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EFFECTS OF POST-HARVEST RISKS ON MAIZE STORAGE BY SMALLHOLDER FARMERS IN THE WEST REGION, CAMEROON

A Thesis submitted to the Department of Development Studies in particular fulfillment of the Requirements for the Award of a Master of Science (MSc) in Agriculture and Development

By

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Buea, November 2015

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DEDICATION

I dedicate this work to my parents, Mr. and Mrs. Teugnoua.

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DECLARATION

I hereby declare that the thesis titled "Effects of post-harvest risks on maize storage by smallholder farmers in the West Region of Cameroon" submitted to the Department of Development Studies of the Pan African Institute for Development-West Africa, Buea in partial fulfillment of the requirements for the award of is the Master of Science Degree in Sustainable Agriculture and Development is the original work of Mbouogning Teugnoua Floriane (0048/MS/MA/PAID-WA). All borrowed materials have been duly acknowledged by means of references and quotations.

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ABSTRACT

In developing countries, smallholder farmers are compelled to manage a great diversity of risks in the process of production and later at post-harvest stage. They are however often too poorly equipped to prevent, avoid or withstand certain shocks, whether expected or unexpected, due to lack of formal safety nets. The effect of risks on farming has received a great deal of attention from numerous researchers in the past, but the specific contribution of post-harvest risks to storage behavior, particularly to storage during lean periods is not so well documented. We carried-out surveys in 150 households in the West Region of Cameroon to identify shocks perceived as the most likely and that would modify the storage practices of small scale maize growers who hold grain during the post-harvest period. Using mainly analyses of variance, we showed how much the different types of risk identified are responsible for allocation of stored maize to various uses, as well as how much influence they have on other relevant aspects of maize keeping in stores. Findings revealed that idiosyncratic risks, especially that of having few alternative sources of income tend to push maize stock holders to rely heavily on precautionary savings in the form of grain, more than all other types of risks faced along the post-harvest period. 74 percent of farmers kept at least 6 per cent of their maize until the lean period. The duration of maize in store, the level of price increase expected for carrying out the largest sales of maize in a year, the main motive for keeping maize until lean period, the main disincentive to maize storage and finally the percentage of stored maize sold to obtain cash were significant determinants of this proportion, found through ordinal regression analysis. These results highlight the need for policy makers to make formal savings systems more affordable to smallholder farmers and to reduce those risks that seem more difficult to manage at the household level along the maize post-harvest period.

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ACRONYMS AND ABBREVIATIONS

APHLIS: African Post harvest losses Information System

BUCREP: Central Bureau for Population Census.

ECAM: Cameroon Household Survey

EESI 2: Second survey on employment and the informal sector

FAO: Food and Agriculture Organization of the United Nations

Fig.: Figure

GESP: Cameroon Growth and Employment Strategy Paper

Ha: Hectare

INS: National Institute of Statistics

MINEPAT: Ministry of Economy, planning and Regional Development.

OECD: Organisation for Economic Cooperation and Development

CHAPTER ONE

INTRODUCTION

1.1. Background to the study

Dramatic events such as changing weather patterns, severe food shortages and financial shocks in many parts of the globe have all been suggesting a more and more complex and threatening global risk landscape (Elhaut, 2011). For countries that rely heavily on agriculture and natural resources, cautious management of these risks may become critical to achieving socio-economic development, especially as they hardly produce isolated effects.

Agriculture is indeed the main stay of Sub-Saharan African economies (Balgah and Buchenrieder 2011; Abass *et al.*, 2013). As such, the performance of this sector can mean a significant change from deficit to stability or to surplus and vice versa. Grain cereal production and commercialization in this part of the globe is particularly important to smallholder farmers who provide more than 75% of the food consumed in the area but however remain the poorest and most food insecure (FAO, 2012; Fan *et al.*, 2013). Among farmed cereals, Maize (Zea Mays L.) constitutes an important portion of the diets of people and livestock and is widely grown in Sub-Saharan Africa (Epule and Bryant, 2014).

In this part of the globe, formerly isolated from large markets and global policies, subsistence maize farms, just like other small scale farming units now suffer from a variety of exogenous shocks quickly spreading in the globalizing trade. This eventually generates more risk and uncertainty in farm decision-making. Abu *et al.* (2011) elucidated that in Cameroon, particularly in the West Region, maize has moved from the status of subsistence crop to a cash crop, a risk reduction strategy after sharp decreases in the prices of coffee and cocoa in the past three decades. They added that this change has also been attributed to growing demands for maize from varied consumers, prompting subsistence

farmers to seek increased production and sales, but some new shocks threaten their livelihoods. These include high volatility of food prices as well as a sharp increase in post-harvest loss of maize in the Region from 18% to 22.6% of total output in 2007, and this proportion kept constant until 2013 (APHLIS, 2013). Poor post-harvest handling has been identified in many low income countries as a potential trigger of food shocks after the 2008 global food price upheaval (World Bank, 2011; *Fan et al*., 2013; Kaminski and Christiaensen, 2014). In the West Region of Cameroon, it adds to the permanent problems of low productivity, poor input technology, land degradation, poor public infrastructure, limited access to credit and market as well as policy constraints as The World Bank (1987) described. Also, farmers' production patterns have changed from purely subsistent systems to increasingly profitable ones, but they have unexpectedly become net buyers of grain (Stephens and Barrett, 2009). These trends call for research to assess the determinants of grain management on small farms, especially those post-harvest risks that shape the storage practices of these farmers. This study attempts to respond to that call.

1.2. Geographical description of the study area

The West Region in Cameroon is the smallest Administrative Region in terms of area in the Country and occupies 13,786 km² of the national territory (BUCREP, 2010). It is found between the 5th parallel North and the 16th parallel South, and between the 10th Meridian East and the 11th Meridian West. It borders 5 other administrative Regions, namely the Northwest, Adamawa, Centre, Littoral and Southwest. In 2010, it was found to have the second (after the Littoral Region) highest population density (128.5inhabitants/km²) among all the 10 existing Regions and a total population of 1,785,285 inhabitants (BUCREP, 2010). The area is dominated by high mountains and plateaus 1000 to 1500m high on average, with peaks like Mt. Manengouba (2250 m) and Mt. Bamboutos (2263 m). The average annual rainfall is 1900mm for 110 to 130 days of rain, and the predominant climate is the Cameroon mountain climate. It is generally humid

with high levels of humidity during dry and rainy seasons as averages 62% and 95% degrees are recorded respectively for January and August. Annual temperatures in the Region rarely go beyond 22^{o}C. The rainy season lasts 7 months in a year and soils are predominantly volcanic with a variety of textures; they are known to be among the most fertile in the Country. The predominant ethic groups are the Bamilekes and the Bamouns, characterized by highly patrilineal societies and agriculture is the main occupation, carried-out mostly with traditional tools on farm plots measuring in majority less than 2 Hectares (MINEPAT Ouest, 2014).

Estimates by MINEPAT and INS (2007) show that in this part of the Country, agriculture makes a source of livelihood for most (79.0 percent) households and 69.3 per cent of all households in the Region are engaged in maize farming. Maize cultivation occupies the first place in terms of agricultural output in the Region and is grown in all the eight Administrative Divisions that make its territory (MINEPAT Ouest, 2014). Moreover, MINEPAT Ouest (2014) reported that maize topped the list of main food crops produced and outweighed their respective outputs in the West Region for 2013 and 2014 (Table 1.1).

Table 1.1: Production of food crops in the West Region of Cameroon (in kg)

Crop	2013	2014
Maize	201 593 000	263 141 000
Beans	105 073 000	91 488 000
Irish Potatoes	34 399 000	41 777 000
Banana	174 529 000	148 352 000
Tomato	87 421 000	94 207 000
Taro	13 902 000	13 510 000
Black Nightshade	34 381 000	35 344 000

Source: MINEPAT Ouest (2014)

