Enhancing Indigenous Agricultural Management Techniques: A Framework to Minimize Post-harvest Losses in Potato Farming in Bui Division, North West Region of Cameroon

Louis Mosake Njomo, Cecils Arnolds, Shillie Peter Ngek

Abstract: ***Global food security is continuously being challenged by postharvest losses. This study focuses on minimizing postharvest losses in potato farming in Bui Division through making use of indigenous knowledge techniques. The methodological framework utilized to realize the aim of this study began with a review of literature in the area of study. The literature reviewed looked at indigenous knowledge practices across the world and how they have helped in preventing postharvest losses. The case study design was used to explore the phenomenon in detail. Purposeful Sampling was used to select research participants that could provide information rich in detail about indigenous potato farming practices in the study area. Individual interviews and focused group discussions were conducted with farmers, agricultural official, traditional rulers and staff of institutions that support agriculture. Participant observations were also carried out by the researcher. Field notes were recorded each time the researcher visited the villages. In the analyses, the author used the Thematic Network Analysis method. The findings of this study show that there are many benefits from using indigenous knowledge in potato farming and that if enhanced, the indigenous knowledge practices of small holder farmers in Bui Division can results in some gains especially minimizing postharvest losses. The framework for minimizing post harvest losses as suggested by this study may enable policy makers and stakeholders to tailor efforts towards minimizing postharvest losses by enhancing the indigenous knowledge techniques of the farmers. This study will make a contribution in the enhancement of indigenous knowledge on the prevention of postharvest losses in potato farming. The study could also serve as a reference document for potato farmers and other stakeholders who may be interested in helping small holders farmers engaged in potato farming.***

Keywords: Indigenous Knowledge, Agriculture, Postharvest Loss, Thematic Network Analysis, Potato Cultivation

Paper Layout: This paper is divided into five main parts. Part one is the introduction and the problem statement under investigation. Part two reviews literature on some key issues directly linkd to the study. Part three is the methodological approach employed in the study. Part four centers on the study findings and discussions and part five gives a conclusion and recommendations based on study findings.

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Dr. Louis Mosake Njomo, Department of Marketing, University of Douala (Essec), Douala, Cameroon. E-mail: lmnjomo@gmail.com

Prof. Cecils Arnolds, Graduate School of Business, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa. E-mail: Cecil.arnolds@nmmu.ac.za

Dr. Shillie Peter Ngek, Department of Agribusiness Technology, University of Bamenda E-mail: spngek@yahoo.co.uk

construction, communication and exploitation of resources. As stated by Warren (2001), every society has indigenous knowledge mechanisms that provide the basis for decision making and the development of techniques of coping with current problems. Indigenous agricultural practices are noted to have helped smallholder farmers in ensuring good yields as a means for food security and nutrition in preserving their harvest and benefiting from higher prices during off farming seasons (Govinden, 1984). Studies (Govinden (1984), Zimmer, (1998), FAO, (1996), Misiko (2007)) have also demonstrated that indigenous agriculture also positively contributes to reducing environmental degradation.

It is worth mentioning that in Cameroon just like many countries in Africa, indigenous agriculture plays a very important role in developing the agricultural sector. A lot more contribution can be made to developing agriculture if indigenous agricultural practices are encouraged and developed. Current views about indigenous knowledge posit that indigenous knowledge holds a lot of assurance for agriculture, food security and sustainable development (Agrawal, 1995; World Bank, 1998). Agrawal (1995) argues that indigenous knowledge is cost effective and sustainable and hence stands the chance of facilitating development in all aspects of life. Such arguments thus uphold the value of indigenous knowledge and the need for such knowledge to be studied and advanced.

In Cameroon, agriculture is the predominant economic activity, with its practices largely indigenous, passed on from generation to generation. Many indigenous agricultural practices in Cameroon have been found to be largely effective in promoting agriculture. Unfortunately, there are little or no structures to identify and promote these practices. In addition, research projects have not been carried out to examine indigenous knowledge in agricultural production. Training of agricultural and extension service staff has ignored the potential of indigenous knowledge and has focused more on western knowledge techniques. As a result, the Cameroonian agricultural sector continues to remain underdeveloped. One of the major challenges confronting the agricultural sector is post-harvest losses especially in the potato sector.

High postharvest losses results in low incomes to farmers as such negatively impacting on their socioeconomic livelihood conditions and brings about food insecurity especially during off seasons. Also, the employment potential of the agricultural industry is reduced resulting in high poverty levels in the country.

Therefore, this study seeks to identify indigenous agricultural practices that can be advanced to minimize post-harvest loses in potato farming and enhance food security. In this regard, the study attempts to develop a framework for the advancement of indigenous knowledge techniques to minimize postharvest losses in potato farming in Bui Division North West Region of Cameroon.

I. LITERATURE REVIEW

a) Conceptual development Indigenous knowledge

Evidence shows that indigenous people have a range of knowledge which has evolved over time and continuous to evolve. Some of this knowledge has been learned from their ancestors and some has been arrived at as a mechanism to meet up with environmental conditions (.Barasa, 2007; Owuor, 2007; Johnson, 1992).

