services are not available to farmer groups or traders who wish to deposit relatively small volumes of a commodity (e.g 50-100ton)" (Coulter, Sondhi et al., 2000). The average producer is often forced to sell immediately after harvesting due to high storage costs. The authors further proposed an alternative storage system approach for Africa, acknowledging that the North America warehouse model may not be appropriate. Some of the differences discussed include assurance of public regulatory functions and difficulty of overcoming embezzlement, ensuring financial sustainability and ensuring that smallholder farmers benefit from the system.

CHAPTER III

METHODS

Conceptual Framework

Grain storage offers the potential to provide a consistent supply of grain in the face of weather and pest related production problems and also enables the capturing of best prices in the face of within year price volatility. The price inconsistency between harvest periods allows producers to capture profit from stored grain. Moreover, it is not financially possible for small-scale famers to take advantage of seasonal increases in grain prices (Jones et. al 2011). Producers often sell part or all of their harvested grain directly after harvest because they lack storage capacity, have debts, or face cash restrictions. Timing of grain sales vary. Ghanaian studies indicate an average storage period for smallholders of three to four months (Motte et al., 1995). To assist African grain producers in analyzing the relative merits of grain storage systems as a potential alternative for economic improvement, a feasibility study has been conducted of two grain storage systems for a corn producing region in Ghana.

Feasibility Study

A feasibility study is the progression of thinking through a concept, idea or a business opportunity from start up to complete implementation and allows for a complete understanding of the potential viability before implementation. The intention of a feasibility study is to assist in determining if a business opportunity is achievable, sensible, realistic, and viable. Feasibility studies are conducted in diverse disciplines such as education, construction, business ventures and other program initiatives. Feasibility studies help venture capitalist, entrepreneurs and investors determine if their proposed business idea can be profitable.

According to Vincent Amanor-Boadu (2003) a visiting professor and director of the value-added business development program at Kansas State University, “a feasibility study or assessment is conducted at three levels. The first level involves operational feasibility and the question that is asked at this level is “will it work?” The second level involves technical feasibility and its associated question is “can it be built?” The third and final level is economic feasibility and it brings the operational and technical levels together into a common unit by asking “will it make economic sense if it works and it is built?”

The purpose of a feasibility study varies, but one important role for all feasibility studies is the identification of the factors that will be important to the success of the opportunity under study. For example, the construction of centralized grain storage facility may be feasible in a farming community but infeasible in an area with little or no production. For this reason, it is essential to understand the environment of the proposed project. Boadu (2003) further explains that there can be three possible results for a feasibility study: (1) feasible; (2) feasible with changes; and (3) infeasible, all of which are identified within market, location, and project context. A good study can cut down on project development time, and save investors money.

A feasibility study is a significant tool used to aid in making a decision as to whether or not the proposed venture is viable. For this study, we focus on a grain storage business venture and analyze the construction process and compare two different storage systems and the rate of return for each. Six steps in the process are as follows;

(1) Estimate required capital or seed money needs for the venture

(2) Estimate capital required for the construction of the facilities and equipment

(3) Estimate needed operating capital

(4) Estimate potential revenues

(5) Estimates contingency requirement such as additional operating capital needs in case of delays

(6) Determine the sources of capital and equity from local investors, banks, government, grants, venture capitalist, and investors..

Project Overview

This study examines the feasibility of a proposed business organized by the Non-Government Organization (NGO), Agriculture Youth Advancement (AYA project). The AYA project seeks to take advantage of the lack of grain drying, grain storage and management systems in the community of Ejura-Sekyeredumase, in the district of Kumasi, in the Ashanti region of Ghana. AYA Project is an Agribusiness NGO dedicated to providing full agribusiness services, as well as serving as a resource center. AYA recognizes that Ghana has attractive commercial farming opportunities, and has acquired 5 hectors of land in partnership with Nso Nyame Ye Women's cooperative. The women’s cooperative will have the right to store grain and will be accountable for storage and handling fees which will be .20 cents per bushel for handling and .05 cents per bushel per month for storage. Approximately 50% of the capacity will be used to store grain for non-members at the same fee structure. This fee will allow AYA Project to meet all projected expenses and generate a return on the investment. The members return will include the price gain they achieve from grain storage.

This study investigates the profitability of a grain storage venture proposed by the AYA Project. The venture is in partnership with Nso Nyame Ye Women's cooperative.. This study begins by examining the cost and returns of two grain storage facilities in the Ejura – Sekyereduamase district. The costs and returns are then used to project the net income, cash flow, and return on investment of the grain storage systems. The goal of developing the grain storage facility is to assist local producers in achieving higher grain prices and expand their market opportunities. Finally, a sensitivity analysis is conducted to evaluate the potential variation in returns of the grain storage systems as prices and costs vary over time.

Grain Storage Venture

A joint venture between AYA project and the Nso Nyame Ye Women's Cooperative will allow the cooperative's producers to access grain storage at a lower price and provide an opportunity to centralize grain storage management and gain market access as well as provide a stable infrastructure for further business opportunities. The proposed grain storage venture will operate under a limited liability company (LLC). The Cooperative's fifty farmer members will purchase shares in the LLC and receive storage rights based on the capital they provide. AYA Project LLC will raise the capital needed for construction of the grain storage facility and will also hire two full time employees to manage the grain inventory. In addition to having the rights to store grain, each member/owner will be accountable for storage and handling fees connected to their level of production capacity. It should be clear that each member/owner is also responsible for these fees whether they use the facility or not. It is expected that approximately 50% of the storage facility will handle and store grain from non-members at a structured fee. Fees and cash flow projections reflect expenditures at the end of year five.

Description of the Facilities

Two grain storage facilities are evaluated, a flat in-bin dryer storage system (dries and stores grain in bulk) and warehouse storage systems (grain is dried, bag, and stored).

In-bin dryer and storage system: Flat Storage

The flat in-bin system will be divided into one side for rice and the other for corn. Figures 1 and 2 illustrate the flat storage design (Committee, 1997).

The concrete flat, in-bin facility will have the capacity to dry and store 800,000kg of grain. The in-bin storage facility will have a low temperature bin dryer and solar heat will be used as a source of energy to reduce energy costs. The in-bin solar dryer can manage low temperature and maintain low moisture to lower spoilage. The solar dryer provides a feasible alternative when gas/diesel is not available. Figure 1 shows an example of an in-bin grain dryer and storage system. In this example the grain will be dried in bulk and stored in a controlled environment, this will also help to maintain its grain quality.