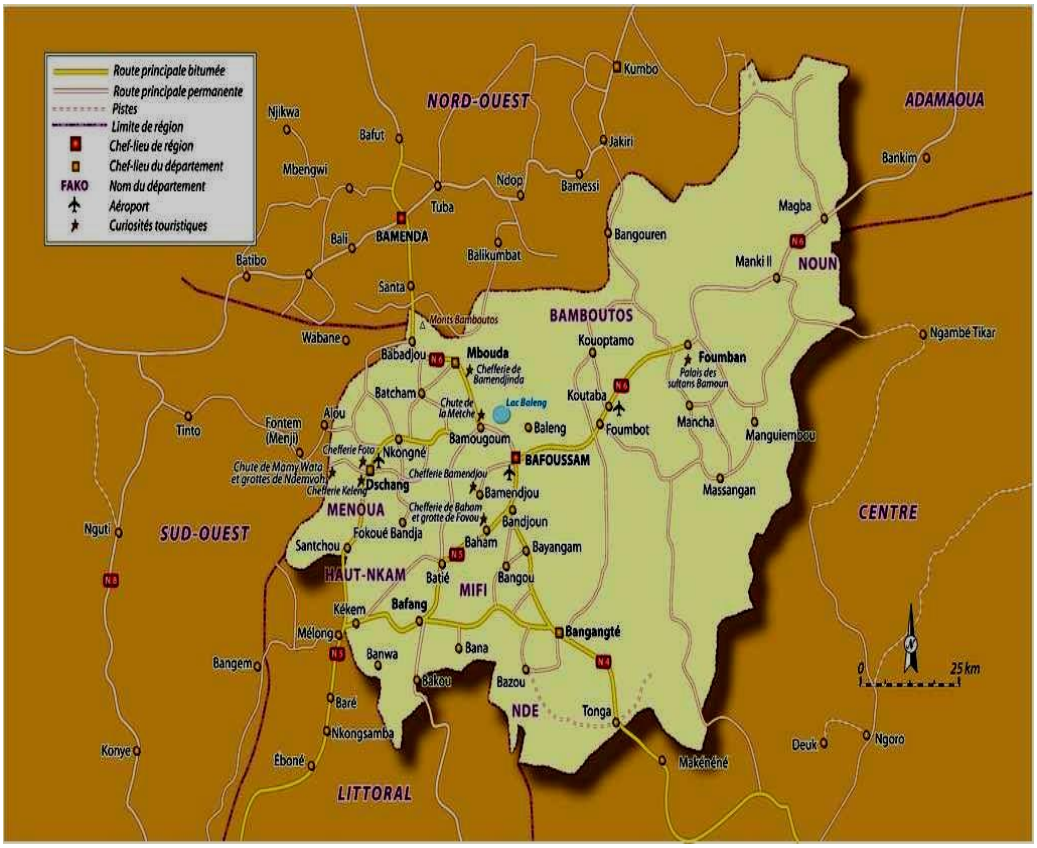

Figure 1.1: Map of the West Region, Cameroon

Source: Encarta 2009

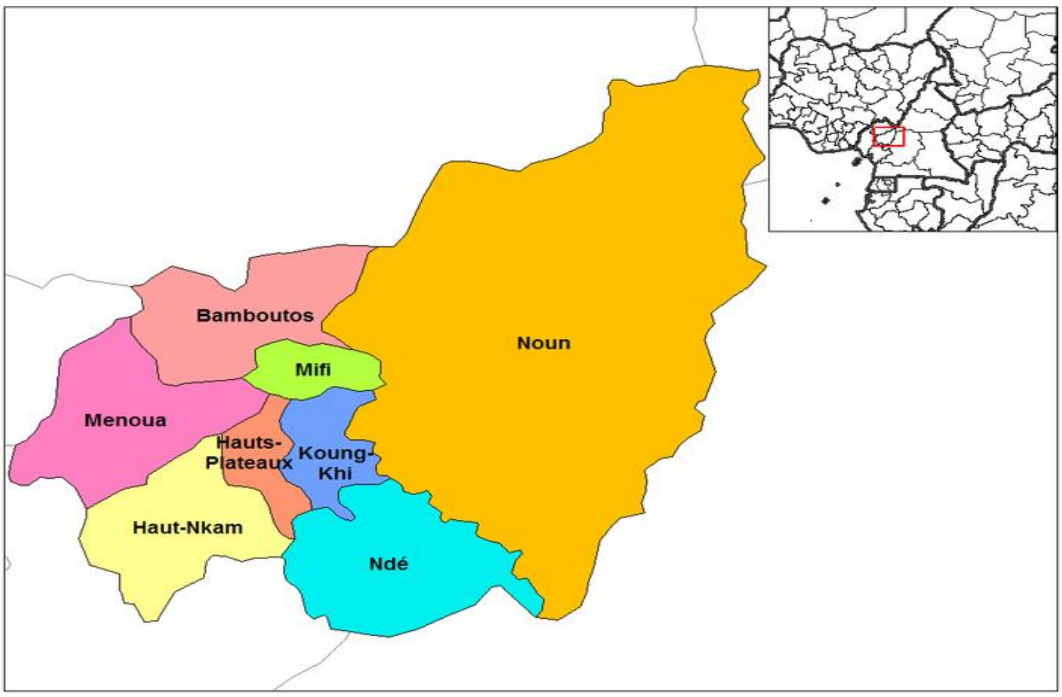

Figure 1.2: Map of administrative Divisions of the West Region

Source: Encarta 2009

1.3. Statement of the problem

Maize is not only a staple food in Cameroon, but it is also considered an economic safety net (Epule and Bryant, 2014) as much of it is often stored for several months and sold at successively higher prices on local markets (Nukenine, 2010). Value adding through drying and storage is however challenged by inefficient storage technology, price uncertainty, risk aversion or urgent need for cash among others (Kadjo *et al.*, 2013). As a consequence, some farmers wanting to avoid potential shocks might opt for early sales at very low prices (De Janvry and Sadoulet, 2011). This eventually undermines their food and financial security as they often end up purchasing grain during the lean period at higher rates. Others might decide to hold large stock until the following planting period and would often be compelled to sell grain of a poorer quality at very low prices due to pest attack. This equally leads to low returns and low profitability of the livelihood. Alarming current estimates indeed reveal that, 1 out of every 5 kilos of grain produced in Sub-Saharan Africa is destroyed by pests and decay (World Bank, 2011; Kimatu *et al.*,2012). According to Kiaya (2014) this situation aggravates the already challenging low food availability, low agricultural incomes and limited market opportunities for small scale farmers who are yet net deficit grain producers (Hodges *et al.*, 2013). Ideally, maize would be stored in sufficient quantities to cover the food and financial needs of a farm household between harvest and lean periods, but the diversity of risks a small scale farmer is compelled to manage could greatly influence storage decisions and practices.

1.4. Objectives of the study

The main objective of this study is to assess the relationship between post-harvest risks and stored maize management by smallholder farmers.

The specific objectives are:

- To identify major risks faced by smallholder farmers from maize harvest to the following planting season.
- To determine the effects of these risks on maize storage.

1.5. Hypotheses

The null hypothesis is:

Post-harvest risks have no statistically significant effect on storage.

$$\mathbf{H_0: \mu = \mu_o.}$$

The alternative hypothesis is:

Post-harvest risks have statistically significant effects on storage.

$$\mathbf{H1: \mu \neq \mu_o.}$$

1.6. Scope of the study

This research was designed to study the effects of post-harvest risks on the storage of maize by smallholder farmers who grow, store and sell maize in rural areas of the West Region in Cameroon. Post-harvest risks included the most pertinent risks that farmers face along the period following maize harvest. These risks were classified into three categories: social, economic, institutional, nature-made and personal/idiosyncratic. The major storage patterns measured in order to observe changes in their values in the presence of these risks were: the proportion of maize output kept in store at the beginning of the post-harvest period (Month of October), the percentage of stored maize left in store at the beginning of the following planting period, the percentage of stored maize meant for household consumption, the percentage of stored maize meant for sale, the length of maize storage, the percentage of stored maize attacked by pest, the main disincentive to storing maize, the main motive for storing maize until lean period, the average duration of maize storage, the longest stored crop in a year, the state of the maize store, the type of maize store, the level of price increase expected, the type of protectants used and the annual cost of storage.

1.7. Significance of the study

This research is of great relevance to the maize value chain in the West Region of Cameroon as it may help making a critical assessment of storage systems in small-scale farms under the influence of globalising markets and other emerging trends. It is also a step beyond mere quantification of post-harvest losses and separate analyses of their causes, which are main limitations of previous research. This study brings more precision to previous works on determinants of storage and suggests interactions to be verified by researchers who may be conducting research on storage in the fields of economics, sociology and agronomy but often undermine the effects of certain risks on this activity under peculiar circumstances. Suggestions made through this research would also help policy makers to design policies that seek to remove impediments to sound maize grain management or that reduce the vulnerability of smallholder farmers to post-harvest shocks. It would equally enable maize farmers to identify major threats to storage with a view to seeking efficient means to reduce them for better incomes and greater availability of food.

1.8. Organization of the study

This thesis comprises five chapters. The first chapter begins with an introduction to issues and trends relating to risk and smallholder grain management in Sub-Saharan Africa and Cameroon. It follows with an overview of main geographical characteristics of the West Region in Cameroon and ends with presentation of the rationale underlying this study. In the second chapter we review published material and previous theories on the research problem. The third chapter expatiates on methods used to carry-out the research. Detailed description of variables involved and statistical analyses performed are found in this part. In the fourth chapter, reporting of data analysis and discussion of research findings are the main concerns. The last chapter contains a summary of findings, a conclusion, recommendations, and it opens the debate for further research on the matter.

1.9. Definition of key terms

Post-harvest handling: Post-harvest handling refers to practices used in the chain of interconnected activities from the time of harvest to the delivery of food to consumers, including harvesting, drying, threshing, winnowing, storage, processing, packaging and transportation (Abass *et al.*, 2013).

Storage: A way or process by which agricultural products or produce are kept for future use (Nukenine, 2010).

Stock: A supply of something for use or sale (Cambridge International Dictionary of English, 1999).

Risk: 'A danger of loss or harm' (Cambridge International Dictionary of English (1999).

Storage Loss: It refers to "a measurable decrease of stored food grain which may be quantitative, qualitative, nutritive or economic" (Abass *et al.*, 2013).

Smallholders: According to the FAO (2012) these are "small-scale farmers, pastoralists, forest keepers, fishers who manage areas varying from less than one hectare to 10 hectares. Smallholders are characterized by family-focused motives such as favouring the stability of the farm household system, using mainly family labour for production and using part of the produce for family consumption".

Lean period: A period when there is not enough of something, especially money or food (Cambridge International Dictionary of English, 1999).

Granary: A large building for storing wheat or other similar crops (Cambridge International Dictionary of English, 1999).

Post-harvest period: The post-harvest period is the period that runs from crop exit from the field to the time of culinary preparation (FAO, 2009).

Idiosyncratic risk: "A risk that affects a household individually, it arises due to factors such as field specific problems, a disease that affects a household member etc" (Korir, 2011).

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. Small scale farming and risk

The Food and Agriculture Organization of the United Nations (FAO, 2012) in a brief factsheet reported that in low income countries, out of the 2.5 billion people that derive their income from agriculture, 1.5 live in smallholder households and are hit by extreme poverty. These smallholders manage 80 percent of the farms in Sub-Saharan Africa, supply 80 percent of the food consumed in the area but are well known for not being food and income self-sufficient (FAO, 2012). They are portrayed in many studies as the most vulnerable to shocks worldwide, whether economic, social, environmental or political (Chuku and Okoye 2009; Fafchamps, 2009; Bonfatti, 2014). As a result, these farmers make decisions and operate under uncertainty that permanently hypothecates their welfare (Kouame 2011). Uncertainty is here understood as a situation in which a farmer does not know for sure the outcomes of his decision, has imperfect knowledge of, or simply does not know the future, but is exposed to forces beyond his control that may or may not cause losses. According to Harwood et al (1999) and to the opinion of Heinrich (2002), unknown probabilities and unknown possibilities are often called uncertainty. Actually, the main point of these authors was that while uncertainty is omnipresent, risk may be absent in certain circumstances.

The notion of risk has been extensively analyzed by economists as well as by other social scientists, and most works conceived it as the known probabilities or likelihood that returns of an investment would fall below disastrous or intolerable levels (Aimin 2010; World Bank 2011; Domingo *et al.,* 2015). Harwood *et al.* (1999) had previously defined risk as “the possibility of

adversity or loss", the possibility of harm to one's health, to one's productive assets, and as "uncertainty that matters". To their opinion, any uncertainty that would affect an individual's welfare or that would be worth worrying about could be called a risk. Similarly, Roumasset (1979) asserted that "Risk has to do with the degree of uncertainty in a given situation" and he defined uncertainty as "a state of mind in which an individual perceives more than one possible outcome from a particular act". Given that consensual definition of risk among scholars lacked, this perception has been subjective to each and thus the terms uncertainty and risk have often been used interchangeably in economists' works as in Korir (2011) and in Kouame (2011) due to the fact that they both imply variance, chance of loss, and to the fact that both contribute to variability of outcomes, to shocks or adversity. In this study we referred to risk mainly as likelihood of a shock.

A great deal of recent literature including Cervantes-Godoy, Kimura and Anton (2013) and Domingo et al (2015) emphasises the fact that farming is a financially risky income generating activity, as it involves from production to sales a wide diversity of risks and uncertainties that if not well managed, could lead in the short, medium or long term to severe income insecurity and eventually welfare shocks. Indeed, there is a shared belief among many researchers that one can hardly find any livelihood as risky as, or riskier than agriculture, especially small scale farming (Aimin, 2010). This is due for many, to its extreme dependence on hardly predictable or on uncontrollable biological processes and also due to its vulnerability to both nature-made and man-caused phenomena. Traditionally, research on smallholders had identified common threats to their livelihoods such as poor access to infrastructure, markets and modern technologies, as well as lack of capital. There are however emerging challenges in addition to the aforementioned, which according to Fan *et al.* (2013), include weather shocks, health, price and financial shocks. Given that smallholders have kept on evolving with time along the continuum from

subsistence to semi-subsistence and further to commercial agriculture as Elhaut (2011) pictured in a brilliant presentation, it becomes crucial to examine each component of the transforming risk landscape they face, to study their response to such challenges and develop efficient risk management strategies so as to help build resilience against new unforeseen shocks and ensure the sustainability of their livelihoods (Chuku and Okoye, 2009); in line with this, a great deal of literature on risk dwelt on categorizing and describing sources of agricultural risks in many different ways, some of which are presented below.