Barasa, (2007), defines indigenous knowledge as holistic tradition, scientific knowledge of a people, land, natural resources and environmental development over time resulting from inter-relationship of the people and their natural environment. This implies that the term indigenous knowledge can be used to refer to knowledge that identifies with a specific ethnic group, hence unique to a given culture or society and thus forms the basis for decision level making in the community. Rouse (1999), Gyekye, (1996) stresses that in reality, indigenous knowledge is used to manage all the sectors and sub sectors of the traditional economy with established distinct systems of knowledge, innovations, practices and strategies to use, protect, conserve and sustain resources. Thus indigenous knowledge as a concept expresses knowledge as being typical and belonging to specific places with common cultural and social ties, hence reflecting uniqueness on how different communities make sense of the world, conceptualize communal problems and develop solutions that are context specific (Owuor, 2007).

According to the World Intellectual Property Organization (WIPO, 2001), indigenous knowledge encompasses the traditions, artistic works, inventions, performances, designs, marks, names and symbols of a people. Therefore, categories of traditional knowledge could include: agricultural knowledge, scientific knowledge, ecological knowledge and medicinal knowledge (WIPO 2001, 25). Further, WIPO (2001), stresses that indigenous knowledge is an adaptable, dynamic system based on skills, abilities and problem solving techniques that change over time depending on environmental conditions,

b) Indigenous agriculture

Just like the term agriculture, indigenous agriculture has also been viewed in varied ways. According to Pace (2015), indigenous agriculture or farming is the conduct of agricultural activities based on people¶s cultures that are deeply connected to particular places.

According to Jha (2008), indigenous agriculture as a highly chance-dependent agricultural system where in the practices of the people are dependent on natural occurrences some of which the people find difficulties predicting. By this definition, Jha (2008) argues that farmers engaged in indigenous agriculture depend highly if not entirely on nature.

From a practice-learning perspective, Waters-Bayer (1992), defines indigenous agriculture as farming and land use practices of a people based on generations of experience, informal experiments and intimate understanding of the biophysical and socio-cultural environment in which they operate.

c) Potato farming

Potato is one of the world¶s most important root and tuber crop (FAO, 2009). According to the FAO (2009), potato is grown in over 125 countries, consumed by over a billion people worldwide. In the developing countries, millions of people depend on potato for survival. The ease of cultivation of potatoes and its nutritional value has been noted to be responsible for the expansion of potato production in developing countries though production in these countries is still low when compared with developed countries (FAO, 2009). In Cameroon, potato is an important crop and ranks among the major crops in tons produced after cassava, plantain, cocoyam, and maize, with majority production done by small holders predominantly women, with most marketing done locally (FAO, 2014). Most research works (Spencer and Kaindaneh. 1998; FAO. 2009: Fawole, O.P., 2007) have identified two main types of potato farming in the world. These two main potato farming systems are intensive and subsistence agriculture. According to the FAO (2009), the choice of farming type applied in different parts of the world is dependent on several factors which include socio-economic, policy and institutional, and technical factors. This study focuses on Irish Potato. Irish Potato has many types which include; Russet, Red, White, and Yellow. In this study, the author has focused on the white type of Irish potato.

d) Postharvest loss

In agriculture, the term postharvest denotes the sequence of activities and operations that are carried out after the crop has been removed from its original state in the field or farm FAO (2010). According to the FAO (2009) and Bourne (1977), these activities and operations are either technical (field drying, threshing, cleaning, additional drying, storage, processing) or economic (transportation, marketing, quality control, administration and management).

Building from his definition of postharvest, Bourne, (1977) defines postharvest loss as any loss occurring after harvest and before consumption.

De Lucia and Assennato, (1994), go beyond this view to include that postharvest losses can be measured both quantitatively and qualitatively within the postharvest system.
Some studies such as (Parfitt *et al.*, 2010; Lundqvist et al., 2008; Stuart, 2009; and FAO, 2010) have defined postharvest losses from two perspectives classifying the losses as either food loss or food waste occurring in the postharvest food chain. To these authors, food losses refer to the decrease in edible food mass that originally was intended for human consumption while food waste refers to the discarded quantities of food appropriate for consumption.
In this study, the author agrees with the views of the scholars on postharvest and postharvest losses, but narrows the study to understanding the indigenous techniques utilized to minimize postharvest losses.

