

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF AGRICULTURE AND NATURAL RESOURCES
FACULTY OF AGRICULTURE
DEPARTMENT OF HORTICULTURE

ASSESSMENT OF POSTHARVEST LOSSES IN SOYBEANS PRODUCTION IN
THE BUILSA DISTRICT IN THE UPPER EAST REGION AND SVELUGU
DISTRICT IN THE NORTHERN REGION OF GHANA

BY

PHILIP ATIIM

NOVEMBER, 2011

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THE BUILSA DISTRICT IN THE UPPER EAST REGION AND SAVELUGU
DISTRICT IN THE NORTHERN REGION OF GHANA

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(POSTHARVEST TECHNOLOGY) DEGREE

BY

PHILIP ATIIM

NOVEMBER, 2011

DECLARATION

I hereby declare that, except for specific references to other people's work which have been duly acknowledged, this write-up, submitted to the School of Research and Graduate Studies, KNUST, Kumasi is the result of my own research and that this thesis has not been submitted either in part or whole for any other degree elsewhere.

PHILIP ATIIM Signature Date

(STUDENT)

CERTIFIED BY

PATRICK KUMAH Signature Date

(SUPERVISOR)

CERTIFIED BY

DR B. K. MAALEKUU Signature Date.....

(HEAD OF DEPARTMENT)

DEDICATION

I dedicate this work to my family especially my wife Elizabeth Adanakum; you have been a great inspiration. I love you.

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How empty I would have been without God. Thank you lord for this blessing and protection throughout my study.

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ABSTRACT

The study was conducted to assess the postharvest losses of soybeans in the Builsa and Savelugu districts of the Upper East and Northern Regions of Ghana, respectively. Data was collected from forty (40) Soybeans farmers in each district using a structured questionnaire. The survey revealed that 76.3% of the respondents were males while female soybeans farmers represented 23.8%. The age range of respondents from 18 to 45 years (37.5%) formed the largest group in soybeans farming. Out of the 80 respondents 53 farmers representing 66.3% had no formal education, and 16.3% who had only basic education. Only 6.3% and 11.3% had secondary and vocational education respectively. The study revealed that wrong harvesting time and methods accounted for the greatest of losses in soybeans production with 63.8% cumulative percentage. Crop variety and poor agronomic practices accounted for cumulative percentage loss of 5 and 13% respectively. The losses were reported to be greatest within the last two months of the year (November and December) with losses of between two (2) and three (3) mini bags per acre are reported. Losses were also reported during handling/processing; 21 respondents representing 26.3% and 2 of 2.5% of total respondents said they lost produce during threshing and winnowing respectively. The study showed that most farmers did not have access to training in postharvest handling of soybeans. Twenty-six percent of the respondents have had training while 73% have never been talked to regarding crop handling. NGOs were found to be the main providers of training to farmers in the study area according to 52% of the respondents. Marketing and market channels are limited in the study area; 73 farmers representing 91% of respondents sell in the open market without any formal market system, this group of farmers are always left at the mercy of middlemen who make up 51% of buyers of the crop. Harvesting at the right

time was thought to be the best way to reduce postharvest losses of the crop by 48.8% of the respondents, while use of equipment was considered by 22.5% of the respondents as necessary to reducing losses. 28.8% said training is key to reducing postharvest losses in soybeans.

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LIST OF ABBREVIATIONS

- BDMTDP** - Builsa District Medium Term Development Plan
- FBO** - Farmer-Based Organisations
- MiDA** - Millennium Development Authority
- MoFA** - Ministry of Food and Agriculture
- MT** - Metric tonne
- NGO** - Non-Governmental Organisation
- PNDC** - Provisional National Defence Council

1.0 INTRODUCTION

Soybeans (*Glycine max*) is a leguminous plant of the family Leguminosae native to tropical and warm temperate regions of Asia, where it has been cultivated as a principal crop for at least 5,000 years. The crop has been cultivated from pre-historic times in China. The first record of this crop is dated back to about 3000 BC (Onwueme and Sinha, 1991).

Soybeans was introduced to Africa from China in the late 19th century and it is now widespread across the continent (Smarth, 1990). In Ghana, soybeans was introduced in 1910. The aim was to get farmers to grow the crop as an additional food item and as a possible cash crop for export to England. To this end, soybeans still remains a foreign crop yet to be fully accepted by Ghanaian farmers owing to the crops seemingly difficult cropping and handling nature. This notwithstanding, in the late 1980s to the 1990s, public/private partnership approach was adopted to launch a massive campaign on soybeans production and utilization under the Ministry of Food and Agriculture, Ghana (Plahar, 2006).

In Ghana, soybeans is cultivated mainly in the Northern, Upper West, Upper East, Central and Volta regions. Among these geographical regions, the largest production occurs in northern Ghana, which lies within the Guinea savanna and Sahel agro-ecological zones (Lawson *et al.*, 2008). The average yield for northern Ghana (Northern, Upper West and Upper East regions) was about 2.5 tonnes/ha on the farmers' field (Awuku, 1991), compared to that of USA which was 4.6 tonnes/ha (Richard *et al.*, 1984).

The Upper East Region recorded a production of 7,673 MT while the Upper West Region had 3, 095 MT of soybeans. The total annual tonnage of processed soybeans in Ghana is estimated to range between 26,100 and 35,200 MT. In the same relation, 14, 707 MT of soybeans/grains and oil were exported between 1997 and 2005 from Ghana (Anonymous, 2006)

Soybeans is one of the most important annual grain legumes in the world, and it is considered as a highly nutritive crop (Rothore, 2005). The seed of soybeans consist of 40% protein, 18% fat, 6% ash and 29% carbohydrates (Antarlina *et al.*, 1999). At the household level, farmers in northern Ghana use soybeans in the preparation of dawadawa, soups, koko (porridge), milk etc. as it is considered as a source of inexpensive dietary protein, mineral, and vitamin for both rural and urban dwellers.

Despite the numerous uses of soybeans, the crop has been faced with several challenges that results in massive crop lost (both quantitative and qualitative) among which include low yields as a result of bad farming practices that can be traced to varietal selection, agronomic practices and harvesting methods and time. Poor quality of produce owing to inappropriate handling right after harvesting, processing and through distribution to the point of consumption has also been noted to be a major cause of crop loss leading to food and income insecurity in the country (Plahar, 2006).

Though a wide range of postharvest technologies that can be adopted to improve losses throughout the process of pre-harvest, harvest, cooling, temporary storage,

transport, handling and market disbursement, recommended technologies vary depending on the type of loss experienced and include: using liners for existing packages, sorting produce by quality, providing shade, using tables, using dry ice for insect control, low energy cold storage, monitoring produce temperature, improved transportation, low-cost food processing, solar drying and curing. Since the 1970s, efforts have been made to assess the grain losses suffered by African farmers. Most measures of loss have focused on grain once it has entered farm storage; little data have been generated on harvesting, drying, threshing / winnowing, transport losses or losses as a result of varietal selection and agronomic practices, that form the principal factors (Kader, 2003).

As a result of the aforementioned problems associated with handling of the crop after harvest for both food and income, this project was carried out to address them. The following objectives were set to guide the project implementation.

The project considered all the different phases from harvest to storage with particular emphasis on production at both farm and marketing levels including postharvest processes such as drying and transportation.

1.1 MAIN OBJECTIVE:

To assess postharvest situation of soybean production in Northern and Upper East Regions.

1.2 SPECIFIC OBJECTIVES:

- To determine the causes of postharvest losses of soybean in Northern Ghana.
- To estimate the levels of the losses at the different stages of handling.

2.0. LITERATURE REVIEW

2.1 BOTANY, CHARACTERISTICS AND IMPORTANCE OF SOYBEANS

Soybeans has been known by many names scientifically, but in 1948, Ricker and Morse presented evidence that the correct scientific name should be *Glycine max.* (L.) and this conclusion is generally accepted and used.