2.2. Sources of agricultural risk for small scale farmers

Following a famous publication by Hardaker *et al.* (2004) and similar classifications made by Harwood *et al.* (1999), Korir (2011) identified four major types of risk in agriculture. These are namely yield, price, institutional and personal risks.

He viewed production or yield risk as the possibility of yield variation, either due to variability of climatic/natural factors, input prices, resource endowment at the farm level or household consumption needs that may subsequently have a negative impact on food supply, on revenue or on market prices. Chuku and Okoye (2009) had earlier described yield risk as the most important type of risk affecting stakeholders in the agriculture sector, due to the hardly reducible hardship inflicted at production stage by such events as flood, drought, hail, pests and diseases, that may end-up creating or increasing other risks along the food supply chain. The same finding was made by Harvey *et al.* (2014). Assessing the impact of cyclones and other natural disasters on farming communities in Madagascar, he highlighted their highest impact on farm productivity; as output yet low, had to be used primarily for home consumption.

Market or price risk was referred to as risk that emanates from the unpredictable changes in market structure and access, exchange rates, input and output prices. It is worth mentioning that this risk takes a pervasive nature in nowadays

globalised and more complex markets, involving a mix of local and international price variation and generating high market and price volatility, frequently resulting in income loss for small producers (Harwood *et al.,* 1999).

Yield and price risks have been identified in literature as main risks that influence resource allocation by farmers and are often said to be interdependent particularly in small, poorly integrated markets, where high yields and storage for a specific crop by most farmers in the same region, usually result in price decrease. Park (2006) for instance posited that the willingness of a farmer to plant a specific crop depends on market price, on the previous harvest left-over stock available for that crop and on his wealth. He also stressed the fact that crops with low yield risk are often those with lower prices and returns.

Institutional risk had to do with both political risk (risk that government policies may change and lead to added costs for the producer) and transaction risk (danger that transacting partners in a business would fail to conform to agreed terms).

Personal risks involved possible variations in livelihood outcome as a consequence of human problems or life-related events of farm operators such as divorce, death, change of mind, injury or disease. It also included risks related to damage or theft of productive assets, and the risk of running short of cash to finance business activities.

These are however not the only criteria for categorizing agricultural risk, as other works like that of Kouame (2011) identified two main types of risk: business risk and financial risk. She conceived the former as a situation where there is known possibility that income levels will vary, and it comprised technical, social and market risk, meanwhile financial risk was seen to imply risk related to the profitability or rate of return of the farm enterprise, such as the risk of indebtedness and insolvency. Using a different approach, Siegel and Jaffee (2007) classified risks prevalent at the farm level depending on whether

they were linked to weather, biological factors, price, labor and health, policy and politics. They went further to identify the specific risks that lie at each level of the agricultural value chain, adding to the aforementioned logistic and infrastructure risks, as well as management and operation risks. To the opinion of Carlo Cafiero (2008), sources of risk that are important to farmers can be grouped based on whether they occur behind the "farm gate" or beyond it, corresponding respectively to production and market risks.

Other classifications in literature were made with respect to type, level, frequency, timing and severity (Cervantes-Godoy, Kimura and Anton 2013). Type referred to either political, environmental, economic, social, health, natural or environmental risks (Elhaut, 2011), while level had to do with scope of risk; that is whether it mainly affected an individual or household (micro/idiosyncratic), a community or region (meso/covariant), a nation (macro/systemic) and finally the World (super-macro/super systemic). Ranking risks in terms of frequency involved distinction between transitory, trend-related and structural risks. As for timing, it had to do with whether the likelihood of a risk was more pronounced at a point in time. Classifying risks according to severity was made on the basis of capacities needed to manage them; the greater the capacities, the more severe. Going further than classifying, Rispoli (2011) found that despite existing differences, agricultural risks were very often linked with one another.

2.3. Risk management in small scale agriculture

2.3.1. Farmers' attitudes to risk

Farmers' attitude to risk have a direct bearing on their livelihood assets, on the profitability and sustainability of their livelihoods(CGIAR *et al.*, 2012), as it shapes the combination of strategies used for production, savings and sales with a view to prevent or respond to potential and present shocks. Previous research such as Aimin, (2010) has analyzed three distinct peasant farmers' attitudes to risk, namely risk averting, risk loving, and risk neutral. Indeed, every time a

farmer uses an asset, he/she expects a return; but the manner in which the asset is invested is relevant, as some farmers may invest in a way that keeps them from a certain degree of exposure to bad outcomes. These are risk averse farmers; put differently, they are farmers who prefer lower returns with known risks to higher returns with unknown risks. Much literature points to the conservative and risk-avoiding behaviour of most poor farmers (Harwood *et al.*, 1999; Gwata, 2010; Cervantes-Godoy, Kimura and Anton, 2010; Kouame, 2011; Korir, 2011; Fan *et al.*, 2013) on grounds that profit maximization is not the main objective of farm households, but that they have greater interest in reducing their vulnerability to risks and shocks. This generalization has however been refuted by several economic works with contradictory findings such as that of Maertens, Just and Chari (2011) on grounds of lack of empirical measurements on studied determinants of this attitude such as experience and psychology.

Some other farmers are said invest in ways that make them more exposed to perceived risk. These are risk loving or risk preferring farmers, who assume that high risks are positively correlated with high returns (Domingo *et al.*, 2015), and so do often take high risk to gain more income. There should nevertheless be some preconditions for this attitude to prevail. For instance Maertens, Just and Chari (2011) identified in India high stake gambles like heavy investments in irrigation schemes and higher education achievement for one's child, both of which were perceived in the area as major undertakings that bring a lot of wealth to households, thus prompting high risk-taking.

Another category of farmers invest without concern for risk of loss. These farmers neither love nor avoid risk. The relationship we seek to test through our null hypothesis is consistent with this attitude. It actually answers the question as to whether poor producers using a maize-based farming and storage system would be indifferent to post-harvest risks under the influence of certain factors. Some researchers do not however make a clear cut distinction between risk

neutral and risk loving behaviour, on grounds that they often have similar outcomes (Gwata, 2010).

When investigating grain management patterns of small farmers, most studies concluded that there was a tendency towards risk aversion, especially with regards to storage (Lai, Myers and Hanson, 2003) and posited that high levels of risk aversion and risk aversion itself do push farmers to keep part of their produce from one harvest period to another, with occasional sales carried-out along that time frame. Le Cotty *et al.* (2014) precisely found a positive correlation between risk aversion and quantity of grain stored by African farmers from harvest to lean season, but a negative correlation between impatience and quantity stored.

Using three different elicitation techniques to assess attitudes to risk in Southern Philippines, Domingo *et al.* (2015) established a general inclination of farmers towards risk neutral behaviour in the surveyed area, but observed varying choices of same respondents with changing elicitation techniques. They equally identified some socio-economic variables that acted as determinants of risk aversion; namely level of wealth, subsistence constraints, remoteness of area, and farm area. Warnick *et al.* (2008) instead emphasised the difference between ambiguity aversion and risk aversion of Peruvian farmers using an experiment and a survey. They came out with the finding that while risk aversion reduced the probability that farmers would include unsafe/unsure cropping options in their portfolio, ambiguity aversion (aversion from ambiguous outcomes or from very uncertain distribution of outcomes) decreased the likelihood of diversifying farmed crop species (by growing unsure/not well known varieties). Some other researchers focused on analysing the real drivers of this aversion; following an experiment conducted to measure risk aversion and identify its determinants for asset-poor farmers in South Africa, Gwata (2010) held that risk aversion is not inherent to small scale farmers' behaviour and found that in areas where the prevalence of this attitude was high, it was motivated mainly by liquidity

constraints and due to lack of credit as well as insurance facilities. In the same vein, Roumasset (1979) and Tongruksawattana *et al.* (2015) posited that risk aversion might not be the main explanation and driver of most poor farmers' tendency to under-invest in modern storage technologies, but that aversion comes into play with higher levels of household vulnerability to shocks and poor resilience mechanisms.

2.3.2. Farmers' risk management strategies

Although some research has been done on the occurrence of agricultural risks and risk attitudes in smallholdings as mentioned above, much effort seem to have been laid on the various means on which farmers rely to prevent or withstand shocks in general. One of the most interesting works, that of Fafchamps (2009) propounded that risk management was more critical to poor farmers in developing countries "a matter of life or death", due to lack of formal economic and social safety nets in rural areas and to their high vulnerability to diverse shocks. Cafiero (2008) defined a risk management strategy as "a combination of different actions which include preliminary risk and vulnerability assessment and subsequent risk management choice, possibly followed by monitoring and re-evaluation of the actions taken".

Conform to several other agro-economic works, Cervates-Godoy, Kimura and Anton (2013) described two approaches to risk management in farming, namely ex-ante risk management and ex-post risk coping. The first was described as strategies aimed at avoiding, reducing/mitigating, or transferring risk, and usually intervened prior to the occurrence of a shock. The second approach had to do with strategies that aimed at building the capacities of the farm and household to cope with the effects of shocks; to start with ex-ante risk management, avoiding risk has generally been associated in literature with risk aversion attitudes as described above (Gwata, 2010). It is said to include strategies like mixed cropping and mixed farming, income diversification and use of reliable traditional production asset (Korir, 2011). Risk mitigation

however includes crop diversification, adjusting household size to revenues, precautionary savings in the form of buffer stocks, in the form of cash in micro-finance institutions or in rotating savings/credit associations, borrowing from relatives, common property and watershed resource management, off-farm income, micro-insurance and spread sales. In transferring risk to other parties, small farmers appeal to such practices as sharecropping, insurance, contracts, intra-community charity systems and State subventions. Coping with shocks involves sales of farm assets, reduction of household consumption, use of child labour, disaster relief and migration. These strategies were also grouped into formal and informal categories by OECD (2011), with informal risk management involving those options applied at the household and community levels by farmers to handle "small risks", while formal risk management referred to mechanisms put in place by the market and/or by the state to handle risk beyond the capacity of individuals termed "catastrophic risks". It has also been widely emphasised in literature that, just like agricultural risks vary with farm and environment features, so do risk management strategies. Roumasset (1979) for instance stressed the flexibility of crop choices under subsistence constraints in describing a special method of risk reduction used by farmers growing both cash and food crops. He described a typical practice whereby farmers left part of their farming land idle at the beginning of the season so that in case output appeared insufficient to meet consumption, it was later planted to food crop. Attitude to risk therefore have a great influence on the choice of risk management strategy a farmer makes. Analyses of small farmers' risk management strategies in general abound in literature, but we shall focus here on risks linked to post harvest management of grain and farmers 'choices when handling these risks within the specific context of Cameroon, in the West Region of the Country.