e) Effectiveness of indigenous agricultural techniques

In most developing countries including Cameroon, a majority of farmers practice low input agriculture which is an indication of the potential of indigenous knowledge for agricultural development (Mella *et al.,* 2007). As noted by Hart and Vorster, (2006) about 50 per cent of the world's population depends on indigenous knowledge based agriculture for food supply. Several examples show that indigenous knowledge has supported agricultural practice and subsequently agricultural development.
Evidence from studies conducted in Tanzania, show that the traditional sector accounts for about 90 percent of the country's cattle, poultry and seeds planted (Hill, 2003; Mushi, 2008). Further, empirical studies in Ghana, Benin, Niger and Togo (Kaboré and Reij 2003), Samoa (Tikai and Kama 2004), Tanzania (Kauzeni and Madulu 2003), have shown that indigenous knowledge has been of great value in contributing to agricultural production in developing countries. Furthermore, in the western highlands of Cameroon, Takoutsing *et. al.,* (2012) notes that the indigenous system of obtaining crop seeds has been practiced from time immemorial by small scale farmers. In the same light, Kaihura *et al.,* (2003), observed that in Pakistan, lack of appropriate crop and seed varieties, have forced resource-poor tribal farmers to developed and conserved location specific indigenous paddy varieties to cope with climate changes and meet with their food security needs. Therefore, it can be ascertained that indigenous knowledge has been and continues to be successful in promoting agriculture in the developing world and ensuring food availability across the world.
Failures recorded with the utilization of western agricultural techniques in some agroecological zones where indigenous agricultural practices have been successful indicates the effectiveness of indigenous agricultural techniques and has resulted in attention being given to indigenous agricultural techniques (Hart and Mouton, 2005). For example in Ogun State of Nigeria, Adedipe *et al.,* (2004) observed that the high cost, adulteration and health hazards that came as a result of the use of agro-chemicals in cowpea production forced farmers to go back to their indigenous methods of cultivating their cowpeas. This buttresses the strength of indigenous agriculture as being environmentally friendly as well as health-wise.
Equally, a study by Osunade (1994) explained that in Swaziland, farmers determine soil fertility by feeling the soil with their hand as well as identifying the presence of fauna and flora with earthworm casts on nutrient-rich soils, but never on acidic soils. These innovations are peculiar to specific environments and thus have been of great value to the indigenous people. Such indigenous practices of determining the suitability of soils for specific crops have contributed immensely to biodiversity and food security in the communities and thus have proven their worth in enduring agricultural practice among the resource poor small holder farmers.
Reijntjes *et., al.,* (1993) explains that indigenous methods to manage rainfall developed by farmers have been helping agricultural production especially in managing floods. Similarly, Nwonwu (2007) notes that in the Yatenga Region of Burkina Faso, farmers use an indigenous technique called "zay" (holes in which manure and grass are mixed with earth) located in-between rock bunds to prevent run-off. Further, Nwonwu (2007) illustrates that in the Eastern Province of Kenya, the undulating nature of the terrain resulted in farmers using trenching as a method of erosion control and water conservation. These indigenous techniques are noted to have been effective in checking erosion, conserving water, increasing the infiltration of water into the soil and helping vegetation growth in fallow lands.

f) Indigenous knowledge challenges and its impact of agriculture

The challenges of indigenous agricultural techniques have varied impacts, affecting individual small holder farmers, the agricultural sector and the economy of the country. Ziervogel *et al.* (2006) argues that the climate change challenge faced with indigenous agricultural practices has adversely affected food production using indigenous techniques. (Zoellick, 2009; UNFCCC, 2007).
Urama and Ozor, (2010) maintain that by 2020, between 75 million and 250 million people across Africa will be exposed to serious stress in getting water for agricultural practice thus negatively affecting livelihoods for the resource poor small holder farmers. This implies that the erratic rainfalls with high spatial variations will affect the agricultural system which is a source of livelihood for over 70 per cent of Africa¶s population (Strzepek and McCluskey 2007). Challenges to indigenous agricultural practice have been mentioned to likely result in high decline in farm output. Other scholars have projected up to a 50 per cent decline in agricultural production in Africa associating it to the water challenge resulting from climate change and variations (Ringler *et al.* 2010). For crop specific situations, Ringler *et al.* (2010), highlights that in sub-Saharan Africa negative yields impacts will be highest with wheat,

followed by sweet potatoes.

Furthermore, the manifestations of challenges such as decreases in the length of growing seasons and yield potential have profound impacts on Childhood malnutrition levels. In this light, Ringler, *et al.,* (2010) argue that in sub-Saharan Africa particular where indigenous agricultural practice are widely used, 585,000 children will still be facing the risk of malnourishment by the year 2050. On this basis, it can be argued that there is an urgent need to enhance indigenous agricultural techniques of the people so as to counter these likely negative consequences.

Also, Kader, (2002) notes that in some African countries where indigenous practices for preservation are widely used, postharvest loss especially among perishable crops are still very high at about 50 per cent with losses occurring in the field, during transportation, storage and processing. Such high losses in food at an era where the entire community is calling for increase in agricultural production to ensure food security necessitates a need to enhance indigenous agricultural post-harvest management practices noting that to a large extent, most western postharvest management practices are not cost effective and also not adapted to the realities of the resource poor small holder farmers in Bui Division Cameroon.

g) Gap in Literature

Minimizing postharvest losses in agriculture is very vital so as to ensure food security. From the works reviewed, the use of indigenous knowledge techniques in agriculture have been greatly studied with attention paid to its application. However, little attention has been given to examining how indigenous knowledge techniques can be enhanced to minimize postharvest losses in agriculture. Further, literature has not been able to focus on studying crop specific indigenous practices and suggesting a framework for enhancement in minimizing postharvest losses, thus creating a gap in literature which this study seeks to fill.

Furthermore, the scholarly works reviewed on indigenous knowledge and minimization of postharvest losses are foreign hence a gap in literature which through conducting research on indigenous knowledge practices in potato farming in Bui Division, North West Region of Cameroon, this study seeks to fill.