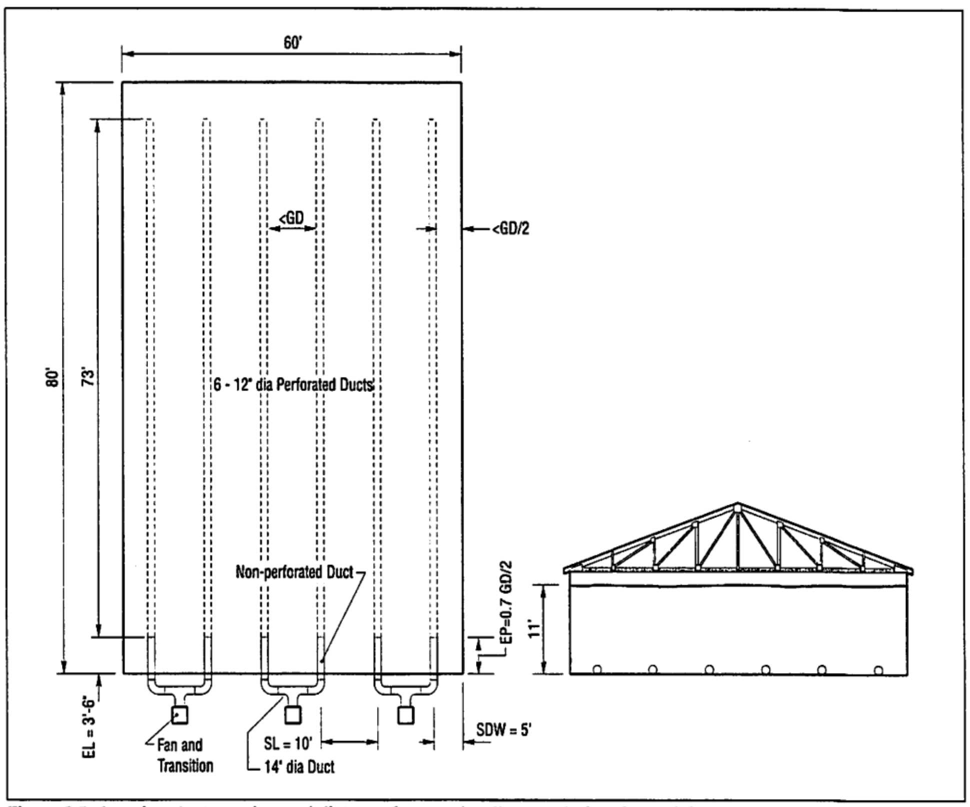


Figure 3.5. Aeration duct spacing and distance from end walls to end of perforated duct.

Figure 1: (Committee, 1997)

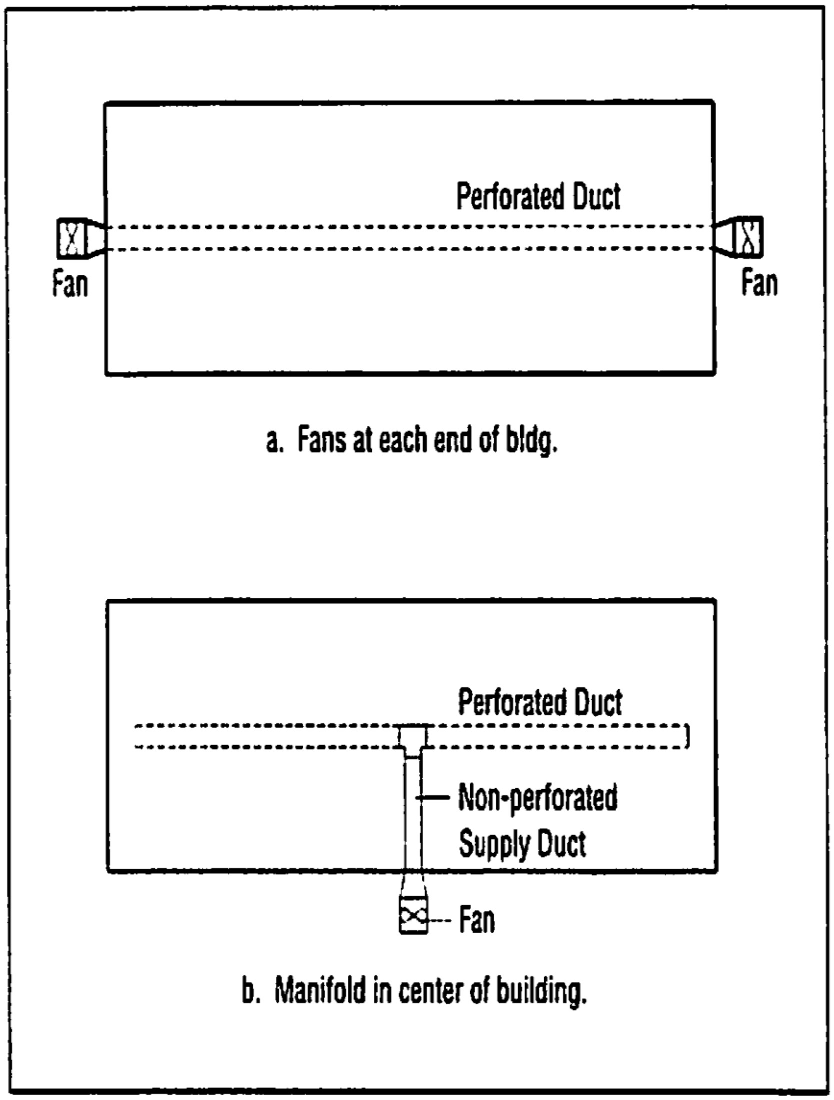


Figure 3.4. Aeration for buildings exceeding 100'.
Use fans at each end of the building or a manifold at the center of the building.

Figure 2: (Committee, 1997)

Warehouse storage system

The warehouse system is different from the in-bin grain dryer system. In the warehouse system, the grain is dried, bagged, and then stored in a metal building (Figure 3). Figure 4 and 5 illustrates the storage and receipt system for a warehouse storage system.

Figure 3: photo of Stillwater milling warehouse.

Figure 4: photo of grain warehouse in Ejura- Sekyedumase in Ghana.