Soybeans is from the family Leguminosae subfamily *Papilionoideae* and genus *Glycine*. *Glycine* comprises about 20 species distributed in the tropics and subtropics of Asia and Australia. The genus is further divided into three subgenera; *Bracteata*, *Glycine* (perennials) and *Soja* (annuals). They are viny perennials used as tropical forages and have diploid chromosome numbers of 22 and 44; and are not hybridized with *Glycine max* (Hinson and Hartwig, 1977).

Soybeans is an arable, annual leguminous crop of native East Asia. It is unclear when the Soybeans plant reached tropical Africa, but it is likely that it was introduced during the 19th century by Chinese traders who were active along the East Coast of Africa.

Plate 1 is a picture of soybean seeds. Seeds are oval in shape and exist in colours of yellow, black, green and red with the yellow being the most common and dominant (Boumans, 1985).



Plate 1: Soybeans seeds

2.2 SOIL AND CLIMATIC REQUIREMENTS OF SOYBEANS

Soybeans is grown from the equator to latitude 55° N or 55° S at altitudes from close to sea level up to 2000 m. Cultivation is successful in climates with hot summers, with optimum growing conditions in mean temperatures of 20°C to 30°C; temperatures below 20°C and over 40°C retard growth significantly. They can grow in a wide range of soils, with optimum growth in moist alluvial soils with good organic matter content and in an equable climate without excessive rainy periods; Soybeans can only withstand a little water logging conditions (Norman *et al.*, 1995).

Soybeans, like most legumes, perform nitrogen fixation by establishing a symbiotic relationship with the bacterium *Bradyrhizobium japonicum* (synonymy: *Rhizobium japonicum*;) However, for best results an inoculum of the correct strain of bacteria should be mixed with the Soybeans (or any legume) seed before planting (Jordan, 1982).

2.3 PLANTING / SOWING

Typically, beans planted during early May have the best yield potential. However, yield depends on several other factors too. Growing conditions at planting time will influence the success of seed germination and seedling vigor. Just because the calendar says it's time to plant doesn't guarantee that it's the optimum time to plant Soybeans.

Soybeans is sown by hand, planter, or by drilling. 3 to 4 seeds / hole are planted at a spacing of 75 cm between rows and 10 cm between stands. Alternatively, seeds are drilled at 50–75 cm between rows and 5 cm within rows. For the early maturing varieties, a spacing of 50 cm between rows and 5–10 cm within rows is recommended because they respond better to narrow spacing than the late-maturing varieties. Sowing seeds more than 2–5 cm deep is not recommended as deeper planting may result in loss of vigor or failure of seedlings to emerge (Dugje *et al.*, 2009).

The Soybeans plant may grow prostrate, not higher than 20 cm or even up to 2 metres in height. Pods, stems and leaves are covered with fine brown or gray hairs; leaves are trifoliolate having three leaflets per leaf and the leaflets are 6-15 cm long and 2-7 cm broad, with leaves falling before the seeds mature. The small inconspicuous self-fertile flowers are borne in the axil of the leaf and are white, pink or purple with fruits growing in pods that are in clusters of 3-5. Fruits are slightly curved and usually compressed pods of 2.5-8.0 cm (Brink and Belay, 2006).

Modern crop cultivars generally reach a height of around 1m, and take 80–120 days from sowing to harvesting. Seeds exist in colours of yellow, black, green and red with the yellow being the most common and dominant (Boumans, 1985).

2.4 HARVESTING SOYBEANS

Soybeans matures within 3–4 months after planting and requires timely harvesting to check excessive yield losses. At maturity, the pod is straw colored. It is recommended that Soybeans be harvested when about 85% of the pods have turned brown for a non-shattering variety but 80% for shattering varieties. Alternatively, the crop can be harvested when the seeds are at the hard-dough stage, when the seed moisture content is between 14 and 16%. Fewer varieties are resistant to shattering but losses in yield may occur from other causes if harvesting is delayed. Harvesting can be done with a cutlass, a hoe, or sickles. Cut the mature plants at ground level, stack them loosely on tarpaulin and allow them to dry in the open for 2 weeks before threshing. Harvest by hand pulling is said to remove the nutrient that the Soybeans has added to the soil (Dugje *et al.*, 2009).

2.5 USES OF SOYBEANS

Soybeans is a good food—soymilk, soycheese, *dadawa*, Tom Brown (infant weaning food), It is also the source of an excellent vegetable oil, It is used in industry to improve soil fertility and controls the parasitic weed, *Striga hermonthica*. Soybeans cake is an excellent livestock feed, especially for poultry, the haulms provide good feed for sheep and goats (Dugje *et al.*, 2009).

According to Lance *et al.* (2005), a record 2.9 million bushel soybeans crop was produced in 2001 on 74.1 million acres with an average per acre yield of 39.6 bushels. The leading Soybeans states are Iowa and Illinois. In 2003, Iowa had 10.6 million acres of soybeans while Illinois had 10.3 million. The highest state yield ever achieved was 50.5 bushels per acre produced by Iowa farmers in 1994.

The majority of the soybeans crop is processed into oil and meal. Oil extracted from soybeans is made into shortening, margarine, cooking oil, and salad dressings. Soybeans account for 80% or more of the edible fats and oils consumed in the United States. Soy oil is also used in industrial paint, varnishes, caulking compounds, linoleum, printing inks, and other products. Development efforts in recent years have resulted in several soy oil-based lubricant and fuel products that replace non-renewable petroleum products.

Lecithin, a product extracted from Soybeans oil, is a natural emulsifier and lubricant used in many food, commercial, and industrial applications. As an emulsifier, it can make fats and water compatible with each other. For example, it helps keep the chocolate and cocoa butter in a candy bar from separating. It is also used in pharmaceuticals and protective coatings.

The high protein meal remaining after extraction can be processed into Soybeans flour for human food or incorporated into animal feed. Soybeans protein helps balance the nutrient deficiencies of such grains as corn and wheat, which are low in the important amino acids, lysine and tryptophan.

Soy flour and grits, made from grinding whole soybeans, are used in the commercial baking industry to aid in dough conditioning and bleaching. They have excellent moisture-holding qualities that help retard staling in bakery products (Lance *et al.*, 2005)

On the local front, mature soya seeds are boiled and used for relishes in tropical Africa, while the immature green beans are eaten as fresh vegetables. The plants are used as feed (fodder, silage) for animals, while some farmers allow the plant residue

to decompose on their fields contributing to soil fertility. The meal after the oil extraction is even more important as it is by far the biggest source of protein used in compound animal feed and human food additives. Milk, yoghurt, flour etc are made from Soybeans at the industrial level.

2.6 Overview and current Postharvest situations

Postharvest losses present one of the main problems not only in rice but also in all grain production. Losses in food crops, occurring during harvesting, threshing, drying, storage, and transportation etc have been estimated to be between 30 and 40% of all food crops in developing countries. If postharvest losses are reduced, the world supply can be increased by 30-40 % without cultivating additional hectares of land or increasing any additional expenditure on seed, fertilizer, irrigation and plant protection measure to grow the crop. To this end, post-production losses and deterioration of food quality are areas of major concern in many developing countries of the world. Backhop (1980).

Harries and Lindbled (1976), defined losses as any change in the ability, edibility, wholesomeness or quality of food that prevents it from being consumed by people. Food losses may be direct or indirect. The direct loss is the disappearance of food by spillage, or consumption by insects, rodents and birds. The indirect loss is the lowering of quality to the point where people refuse to eat it.

They also identified three periods of time, preharvest, harvest and post harvest, during which food may be lost and stated that each period has its own characteristic problems and means of overcoming these problems. Preharvest losses are those,

which occur before the process of harvesting begins, for example, losses in a growing crop due to insects, weeds and rusts. Harvest losses occur between the onset and completion of the process of harvesting, for example, losses due to shattering during harvesting of grain.