II. METHODOLOGICAL APPROACH

RESEARCH APPROACH

The methodological framework of the study is qualitative. The qualitative context implies that data was collected primarily in the forms of words using personal interviews, participant and field observations and focus group discussions. Through close contact with indigenous farmers in Bui Division, the author developed a profound understanding and was able to formulate a conceptualization explaining indigenous knowledge practices of the people of Bui Division as utilized in agriculture.

A. Setting

The study site is Bui Division, located between latitude 6^o00 to 6^020 North of the Equator and Longitude 10^o30 t0 10^o60 East of the Greenwich Meridian. Bui Division is a huge plateau within which passes the Cameroon Volcanic Line and hosts the highest summit (Mount Oku) in the western highlands of Cameroon. This area has two seasons – the dry and the rainy season. The rainy season runs from March to October and the dry season runs from November to February.

Administratively, Bui Division is located in the North West Region of Cameroon. It is made up of six sub divisions: Kumbo, Oku, Jakiri, Noni, Nkum and Mbiame. The traditional setup is also very strong with four main Fondoms namely the Nso, Oku, Mbiame and Noni. Socio-cultural and economic life is fairly distributed throughout the division although there is a concentration of business life in the divisional headquarters.

Bui Division has an agrarian profile thus a reasonably representative sample of Cameroon as a whole. Agriculture in this area is organized at the household level, with the community playing supportive roles such as in seed exchanges, decisions on when planting, harvesting etc should start. The smallholder nature of farming activities grounded on indigenous knowledge makes the area a suitable choice as a field laboratory to explore the interplay of indigenous experiences and interventions which affect local farming practices in the sense of minimizing postharvest losses in potato farming.

B. Sample Population and Sampling Technique

A total of 405 participants took part in the study. The sample population included farmers (360), workers in the ministry of agriculture (15), staff of NGOs working with farmers (15), traditional authorities and other community opinion leaders (15). The multistage sampling technique was utilized in the selection of respondents for the study. The first stage involved the purposive selection and mapping of the main potato production zones in the study area. After the production zones were identified and mapped, the second stage was then the purposive selection of study participants. This was done based on the fact that the participants are indigenes and are involved in potato farming.

The sampling criteria employed were as follows :

For farmers:

- The participant had to be an indigene of any of the villages in Bui Division except Noni. Noni was excluded because potato is not grown there.
- He/she had to be at least 25 years old. Twenty years was selected because it was considered that at this age, an individual in the study area must have been involved in potato farming and hence will be versed with the indigenous potato farming practices.

- He/she had to be in a good mental state in order to consent to participation. The mental state was considered necessary for appropriate responses.
- He/she had to have been actively engaged in potato farming, owning a farm or working in their family farm.
- He/she had to have been into potato farming for over five years. Five years was considered as time long enough to be versed with the indigenous potato farming practices.

For the Officials of the Ministry of Agriculture and Rural Development :

- The participant had to be at least a trained agricultural technician.
- He/she must have worked in Bui Division for at least 5 years.
- He/she had to be actively involved in rendering advisory services to potato farmers in the study area.

For the staff of NGOs and Institutions that promote farming:

- The participant had to be an employee working for such an institution.
- The institution had to have been actively involved in promoting agriculture and especially potato farming in Bui Division for at least 5 years.
- Participants selected from the institution had to be those engaged in activities linked to potato farming.

For the Traditional Authorities:

- Participants had to be from one of the 13 villages selected for the study. Further, he must have been in power for at least 5years. Five years was considered as time long enough for him to have observed occurrences related to traditional activities and potato farming in the study area.

C. Data Collection Methods

Data collection was done through direct interaction with individuals on a one to one basis (interviews) and also through direct interaction with individuals in a group setting (focus group discussions). Participant and field observations were also used by the researcher to collect data.

D. Methods of Data Analysis

In this study, the author used the Thematic Network Analysis as the analytical technique. Firstly after collecting data, the author prepared memos (short notes that captured the essence of what the author learned) and labeled the data. This was followed by analyzing contextual and demographic data. Next was data coding. After the data had been coded, there was a review of the coded data. By looking at the various responses for the various questions posed, the author found specific words, ideas and common issues that recurred. The various responses were then summarized into three main themes (basic themes, organizing themes and global themes). As themes emerge from the data, the author continued data review, carefully searching for negative instances of the patterns.

III. FINDINGS AND DISCUSSIONS

PART ONE: The Nature of Potato Farming in Bui Division

Mixed farming and Mono-farming

Discussions with farmers, agricultural officers and officials of institutions that support farming revealed two types of farming to be characteristic of the nature of potato farming in Bui Division. These two farming systems were mixed farming (with crops like maize, beans, cocoa yams and huckleberry) and mono farming. Farmers highlighted that seasons, soil nutrient needs, seed source, farming tools, labour source and crop health care practices made mixed farming to be widely practiced.