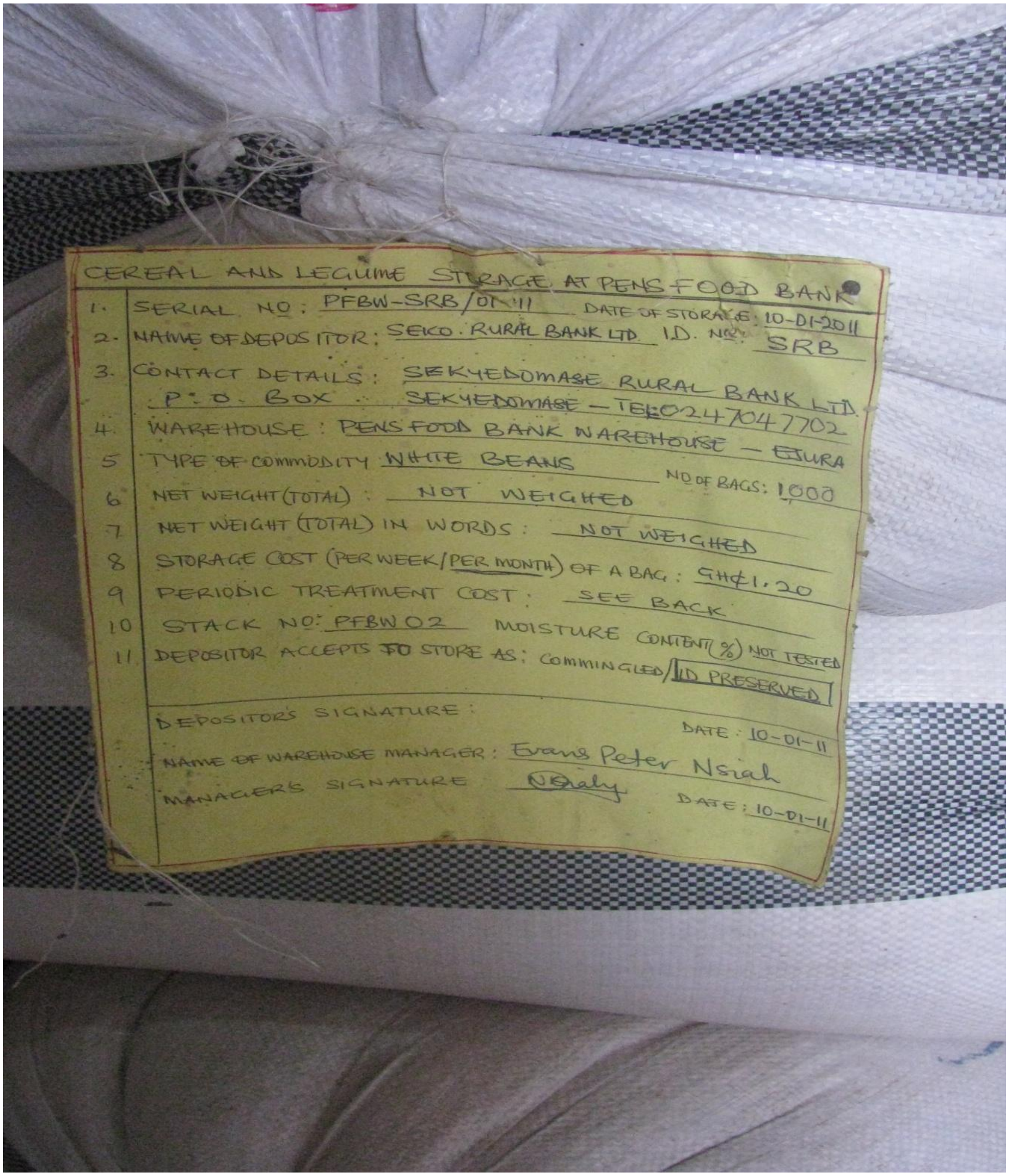


Figure 5: photo of receipt warehouse in Ejura- Sekyedumase in Ghana.

Weight Station

Before storing grain in the warehouse system the grain will be weighed and appropriate cost will be applied.

Figure 6: photo of grain scale in Ejura- Sekyedumase in Ghana.

Model Assumptions

A feasibility template was constructed using Microsoft Excel to project the cost and returns of construction and operation of alternative grain storage systems. Some of the information for the assumptions was obtained through personal email communications with Mr. Evans Peters of Pens Food Bank LLC in the Ejura-Sekyedumase district. The structure of the feasibility template was based on a feasibility assessment template developed for the Agriculture Marketing Resource Center by Dr. Philip Kenkel and Dr. Rodney Holcomb at Oklahoma State University. The completed template contains twelve worksheets of inputs and outputs including worksheets on capital, capacity, storage cost, grain buying and selling prices, personnel and equipment expenses,

The user of the template supplies the required information to generate the financial calculations. The calculations include input values, grain drying, shrinkage, drying cost, market and expense projections, loan amortization, personnel expenses, statement of operations, owners equity, equipment and depreciation, return on investment, owners return, and a balance sheet, all of which were calculated for a ten year period. Detailed explanations of each of the worksheets are provided below.

<u>Input Value</u>

The Input Value sheet can be downloaded and reviewed for additional directions on how to use the template. The template is intended to support the feasibility assessment of various projects. The "input value sheet" contains a basic set of parameters such as the storage capacity, the anticipated amount of stored grain, grain prices, storage price, and marketing prices. In addition, the amount of shrinkage, grain drying, and grain drying costs, personnel expenses, equipment expenses and depreciation are determined.

Shrinkage

Shrinkage is calculated as:

Shrinkage = 100% - % Dry matter Wet grain / % Dry Matter Dry Grain X 100 + .5%

After calculating shrinkage and inputting initial grain volume the total grain volume can be determined (after the water is removed from the grain). The shrinkage calculations were used to determine the actual amount of grain marketed which was less than the amount purchased from the producers. In addition to the moisture shrinkage described above, an additional 1% shrinkage from handling was assumed.

Drying Cost

This sheet allows the user to input values specific to their use. Aeration cost was modeled for both an electric system and a direct drive diesel system with the costs based on the required horse power and either KW/hour or diesel fuel consumption per hour. The supplemental heat for drying was assumed to come from a fuel oil burner and the fuel oil consumption was based on the BTUs required per gallon, number of gallons required and the cost per kilogram for the fuel. Options are available for various sources of energy to allow for scenarios with different energy sources or situations. The baseline assumptions for drying include;

- Beginning moisture of 28%
- Ending moisture of 13%

- Diesel motor for the fans (under the assumption that the local electrical distribution system could not support the required starting load for the fan motors)

Depreciation Expense

This sheet includes detailed cost estimates for the construction of an in-bin grain storage system and a warehouse storage system. This sheet enables the user to choose between an in-bin storage system and warehouse storage system. The vehicles and equipment associated with each system are also included. The grain storage system was valued at $89,500 and was depreciated over ten years using the modified accelerated cost recovery system method (MACRS). The depreciable assets used for calculation includes the cost of construction, bricks, woods, cement, design and consultancy costs, wiring, augers, fans, conveyers, light trucks and vehicles. Buildings are deprecated on a 39 year straight line, special purpose buildings are deprecated on a 10 year straight line, equipment, heavy rolling stock are depreciated on a 7 year life, and light trucks and vehicles are deprecated on a 5 year life all using the MACRS. In addition, the template assumed that additional investments will be made for upgrades and replacements in the 3rd, 6th and 9th year the assumption is based on a percentage of the original equipment investment.

Personnel Expenses

This sheet includes adjustable personnel expenses for various positions, the number of personnel, salary, benefits and overtime percentage. Personnel costs were based on full time employees that consist of a general manager, secretary, and staff that will be employed year round. Taxes and benefits were estimated at 15% of salary expense. A 2% annual inflation rate was applied to personnel costs including benefits.

Market Projection

The market projection sheet includes information on annual output (in kilograms) of corn and rice, storage, and drying. The market projections sheet, table 1 sales projections provides information on the yearly prices per kilogram for rice and corn it also summaries the volume, prices and sales growth information from the input page as well as the gross margins for each year.

Table 1: Sales Projections

Sales Projections						
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Corn marketing	Kilogram	457,691	457,691	457,691	457,691	457,691
Grain Storage	Kg.for 7 months	655,900	655,900	655,900	655,900	655,900
Rice Marketing	Kilogram	94,756	94,756	94,756	94,756	94,756
Grain Drying	$ Kg. for 7months	655,900	655,900	655,900	655,900	655,900
		1,864,247	**1,864,247**	**1,864,247**	**1,864,247**	**1,864,247**

Loan Amortization

In the loan amortization page, (Table 2) illustrates calculations of the loan principal and interest payments over 5 years.

Table 2: Total Investment

Total Investment	$157,100				
Long Term Interest Rate	6.00%				
Percent Financed	50.00%				
Loan Amount	$78,550				
Loan Term	10				
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Beginning Balance	$78,550	$72,591	$66,274	$59,578	$52,480
Interest Rate	6.00%	6.00%	6.00%	6.00%	6.00%
Interest	$4,713	$4,355	$3,976	$3,575	$3,149
Annual Payment	$10,672	$10,672	$10,672	$10,672	$10,672
Principal	$5,959	$6,317	$6,696	$7,098	$7,524
Ending Balance	$72,591	$66,274	$59,578	$52,480	$44,956
Working Capital	$196,846				
Short Term Interest Rate	6.00%				
Interest Amount	$11,811				
Total Interest Expense	$16,524	$16,166	$15,787	$15,385	$14,960
Total Debt	$269,437	$263,120	$256,424	$249,326	$241,803
Total Assets	$376,273	$373,882	$374,335	$376,250	$375,996
Debt/Assets	71.6%	70.4%	68.5%	66.3%	64.3%

Expense Projection

The expense projection sheet provides yearly expenses for ten years based on the information inserted on the input value page (Table 3). Total variable costs are generated by summing the personnel expenses, total labor, cost of goods sold and utilities. The fixed expenses include maintenance, insurance, property tax, depreciation and interest. Lastly, other miscellaneous expenses are included in the total expenses.