2.4. Post-harvest and storage risk management by smallholders in developing Countries and in the West Region of Cameroon.

International concerns for post harvest losses spanned from the huge surplus grain available on markets as a result of the late 1960's "Green Revolution" in Asia, as post harvest experts stood to point at the limited technical capacities of small farmers to handle stocks and began to evaluate losses in kind and in cash. Some authors stress the over-estimation of post harvest losses and "over-investment in loss assessment" (Shepherd, 1991) made by these experts and by the FAO in the mid 1970's, that led to the International Community multiplying efforts to help build farmers' capacities for storing (storing technologies) and processing grain. Post-harvest food loss at farm level has generally been explained as a phenomenon triggered mainly by poor handling (Ngoko *et al*, 2008) often during harvesting and transportation processes but also by "overproduction" (Shepherd, 1991), that is when the farmer produces a quantity he/she does not have capacity to store adequately, to process or chance to sell early enough (Abebe, 2004).

A study on storage systems by Ny (2011) highlighted the fact that in Cameroon just like in other Sub-Saharan African countries, Poor grain farmers often produced a surplus to sell in order to avoid or limit cash/liquidity shortage in the process of meeting other household or farm needs. She however found that limited duration of storage tended to occur not in households more exposed to pest damage, but in those large households that consumed very large shares of their maize as staple food. Though post harvest handling operations are plagued by bad roads, high cost of transportation, poor drying technologies, ineffective treatment (protection from pest), poor threshing tools, lack of market information, limited storage and processing technologies, small farmers have over the years developed a variety of strategies to reduce these risks (World Bank, 2011). Unfortunately, when market prices for output turns out to be lesser than expected, that is when they do not sufficiently compensate for costs

incurred in production and post-harvest handling, some farmers would rather incur more storage losses while waiting for a favourable change in prices (Hodges, 2012); Others would opt for consuming the commodity within own household or farm or would offer as gift, whilst some others may sell instantly, often at loss.

The concern for post-harvest losses at national and local government level has rarely been at the center of agricultural policy making in Cameroon (Nukenine, 2007), as government and donors' efforts have in the past emphasised increased production of staple foods for food security and industry supply motives. This was particularly the case with cereals like maize, with initiatives such as the National Support Programme for the Maize supply Chain (PNAFM 2012). Production rose from 280,000 Metric Tonnes in 1960 to 1,700,000 Metric Tonnes in 2014 (Index Mundi, 2014). Adequate facilities to handle this growing output nevertheless remain unavailable (Mboge and Diop, 1995) especially for small producers still using hardly accessible tracks to fields, inappropriate harvesting techniques, hand-dehusking, hand-threshing, sun-drying under cloudy conditions, drying with smoke from yet scarce firewood (Ny, 2011), inefficient protectants or treatment from pest with either natural or synthetic substances and poor pest control facilities (Nukenine, 2007), inadequate or often very small and fast degrading traditional storage structures (family granaries). As Mboge and Diop (1995) underlined, storage is for most small maize farmers in the West region, the last stage prior to sale, given that most lack appropriate facilities for processing corn. It ensures constant market supply, stabilization of seasonal market prices and preservation of grain/seed quality, having therefore much importance for many farmers (Nukenine, 2007) as quality grain sometimes makes price (Mejia, 2003).

Storage structures used by farmers in Africa have in literature been classified into three categories, namely traditional, semi-modern/improved and modern (Mejia, 2003; Hodges, 2012). Traditional stores included local cribs, barns,

platforms, open fields, roofs and fire places, jute bags; semi-modern ones comprised ventilated cribs, improved rhombus and polypropylene bags; lastly, modern stores included silos and warehouses. Ny (2011) reported that traditional stores made of local material from plant and soil, are predominant in West Cameroon and are often also used concomitantly as dryers but Poor hygiene, poor practices (such as keeping newly harvested grain in the same place with old infested grain or total absence of protection against pest and inadequate store aeration) have been reported as some of the major causes of pest infestation within these structures. In modern ones such as silos, losses are much lesser if the grain has been dried properly, but the dissemination of modern tools has often been limited by unavailable technology for fabrication at local level and by their high purchase cost (World Bank, 2011).

Maize storage has been described in many works (World Bank, 2011; Abass *et al.,* 2013; Tamgno *et al.,* 2013) as the stage recording the highest loss in post harvest operations in small farms, especially when grain has suffered mechanical damage along the preceding stages. Nukenine *et al,* (2007) citing Nukenine (2002) stressed the alarming situation of stored maize infestation by insects, especially the weevil Sytophilus Zea Mays in Cameroon, as it accounts for up to 33% of grain damage in the Adamawa Region. They further highlighted the trend of growing resistance of these pests to synthetic insecticides commonly used by roughly 23% of farmers in some areas of the country, as well as the environmental pollution and health issues these substances generate when usage standards are neither known nor respected, which is often the case.

Maize cultivation in the West Cameroon is mainly rain-fed, and is carried-out along two seasons, one from March to June, and another from July to September. This leads to the harvest taking place most often during rainy periods, when humidity levels are high, transportation means scarce and costs are the highest due to the bad state of roads leading to fields; as a result, even

timely harvested maize is often left piled-up on bare soil for several days, easing insect and mould contamination which may later be aggravated by the use of ineffective drying tools and protectants when moisture levels at storage are still high (20-30%), allowing for continued biodeterioration of produce in stores (Hodges, 2012). Grain left to dry on-field on stalks also often exhibits a level of infestation close to that of early-harvested one because pest attacks start immediately as the crop reaches maturity (Mejia, 2003). In 1988, a Post-Harvest Development Project was carried-out in the Western Highlands of Cameroon supported by the United Nations Food and Agriculture Organization and the United Nations Development Programme (Mboge and Diop, 1994). It sought to relieve farmers from post harvest burdens in handling maize, through the introduction of donkeys to ease transportation from fields to homes and from homes to markets, as well as through dissemination of improved dryers such as the "maize crib" and the "brook-type dryer". Assessment of impact made by such initiative and adequate research in that perspective are however hardly evoked in the post harvest literature concerning the Country. Moreover, available literature barely describes the actual contribution of risk prevalent at post-harvest period to storage practices developed by small scale maize growers.

In the West Region of the country, a good year for a given farmer in a given locality is often also a good year for neighbouring farms as grain farmers are usually encouraged by high demand and prevalence of high prices for certain commodities in a year/season to make higher marketable surpluses the next season/year, which sometimes result in oversupply in local markets and thus, lower prices (Ny, 2011). These low prices might also be spread throughout the period from harvest to lean season due to constant availability of grain on the market, as opposed to the normal scenario of increased grain scarcity at the onset of harvest time (Maitre d'hotel and Le cotty, 2014). Such a situation might create incentives to keep stock for longer periods and could sometimes generate harsh opportunity loss and/or economic losses for low income rural dwellers in

the Region who often make precautionary savings in the form of maize stocks and rely on price arbitrage to increase their economic returns. It might equally be worsened by limited access to credit, non-enforced grain quality standards, limited flow of or access to market information, absence of social safety nets to mitigate shocks as well as limited or inexistent off-farm income among others[1]; these factors might equally be part of explanations for the Region's estimated average of 22.6 % dry weight loss in annual maize output from 2008 till 2013 (APHLIS, 2014).

It is true that some farmers in Cameroon do store maize grain all year round because it is their staple (Nukenine 2010), but given that grain growing provides for approximately 37% of farmers' revenue (World Bank 2011), potential loss in economic value could mean a lot for a household (Kimatu *et al.,* 2012; Hodges, Bernard and Rembold, 2013). Maize farming and marketing has become a very lucrative activity following the 1980's rise in local demand by mill industries and breweries; this allows us to assume that many Cameroonian farmers engaging in that activity are likely to be driven by profit maximisation motives. Lins, Gabriel and Sonka (1981) had perceived general level of wealth and portfolio assets possessed by a farm household as the main determinant of their post-harvest decisions. Similar research observed a significant causal link between risk aversion and stock holding between seasons (Lai, Myers and Hanson, 2003); more precise, Yoo and Giles, (2002) found that precautionary motives drive savings decision in households with lower levels of wealth, thus a negative correlation between wealth owned by a household and proportion of grain output stored for various motives. Using a slightly different perspective, Renkow (1988) argued that the strength of price arbitrage motives is negatively correlated with availability of cash cropping alternatives. To him this is due to the fact that most smallholdings have budget constraints and thus may perceive additional costs in the holding of many different stocks. It may indeed be hard to

[1] A wide plethora of complaints from farmers in rural areas of Cameroon are displayed in the Growth and Employment Strategy Paper (GESP, 2009).

achieve in a situation where a farmer lacks sufficient financial means to handle all other household and farm needs. Others like Korir (2011) found total household income and especially access to off-farm income, as the most influential determinants of grain storage behaviour in smallholdings. Most works therefore seem to point to the wealth-constrained practice of grain stock holding in small farms. Though considering these standpoints, our research makes an argument for a general neglect of the specific link between perceptions of different post-harvest risks (especially shocks likely to occur and to have a perceptible effect on storage to the opinion of each stock holder) and proportion of stock held at the beginning of lean period. This is to account for the fact that decisions made at harvest period may not be implemented in the way the farmer had planned due to unexpected non-economic events. It is thus necessary to examine all the determinants of the whole post-harvest period maize stock management.

2.5. Theoretical Framework

The influence of risk on grain storage patterns has been the focus of some scientific works bridging the gap between research in economics and inquiry in the agriculture and entomology domains. Two famous approaches have explained decision-making as far as storage under risk is concerned. The first one is called the safety-first theory and the second is the expected utility theory (also named Bernoullian Principle).

2.5.1. The safety-first theory

To the opinion of Domingo *et al.* (2015) an individual using the safety-first approach would seek to reduce the "probability of ruin or disaster" or the probability that "one's resources will fall below subsistence levels". Safety-first therefore had to do with avoiding options that involve the risk that one would obtain an outcome below 'acceptable' or minimum levels, which according to Henrich and MCElreath (2002), might be culturally or biologically determined. For a typical Cameroon West Region small maize producer under the threat of storage losses and thus unsure return, this might imply large early sales

combined with small precautionary savings in the form of grain to reduce risk. There is nevertheless a controversy among researchers who studied the influence of safety-first motivations in decision making. Henrich and MCElreath (2002) argued that safety-first farmers were likely to be risk averse but that contrary to other economists perception, this behaviour would be common to wealthy individuals as they would seek to maintain revenues above subsistence threshold, while individuals already living with revenues below subsistence levels would be risk loving, having very few to lose or no acceptable standard of living to maintain.