To highlight the necessity of mixed farming, Kebuh, a middle aged male potato farmer in Oku sub division remarked: *we have only two seasons with potato lasting maximum 3 months and then it is matured and thus it will be waste of time to cultivate farms and plant only potato during the rainy season.* He went further to explain that *mixed farming helped build soil nutrient and made farms fertile as crops like beans were capable of regenerating soil fertility.* Another female participant Mami Nkeh added: *with mixed cropping, the same labour is used to produce diferent crops at the same time.* Similarly during focused group discussions in Nseh, Dzelamonyuy, an elderly woman highlighted *"I have only 4 small farms, all in places far from water. I therefore must mix all crops and plant them in my farms during the rainy season so that I will be sure to have different kinds of food to feed myself, my husband and our 4 grandchildren living with us".*

As regards mono-cultivation of potatoes, findings indicated that it is practiced during the dry season farming period. Study participants explained that potato farming during the dry season which was exclusively mono cultivation was tedious but lucrative when compared to the rainy season farming. This was highly linked to the fact that postharvest losses are minimal as the roads are dry, few people produce and hence the market demand is usually more than the market supply thus keeping prices relatively high. During participant observation to farms in Vekovi, Tatah, a middle age man engaged in the mono cultivation of potatoes remarked: *I must crop potato in this farm in the dry season because in the rainy season this farm is completely taken over by water. So potato cannot do well here in the rainy season. I have to feed my children and my other farms are less fertile when compared to this one.* Similarly, Bannyuy, an elderly man in Tadu said: *I am not employed and my wife too is not employed. I depend on this small farm to cater for my family. I have 7 children and I am struggling to send them to school. I raise money for their school fees thanks to the cultivation of potato in the dry season because the little harvest is usually sold at higher prices when compared to the rainy season harvest.*

Potato farming calendar and crop maturity indicators

Field observations and discussions with farmers indicated that for the rainy season potato farming, when the sky is cloudy around the 3rd month after Christmas (that is the month of March),

farmers know its planting time. This must be accompanied by the development of fresh leaves as well as some specific flowers budding by some trees in the forests (where "gods" are believed to be dwelling). Bee farmers were reported to be those who easily identified the right planting time based on observing the growth of flower in the forest and bushes. Once these symptoms were observed, the traditional authorities then performed traditional rituals believed to increase soil fertility and fruitfulness thereby announcing the beginning of the planting season.

The dry season potato farming was explained to be usually dependent on the rains. Farmers explained that the dry season potato planting begins at different times in different zones, because the rains vary from place to place. Once farmers noticed that the intensity of rainfall was reducing, dry season potato farming started. Generally, farmers explained this usually takes place about 6 months after the rainy season potatoes was planted (meaning in September). Planting potato for dry season farming along the bounds of streams and in marshy areas was observed to be done later in October and November depending on the amount of water in the soil.

Indigenous technique of determining maturity of the potato tuber for harvesting was through observation and trial testing. Farmers explained that, two months after planting, the potatoes could be matured based on the fertility of the soil and the intensity of rains after planting. Based on observation, the indigenous potato farmers mentioned that when potato leaves are getting yellow, with the flower drying off, it was usually an indication that the potato was ready for harvesting. So once they noticed yellowish potato leaves, they conducted trial harvesting as a means of establishing with certainty maturity. The indigenous potato farmers stated clearly that three weeks post flowering was enough time for the tubers to get mature for harvesting.

Generally, it was observed that two (2) weeks after the yellowing of potato leaves, the crop was matured and ready for harvesting. Harvest time was determined based on the intensity of post planting rain fall, yellowing of potato leaves 2 months after planting and the drying of the potato flower three weeks after flowering. Trial test harvesting was reported to be efficient in establishing with certainty the maturity of the potato tubers.

PART TWO: Indigenous Postharvest Practices Utilized in Potato Farming by the People of Bui Division

The need of food for household consumption as well as the need to make higher profits by selling during off season made indigenous people to develop a variety of ways of processing and preserving their potatoes. During field interviews and focus group discussions, it was, noted that indigenous farmers made use of more than one of the indigenous techniques of potato processing and preservation so as to prevent losses occurring postharvest. According to the farmers, the preservation practices depended on the climatic conditions of the place and the time of harvest. To maintain quality, preservation practices revolved around the continued observation and the selection of bad tubers averagely bi-monthly. Hence, this minimizes post-harvest losses as such making the local agricultural system somehow profitable for the resource smallholder farmers. The different drying methods as mentioned by the farmers are discussed below.

Drying in House Ceilings

Small holder indigenous farmers in Bui Division store potatoes at home by keeping in house ceilings. The ceilings are specially prepared with bamboos that are covered with mud. Bamboos as raw materials are often readily available to the villagers while the construction of the roofs is usually done by elders who master the technique. Once the mud gets dry, the ceilings usually remain very dry. The potato in these ceilings is usually free from moisture and thus can last for up to 6months. Most often, these ceiling are kitchen ceilings and continuous heat resulting from cooking keeps the potatoes dry. This preservation technique was observed to be widely used in cold areas like the areas around the forest in Simonkoh, Tadu and Vekovi.

- **Drying of potatoes using Saw Dust and Dry Grass**

Another indigenous drying technique involved the use of saw dust and dry grass. With this preservation technique, farmers who do not have house roofs adapted for potato preservation usually use an empty dry room. In the room, heaps of saw dust are poured on the floor, then potatoes are piled on the saw dust, and saw dust is again used to cover the potatoes. In some cases, farmers again cover it with dry grass. The rooms are usually kept closed and access is prohibited for non-family members. This was observed to be the widely used preservation technique utilized for preserving potatoes farmers for commercial purposes.