Table 3: Expense Projections

Labor	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Salaries		$26,400.00	$26,664.00	$26,930.64	$27,199.95	$27,471.95
Benefits		$3,960.00	$3,999.60	$4,039.60	$4,079.99	$4,120.79
Overtime		$828.00	$836.28	$844.64	$853.09	$861.62
Total Labor	**$0.00**	**$31,188.00**	**$31,499.88**	**$31,814.88**	**$32,133.03**	**$32,454.36**
Cost of Goods Sold		$226,690.35	$226,690.35	$226,690.35	$226,690.35	$226,690.35
Utilities		$3,000.00	$3,030.00	$3,060.30	$3,090.90	$3,121.81
Total Variable	**$0.00**	**$260,878.35**	**$261,220.23**	**$261,565.52**	**$261,914.28**	**$262,266.52**
Fixed						
Maintenance		$3,042.00	$3,072.42	$3,103.14	$3,134.18	$3,165.52
Insurance		$3,042.00	$3,072.42	$3,103.14	$3,134.18	$3,165.52
Property Tax		$785.50	$793.36	$801.29	$809.30	$817.39
Depreciation		$13,809.91	$21,005.11	$17,984.45	$9,677.11	$9,050.55
Interest		$16,523.78	$16,166.22	$15,787.20	$15,385.44	$14,959.57
Total Fixed	**$0.00**	**$37,203.20**	**$44,109.53**	**$40,779.22**	**$32,140.20**	**$31,158.55**
Other						
Supplies		$1,000.00	$1,010.00	$1,020.10	$1,030.30	$1,040.60
Miscellaneous*		$500.00	$505.00	$510.05	$515.15	$520.30
Total Other	**$0.00**	**$1,500.00**	**$1,515.00**	**$1,530.15**	**$1,545.45**	**$1,560.91**
Income Taxes		$12,122.73	$11,251.14	$11,607.53	$12,600.52	$12,674.20
Total Expenses	**$0.00**	**$311,704.27**	**$318,095.89**	**$315,482.42**	**$308,200.45**	**$307,660.17**

Summary of Revenues, Expenses and Cash Flows

The cash patronage represents 60% of after tax profits and the difference between after tax profits and cash flow (depreciation, loan principal payments and additional investments in fixed assets). The 30% of profit are paid in the form of stock and the baseline model assumed that the stock was redeemed for cash in the 7th year. (Table 4 and 5) summaries the income, expenses, and net profit over ten five years.

Table 4: Statement of Operation and Cash Flow Statement

Gross Sales	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Corn marketing	$0.00	$329,537.52	$329,537.52	$329,537.52	$329,537.52	$329,537.52
Grain Storage	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Rice Marketing	$0.00	$71,066.76	$71,066.76	$71,066.76	$71,066.76	$71,066.76
Grain Drying	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Sales	**$0.00**	**$400,604.28**	**$400,604.28**	**$400,604.28**	**$400,604.28**	**$400,604.28**
Cost of Goods Sold		$226,690.35	$226,690.35	$226,690.35	$226,690.35	$226,690.35
Total Gross Margin		$173,913.94	$173,913.94	$173,913.94	$173,913.94	$173,913.94
Operating Expenses						
Variable	$0.00	$34,188.00	$34,529.88	$34,875.18	$35,223.93	$35,576.17
Fixed	$0.00	$37,203.20	$44,109.53	$40,779.22	$32,140.20	$31,158.55
Other	$0.00	$1,500.00	$1,515.00	$1,530.15	$1,545.45	$1,560.91
Total Operating Exp.	**$0.00**	**$72,891.20**	**$80,154.41**	**$77,184.55**	**$68,909.58**	**$68,295.63**
EBIT	**$0.00**	**$129,669.25**	**$121,176.89**	**$124,124.11**	**$132,990.31**	**$133,252.08**
Common stock dividend		$0.00	$0.00	$0.00	$0.00	$0.00
Preferred stock dividend		$0.00	$0.00	$0.00	$0.00	$0.00
Profit before Patronage	$0.00	$101,022.74	$93,759.53	$96,729.39	$105,004.35	$105,618.31
Cash Patronage Refund		$60,613.64	$56,255.72	$58,037.63	$63,002.61	$63,370.98
Qualified Patronage Refund		$0.00	$0.00	$0.00	$0.00	$0.00
Non-Qualified Redeemed		$0.00	$0.00	$0.00	$0.00	$0.00
Before Tax Income		$40,409.10	$37,503.81	$38,691.75	$42,001.74	$42,247.32
Tax	$0.00	$12,122.73	$11,251.14	$11,607.53	$12,600.52	$12,674.20
After Tax Profit	**$0.00**	**$28,286.37**	**$26,252.67**	**$27,084.23**	**$29,401.22**	**$29,573.13**

Table 5: Estimate of Cash Flows

Estimate of Cash Flows	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
After Tax Profits	$0.00	$28,286.37	$26,252.67	$27,084.23	$29,401.22	$29,573.13
Depreciation	$0.00	$13,809.91	$21,005.11	$17,984.45	$9,677.11	$9,050.55
Principle	$0.00	$5,959.43	$6,316.99	$6,696.01	$7,097.77	$7,523.64
Additional Asset Purchased		$0.00	$0.00	$28,366.67	$0.00	$0.00
Gross Cash Flow from Operations		$36,136.85	$40,940.79	$38,372.66	$31,980.56	$31,100.04
Common stock redemption						
Qualified Redemption		$0.00	$0.00	$0.00	$0.00	$0.00
Non-Qualified Redemption						
Cash Flow	**$0.00**	**$36,136.85**	**$40,940.79**	**$10,005.99**	**$31,980.56**	**$31,100.04**
Cumulative Cash Flow		**$36,136.85**	**$77,077.64**	**$87,083.63**	**$119,064.19**	**$150,164.22**

Return on Investment

An essential part of the template is the return on investment page that summarizes the feasibility of the grain drying, storing, and marketing. The feasibility measures used for calculation are net present value (NPV), internal rate of return (IRR), return on assets (ROA), average return on assets (ARA) and payback period all of which are determined by using standard calculations.

"The net present value (NPV) of a project simply expresses the difference between the discounted present value of future benefits and discounted present value of future costs. A positive NPV for a given project tells us that the project benefits are greater than its cost, and vice versa" (Campbell and Brown, 2003)."The discount rate at which the NPV becomes zero is called the internal rate of return (IRR) " (Campbell and Brown, 2003).

“Return on assets (ROA) should be determined at both book value and fair market value., ROA at fair market value represents the percentage return on the average total resale value that is estimated for all assets involved in the business during a particular year” (Ferguson, 1990). ROA at book value represents the percentage return on the actual cost of all assets involved in the business during a particular year (Ferguson, 1990) ROA is an accounting based concept and is calculated as after tax income divided by the book (or fair market) value of assets. Because ROA is impacted by accounting conventions and it does not consider the time value of money it is generally less preferred relative to internal rate of return IRR. Lastly, the payback period represents the number of years required for the project’s cash flow to equal the original investment. The major disadvantage with the payback method is that it does consider cash flows past; the payback period does not reflect the timing of the cash flows. It is often used as a simple, initial measure of feasibility. Because the cash flows were determined in our model on an annual basis the payback period was only calculated in whole year increments.