Postharvest losses occur between the completion of harvest and the moment of human consumption. The reduction of grain losses, especially those caused by insects, microorganisms, rodents and birds can increase the available food provisions.

Insufficiencies in one of these areas results in significant amounts of horticultural crops that are lost due to harvesting at an incorrect stage of produce maturity, water loss, drought, extreme temperatures, physical damage, contamination by pests and market competition.

In developing countries, losses of the order of 40-75% have been reported. Postharvest loss result not only in the loss of the actual crop, but also losses in the environment, resources, labor needed to produce the crop and livelihood of individuals involved in the production process. When 30% of a harvest is lost, 30% of all the factors that contributed to producing the crop are also wasted (Clark *et al.*, 1997).

The majority of rural populations in developing countries has limited to no resources and solely depends on the agricultural sector for their subsistence, livelihood and revenue. Therefore, postharvest losses are often felt with greater magnitude than in developed nations. While in developing countries the share of postharvest activities in

total value added of food products tends to be lower, there is a tendency towards greater importance of postharvest operations (Goletti and Wolff, 1999a).

Mrema and Rolle, (2002), found that the amount of resources used and the efficiency of production are contingent upon use of appropriate technologies, infrastructure, storage, processing, marketing and transportation. This is against the reasoning of Acedo and Weinberger, (2006), that small-scale farmers depend heavily on the agricultural sector but they experience disturbingly high levels of postharvest loss due to over-ripening, decay and physical injuries caused during handling, packaging and transporting

According to Hall (1980), Postharvest loss is any part of the harvested produce that is desired but failed to reach its point of utilization, or if utilized fails to yield its full value. These postharvest losses occur in the form of weight loss (quantity) quality, nutritional, economic (market value) and loss of seed viability.

Tyler (1982), also said that postharvest losses may be due to a variety of factors, the importance of which varies from commodity to commodity, from season to season, and to the enormous variety of circumstances under which commodities are grown, harvested, stored, processed and marketed. The estimated Postharvest Losses (PHL) are the % reduction in weight of ready to consume grain incurred after the crop is detached from the parent plant and removed from the field.

Grains and legumes may be lost in the pre-harvest, harvest and postharvest stages. Pre-harvest losses occur before the process of harvesting begins, and may be due to insects, weeds and rusts. Harvest losses occur between the beginning and completion of harvesting, and are primarily caused by losses due to shattering. Postharvest losses occur between harvest and the moment of human consumption.

They include on-farm losses, such as when grain is threshed, winnowed and dried, as well as losses along the chain during transportation, storage and processing. Important in many developing countries, particularly in Africa, are on-farm losses during storage, when the grain is being stored for auto-consumption or while the farmer awaits a selling opportunity or a rise in prices.

The story in Ghana is just reflective of this if not worse. Ghana currently produces only 51% of her cereal needs; cereals constitute the staple food of Ghanaians especially people of northern Ghana. This is evident as an estimated 20- 30 % of cereals and legumes and about 20-50% of her fruits, vegetables, roots and tubers are lost annually resulted in the country experiencing food insecurity (Nicol *et al.*, 1997)

Since the 1970s, efforts have been made to assess the grain losses suffered by African farmers. Most measures of loss have focused on grain once it has entered farm storage; little data have been generated on harvesting, drying, threshing / winnowing, transport losses or losses as a result of varietal selection and agronomic practices, that form the principal factors (Boxall, 1986).

Reducing postharvest losses for fresh produce, reported to be in the 30 to 50% range, has been demonstrated to be an important part of sustainable agricultural development efforts meant to increase food availability (Kader, 2005), but during the past thirty years less than 5% of the funding provided for horticultural development efforts has gone toward postharvest areas of concern, while more than 95% has gone toward trying to increase production (Kader and Rolle, 2004).

The problems associated with postharvest losses of crops are many and varied. Losses may occur for two main reasons; during harvesting, handling, processing and transport grain may be scattered, dispersed or crushed. Alternatively, the grain may be subject to biodeterioration. Postharvest losses due to biodeterioration may start as the crop reaches physiological maturity, i.e. when grain moisture contents reach 20-30% and the crop is close to harvest. It is at this stage, while the crop is still standing in the field, that storage pests may make their first attack and when unseasonal rains can dampen the crop resulting in some mould growth. A key issue is the weather conditions at the time of harvest.

All small-scale African farmers rely on sun drying to ensure that their crop is sufficiently dry for storage. If weather conditions are too cloudy, humid or even wet then the crop will not be dried sufficiently and losses will be high. Climate at the time a crop should be drying is key to understanding the potential losses of durable crops. However, successful drying alone is not a remedy against all postharvest losses since insects, rodents and birds may attack well dried grain in the field before harvest and/or invade drying cribs or stores after harvest (Hodges, 2006).

The general and encompassing issue however is the lack of appropriate technologies by farming communities, a situation according to agricultural experts, is having a rippling effect on food security in the continent. This general view (problem) could however be looked at in several segment which include;

2.6.1 Production factors.

The various varieties of Soybeans, owing to their different maturity periods and growth characteristics poses a lot of challenges that farmers need to appreciate. Agronomic practices of soybeans are not well known and practiced by farmers. This development often results in low yield due to weeds and disease infections. The inability of farmers to determine the right time of harvesting often leads to discoloration or shattering of seeds (Tyler, 1982).

Alternatively, the grain may be subject to bio-deterioration. Postharvest losses due to bio-deterioration may start as the crop reaches physiological maturity, i.e. when grain moisture contents reach 20-30% and the crop is close to harvest. During postharvest operations there may be losses of both cereal quantity and quality but what is of concern is loss of quantity (weight loss). The reason for this is that if, after a quality change, cereals are still fit for human consumption then there has been no loss in food availability Postharvest operations for cereal grains follow a chain of activities starting in farmers' fields and leading eventually to cereals being supplied to consumers in a form they prefer.

When determining the losses that may occur in this chain it is conventional to include harvesting, drying in the field and/or on platforms, threshing and winnowing, transport to store and then farm storage. Additional links in the postharvest chain are

included in the cereal supply loss calculation such as such as transport to market and market storage

2.6.2 Processing factors

Produce losses owing to inappropriate processing methodology leaves much to be desired. The use of traditional methods tends to aggravate the situation of postharvest loss. Threshing and winnowing for instance contribute to about 5% quantitative and 8% qualitative (broken) losses of the crop resulting in inability to meet production targets (Lance *et al.*, 2005).`

Besides the broken grains, threshing soybeans the traditional way; using sticks to hit a hip of the produce on the bare ground or on a small material is considered to be very laborious and outmoded. Stones and crop residue contamination tends to affect the produce quality leading to lower yield supply and poor price offers. This situation compounds the food and income security of farmers most especially the rural farmers. Produce quality is also affected by insufficient drying which results in moulds, yeast and other agents of bio-deterioration and gives rise to poor marketability. All small-scale Ghanaian farmers rely on sun drying to ensure that their crop is sufficiently dry for storage. If weather conditions are too cloudy, humid or even wet then the crop will not be dried sufficiently and losses will be high.

Climate at the time a crop should be dried is key to understanding the potential losses of durable crops. However, successful drying alone is not a remedy against all postharvest losses since insects, rodents and birds may attack well dried grain in the field before harvest and/or invade drying cribs or stores after harvest.

It might be thought that higher crop yields of cereals, i.e. bigger harvests, are associated with greater postharvest losses but this effect is likely to be small compared with other factors such as climate at harvest. With very big harvests it is possible that in some locations there is insufficient manpower to bring in the crop or it would be harvested with a reduced efficiency (Hodges, 2006).