At the farm level, a typical on-farm preservation technique observed was covering with dry grass. During the rainy season potato harvest which is meant for consumption is preserved on-farm in farm houses that are usually constructed with local materials. The potatoes are placed in one corner in the thatched farm house and carefully covered with leaves to prevent contact with water. In this way, the potatoes remains relatively dry and are not subjected to high degree of rot.

- **Drying of Potatoes in Shelves (Semi Cupboard-like Stands)**

Also, to prevent postharvest losses, some indigenous farmers preserved their potatoes using shelves (semi cupboard-like stands). The stands are usually constructed using wood and/or bamboos. These stands are kept in dark rooms and potatoes piled on them. This keeps the potatoes free from contact with the ground and thus it remains dry. Such rooms are usually built in such a way that the sun rays do not penetrate. Farmers¶ belief that without contact with the sun rays, the potatoes can last longer. Agricultural officials in the study area reported that this method significantly reduced postharvest losses.

- **Sun Drying**

Another indigenous technique used by farmers to prevent postharvest losses is by drying the harvested potatoes in the sun. Field interviews with farmers revealed that sun drying as an indigenous potato processing technique was usually plagued with the challenge of having continuous sun shine for say a day or two during the harvesting period. The sun drying technique farmers explained is usually very tedious as it demands that every day, farmers carry the potatoes and place under the sun and once the sun is going down they carry it back. As observed, the difficulty of drying in the sun was aggravated by the heavy rains characteristic of the rainy season harvesting period.

Other indigenous methods used to minimize postharvest losses

I. The use of Potato Pits to prevent postharvest losses

Potato pits was another indigenous preservation technique utilized by the small holder farmers to prevent postharvest losses. In situations where there are no farm houses, it was observed that a pit is dug and potatoes poured inside and then covered with soil. This is done is such a way that it is impossible for water to stand there. The area is then marked with a sign best known to the farmer. With this technique, a pit is dug and lined with dry grass. Then potatoes are place in layers in the pit with wood ash sprinkled at each layer as a measure to fight pathogens. After all the potatoes have been filled in the pit, it is then covered with dry grass and soil. The area where the pit is sunk is usually well catered for to prevent the pit from direct contact with water.

This technique is usually for a very short time during the rainy season because the wet nature of the soil causes rot. During the dry season harvesting period, on-farm preservation by digging a pit is very much utilized as the soil is dry, thus the challenges of rot resulting from contact with water are minimal.

As highlighted by farmers during focus group discussion, the preservation technique by digging a pit was reported to be more effective and efficient and resulted in very minimal on-farm postharvest losses for dry season preservation than the rainy season preservation.

II. Preventing postharvest losses by flooring

As highlighted by farmers during focus group discussions, prevention of postharvest losses through preserving potato seeds was slightly different from preservation of tubers for food. As recounted by an elderly female farmer in Kevu, *Seeds are usually preserved at home by pilling directly on the bare floor. Neither saw dust nor dry grass is used. Instead, I pour some small wood ash on it to heal any wound on the tubers that might have occurred during harvesting.* The rooms where seeds are preserved are also usually access prohibited. Farmers mentioned that the rooms are usually opened such that sun rays can reach the seeds when it was about two weeks to planting. Indigenous farmers hold the belief that by letting sun rays touch the seeds makes germination faster.

III. Domestication of Cats as a means to prevent postharvest losses

During field visits, it was observed that the farmers rear cats. Farmers justified the rearing of cats as being a way to reduce damages caused by house rats that eat potatoes. Cats were thus considered as a domestic animal necessary for minimizing post-harvest losses resulting from potato consumption by rats. For example a female farmer in Nseh said: *I prefer a Cat to a Dog. I do not need to feed the Cat but the Cat will help me catch rats that destroy my potatoes.*

IV. The use of fresh leaves/calabash to preserve processed potatoes for home consumption

Processed potatoes was also preserved using some indigenous techniques with varied lasting durations. Potatoes pounded with beans, or just pounded potatoes was tied in banana leaves and carefully preserved in baskets made from bamboos. This preservation technique is limited in that the processed potato can last a maximum of 3 days after which it loses quality. Potato flour is usually kept in a calabash. The flour stored in a calabash was reported to last for more than six months without losing its quality.