Sensitivity Analysis

According to Breierova and Choudhari (1996) “Sensitivity analysis is used to determine how “sensitive” a model is to changes in the value of the parameters of the model and to changes in the structure of the model. For the purpose of this feasibility study a sensitivity analysis was conducted to project the outcome of change in commodity prices, storage price, and drying prices. The sensitivity analysis includes projections for the price for corn, cost of corn storage, cost of corn drying, rice prices, cost of rice storage, and cost of rice drying. The feasibility template was used to estimate the returns on investment for each sensitivity scenario. The internal rate of return (IRR), net present value (NPV), return on assets (ROA), and payback period were calculated to measure return on investments. The sensitivity of return on investment for corn price, cost of corn storage, cost of corn drying, rice price, cost of rice storage, and cost of rice drying were performed for all the six scenarios. It's important to note that irrespective of the scenario the baseline value of internal rate of return (IRR), net present value (NPV), return on assets (ROA) and payback period remain constant. Details of the sensitivity analysis for the in-bin storage system and the warehouse storage system and are discussed in a subsequent section.

General Assumptions

The basic assumption for the preliminary feasibility estimates are provided in Table 5. The model illustrates a group grain storage operation storing 800,000 Kilogram. 543,000 kilogram of corn and 112,500 bushels of rice harvest was assumed to be produced during the two harvest seasons in Ghana, the major season (August- October) and the minor season (January- February), with the grain drying process being completed within a 3 week period.

The assumption table depicts 50% financing with a total project cost of $157,100. A loan term of 10 years and interest rate of 6% were used in projecting interest and principal payment requirements. It was also assumed that the grain storage LLC has no line of credit needed for the start-up or any expenses and thus 100% of the expenses will be financed. Moreover, payments for member's grain will be postponed until the LLC generates income from grain sales, a line of credit will be needed to purchase grain from non-members. This short term credit line is further explained in the 36 months cash flow projection. The maximum working capital required is $123,029.

Grain Handling Cost and Revenue Assumptions

The projections were based on an annual storage of 655,900 kilogram; 543,400 of corn and 112,500 of rice. An average weight loss due to handling (shrinkage) of 15% and handling shrinkage at 1% moisture loss, turning and aeration costs were estimated at $.003 per kilo at a corn price of $0.37 per kg, rice price at $ 0.40 per kilo and cost of handling and storage is assumed to be $0.13 per kilo. Table 6; below summaries the baseline assumptions for the feasibility study.

Table 6: Baseline Assumptions for Feasibility Study and Business Plan

Capacity- kilogram	800,000
Facility cost	$157,100
Maintenance % of facility cost	2%
Property tax % of facility cost	0.50%
Insurance % of facility cost	2.00%
Percent financed	50%
Interest rate	10%
Loan term-Years	10.0
Initial working capital	$100,000
Maximum working capital	$123,029
Average working capital	$50,000
Start-up and contingency cost	$5,000
Short term interest rate	6%
Telephone & internet- per year	$100
Electricity- office &Lighting per year	$100
Benefits as % of salary	15%
Expense inflation rate	1%
Wage inflation rate	1%
% Member Business	50%
% Profits Retained	40%

Grain Drying

. Under the grain storage LLC the members will not be charged for drying, the expense will be absorbed by the cooperative out of their margin between the harvest and final sale price. For the purpose of this study we can assume that dryer charges are \$.05/point of moisture with dryer operating cost at \$0.13/kilo per point of moisture. It is projected that dryer operating cost is an additional source of income for the AYA Project, while seasonal labor cost will reflected in the personnel expenses. Interest expenses and loan principal payments are summarized in (Table 7); the loan was amortized over 10 year period, the 5 year depreciation is illustrated below.

Table 7: Annual Total Depreciation

Annual Total Depreciation					
Year	1	2	3	4	5
Buildings	\$2,295	\$2,295	\$2,295	\$2,295	\$2,295
Special Purpose Buildings	\$0	\$0	\$0	\$0	\$0
Equipment and Heavy Rolling Stock	\$2,515	\$4,310	\$3,078	\$2,198	\$1,572
Light Truck and Vehicles	\$9,000	\$14,400	\$8,640	\$5,184	\$5,184
Additional Depreciation	0	0	3971.333333	0	0
Total Depreciation	\$13,810	\$21,005	\$17,984	\$9,677	\$9,051

Buildings	39 year Straight Line
Special Purpose Buildings	10 year with percentage from table
Equipment and Heavy Rolling Stock	7 year with percentage from table
Light Trucks and Vehicles	5 year with percentage from table

Table 8 depicts the personnel cost assumptions, based on full time employees that consist of a general manager, secretary, and staff that will be employed year round.

Table 8: Personnel Costs

Occupation	Number	Salary/each	Total Salary	Benefits	Overtime%	Overtime	Total
Manager	1	$8,400	$8,400	$1,260	0%	$ -	$9,660
Secretary	1	$3,600	$3,600	$540	0%	$ -	$4,140
Elevator staff (4)	4	$3,600	$14,400	$2,160	5%	$ 828	$17,388
	0	$0	$0	$0	0%	$ -	$0
Total Personnel Costs			$26,400	$3,960		$828	$31,188

CHAPTER IV

RESULTS

Storage Cost Comparison

The ware house system (current technology) appears more expensive than the in-bin system and is labor intensive. On the other hand the in-bin system (improved technology) is considerable cheaper to construct with value added end product and less labor is required (Table 9).

Table 9: Storage Cost Comparison

Buildings Description	In-Bin System		Warehouse System	
Storage facility cost	$	64,000	$	80,100
Design and consultancy cost	$	10,000	$	10,000
Construction cost	$	8,000	$	8,000
Labor	$	0	$	7,500
Dryer bin	$	7,500	$	0
Total Buildings	$	89,500	$	105,600
IRR		**63.08%**		**56.76%**

Feasibility of the In-Bin Storage System

The first scenario examines the effects of the change in corn prices. For the baseline corn price at $0.37 per kilogram, the sensitivity result shows an internal rate of return of 68.11%, net present value (NPV) of $444,790, return on assets (ROA) of 55.54%, and a payback period at 2 years (Table 10). In comparison, a corn price of $ 0.17 per kilogram yielded an internal rate of return (IRR) of 123.07%, net present value (NPV) of $935,335 return on assets (ROA) is 106.83%, and a payback period decreases to 1 year. However, when the corn price is higher than the baseline price at $0.52 per kilogram, the rate of return (IRR) decrease to 23.51%, net present value (NPV) also decrease to $76,881 the return on asset is 17.08%, and payback period increases from 2 years to 5 years. When the corn price is at $0.58 the IRR becomes negative the payback period is zero.

Table 10: Results for Baseline Corn Price at $0.37 per Kilogram

	0.17	**0.22**	**0.27**	**0.32**	0.37	**0.42**	**0.47**	**0.52**	**0.57**	**0.58**
IRR	123.07%	109.43%	95.75%	82.00%	68.11%	53.99%	39.36%	23.51%	3.70%	-1.72%
NPV	$935,335	$812,699	$690,062	$567,426	$444,790	$322,154	$199,517	$76,881	($45,915)	($71,022)
ROA	106.83%	94.01%	81.18%	68.36%	55.54%	42.72%	29.90%	17.08%	4.25%	1.67%
Payback Period	**1**	**1**	**1**	**2**	**2**	**2**	**3**	**5**	**0**	**0**

*** Variation of 0.05 based on personal email communication with Mr. Peter Evans**

The second scenario (Table 11) considered the change in rice prices. For a baseline rice price of $0.40 per kilogram, the internal rate of return (IRR) is 68.11%, net present value (NPV) of $444,790 return on assets (ROA) of 55.54%, and a payback period at 2 years. When rice price is decreased to $0.20, the internal rate of return (IRR) increases to 79.62%, net present value also increase to $546,347 the return on asset also increase to 66.16%, but the payback period states the same at 2 years. When rice price increases to $ 0.70 per kilogram, the internal rate of return (IRR) decreases to 50.51%, net present value (NPV) decreases to $ 292,454, the return on assets decreases to 39.61% and the payback period remains at 2 years. In this case it appears that only when the rice price reaches $1.39 does the grain storage facility become economically infeasible, the IRR becomes 1.13%, NPV is a negative $58,320, ROA is 2.97% and the payback period is zero years.