2.5.2. The Expected Utility theory

The second theory departs from utility maximisation motives of farmers. Dillon (1979) described the expected utility theory as one that rests on an individual's "personal strength of belief about the occurrence of uncertain events and his personal valuation or utility of potential consequences". Thinkers adhering to this theory argued that the expected utility of the outcome drives decisions made by individuals. These individuals could be classified into three distinct categories depending on their attitudes to risk: risk averse, risk seeking or risk neutral. A farmer under risk who seeks to maximise his/her expected utility would often make choices involving less income variation. According to Kadjo *et al.* (2013), such an individual would hardly separate marketable stock from consumption stock, and might hold grain stock even if expected lean period prices are detrimental to his expected revenue. His/her utility curve therefore shows a concave shape. For an individual who is risk seeking, choices that involve more variation in income would be preferred, as he/she would not seek to maximize utility of the outcome and therefore may not rely heavily on precautionary savings. This individual is graphically described by expected utility theorists as having a convex utility curve. Risk neutral individuals are however said to have straight line utility curves, and would be expected to simply choose those options involving higher revenues irrespective of the utility of their outcomes (Henrich and MCElreath, 2002).

The expected utility theory and the safety first theory have both been criticised on grounds of assuming linear correlations of probabilities in individuals' decision making and thus failing to consider influential factors other than attitudes towards risk and subjective aspirations; this includes socio-cultural, geophysical and policy constraints (Gwata, 2010; Bowman and Zilberman, 2013).

Renkow (1988) pioneered the analysis of antagonism between risk aversion and price arbitrage in storage of staple food and he believed that both expected utility and safety first might not prevail at the same time. Abebe (2004), Lee and Sawada (2005), and Park (2006) nevertheless reconciled these two apparently divergent approaches in analysing the effects of liquidity constraints on sales and savings patterns for grain growers in Ethiopia, Pakistan and China respectively. They highlighted the fact that when well functioning formal financial institutions such as insurance and micro-credit are inexistent in rural areas, grain stock is held by poor farmers as a form of savings in kind, as it may easily be sold for cash in times of need, in times of high price prevalence, but it concomitantly makes a buffer against food shortage, therefore reducing household reliance on the market for the purchase of food for own consumption.

2.5.3. Model of Storage

The influence and impacts of post-harvest risks and/or shocks on maize storage have been poorly examined in past literature, as economic justifications or explanations of mere stock holding and analyses of storage technology constraints dominate published material. Nevertheless, Kadjo *et al.* (2014) exceptionally attempted to fill this gap in investigating the relationship between access to storage technology, expected quantity and value of dry weight storage losses (quantitative losses caused by pest damage) and storage behaviour in Benin under circumstances of highly volatile maize prices. Their findings revealed two main positive correlations: One highlighted that the more market-oriented a farmer is, the more likely is his/her preference for risk of storage losses, as price arbitrage may compensate for incurred losses. The other positive

correlation was found between technology used (implying household physical and/or financial assets to afford improved technology) and quantity stored. Although their research brought more insight on the effects of grain management capacity on storage decision at period of harvest, it is limited in that it assumed a farmer who has used a given storage technology for a certain number of years under specific environmental conditions, will expect from harvest period a precise amount of loss in quantity. This might not always be the case as some farmers, especially those in the West Region of Cameroon find it increasingly difficult to dry maize adequately due to scarcity of firewood and fear of theft in local cribs; this may provoke greater and thus varying magnitude of pest damage in stores with time. Their study also laid a lot of emphasis on harvest period storage determinants, whilst factors influencing stock holding during lean period (beyond harvest period to whole post harvest period) may be different and even of more critical interest when investigating on grain management constraints in small farms. This does not however confer less merit to this approach. In fact, Kadjo *et al.* (2014) developed the first model of storage proper to Sub-Saharan Africa small grain farmers, based on the expected utility theory and which we shall use in this study because of its simplicity and adequacy to explain storage patterns in the circumstances proper to our study area. The model was built as shown below.

$$S = \beta o + \mathbf{L}\beta 1 + \mathbf{T}\beta 2 + \mathbf{P}\beta 3 + \mathbf{C}\beta 4 + \mathbf{Sa}\beta 5 + \mathbf{Q}\beta 6 + \mathbf{So}\beta 7 + \mathbf{M}\beta 8 + \mathbf{E}\beta 9 + \mathbf{R}\beta 10 + \varepsilon$$

Where **S** represented the quantity of stored maize at the beginning of the storage period (in kilograms); **L** measured expected percentage of losses from the total stock (%); **T** captured the storage technology used by the farmer (equipment + protectants); **P** measured the subjective expected percentage of increase in price from harvest to lean period (%); **C** was an estimate of the daily food intake per capita during the harvest period and was used as a proxy for level of household maize consumption (kcal); **Sa** measured the amount of cash savings at the beginning of the harvest period(francs); it was used as a measure of cash wealth

obtained from on and off-farm activities at the start of the harvest period; **Q** represented the total maize production/output (kg) **So** measured the quantity of stock carried-over from previous harvest (kg); **M** was the farmer's motives for storing maize and was equally used to assess utility of maize during storage period; **E** measured capacity to meet needs or preference for other goods during post-harvest period (francs). It involved expectation of cash from loans and reimbursement; **R** was a set of control variables that could have an effect on the main covariates and therefore would interact with the error term **ε** (it included: existence or absence of government's safety nets to limit spatial food scarcity and pest infestation; number of years the storage technology had been used; and household characteristics such as age, education and sex; and the amount of loan from formal or informal sources during harvest period; and finally vectors of correlation to the tested covariates).

2.6. Gaps Filled in Literature

The literature on grain storage under risk depicts a variety of causal relationships, but almost all researchers agree on the fact that many factors linked to wealth and income have an undeniable effect on the manner in which storage is planned and practiced by a small producer who is likely to sell a surplus or part of his stored grain. We draw from these findings to test our hypothesis that put in question their applicability in a context where semi-subsistent maize producers in majority rely also on storable pulses such as the common beans (Phaseolus Vulgaris) for income and consumption. This is with a view to identifying all factors of risk, drivers of loss or likely shocks other than economic problems that may shape a farmers' maize stock management.

The other novelty brought about by this work is a move from the limited perception of Kadjo *et al.* (2013) that mere expected loss in quantity causes a semi-subsistent farmer to store a smaller share of his/her output within the three months following harvest, to examine the extent to which other post-harvest threats are critical to poor farmers from the onset of post-harvest period to the

planting or lean period; and thus the effect such risks and the management strategies chosen by producers have on proportion of maize stock left at the beginning of the lean period (March in the West Region).

We also verify the claim of Henrich and MCElreath (2002) that wealth is not an important factor in determining risk preferences when it concerns individuals from different socio-cultural backgrounds. These researchers indeed found through experimental research that wealthier and more learnt individuals ironically tended at risk averse attitudes, as opposed to poorer ones. Again, the timing of cash shortage may not always occur as planned by the farmer, and so we here posit that income constrained or insecure farmers are more likely to store part of their grain until lean period for precautionary or income security motives. We do not however exclude the possibility that such stock may end-up being used for self-consumption in case of food insufficiency or in case low price prevalence during lean times.

Having reviewed published material relating to our topic of interest, we believe another major gap in literature would be filled by this research. While previous works have established a clear link between income insecurity risk and proportion of stock held at harvest period, we go further to inquire on the effects of other post harvest risks on grain management patterns and stock of maize held beyond that period that is when farmers are even more likely to face shortage of cash. This is also meant to take into account the fact that intermediary purchasers and local markets often create disincentives to handle grain properly and to meet certain quality standards when storing maize, as poor quality grain (damaged by pest) is commonly purchased from small producers, though at a discount during this post harvest period; and this trend may encourage stock holding for income motives despite incurred losses to pest by many small producers, whether market-oriented or not. Though such an attitude may hide both risk avoiding and risk loving features, it somehow obeys to the logic of safety first theorists as well as to the logic of expected utility theorists, given that the utility of holding stock is maximised until the lean period.

CHAPTER THREE

METHODOLOGY OF THE STUDY

3.1. Model specification

The model we construct to study the major determinants of storage for surveyed households is a modified form of the storage model built by Kadjo *et al.* (2013) to examine determinants of harvest period grain storage. It is presented below.

$$S = \beta o + \mathbf{L}\beta 1 + \mathbf{T}\beta 2 + \mathbf{P}\beta 3 + \mathbf{C}\beta 4 + \mathbf{Sa}\beta 5 + \mathbf{Q}\beta 6 + \mathbf{So}\beta 7 + \mathbf{M}\beta 8 + \mathbf{E}\beta 9 + \mathbf{D}\beta 10 + \mathbf{R}\beta 11 + \varepsilon$$

3.2. Description of variables in the model

The vectors:

S=Average proportion of maize output available in the storage unit at the beginning of the month of March described here as the start of planting period for maize (%).

L=average annual proportion of losses to pests from the total stock (%).

T=the annual cost of storing maize (frs).

P=the subjective expected incremental increase in price from harvest to period of largest sales (%).

C=the proportion of maize stock for household consumption and gifts (%).

Sa =the share of off-farm income in total income (%).

Q=the total maize production/output (kg).

So=the major disincentive to storing maize during post-harvest period.

M=the farmer's main motive for storing maize until lean period and is equally used to assess utility of maize during post- harvest period.

E=the farmer's capacity to meet needs or to satisfy preference for other goods during post-harvest period; It involves level of access to small credit.

D=the average duration of maize in store per annum (in months).

R=control variables that may affect the main covariates and interact with the error term **ε** (it includes: storage technology used; state of the store; household size and main breadwinner).

ε = the error term

Although proposed predictors presented as such may not allow one to clearly identify perceived risk, they are however proxies to capture sources of risk or factors that drive shocks or put differently, factors that make losses likely.

3.3. Study design

This research employed a combination of quantitative and qualitative research designs. A Multistage sampling was used to select respondents and participants in ways that ensured representativeness of the target population (small scale maize farmers and stock keepers). At the first stage purposive sampling was used to select 5 zones/divisions in the West Region where maize is produced, consumed by smallholder farmers and is equally stored for several months after harvest. This selection was done based on evidence of geographical disparities in maize farming and management in the Region. These five zones are namely: Noun, Bamboutos, Mifi, Hauts-Plateaux and Menoua Divisions. The second stage involved simple lottery/ballot sampling technique to select 4 villages or neighbourhoods in each zone. At the last stage we used the convenience sampling technique to select 7 smallholder farmers from the first two neighbourhoods/villages selected and 8 smallholder farmers in the last two villages/neighbourhoods selected from each zone. 30 individual questionnaires were then administered to these farmers in each of the five zones, giving a total of 150.