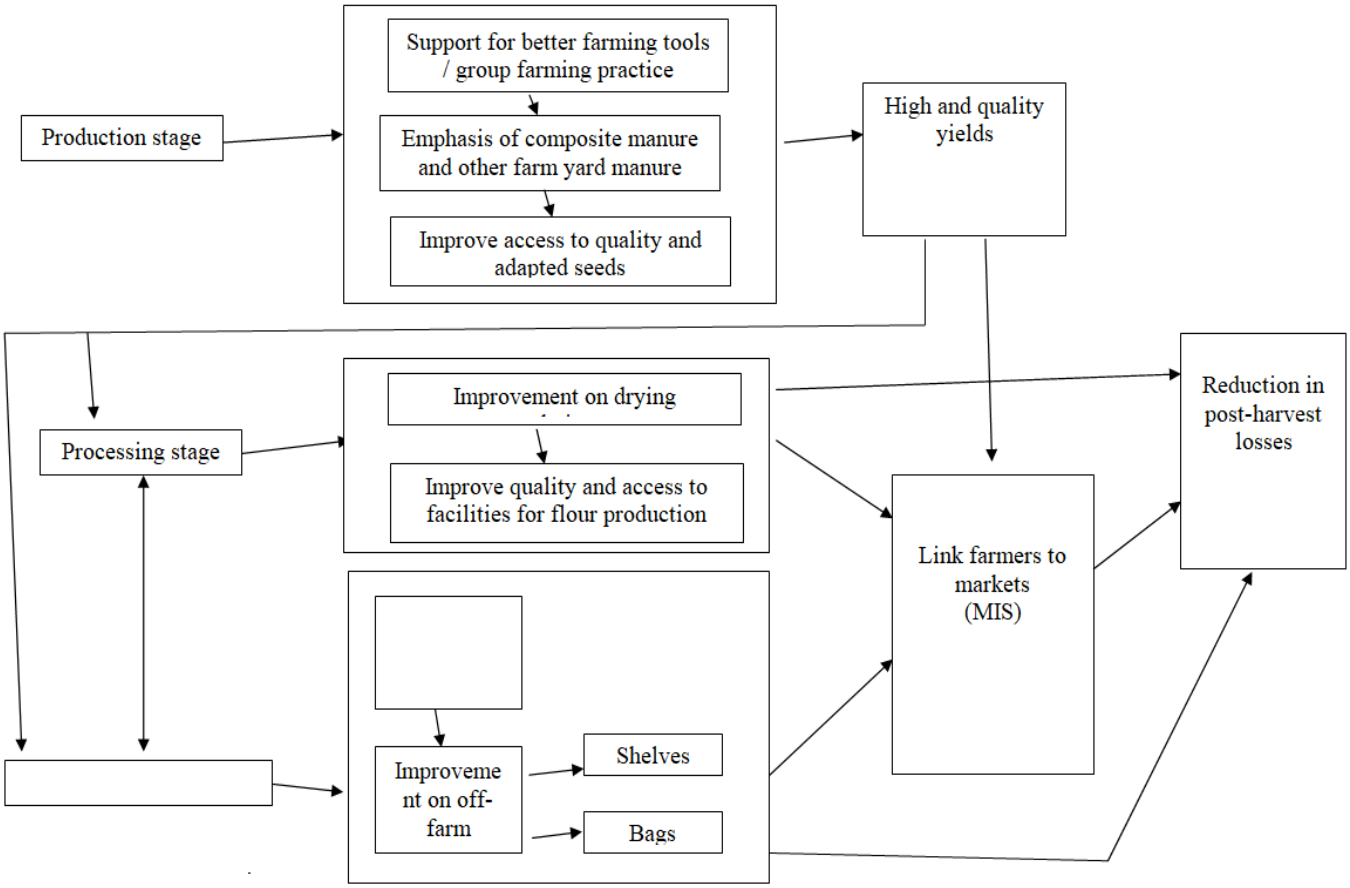
PART THREE: A Framework to Minimize Postharvest Losses in Potato Farming In Bui Division, North West Region of Cameroon

This study clearly shows that small holder farmers possess abundant knowledge with respect to agricultural practices with some indigenous knowledge practices noted to be contributing significantly to productivity and in minimizing postharvest losses in potato farming. These practices were highly mentioned by the farmers during field interviews with the general wish for better measures to prevent postharvest losses. For example an elderly man in Ijim said: *we have several different ways of preserving our harvest but none of these methods has helped us to record very minimal postharvest losses. We really need assistance to improve our preservation facilities and methods.* Thus, it is important that these indigenous knowledge techniques should be enhanced to minimize postharvest losses so as to ensure the world cry of food security as well as improve socioeconomic livelihood conditions of the small holder farmers.

Potato is a very perishable tuber and its perishable nature makes preservation very difficult. Results from the field necessitate a conceptual framework incorporating indigenous knowledge systems so as to intervene effectively in minimizing postharvest losses. This framework is not aimed at being a substitute for existing models but stands as a complement, building on farmers' indigenous knowledge base as utilized in potato farming in Bui Division, Cameroon.

The framework is divided in three stages namely production, processing and preservation. It identities some areas where indigenous knowledge techniques need to be enhanced hence it is a crop specific value added framework for the advancement of indigenous knowledge practices in potato farming, processing and preservation so as to minimize postharvest losses.

A Framework to Enhance Indigenous Knowledge Techniques so as to Improve Production and Minimize Postharvest Losses in Potato Farming in Bui Division



Source: The Authors

IV. ENHANCEMENT AT THE PRODUCTION STAGE

With the growing talk on climate change, indigenous knowledge farming practices have been highlighted to be environmentally friendly UNCTAD, (2009). However, the constrained resource setting has limited farmers from making maximum potential of their knowledge base. For example, during field interviews, farmers mentioned access to quality and adapted seeds as a serious hindrance to their production efforts. Further, farmers explained that farms are getting old and there is need for soil fertility to be improved upon as well as the use of adapted seeds. This framework thus suggest that farmers indigenous knowledge should be enhanced by making available seeds that are adapted to climate physiognomy ecology of Bui Division.