Table 11: Result for Baseline Rice Price at $0.40 per Kilogram

	0.20	**0.25**	**0.30**	**0.35**	**0.40**	**0.45**	**0.50**	**0.55**	**0.60**	**0.65**	**0.70**	**1.39**
IRR	79.62%	76.75%	73.88%	71.00%	68.11%	65.22%	62.31%	59.38%	56.44%	53.49%	50.51%	1.13%
NPV	$546,347	$520,958	$495,569	$470,179	$444,790	$419,401	$394,011	$368,622	$343,233	$317,843	$292,454	($58,320)
ROA	66.16%	63.50%	60.85%	58.20%	55.54%	52.89%	50.23%	47.58%	44.92%	42.27%	39.61%	2.97%
Payback Period	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**0**

*** Variation of 0.05 based on personal email communication with Mr. Peter Evans**

Table 12 describes the results of examining changes in storage prices where the storage cost is at a baseline price of $0.02 per kilogram. The internal rate of return (IRR) is 68.11%, net present value (NPV) is $444,790, return on assets (ROA) is 55.54%, and the payback period is 2 years. When storage costs decreases to $0.005per kilogram, the internal rate of return (IRR) increases to 73.78%, the net present value (NPV) increases to $494,671, the return on assets increases to 60.76%, and the payback period remains at 2 years. On the other hand, when the storage costs increase to $0.045, the internal rate of return (IRR), decreases to 58, 58%, net present value (NPV) decreases to $361,655, return on assets (ROA) decreases to 46.85% and the payback period remains 2 years. The

IRR is close to reaching zero when the storage cost increases to $0.170 per kilogram. At this cost, the IRR is 1.98%, NPV is negative $54,343, and the payback period is zero years.

Table 12: Result for Baseline Corn and Rice Storage at $0.02 per Kilogram

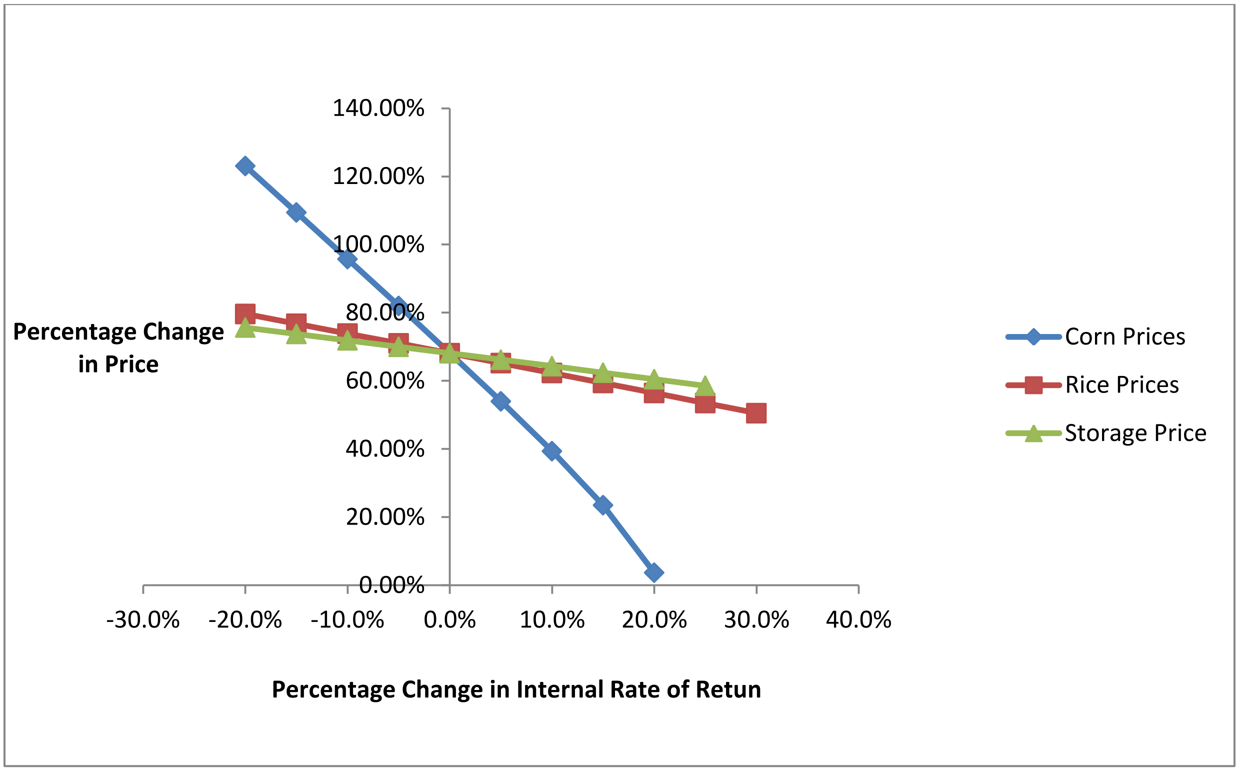
	0	**0.005**	**0.010**	**0.015**	**0.020**	**0.025**	**0.030**	**0.035**	**0.040**	**0.045**	**0.170**
IRR	75.66%	73.78%	71.90%	70.01%	68.11%	66.22%	64.32%	62.41%	60.50%	58.58%	1.98%
NPV	$511,298	$494,671	$478,044	$461,417	$444,790	$428,163	$411,536	$394,909	$378,282	$361,655	($54,343)
ROA	62.49%	60.76%	59.02%	57.28%	55.54%	53.80%	52.06%	50.33%	48.59%	46.85%	3.38%
Payback Period	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**0**

***Variation of .005 based on personal email communication with Mr. Peter Evans**

Summary of Sensitivity Analysis for Baseline Scenario: In- Bin System

Figure 7 summarizes the result of the sensitivity analysis preformed for the in-bin storage system comparing corn price, rice price, grain drying, and grain storage. The chart was constructed by estimating the internal rate of return (IRR) when the respected values were changed by 10.0% from the baseline price, keeping other variables constant. The sensitivity indicates when the variable is lower than the baseline price the internal rate of return (IRR) increases, and when the variable is higher than the baseline value the IRR decreases in percentage. The net present value (NPV) and return on assets also follows the rate of return (IRR) trend. The payback period was also sensitive to the change in price. The sensitivity analysis indicated the results are very sensitive to variation in grain prices, storage and drying prices.

Figure 7: Sensitivity of Corn, Rice and Storage Prices



The sensitivity of the fan time illustrates the change in time required to dry grain to a proper storage moisture percentage Table 13. The baseline assumption for the fan time was estimated at 72 hours (three days); a sensitivity of the 30 hours increase from the baseline assumption illustrates the change in total drying cost and the percentage change in the internal rate of return (IRR).