In addition to administering questionnaires, 2 (two) focus group discussions were conducted in two of the 20 sampled villages, chosen this time again through probability/ballot sampling. These are namely: Batyo in the Mifi Division and Baleveng in the Menoua Division. Structured interviews with open-ended questions from an interview guide prepared in advance were used

with the aim of generating a debate and compromise on certain issues. A synthesis of these discussions was made by the researcher and presented to participants one week after each group discussion had taken place, for validation of findings. Each focus group was made-up of the neighbourhood/village's Chief or his representative, two members of the local development committee, the agriculture zone extension worker, five male smallholder farmers and five female smallholder farmers. We ensure that among these ten farmers, 4 farmers' households had been surveyed using questionnaires. These farmers were selected using systematic sampling from a list of farmers in the Neighboorhood/village available at the Sub-Division's devolved services of the Ministry of Agriculture and Rural Development. Apart from this primary data, secondary data were also derived from review of books, various sorts of published documents, electronic Journals, reports and websites.

3.4. Analytical approach

Descriptive statistics (mean, standard deviation and variance) on household socio-demographic characteristics, farm and household socio-economic features, maize farm management features, post-harvest risk perception, storage systems and practices, post-harvest maize sales patterns were computed;

To test for the possibility of a relationship between variables, we used were possible parametric tests such as One-way analysis of variance and the Pearson's product Moment coefficient of correlation.

Prior to testing whether perceived post-harvest risks (most likely shocks that affect maize storage) and storage patterns were related, compliance to basic assumptions for independent measures Analysis of variance (ANOVA) were verified and parametric tests were performed. When data failed to meet these assumptions, non-parametric tests such as Kruskal-Wallis Test or Man-withney U. test were carried-out or else, the Pearson Chi-Square value was computed. Similarly, assumptions of the Pearson Product-Moment Correlation Index were checked with respect to both independent and dependent variables prior to

running tests of correlation. Where population's estimates failed to comply with these assumptions, the Spearman correlation index was computed. Only variables significantly related with the Response variable (at 95% confidence interval) were included in the regression model and other analyses.

One-way analyses of variance were performed to assess the level of changes in duration of storage, annual cost of storage, percentage of stock for home consumption, percentage of stock sold for cash income, proportion of losses caused by pests (insects, rodents and moulds), proportion of stock left at the onset of new planting period for each specified category of post harvest risk.

Spearman correlation tests were performed to examine through significance if there were changes in average proportion of stock available at planting period for different duration of the hunger period, proportion of output available in storage unit at the beginning of the month of October, level of access to small credit, respondent's age, share of off-farm income in total annual income, available storage facility, type of drying facility, state of store, household size, level of education, average annual duration of maize in store, main motive for storing maize, average quantity of maize purchased in a year and other potential predictor described in the model above. Finally, ordinal regression was computed to predict level and direction of changes in stock available at planting period for different values of variables found to be significantly correlated with the dependent variable.

Data was entered in a Microsoft Excel Spreadsheet and analysed using the SSPS 20.0 (statistical package for the social sciences) software.

3.5. Validation of results

To ensure the reliability of the data collection instruments (questionnaires and interview guide), pretesting was carried out. The questionnaire and interview guide were pretested in two villages. At the end of this pre-test, some questions were added, some rephrased to reduce ambiguity, while others were discarded

completely. Also, all of the variables captured in the questionnaires have been used extensively in studies of similar nature by other researchers (Siegel and Jaffee 2007; Korir, 2011) and international research organisations (OECD, 2011; World Bank, 2011). Finally, the variables chosen were directly related to objectives and hypothesis of the study.

Reliability, validation, and generalisation of our model and other results were equally ensured by conducting analyses with 95% confidence intervals. Also, our sample size was chosen in conformity with norms of consistency in statistical analysis especially for regression, such that the ratio of observations used for each test to the total population was 30; this means that, for 15 predictors we had 10 times 15 individuals a population of respondents to questionnaires (150 subjects). Our findings can therefore be generalised to the whole population of small scale maize producers who keep stock in the West Region and other populations with similar maize storage features in Cameroon. The study could be replicated especially where smallholders face similar disincentives to store grain cereal.

When performing statistical analyses, we took into account the fact that our independent variable could assume different categories, given that major post-harvest risks may include nature-induced risk, economic risk, personal risk, institutional risk or social risk. This categorization approach was drawn from major types of risks identified in previous works cited in the literature review.

Control for extraneous variables was done by ensuring that respondents were from different households and satisfied the basic criteria of smallholding set by the Food and Agriculture Organization of the United Nations (FAO, 2012), namely heavy reliance on household labour and use of the produce primarily for household consumption. Independent observation was also used in 15 households.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

4.1.1. Demographic and socio-economic characteristics of surveyed households

Although production and storing of maize was common to respondents, they differed on many aspects of demography and socio-economic organisation.

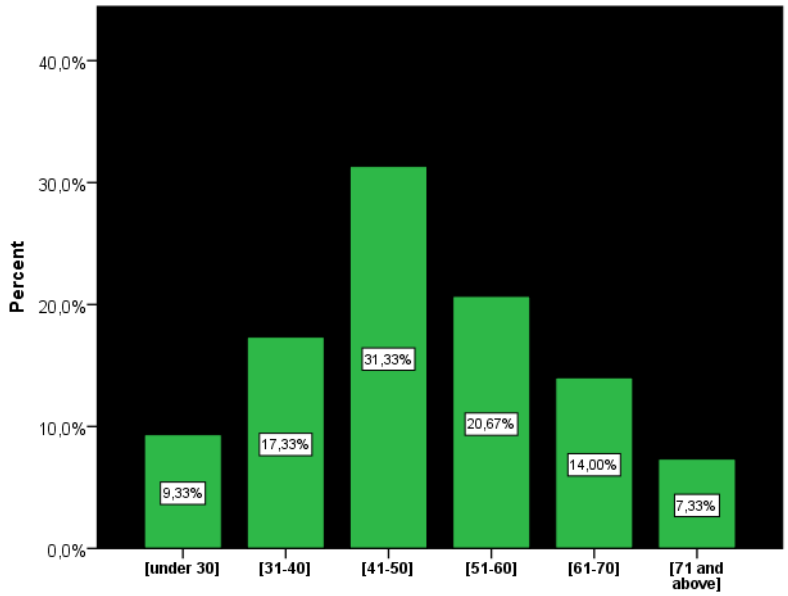

Figure 4.1: Age of respondents

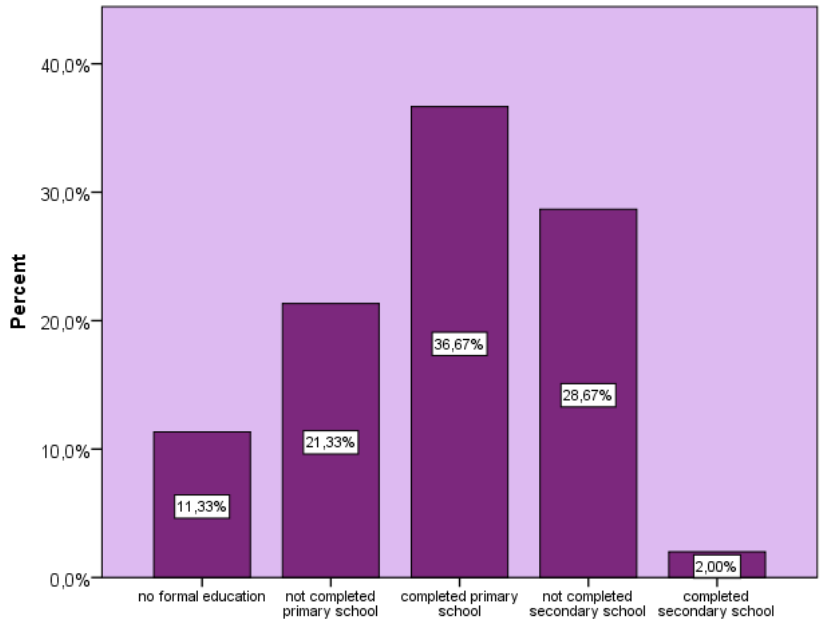

Figure 4.2: Respondents' level of education

With a total sample size of 150 farmers of which 63.3% were females and 36.7% males (Table 4.1), the median age class was [41-50] years old (fig.4.1) and it was found that a great share of respondents (67, 34) had completed at least primary school (fig.4.2). this finding confirms estimates of the 2010 Survey on Employment and on the Informal Sector (INS, 2011) that literacy rates in the rural areas of West Region are high (77.2%) on average, with males recording 67.0% and females 48.6%. However, Pearson Chi-Square value X^2=6.86 with 4 degrees of freedom indicated no significant relationship between gender (sex of the respondent) and level of education in the sample.

Table 4.1: Sex of respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	55	36,7	36,7	36,7
	female	95	63,3	63,3	100,0
	Total	150	100,0	100,0	

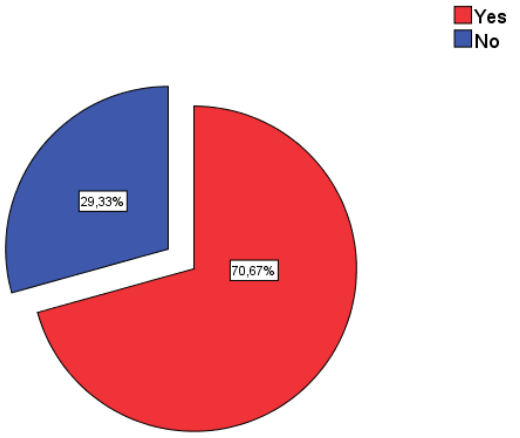

Figure 4.3: Ownership of a functional mobile phone

Majority of respondents (>70%) owned a functional mobile phone (fig.4.3) and often made use of it to obtain information on local market trends for main cash and food crops.

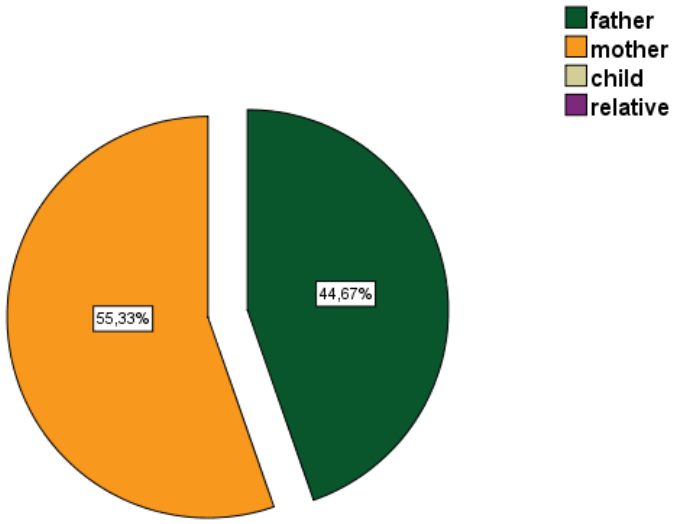

Figure 4.4: Main breadwinner of household

Women were the main breadwinner in most households (>55%), and none of the households relied heavily either on child or relative to provide for daily needs (fig.4.4). Statistical analysis using Independent measures One-way ANOVA showed that having a mother or father as main breadwinner of the household was significantly related to the average household annual income ($P < 0.05$), to the share of off-farm income in annual revenue ($P < 0.05$)and to the average annual agricultural expenditure($P < 0.05$). Precisely, male-headed households had higher proportions of off-farm income than female-headed ones. A great majority of households (82%) had at least 5 to 8 members, with 59% of households having 4 to 7 school-going people in the 72 households comprising 5 to 8 members. For male-headed households however, the size of the household was greater ($P < 0.05$) than for female headed households (Table 4.2).