Other primary processing forms such as sorting and grading is totally disregarded by subsistence farmers. Where it exists however it is woefully inadequate. Immature grains and other grain that suffered water stress during maturity and has become greenish, deformed grains that are smaller than normal are all collected together and bagged for storage or sale. This negative development does not support the smooth marketing of the crop especially in national and international trading where they are always found to fall below the acceptable standards.

2.6.3 Distribution factors

The distribution chain is very critical and must be carefully planned. Losses due to spillage, contamination and disease and pest attack mostly occur during the periods of storage and transportation.

Unavailable / poor storage facilities are one of the principal factors faced by producer right after harvest and to the seller after mopping up grains from producers. In Ghana many different storage systems/structures exist though specific to geographical location. The issue of grains and for that matter Soybeans storage in the north has over the years remained a challenge in ensuring food security by means of storing surplus produce for later consumption and sale. Soybeans producers and sellers in this

case rely on the indigenous systems for controlling postharvest losses. Jackai and Adallah (1997) indicated that sometimes these indigenous storage systems and pest management strategies are ineffective and labour intensive.

Anderson (1973) defined storage as a repeated interim phase in the complex logistics of moving grains from producers to processors and grain products from processors to consumers. Archeological evidence indicates that grains were grown and stored in bulk about 7000 years ago (Lee and Roberts, 1960). The common storage systems used in preservation of Soybeans in the north of Ghana are Jute sacks, polythene bags, baskets and clay pots.

Transportation challenges encompass the general haulage system that looks at bad roads, inappropriate containment etc. The road network linking the production centres to the markets are generally deplorable and are often blamed on the delays of produce delivery at the points of distribution.

The bad nature of the roads is also the cause of produce spoilage due to frequent vehicular break down. Besides the introduction and use of hermetic bags, most containers do not provide the right condition and support for soybeans holding through the transportation period thereby resulting in spillage and contamination. Poor or lack of market network between producers and sellers gives rise to produce loss and high cost of production due to pest attack and contamination during storage and high storage cost respectively.

3.0 METHODOLOGY

3.1 Study Area

The survey was carried out in two (2) districts in Northern Ghana; Builsa district in the Upper East Region and Savelugu in the Northern Region. Two (2) communities each; Chuchuliga and Wiaga in the Builsa district and Zuogo and Nantongkoruko in Savelugu were covered by this project.

This selection was arrived at due to the fact that the two districts are key production areas of the crop since 2008 under the Market Access Project been implemented by Association of Church Development Project (ACDEP) partners in the Northern and Upper East regions.

3.2. Builsa District

The Builsa district lies between longitudes 1°05' west and latitudes 10°20' north and 10°50' north. It is bounded on the North and East by the Kassena-Nankana districts, on the west by the Sissala district and on the south by the West Mamprusi district and part of Kassena-Nankana district. The District covers an area of 2,220 Km² and constitutes 25.1% of the total land area of the Upper East Region.

The vegetation of the district is characterized by savannah woodland and consists mostly of deciduous, widely spaced fire and drought resistant, trees of varying sizes and density with dispersed perennial grasses and associated herbs. Through the activities of man, the woodland savannah has been reduced to open parkland where only trees of economic value like baobab, acacia, shea nut and dawadawa have been retained with time.

The District has mean monthly temperatures ranging between 21.9°C and 34.1°C with the highest temperatures recorded in March, which can rise to 45°C. The lowest temperature is recorded in January. There is only one rainy season, which builds up gradually from little rains in April to a maximum in August – September and then declines sharply coming to a complete halt in mid-October when the dry season sets in. Rainfalls are very torrential and range between 85mm and 1150mm p.a. with irregular dry spells occurring in June or July. The dry season is characterized by dry harmattan winds and wide diurnal temperature ranges.

There is a wide fluctuation in relative humidity with as low values 30% in dry season and above 75% in the wet season. Due to the wide ethnic and cultural diversities the region was stratified into three broad groups. These diversities affect agricultural systems, soil potentials among others and hence the type of crop cultivated and postharvest handling methods practiced (BDMTDP, 2010-2013)

3.3 Savelugu District

Savelugu District is one of the eighteen (18) administrative districts of the Northern Region. It was established by PNDC Law 207 under the Legislative Instrument of 1988. It was carved out of the then Western Dagomba District Council, which included Tolon/Kumbungu and Tamale Metropolitan Assembly. The District is located in the Northern Region of Ghana. It shares boundaries with West Mamprusi in the North, Karaga to the East, Tolon/Kumbungu in the West and Tamale Metropolitan Assembly to the South. The District's total land area is 1790.70 sq. km. The District is generally flat with gentle undulating low relief. The altitude ranges between 122 to

244 metres. above sea level with the southern part being slightly hilly and sloping gently towards the North.

The main drainage system in the District is made up of White Volta and its tributaries. The effect of the drainage system is felt mostly in the northern part of the district covering the areas between Nabogu and Kukuobilla. These areas are prone to periodic flooding during the wet season, thus making them suitable for rice cultivation. One of the tributaries of the White Volta, Kuldalnali, stretches to constitute a natural boundary between the District and Tolon/Kumbungu district.

The area receives an annual rainfall averaging 600mm, considered enough for a single farming season. The annual rainfall pattern is erratic at the beginning of the rainy season, starting in April, intensifying as the season advances raising the average from 600mm to 1000mm. Temperatures are usually high, averaging 34°C.

The maximum temperature could rise as high as 42°C and the minimum as low as 16°C. The low temperatures are experienced from December to late February, during which the North-East Trade winds (harmattan) greatly influence the District. The generally high temperatures as well as the low humidity brought about by the dry harmattan winds favour high rates of evaporation and transpiration, leading to water deficiencies.

The District lies in the interior (Guinea) Savanna woodland which could sustain large scale livestock farming, as well as the cultivation of staples like rice, groundnuts, yams, cassava, maize, cowpea and sorghum. The trees found in the area are drought resistant and hardly shed their leaves completely during the long dry season.

Most of these trees are of economic value and serve as important means of livelihood, especially, for women. Notable among these are shea trees, (the nuts which are used for making shea butter) and dawadawa that provides seeds used for condimental purpose. The sparsely populated north has denser vegetation mostly with secondary forest. The populous south on the other hand, is depleted by human activities such as farming, bush burning and tree felling among others. (Anonymous, 2011) www.Ghanaweb.com

3.4: Target Population

The survey targeted producers (farmers) as one of the principal actors of the Soybeans commodity value chain. The survey covered both men and women involved in the Soybeans production industry.

3.5: Data source

The study utilised both quantitative and qualitative methods of data collection. Questionnaire (closed and open ended) was used to gather information from farmers. This method was used because the number of farmers cultivating Soybeans as well as the depth of their practice was crucial to understanding the postharvest situation of the crop. However, more emphasis was laid on qualitative methods because that facilitated the collection of more in depth information.

Quite a myriad of literature exist globally on the subject of study. Postharvest losses have been discussed from various angles and varied conclusions have been drawn. This study reviewed published books, reports and articles relevant to the study and to augment primary facts. It unearthed areas covered and research gaps that need further investigation.

The following institutions and departments were visited to collect / gather relevant information:

- The Presbyterian Agricultural stations in Tamale and Sandema
- University for Development Studies Library facility.
- Savanna Farmer Marketing Company
- Tamale Metropolitan directorates of Ministry of Food and Agriculture.
- Savanna Agricultural Research Institute library.

3.6: Survey questionnaire

Forty open-ended questionnaires were administered to 40 randomly selected farmers (Producers) in each of the two selected communities of the two districts. These farmers were made up of contract farmers with NGOs such as Savanna Farmer Company Ltd and Technoserve, and also individual farmers. The survey sought to assess the following parameters as associated with crop losses: varietal selection, agronomic practices, time of harvesting, method of harvesting, and equipment and tools usage (Appendix A).