Table 13: Sensitivity Result on Fan Time

Grain Drying		
Fan Time/Hours	**Total Drying Cost**	**IRR**
72	**0.009642328**	**68.11%**
102	0.013499471	66.65%
132	0.017356614	65.19%
162	0.021213757	63.72%
192	0.025070899	62.25%
222	0.028928042	60.77%

Table 14 summarizes the sensitivity result with respect to change in grain volume. The baseline assumption for the capacity is 800,000 kilogram, with 655,900 total volume used for the model assumptions. The purpose of this sensitivity is to illustrate the change in internal rate of return (IRR) as the grain volume decrease simulating a poor harvest.

Table 14: Sensitivity Result on Grain Volume

Volume Analysis			
Corn	**Rice**	**Total Volume**	**IRR**
543,400	**112,500**	**655,900**	**68.11%**
489,060	101,250	590,310	58.69%
434,720	90,000	524,720	49.09%
380,380	78,750	459,130	39.20%
326,040	67,500	393,540	28.79%
271,700	56,250	327,950	17.32%
217,360	45,000	262,360	3.17%

Feasibility of the Warehouse Storage System

The in-bin storage system is cheaper to construct and requires les labor. However, while the warehouse system does appear to be attractive and could also be feasible. The baseline financial results for the warehouse system are provided in (Table 15-19).

Sensitivity Analsyis for the Warehouse Storage System

Table 15 examines the effects of the change in corn prices. For the baseline corn price at $0.37 per kilogram, the sensitivity result shows an internal rate of return of 61.20%, net present value (NPV) of $425,151 return on assets (ROA) of 49.6%, and a payback period at 2 years. In comparison, a corn price of $ 0.17 per kilogram yielded an internal rate of return (IRR) of 111.24%, net present value (NPV) of $915,696 return on assets (ROA) is 96.19%, and a payback period decreases to 1 year. However, when the corn price is higher than the baseline price at $0.52 per kilogram, the rate of return (IRR) decrease to 19.94%, net present value (NPV) also decrease to $57,242 the return on asset is 14.79%, and payback period increases from 2 years to 6 years. When the corn price is at $0.57 the IRR becomes less than 1% and the payback period is zero.

Table 15: Results for Baseline Corn Price at $0.37 per Kilogram

	0.17	**0.22**	**0.27**	**0.32**	**0.37**	**0.42**	**0.47**	**0.52**	**0.57**
IRR	111.24%	98.85%	86.40%	73.88%	61.20%	48.26%	34.75%	19.94%	0.93%
NPV	$915,696	$793,060	$670,423	$547,787	$425,151	$302,515	$179,879	$57,242	($65,712)
ROA	96.19%	84.56%	72.93%	61.30%	49.67%	38.05%	26.42%	14.79%	3.15%
Payback Period	**1**	**1**	**1**	**2**	**2**	**3**	**4**	**6**	**0**

*** Variation of 0.05 based on personal email communication with Mr. Peter Evans**

Table 16 illustrates the effects of the change in rice prices. For the baseline corn price at $0.40per kilogram, the sensitivity result shows an internal rate of return of 61.20%, net present value (NPV) of $425,151, return on assets (ROA) of 49.67%, and a payback period at 2 years. In comparison, a rice price of $ 0.20 per kilogram yielded an internal rate of return (IRR) of 71.71%, net present value (NPV) of $526,708 return on assets (ROA) is 59.31%, and a payback period of 2 years. However, when the rice price is higher than the baseline price at $0.70 per kilogram, the rate of return (IRR) decrease to 45.06%, net present value (NPV) also decrease to $272.815 the return on asset is 35.23%, and payback period increases from 2 years to 3 years. When the rice price is at $1.39 the IRR becomes negative the payback period is zero.

Table 16: Results for Baseline Rice Price at $0.40 per Kilogram

	0.20	**0.25**	**0.30**	**0.35**	**0.40**	**0.45**	**0.50**	**0.55**	**0.60**	**0.65**	**0.70**	**1.39**
IRR	71.71%	69.10%	66.47%	63.84%	61.20%	58.55%	55.89%	53.21%	50.51%	47.80%	45.06%	-1.60%
NPV	$526,708	$501,319	$475,930	$450,540	$425,151	$399,762	$374,372	$348,983	$323,594	$298,204	$272,815	($78,117)
ROA	59.31%	56.90%	54.49%	52.08%	49.67%	47.27%	44.86%	42.45%	40.04%	37.64%	35.23%	1.99%
Payback Period	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**0**

***Variation of 0.05 based on personal email communication with Mr. Peter Evans**

The final scenario (Table 17) examines storage cost at a baseline price of $0.02 per kilogram. The internal rate of return (IRR) is 61.20%, net present value (NPV) is $425,151, return on assets (ROA) is 49.67%, and the payback period is 2 years. When storage costs decreases to $0.005per kilogram, the internal rate of return (IRR) increases to 66.38%, the net present value (NPV) increases to $475,032, the return on assets increases to 54.41%, and the payback period remains at 2 years. On the other hand, when the storage costs increase to $0.045, the internal rate of return (IRR), decreases to 52.47%, net present value (NPV) decreases to $342,016, return on assets (ROA) decreases to 41.79%, and the payback period remains 2 years. The IRR becomes negative when the storage cost increases to $0.170 per kilogram. At this cost, the IRR is -0.77%%, NPV is negative $74,140, and the payback period is zero years.

Table 17: Results for Baseline Corn and Rice Storage at $0.02 per Kilogram

	0	0.005	0.010	0.015	0.020	0.025	0.030	0.035	0.040	0.045	0.170
IRR	68.10%	66.38%	64.66%	62.93%	61.20%	59.47%	57.73%	55.98%	54.23%	52.47%	-0.77%
NPV	$491,659	$475,032	$458,405	$441,778	$425,151	$408,524	$391,897	$375,270	$358,643	$342,016	($74,140)
ROA	55.98%	54.41%	52.83%	51.25%	49.67%	48.10%	46.52%	44.94%	43.37%	41.79%	2.36%
Payback Period	2	2	2	2	2	2	2	2	2	2	0

***Variation of .005 based on personal email communication with Mr. Peter Evans**

Figure 8: Summary of Sensitivity Analysis for Baseline Scenario: Warehouse System