Furthermore, since indigenous potato farming demands a lot in terms of labour, there is need to strengthen the farmers¶ practices of group farming. Grouping farmers and strengthening them into cooperatives/common Initiative Groups and providing minimal support through training and farm tools will significantly impact on potato farming in Bui Division. Mechanized farming can also be introduced especially in the low lying areas. This will be a great substitute for human labour and will boast production. Since fallow periods (a major indigenous technique of regenerating soil nutrients and soil fertility) are reducing due to population pressure on land (FA0, 2010), training farmers on better techniques of preparing organic manure and better organic farming techniques will increase organic matter content in the soil and make the soils more resistant to drought as such supporting agricultural production IFOAM (2007), FAO (2008).A great source of organic manure can be from sewage. This can be done through the use of composting toilets as the area practices only on-site sanitation.

With improvements through seeds and support for communal farming, high quality potatoes with be harvested and thus a need to link farmers to markets in the major towns of the country and even of the west African sub region as Cameroon serves as a major bread basket in this sub-region. Such a market link will significantly reduce postharvest losses as farmers will transfer the risk of preservation to buyers. Therefore it can be noted that such enhancement of indigenous techniques at the production stage will positively improve on the socioeconomic livelihood conditions of small holder farmers practicing potato farming in Bui Division.

A. Enhancement at the Processing Stage

As observed from the field, the indigenous knowledge processing capacity is basically efficient in the short term than long term. Most processing was transformation for immediate and short term consumption. This calls for an urgent need to enhance indigenous processing techniques so as to minimize postharvest losses. Field studies identified drying and improvement of facilities for potato flour production as the main processing activities that need to be enhanced. By improving on drying, small holder farmers can make much gain as postharvest losses will be reduced .Better conditions for drying can be realized through support to farmers to construct storage rooms with good shelves. With reduction in postharvest losses and linkage to markets, farmers will experience higher incomes and their welfare conditions will improve.

Also, transformation and processing of potato to flour was almost inexistent in the study area. This was linked to lack of grinding facilities and the insufficiency of electrical energy needed to install and run the grinding facilities. The use of renewable energy resources which are abundant in the area will improve upon energy and encourage petit business persons to install potato grinding facilities in these areas. Thus strengthening the indigenous practice of potato flour production with low cost grinding machines will significantly reduce postharvest losses as small holder farmers will convert their potato from the form which is difficult to preserve into potato flour which can be easily preserved for a long period.

B. Enhancement at the Preservation Stage

Household food needs depend on a sustainable supply of food at all seasons, thus a need for an adequate food system, with efficient preservation so as to minimize postharvest losses. Field results showed that preservation of perishable crops like potatoes is very challenging. Though Indigenous knowledge techniques are useful, the level of postharvest losses were noted to be very high thus confirming the view of FAO–World Bank, (2010); Prusky, (2011) on the magnitude of postharvest losses experienced in food production across the world. To meet with the growing food demand, there is need to strengthen indigenous knowledge techniques as utilized in preservation.

Field observations and interviews show the need for enhancement of both on farm and off farm preservation facilities. By enhancing on- farm preservation facilities and making such facilities more water proof, warm and dry enough, the consequences of damp weather which increases rot in potatoes will be reduced. This will thus reduce the quantity of postharvest losses occurring as a result of lack of appropriate on-farm preservation facilities. Similarly, enhancement of off-farm preservation facilities will also have a significant impact. Field observations and interviews identified preservation on shelves and using bags as the most appropriate indigenous knowledge techniques that can be enhanced to minimize postharvest losses. With shelves, the potatoes are suspended and do not have direct contact with the cold floor thus providing favourable conditions for continuous drying especially in situations where there was no adequate drying before storage. Improvements in storage facilities and capacity have been highlighted by the World Bank (2010), as a suitable way to minimize postharvest losses in grains in Sub Saharan Africa.

V. CONCLUSION

This study has established a framework for the minimization of postharvest losses in Bui Division, North West Region of Cameroon. The framework is divided in three stages namely production, processing and preservation. It identities some areas where indigenous knowledge techniques need to be enhanced hence it is a crop specific value added framework for the advancement of indigenous knowledge practices in potato farming, processing and preservation so as to minimize postharvest losses. If given adequate consideration, this framework may facilitate investment in potato farming and related businesses as such ensuring job creation and sustained livelihoods. In addition to the framework, the study uncovered other important issues about potato farming in Bui Division that must be considered such as nature of potato farming and the motivating factors for the choice of adoption of the different farming systems.

Policy considerations may be needed to exploit the full potential of indigenous knowledge techniques in agriculture. For example, by developing and implementing bio-conservation programmes and laws that facilitate the securing and preserving of virgin lands for the future farmers. Also, indigenous techniques may be incorporated into formal training programmes of agricultural staff while at same time encouraging group farming through support to farmer cooperatives and common initiative groups.

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