3.7: Data analysis

Data gathered from the field on beneficiaries was analysed using the Statistical Package for Social Scientists (SPSS) version 17. The information obtained was analysed and interpreted using descriptive techniques (frequencies and cross tabulations). Tables, bar charts and pie charts were also used to present data. Graphical presentations were made to carry instant information in a concise and understandable manner without reading the main text.

4.0 RESULTS

4.1 Field Survey

Results of the field survey are shown in bar and pie charts covering gender, age, and educational background of respondents, as well as assessment of the causes of postharvest losses of soybeans and how they can be managed in the Northern and Upper East Regions of Ghana.

4.1.1 Gender of Respondents

Figure 1 indicates the gender of the respondents. Out of the 80 farmers interviewed, sixty-one (61) were males representing 76.3% of the respondents, while nineteen (19) were females representing 23.8% of the sample size.

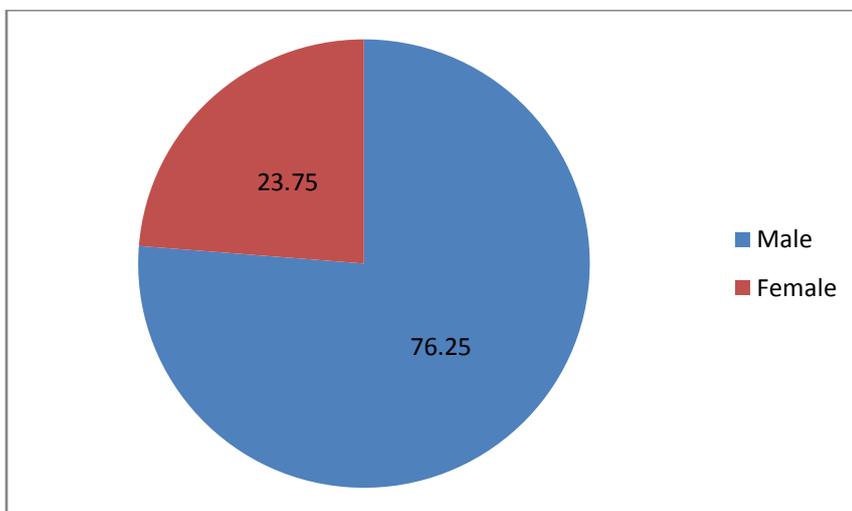


Figure 1: Gender of Respondents.

4.1.2 Age profile of respondents

From Figure 2, the modal age group is 36-45 with thirty (30) farmers representing 37.50% of the respondents which was closely followed by the age range of 26-35 which recorded 23.8% (19 respondents). However, the age ranges 18-25, 46-55 and above 55 years group recorded 13.8%, 18.75% and 6.3% respectively. There were few soybean farmers above 55 years old.

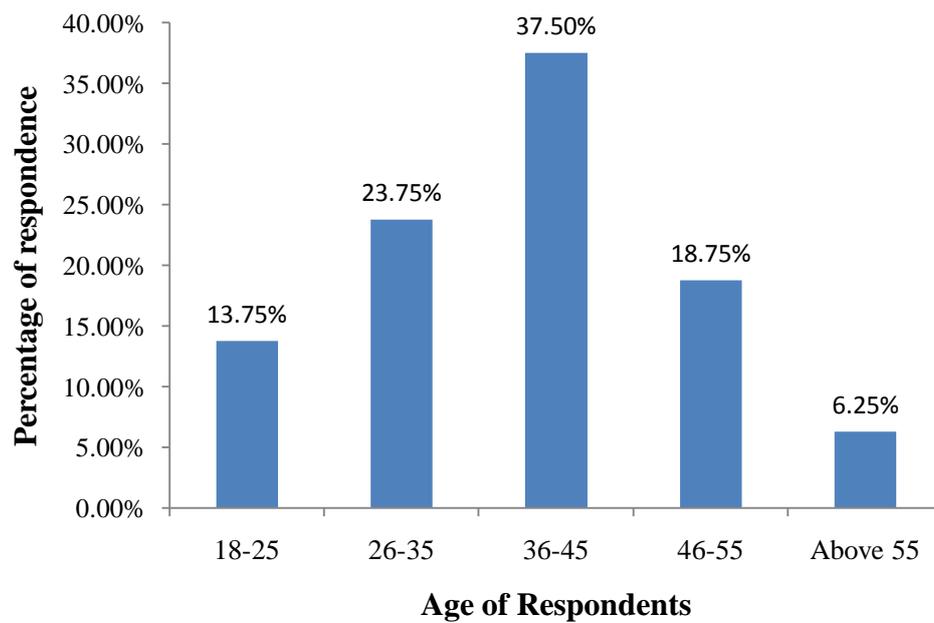


Figure 2 Age profile of respondents.

4.1.3 Educational level of Respondents

The impact of education in agricultural production is immeasurable. Responses from the field work indicate that majority of farmers who are into soybeans cultivation in northern Ghana are illiterate. This is evidenced in Figure 3 which indicate that about 53 farmers representing 66.3% of the sample size have no formal education while 16.3% and 6.3% of the respondents have acquired only basic and secondary education respectively. 11.3% had vocational and Arabic education.

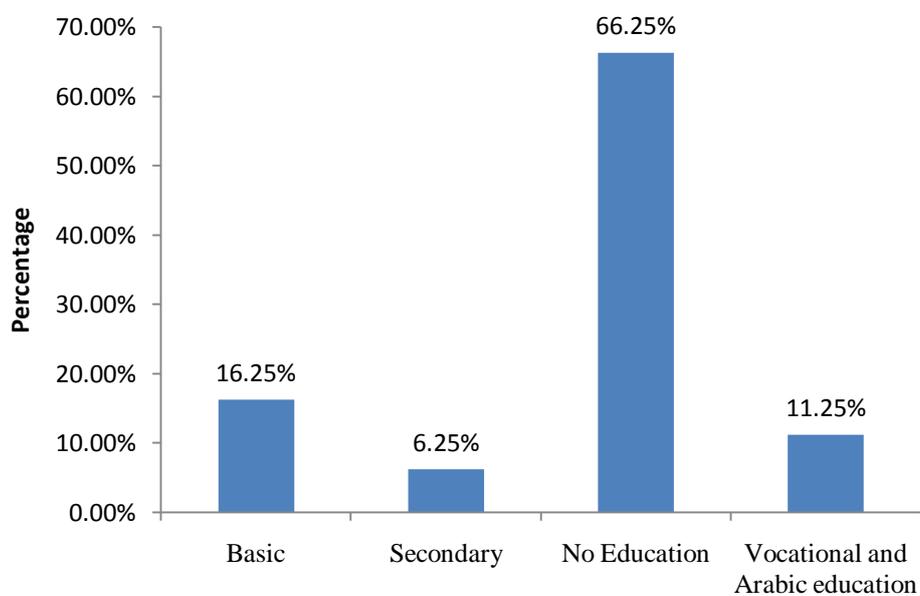


Figure 3: Educational Level of Respondents.

4.1.4: Causes of Postharvest Losses.

From Table 1, seven (7) farmers representing 8.8% of the respondents attributed their losses to crop poor agronomic practices. Eleven (11) farmers representing 13.8% indicated that their losses were as a result of poor weather and wrong time of harvesting. Eighteen (18) and twenty-five (25) farmers making up 22.5% and 31.3% respectively of respondents indicated that, their losses were as a result of poor harvesting methods and outmoded process methods being practiced in the area in northern Ghana. Only four (4) farmers each representing 5% attributed their losses to crop varietal selection and poor storage systems respectively.

Table 1: Causes of Postharvest Losses.