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Table 4.2: Relationship between sex of household head and household size

Count							
		Household size					Total
		[1-4]	[5-8]	[9-12]	[13-16	[17 and above]	
Sex of the household head	**Male**	11	49	26	5	7	98
	Female	16	23	11	2	0	52
Total		**27**	**72**	**37**	**7**	**7**	**150**

It is also worth mentioning that household size was significantly associated (P>0.05) with Administrative Division, as 43% of households in the Mifi Division had at least 9 to 12 members, whereas other Divisions had relatively small size households.

The mean income was found to be CFA 258 704.67 Francs. The lowest income value recorded was CFA 167 000 Francs while the highest income value was CFA 387 000 francs. Having a high income was significantly associated with tenure of land farmed (P <0.05) as those with purchased land had higher incomes, followed by those who had inherited land. Those with less secure land tenure (rental, sharecropping or family-owned) had relatively lower incomes. A significant positive correlation was equally found between average annual income and share of off-farm income (r=0.37), average annual agricultural expenditure (r=0.35), average area of farm owned (r=0.33), average annual maize output (r=0.41) and average farm area occupied by maize (r=0.33). Average annual household income just as its above mentioned covariates was however negatively correlated with average length of the hunger period(r=-0.33). Correlative tests between average household annual income and the share of maize revenue in annual income however showed that these variables were not correlated (r=0.12).

The mean area of maize farm was 1.013 Hectare and the mean length of the hunger period was 3 months while average maize output in the sample was 762.09 kg.

Average annual maize output was found to be negatively correlated with length of the hunger period (r= -0.341) as higher outputs were associated with shorter hunger periods. The mean share of maize revenue in annual income in the sample was 26.57%, while the mean share of income from livestock breeding in total farm income was 8.30%.

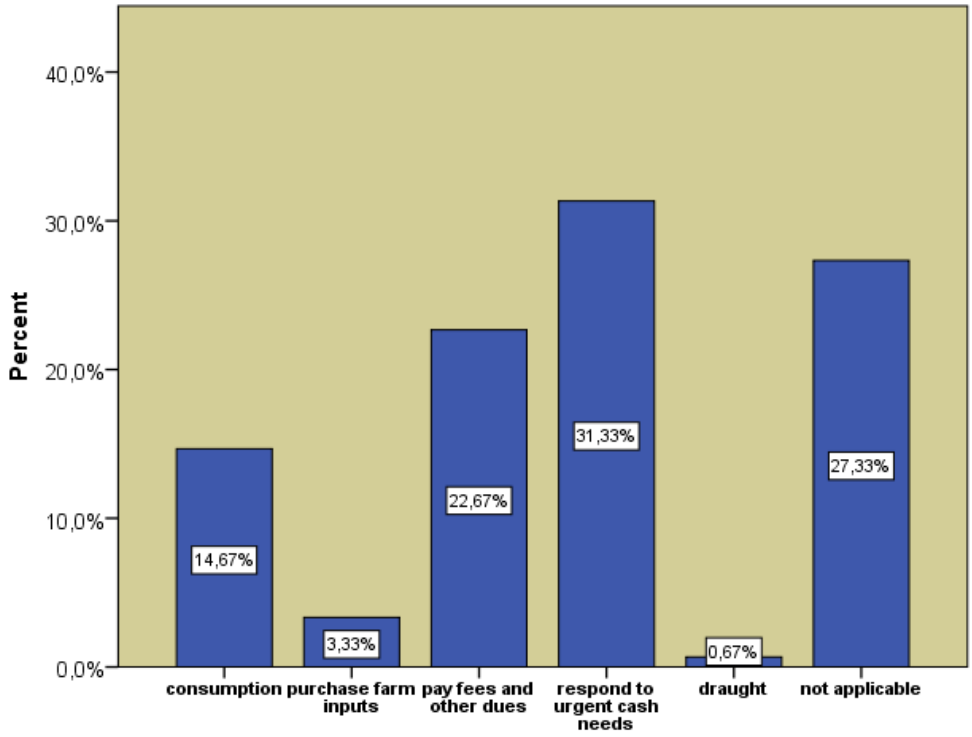

Figure 4.5: Use of livestock

The average contribution of livestock breeding to agricultural revenue in the sample as highlighted above may be as a result of the manner in which such livestock is managed. A little more than 27 % of respondents did not raise animals while for a great share of those who did (>57%), these activities were carried-out mainly because livestock constitutes a kind of precautionary savings to resort to in case of need and not as a pure income generating activity. Interviews revealed that higher pest and diseases prevalence with time had led to a growing neglect of animal production by many smallholders in the Bamboutos

and Menoua Divisions. All those who reported breeding stock primarily for consumption purposes actually had a very negligible local poultry and neither cattle nor Pig, as the latter were kept in few of the farm households surveyed, purposefully for eventual urgent financial needs (fig.4.5).

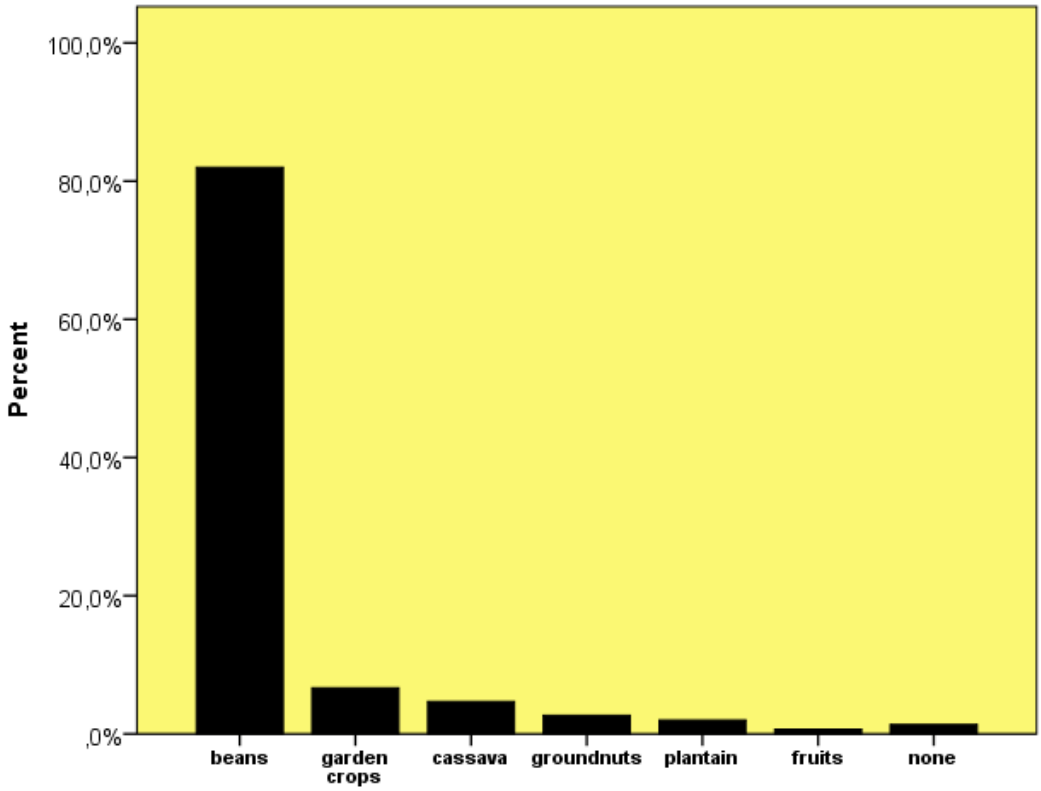

Figure 4.6: Crops other than maize sold for income

Most maize growers surveyed (>80%) sold beans to earn cash (fig.4.6) and admitted that keeping beans stock was uneasy due to weevil damage. Also, households with many school going members were often compelled to sell large shares of their produce to pay fees. Moreover, higher market rates for beans prevailed compared to maize and beans were mostly harvested in the dry season (as from December) when demand is high.

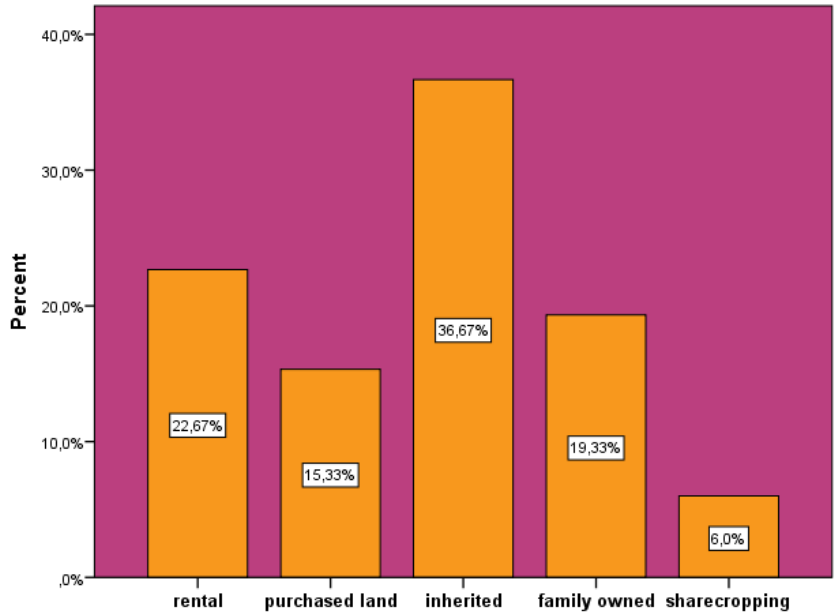

Figure 4.7: Tenure system for type of land most farmed

37% of surveyed farmers grew crops on land inherited from family, but 15% of respondents had purchased farmland on which most agricultural activities including maize farming were carried-out (fig.4.7). According to participants of focus-group discussions, the practice of sharecropping was progressively fading-away with generalised drop in soil fertility status and because of mistrust among sharecroppers.