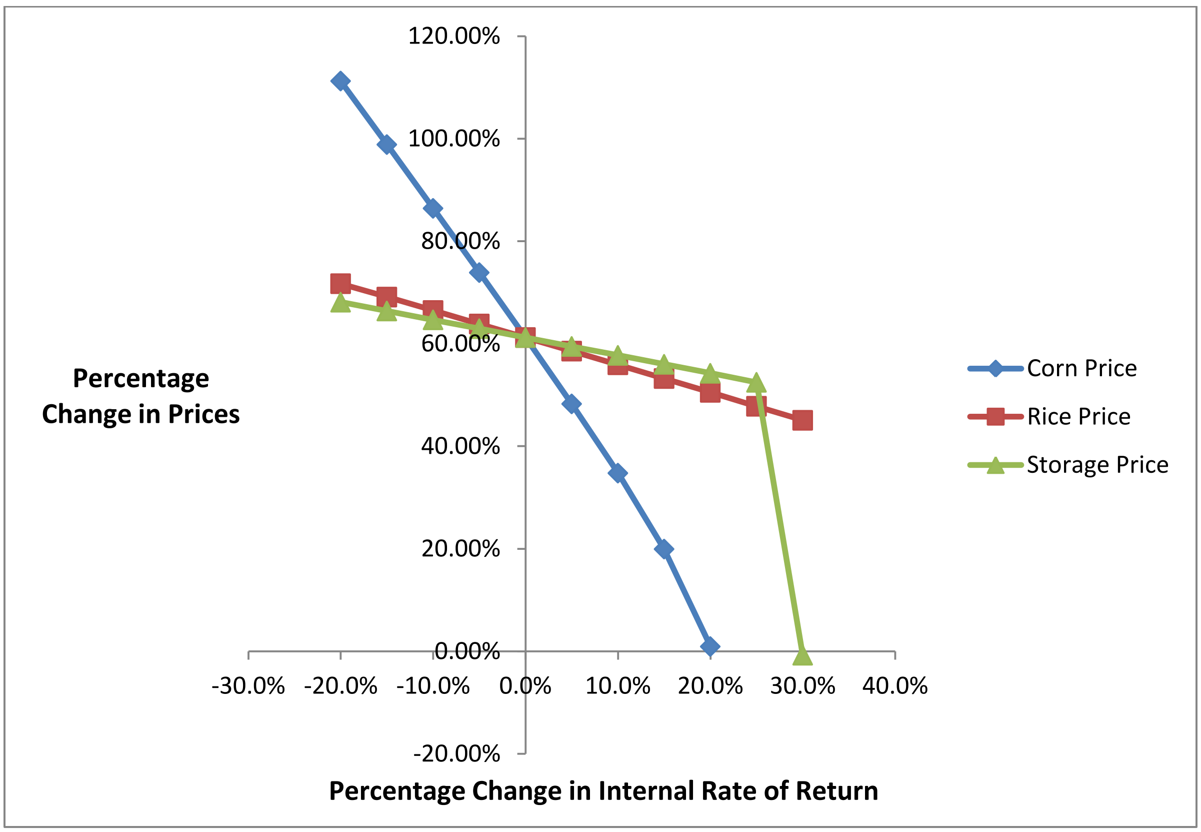


Figure 8 illustrates the result of the sensitivity analysis preformed for the warehouse storage system comparing corn price, rice price, grain drying, and grain storage. The chart was constructed by estimating the internal rate of return (IRR) when the respected values were changed by 10.0% from the baseline price, keeping other variables constant. The sensitivity indicates when the variable is lower than the baseline price the internal rate of return (IRR) increases, and when the variable is higher than the baseline value the IRR decreases in percentage. The net present value (NPV) and return on assets also follows the rate of return (IRR) trend. The payback period was also sensitive to the change in price. The sensitivity analysis indicated the results are very sensitive to variation in grain prices, storage and drying prices.

The sensitivity of the fan time illustrates the change in time required to dry grain to a proper storage moisture percentage (Table 18). The baseline assumption for the fan time was estimated at 72 hours (three days); a sensitivity of the 30 hours increase from the baseline assumption illustrates the change in total drying cost and the percentage change in the internal rate of return (IRR).

Table 18: Sensitivity Result on Fan Time

Grain Drying		
Fan Time	**Total Drying Cost**	**IRR**
72	**0.009642328**	**61.20%**
102	0.013499471	61.20%
132	0.017356614	61.20%
162	0.021213757	61.20%
192	0.025070899	61.20%
222	0.028928042	61.20%

Table 19 summarizes the sensitivity result with respect to change in grain volume. The baseline assumption for the capacity is 800,000 kilogram, with 655,900 total volume used for the model assumptions. The purpose of this sensitivity is to illustrate the change in internal rate of return (IRR) as the grain volume decrease simulating a poor harvest.

Table 19: Sensitivity Result on Volume Analysis

Volume Analysis			
Corn	**Rice**	**Total Volume**	**IRR**
543,400	**112,500**	**655,900**	**61.20%**
489,060	101,250	590,310	52.57%
434,720	90,000	524,720	43.75%
380,380	78,750	459,130	34.61%
326,040	67,500	393,540	24.90%
271,700	56,250	327,950	14.07%
217,360	45,000	262,360	0.41%

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CHAPTER V

CONCLUSION

The focused area for the purpose of this study is the Ejura-Sekyedumase district of the Ashanti, Region in Ghana. The feasibility analysis was performed on two grain storage facilities and for four different scenarios, two of which analyzed the difference in corn and rice prices, and the others compared the variation in drying and storage prices. An Excel based feasibility template was generated to perform the feasibility analysis. The template allowed for comparing grain prices, drying cost, and storing costs.

This study explored the feasibility of a proposed business venture by Agriculture Youth Advancement (AYA Project) LLC which involves the construction of a centralized grain dryer and storage system in Ghana. The capacity of the grain storage facility is 800,000 kilogram storing 543,400 of corn and 112,500 of rice on an annual basis. The financial projections determined that $.13 drying fee per kilogram and $0.02 storage fee per kilogram (includes fumigation fee) will allow the AYA Project to cover all anticipated costs and generate an annual profit. The projections included detailed monthly cash flows for the first 24 months of operation and $1,500 for contingency expenses. At the baseline assumptions AYA Project LLC achieves an internal rate of return of 23.15% under the assumption that AYA distributes 60% of its profits to its members and the members achieve a net cost of storage of $0.02 per kilo and net cost of grain drying at $0.13 per kilo.

Specific Conclusions

The feasibility template was used to determine the economic feasibility of constructing and operating a grain storage facility in a specific area of Ghana. The template provides a helpful process for understanding the impact of changing values of important factors in the economic feasibility of developing grain storage facilities. The in-bin storage system was determined to be slightly more profitable than the warehouse system. However, based on our assumption, a centralized grain storage facility in this area of Ghana appears to be economically viable, generating high returns to members. While the in-bin storage system is more profitable than the warehouse system at baseline levels and assumptions, the in-bin system is also more sensitive to volume of grain received.

Limitations and Recommendations for Future Research

The feasibility template created for the purpose of this study has the potential to help the farming community in Ghana become more profitable and opportunity for grain drying and storing ventures. The projects also assume that grain storage shrinkage and moisture loss are at moderate level described in the baseline assumptions. This will require the user to implement accurate procedures and for stored grain. The projects include a brief analysis of the change in corn, rice, drying cost, and storage cost. This provides a scale for potential price gains as grain prices fluctuates.

Several assumptions were made for the input prices for corn, rice, drying, and storage costs. Other data and information gathered were from Mr. Peters Evans of Pen Food Bank in Ghana. The results of this study highly depended on factors such as corn price, rice price, drying and storage prices. As the research went further it became difficult to gather exact values needed to conduct the necessary calculations for drying cost, and storage cost. At times, the approach taken to identify the actual cost of drying grain, or storing grain will be to understand the United States method or price and then convert the values to fit Ghanaian standards. Therefore, an exact value was hard to find as such information were not available. Based on the sensitivity results, drying and storage venture can be economically feasible and it's recommended for producers in Ghana to consider. Future research can evaluate the cost and benefit of introducing the in-bin system and assess the risk.

This drying system modeled in this feasibility analysis consisted of a diesel fuel powered aeration fan and a fuel oil fired burner for supplemental heat. The feasibility and possible cost advantages of a solar powered system are a topic further research. In addition to capital and operating costs, the time required to dry grain with a solar system will be a key consideration. This research has examined only a single scale of grain storage. The costs and returns of storage for other scales of storage is also a worthy topic for investigation.

This study has demonstrated high returns to a centralized storage system. This result is due in part to the large discrepancy between the harvest price paid to producers and the subsequent value of the grain later in the season. This situation is what economist commonly refer to as a market failure. As this market failure is corrected through the formation of storage infrastructure, the returns for storage will likely decrease. It is not possible to forecast future changes in the spread between harvest and later season grain prices that may occur as storage infrastructure is created and that lack of information is recognized as a limitation of this study.

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