Causes of postharvest losses	Frequency	Percent	Cumulative Percent
Crop variety	4	5	5.0
Poor agronomic practices	7	8.8	13.8
Poor weather	11	13.8	27.5
Wrong harvesting time	11	13.8	41.3
Method of harvesting	18	22.5	63.8
Processing method	25	31.3	95
Storage system	4	5	100
Total	80	100.0	

4.1.5 Period of harvesting.

From Table 2 it is clear that a few farmers harvest their produce between September and October where eleven (11) and nine (9) farmers representing 13.8% and 11.3% respectively were recorded with a cumulative of 25.0% of respondents falling in this group. Also most of the farmers in the survey area harvest their soybeans in November and December. While forty-two (42) farmers representing 52.5% harvested in November and eighteen (18) farmers forming 22.5% do their harvested in December.

Table 2: Period of harvest.

Period of harvest	Frequency	Percent	Cumulative Percent
September	11	13.8	13.8
October	9	11.3	25.0
November	42	52.5	77.5
December	18	22.5	100.0
Total	80	100.0	

4.1.6 Estimated losses by harvest period

Figure 4 shows that losses were higher in the last two months of the year where figures of 2 and 3 mini bags (45kg) out of an average of 12 mini bags per acre is lost in November and December respectively. Harvesting in September recorded the least loss figure of less than 1 mini bag, while October harvesting resulted in 1 mini bag of 45kg.

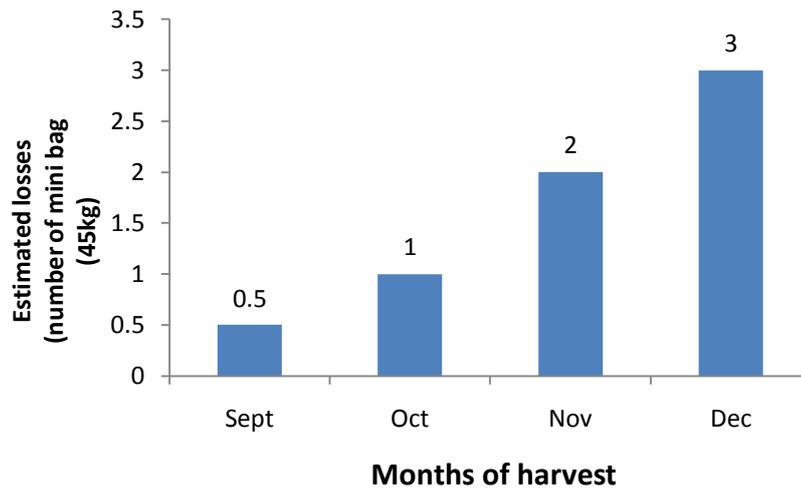


Figure 4: Estimated losses by period of harvest.

4.1.7: Losses due to poor processing practices.

From figure 5 below, fifty-seven (57) farmers representing 71.3% of the respondents indicated that they lost produce during harvesting of Soybeans. Out of 80 respondents, twenty-one (21) representing 26.3% of the respondents during the field survey also indicated that they lost soybeans at threshing and winnowing. Only 2 respondents making up 2.5% of the 80 farmers interviewed indicated that they experienced losses during the drying stages of produce processing.

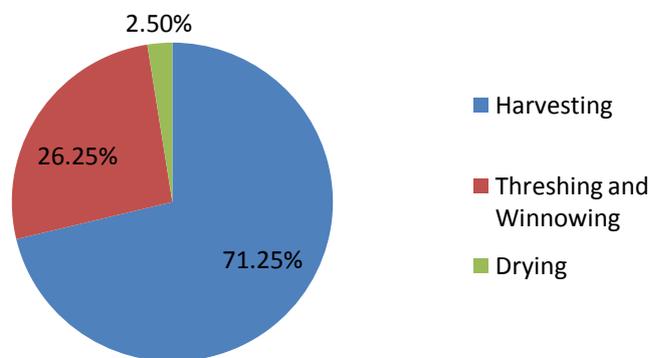


Figure 5: Losses in the Processing stages.

4.1.8 Availability of ready market for harvested Soybeans

Results of the survey pointed out to the fact that majority of the Soybeans farmers, 73 farmers out of 80, representing 91.3% of the respondents in the study area had no access to ready and reliable market for the produce. Seven (7) farmers out of the 80 interviewed, and forming 8.8% of the respondents, however indicated that they had been linked to a market channel with which they signed contracts.

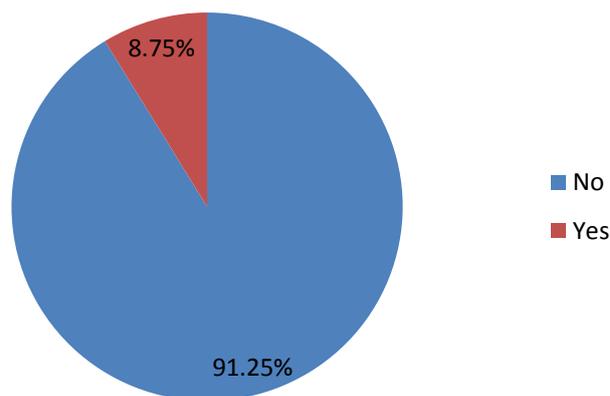


Figure 6: Availability of market for Soybeans.

4.1.9: Forms of marketing of Soybeans

Table 3 below revealed that the main buyers for Soybeans are market women by 41 out of the 80 farmers interviewed in the survey and representing 51.3% of respondents. 40% of the interviewees, (32) farmers indicated that they sold their produce to institutional buyers such as NGOs and government agencies.

Table 3: Forms of marketing of Soybeans

Market Channels	Frequency	Percent
Market women	41	51.3
Institutional buyers	32	40.0
Total	73	91.3
Missing	7	8.8
Total	80	100.0

4.2.0: Number of farmers that received training on postharvest management.

Table 4 indicates that only twenty-one (21) of the respondents which represents 26.3% had received training on postharvest handling improve / increase production. However, forty-seven (47) of the 80 farmers covered in this survey and representing 58.8% of the respondents had not benefited from any training related to postharvest management as of the time of this study. Twelfth (12) farmers representing 15% could not indicate whether they had any form of training in postharvest management.

Table 4: Number of farmers that receive training in postharvest management

Any training on postharvest losses	Frequency	Percent	Cumulative Percent
Yes	21	26.3	26.3
No	47	58.8	85.1
Total	68	85.0	
Missing	12	15.0	
Total	80	100.0	

4.2.1: Training service providers in postharvest management

From table 5, Forty-two (42) respondents representing 52.5% of the sample 80 had benefited from postharvest training programme offered by NGOs. Farmer-Based Organization leaders provided postharvest management training to 3 farmers which represent 3.8% of the farmers interviewed. Only 1 farmer (1.3%) indicated that he had been trained by MoFA. Most of the 34 farmers representing 42.5% could not mention any form of training received.

Table 5: Training service providers in postharvest management

Organizations	Frequency	Percent
MoFA	1	1.3
NGO	42	52.5
FBO Leaders	3	3.8
Sub-total	46	57.5
Missing	34	42.5
Total	80	100.0

4.2.3: Reducing Postharvest losses.

The results of the survey as shown in Figure 7 revealed that thirty-nine (39) farmers making up 48.8% of the respondents indicated that harvesting soybeans at the right time was important to reducing or avoiding postharvest losses. On the contrary, 28.8% of the respondents claimed that adequate training in postharvest handling of Soybeans was important to reducing postharvest losses of the crop, whereas 22.5%

were of the view that availability and use of equipment for harvesting and processing will greatly reduce postharvest losses in soybeans.

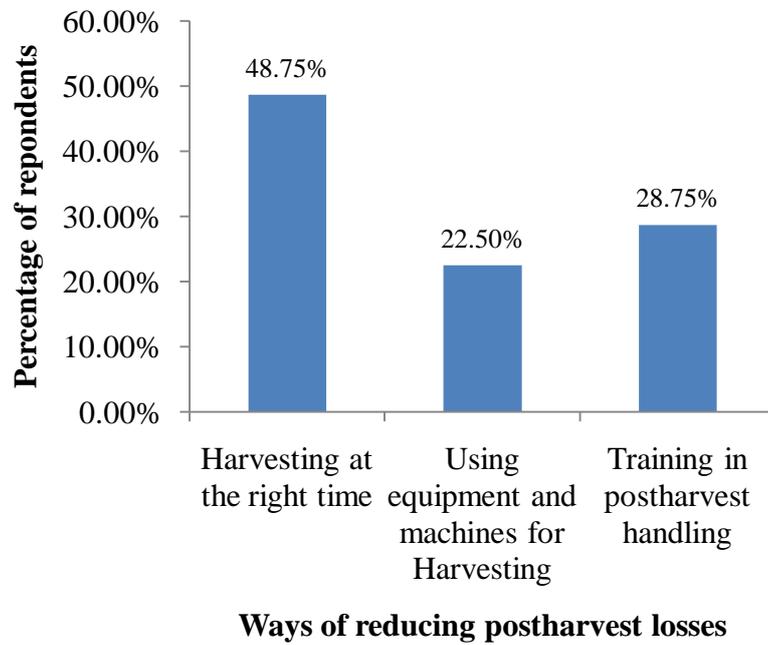


Figure 7. Reduction of postharvest losses during handling

5.0 DISCUSSION

5.1 GENDER DISTRIBUTION

In most farming communities, gender is significant in crop cultivation. The situation is not different for Soybeans cultivation in northern Ghana. The results showed that more men (76%) were engaged soybean production than women (24). The rationale for male dominance could be simply that they are family heads and are the sole owners and controllers of land for farming including other resources on the land and also provide food for the family. Women from the study area on the other hand are housewives and do not have their own farm land to do cash cropping. Women are however engaged in farming and are basically responsible for processing, preserving and marketing of farm produce.

The accession by (Quisumbing *et al.*, 1995), that although they provide 60 to 90% of the farm work, as women they usually lack technical knowledge, and often have poor access to current information, markets and credit, to engage in cash crop farming, those few who are farming also experience losses as a result of low capacity holds true for the study area. This notwithstanding, women are observed to make up the major labour force involved in about 90% of the entire postharvest handling chain of the crop and of other crops in the area.

5.2 AGE PROFILE

Age plays a vital role in productivity of agriculture as both youth and old are in the front line of farming in the area. The age factor generally was observed to rise from 18 to 36 years and then fell to 55 years.

The findings brought to light that those who were within the age group of 36-45 years making up a majority of the youth dominated with approximately (30%). Most of them are energetic and find it possible to combine the cultivation of food and cash crops. This is against the background that Soybeans cultivation requires more labour and skill to cultivate, and that agricultural practices in the area still relies on manual tillage and processes which also require excessive labour. By age 46 to 55 and beyond, a lot of farmers are not very strong to do any serious farming that can combine cash cropping.

5.3 EDUCATIONAL LEVEL

Responses from the study indicated that majority of the Soybeans farmers in study area are illiterate. This phenomenon is typical in Africa and particularly in northern Ghana where agriculture is basically subsistence and make up a huge proportion of the livelihoods of the rural folks who are often not educated. This development is seriously affecting agricultural productivity since most of our illiterate farmers are not aware of good agronomic practices and many other issues regarding postharvest handling and storage of crops especially commercial crops such as Soybeans. This phenomenon also greatly affects agricultural technology adoption on the part of farmers.

5.4 CAUSES OF POSTHARVEST LOSSES.

Several different factors have been identified by some researchers as the causes of postharvest losses, more especially in soybeans production. According to Tyler (1982) postharvest losses may be due to a variety of factors, the importance of which varies

from commodity to commodity, from season to season, and to the enormous variety of circumstances under which commodities are grown, harvested, stored, processed and marketed.

The study indicated that harvesting and processing challenges were the most important causes of losses in soybeans in the study area; recording a total of 53.30%. This accession could be attributed to the fact that the farmers in this area who are also small holders do not have access to any form of equipment for harvesting. They rely on manual and outmoded methods of harvesting that tend to increase the shattering of the beans. Crop is pulled out of the soil by hand and piled up in tarpaulins for threshing. This involves piling soybeans plants on tarpaulin or putting dry Soybeans pods in sacks and beating them with sticks. The material is then winnowed to remove the seeds from the debris as in Plate 2. According to Dogji *et al.* (2009) this is not a good practice in the 21st century as the act of uprooting the crop tends to cause the removal of the nutrient that the soybeans plant has added to the soil. This goes to explain why soils in the areas are continuously being impoverished even with the cultivation of legumes that are supposed to fix nitrogen into the soil.

5.5 ESTIMATED LOSSES vs PERIOD OF HARVESTING.

The study revealed that huge quantum of losses occurred in November and December. Farmers whose harvest coincided with these months will experienced losses in the region of 2 to 3mini bags (45kg) per acre (see Figure 4). These losses are attributable to dry weather condition as a result of effects of harmattan which is predominant in the area and severe during this period. This perhaps explains why most of the farmers preferred to cultivate Janguma which is a minimum shattering variety with a maturity

period of four (4) months (120 days) as against the Salontie 1 and 2 which is of short maturity (90 days) but shatters a lot. Due to late start of the rains therefore, farmers are forced to plant in July or August requiring the crop to stay till Nov-Dec. thereby resulting in the losses at harvest. Majority of soybeans farmers therefore seem to be aware of the Nov/Dec harvest losses as many of them lean towards September and October harvesting as evidence in the graph. Zane *et al*, (1993) asserted that soybeans harvesting be completed as quickly as possible after beans first reach combine maturity since late harvesting at low moisture content can cause high shattering losses.

5.6 LOSSES IN THE PROCESSING STAGES.



Plate 2: Manual Threshing and Winnowing of Soybeans.

The study revealed that processing (threshing and winnowing) remained a major challenge in the postharvest handling of soybeans. This is evident from Figure 5, where 26% of respondents attributed crop losses to threshing and winnowing factors. This phenomenon is attributed to the fact that farmers in this area who are small scale and or subsistence farmers do not employ modern equipment and technology to harvest and process their soybeans.

El- Hissewy (1999) concluded that during harvest and postharvest operations, the largest amount of losses was determined as large as 28.5 % when manual harvesting and threshing by tractor (Treading) and use of traditional mills were used. In general, the harvest and postharvest losses ranged between 8.1 % and 28.5% and differed according to the methods used during this step. However, most of these losses were due to the use of the traditional mills. This manual means of processing often limits their capacity to maximize their total yields. Manual processing involves piling soybeans plants on tarpaulin or putting dry soybeans pods in sacks and beating them with a stick. The material is then winnowed to remove the seeds from the debris. This process of beating the produce in sacks and tarpaulins results in grain being crushed / broken which eventually affected the quality of the grain thereby reducing its marketability.

The survey also revealed that soybeans postharvest losses occurred in the other stages of processing such as drying and storage. According to the study, 2.50% of respondents experienced losses through drying. Soybeans drying in the north was achieved by sun drying whereby beans were spread on tarpaulins or on the bare flour

in some worse cases to dry under the sun in the open. Others also left the unthreshed beans on the farm to dry before threshing.

An International Development Research Centre (IDRC) (1989) report showed that harvesting and drying grain loss of 16.3% and 9.5% were recorded in Swaziland and Zimbabwe, respectively. The report further indicates what might be expected when climatic variations in the future lead to crops being harvested in unfavourably wet weather. Losses at this point occur as a result of rain / moisture that cause soybeans grain to become mouldy as they stay for long and sometimes unattended to.

Sand and other foreign matter also contaminate the beans during drying due to exposure to the environment. Losses due to animals (goats and sheep and birds) eating and spilling bean under drying are also highly appreciable. Soybeans storage in the north is still in its traditional stages as no form of ware housing is provided for the harvested produce. This goes to buttress the finding of Lee and Roberts (1960) that the common storage systems used in preservation of soybeans in the north are Jute sacks, polythene bags, baskets and clay pots.

Respondents in this study did not attribute significant loss to storage. which is perhaps due to the fact that there are no known major storage pests of Soybeans besides some pockets of reports of rodent attack. This point has been buttressed by Plahar (2006), in his findings that the extent of insect infestation during storage is negligible as over 95% of farmer do not practice any form of pretreatment prior to storage. As such it

could be concluded that Soybeans farmers generally have little constraints in storage which may be a matter of space.

This notwithstanding, a review of crop storage systems and estimates of postharvest losses under farmer storage in the Upper East region of Ghana according to (Sugri *et al.*, 2010) showed that cowpea and bambara nut recorded higher losses of 13.53 and 11.03 % compared to 3.48, 4.78, 6.68, 2.15, 1.71 and 3.09 % in maize, sorghum, millet, rice, Soybeans and groundnut, respectively. Jackai and Adallah (1997) indicated that sometimes soybeans producers and sellers rely on the indigenous systems for controlling postharvest losses, most of which are indigenous storage systems and pest management strategies are ineffective and labour intensive.

5.7 LOSSES DUE TO LACK OF TRAINING

The study revealed that only twenty-one (21) of the respondents which represents 26.3% received training on postharvest handling offered to increase production. However, forty-seven (47) of them representing 58.8% of the respondents had not benefited from any training as of the time of this study. This analysis shows that lack of training possibly affected the level of postharvest losses in soybeans. This is against the background that the crop is quite new to some of the rural farmers and its cultivation practices are not well understood yet by them may also compound the problem.

The study further revealed that most of the postharvest handling practices are manual, indigenous and natural; as no single farmer adopted any form of modern technology or best practices in handling of soybeans in the area. Harvesting, threshing and cleaning was done manually and drying was also predominantly by sun drying.

Caswell (1994) stated that large-scale efforts to commercialize new grain uses beyond the farm gate have been less than spectacular to date and that much research is devoted to development of seed genetics which provide the characteristic of interest rather than research that seek to address management of the supply chain in a way that will allow movement of the grain from the producer to the end-user in an efficient manner.

5.7.1 LOSSES AS A RESULT OF LACK OF MARKET ACCESS.

Figure 6 indicates that soybeans marketing is difficult in the study area and this poses a challenge to postharvest management of the crop. The study revealed that the main buyers for soybeans are market women according to 41 out of the 80 farmers interviewed in the survey representing 51.3% of respondents. Forty percent (40%) of the interviewees, (32) farmers said they sold the beans to institutional buyers such as NGOs and government agencies. This situation arises from the fact that the farmers do not have adequate storage system to store their produce in good condition for a long time to attract high prices in the off season.

As soybeans farmers still sold in the open market, the market women took unfair advantage of their lack of adequate storage facilities to buy the produce off at low prices during harvest. Those who store, could store up to six months and sell only when they are required to do so to meet financial needs at home. Those without proper storage facilities are forced to store for long periods thereby loose some produce as a result of rodents attacks.

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The results of the survey showed that majority of the soybeans farmers in northern Ghana loose produce due to lack of knowledge in appropriate handling of the crop, this was largely as a result of inadequate training in postharvest management of soybeans for them. Harvesting practices were found to be the single greatest cause of postharvest losses of Soybeans in northern Ghana and was widely attributed to late harvesting and the lack of equipment to aid in the harvesting and processing of the crop, leaving farmers with no choice than to continue to use manual and traditional or outmoded methods.

Fewer women were found to be engaged in soybeans cultivation as compared to their male counterparts. This is observed to have an impact on the empowerment of women and livelihoods of the households in general. Marketing constrains remain issues to be considered in any attempt to address the postharvest situation of soybeans.

Ghana's postharvest technology systems therefore need to be improved if the nation must attain food security as proposed in the vision 2015 goal. There is the need for policy interventions that would empower some level of commercial and mechanized agriculture. Postharvest technology is therefore vital to feed into current developments in government policies and interventions such as the Youth in Agriculture, the establishment of mechanization centres across Ghana, Millennium challenge Account (MiDA), Savanna Accelerated Development Authority (SADA), Low Land rice Project, among others which are expected to boost up agricultural productivity. These interventions further underscore the need to improve postharvest technologies to handle the expected surpluses.

In view of the importance of soybeans production to the livelihood of the Northern Farmer it will be prudent for Government (MoFA) and NGOs to put together a more systematic education on best agronomic practices and Postharvest Handling of Soybeans for the small-scale rural farmer.

Government must step up moves to mechanize agriculture. (Set up Agri-business centres) such as the models being considered under the MiDA project; that will come with a complete processing and storage line to serve the small scale farmer. Reliable market channels should also be identified and linked up with the producers to mobilize produce including surpluses during harvesting.

There is the need for more research to be done on the postharvest handling of Soybeans and other crops to provide adequate knowledge of best postharvest practices to enable producers and distributor maximize production and marketing.

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APPENDICES

Appendix A. Survey Questionnaire

**KNUST -FACULTY OF AGRICULTURE, DEPARTMENT OF
HORTICULTURE**

INTRODUCTION

This survey is being conducted for the purpose of providing data and facts for the write-up of a MSc. Postharvest Technology Thesis of a student of the Kwame Nkrumah University of Science and Technology, Faculty of Agriculture, Department of Horticulture.

The project topic is; “Assessment of Postharvest losses in Soybeans production in the Upper East and Northern Regions” it is intended to identify and assess the various factors that have bedeviled the Soybeans industry from the point of view of the producer despite its numerous uses, benefits and wide promotion.

Your swift response would be most appreciated. Thank You.

Survey Questionnaire

Place:..... Date Age

Name of respondent (optional).....

1. Sex:

A. Male

B. Female

2. Educational level;

A. None

B. Basic

C. Secondary

D. Tertiary

E. Others

1. How long have you been growing Soybeans?

2. What is the area of your Soybeans field in acres?

3. What Soybeans variety or varieties do you grow?

4. What pre-harvest factors cause postharvest losses of Soybeans in your perception?

A. crop variety

B. Poor agronomic practices

C. Poor weather

D. wrong harvesting time

5. When do you harvest your crop?

6. How do you harvest? Describe.....

.....

.....

.....Do you experience postharvest losses?

A. Yes

B. No

7. How much do you loss? (Quantify).....

8. How do the losses come about? Describe

.....

.....

9. At what stage do you experience the highest postharvest losses?

A. Harvesting

B. Threshing and Winnowing

C. Transportation

D. Milling.

E. drying

F. Storage

10. What threshing method do you use?

A. Manual

B. Machine.

11. What is your perception of postharvest losses of Soybeans in general?

(Estimate / quantify)

12. What harvesting method do you use?

A. Manual

B. Tractor drawn implement.

C. Combine Harvester

13. Do you own / use any postharvest equipment or machine?

A. Yes

B. No

14. If yes, which one(s)

A. Dryers

B. Sorters

C. thresher

D. Others.....

15. How long do you store your produce before marketing?

A. 2 weeks

B. 1 month

C. 3 months.

D. 6 Months.

E. None.....

16. How do you store your produce?

A. floor

- B. Sacks,
- C. under tarpaulin
- D. warehouse

17. Have you receive any training on postharvest losses before?

- A. Yes
- B. No

18. If yes, from what organization.

- A. MoFA
- B. NGO
- C. FBO leaders.
- D. other.....

19. How do you dry your Soybeans?

- A. Sun
- B. Solar
- C. Oven.

20. Do you have ready market for your produce?

- A. Yes
- B. No

21. If yes, who are your market channels.....

22. What do you think can be done to reduce postharvest losses of Soybeans from harvesting to marketing?.....

THANK YOU!

Appendix B.



Plate 3- A localized storage system for grains and legumes in the north of Ghana