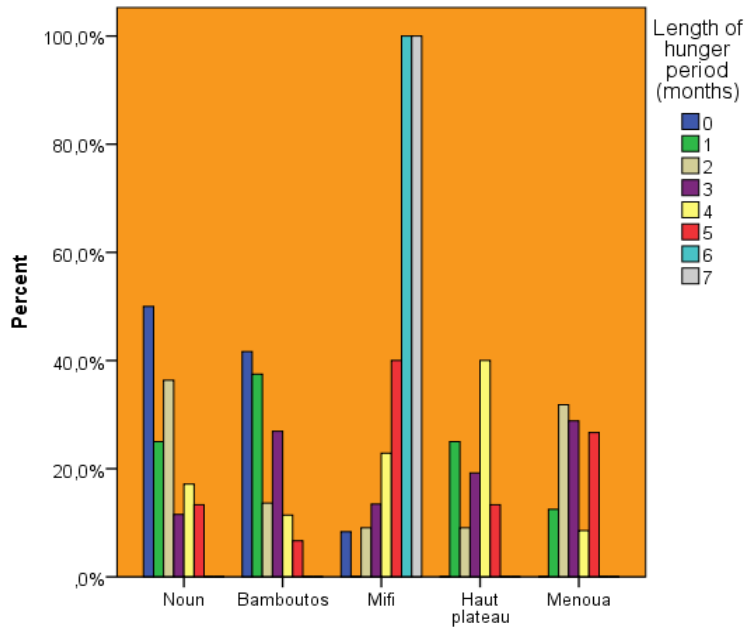

Figure 4.8: Divisions and Length of the hunger period

Annual length of the hunger period in households differed significantly (P <0.05) across Divisions. Households with the longest hunger periods were located in the Mifi, as 40 per cent of households with 5 months-long and 100 per cent of households with 6 and 7 months-long hunger period were found in this area. The majority of households with no hunger period (zero months) were found within the Bamboutos and Noun Divisions (fig.4.8).

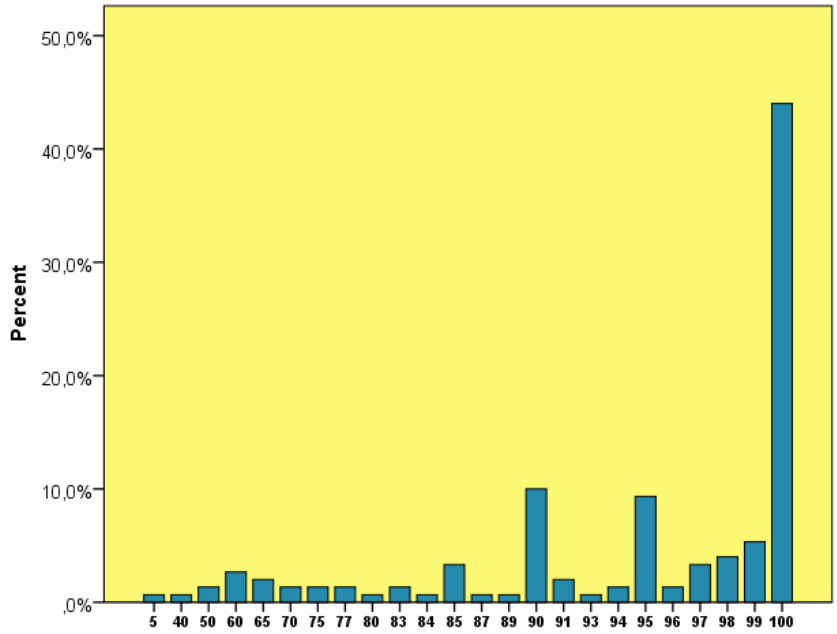

Figure 4.9: Share of farm income in annual income (%)

45% of respondents derived a hundred per cent (100%) of their total yearly revenue from farming (fig.4.9). This confirms estimates of BUCREP (2010) that farming makes a major input in incomes in the Region. The mean share of farm income in total income was 92.3 per cent. As expected, most households (68%) reported having no source of off-farm income. Higher farm contributions to annual income tended to be associated (P <0.05) with smaller Households and lower levels of access to small credit (P <0.05). Indeed, 83 farmers out of 150 revealed having no or very limited access to small credit whether from Rotating Savings and credit associations or micro financial institutions, and the main justification behind this situation was their low share of cash savings in these structures (Table 4.3).

Table 4.3: Relationship between access to small credit and explanations for zero or poor access.

Count				
		Level of access to small credit		Total
		zero access	Poor	
Reason for zero or poor access to small credit	poor savings	24	19	43
	lack of collateral	21	19	40
Total		45	38	83

Noteworthy, among those who reported borrowing from one source or another, (71.33%) were compelled to borrow funds by urgent uncertainties such as health care or school fees.

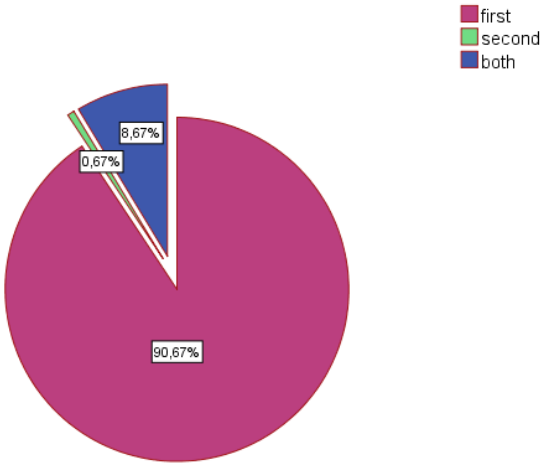

Figure 4.10: Main maize harvest season

Most respondents (90.67%) reported harvesting maize during the first season (fig.4.10), which is found within the rainiest period, notably between early July and September. No relationship was found between either mould-damaged percentage of stock or proportion of losses to pest and harvest period for maize. It was therefore not consistent with previous findings by Ny (2011) in Dschang (a town in the Menoua Division) who pointed at the choice of harvest season as

one of the main cause of pest damage. She found particularly that moulds developed on maize grains stored in most attics as a result of delayed transportation from the field. Group discussions revealed that it was almost unavoidable to harvest huge quantities of maize within the rainy season without having soaked maize, as rain fell heavily once or twice on a daily basis during this period of harvest.

4.1.2. Maize storage and sales patterns in surveyed households

To examine maize storage and sales characteristics in the sample, questionnaire survey was combined with independent observation by the researcher, and the main finding was that farmers in majority (89%) stored 100 per cent of their output on-field or on-farm and drying tools as well as maize stores used in the study area were predominantly traditional.

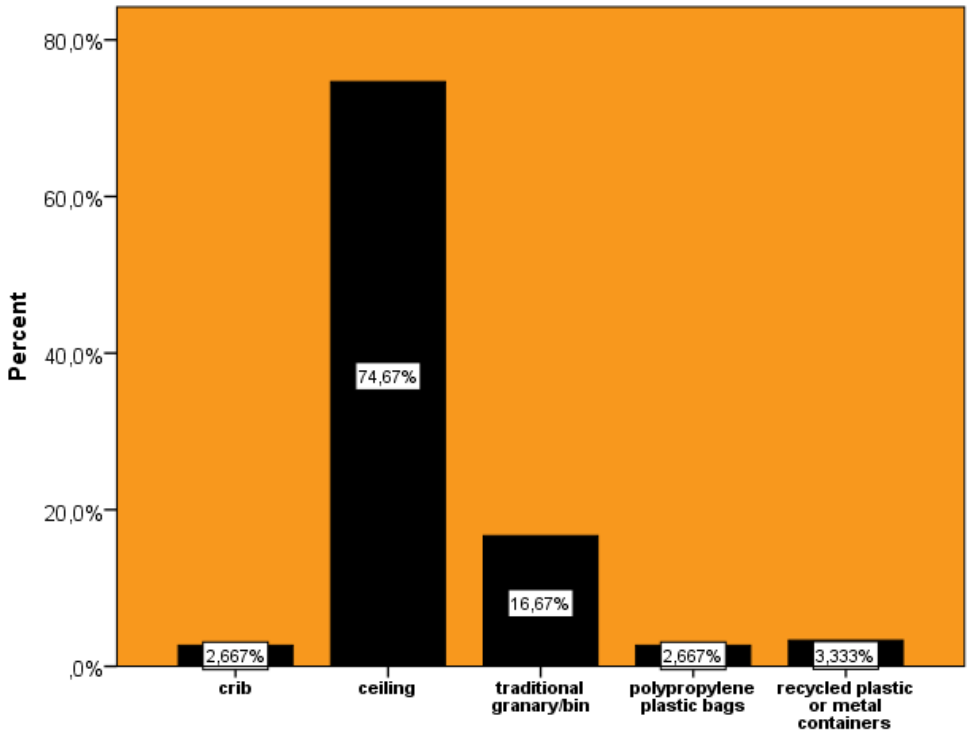

Figure 4.11: Main type of maize store used

A common pattern for maize storage in the study area was the use of dryers concomitantly as stores when maize grain got dry on cobs. Ceiling made of bamboo was the principal storage unit for close to 75% of the surveyed

population (Fig.4.11). It was equally common to find maize cobs partially unshelled and hanged out of or inside kitchens in households using this roof/attic storage method (fig.4.32). Group discussion revealed that these cobs were selected on-field for next planting season seeds, and hanging above fire/stove ensured greatest protection from weevils, moulds and rodents. Improved natural ventilate structures called “cribs” (fig.4.33) were common maize dryers in the Noun Division but not always used as stores, whereas traditional granaries or bins made from bamboos (fig.4.34) were commonly found in the Menoua Division and villages of Bamboutos that shared geographical boundary with Menoua. Those who reported storing maize mainly in recycled plastic or metal containers (mostly 20 litres recycled cans or tins) admitted having much to lose if pest damage occurs and thus found these tools more efficient than traditional ones for keeping grain safe. Discussion in focus groups revealed that among those who stored maize in common polypropylene woven bags, most (≈91%) were accustomed to early sales and sold large proportions of their maize for income. Farmers exhibiting these features thus kept maize unshelled so that it was ready for purchase at all times, but the stock was not meant to last for more than 3 months as insects, moulds or rodents would start damaging grain. The type of store used was not significantly related to the proportion of output stored at the beginning of the month of October, considered as the start of the post harvest period. Nevertheless, among the 4 households surveyed that used mainly recycled plastic containers, only 1 held stock of more than 400 kg of maize. Age of the store and years of experience in using the main storage technology were not significantly different across farmers and many could neither trace with precision the year of construction or time of purchase, nor reliably estimate the cost of their store. Also worth mentioning is the fact that a little more than 95 per cent of surveyed maize stock holders reported having enough space in their store to accommodate their annual output and even twice the stored quantity. Modern stores like improved bags, silos and warehouse systems were unknown to many respondents. ($P < 0.05$) indicated highly significant relationship between

store type and maize dryer used. Table 4.4 shows that majority of those who used ceiling as a dryer also used it as a store.

Table 4.4: Relationship between types of dryer and types of store used.

Count					
		Type of drying facility			Total
		tarpaulin	crib	ceiling/attic	
Main storage facility	crib	0	4	0	4
	ceiling	25	0	87	112
	traditional granary/bin	1	0	24	25
	polypropylene plastic bags	0	2	2	4
	recycled plastic or metal containers	3	0	2	5
Total		**29**	**6**	**115**	**150**

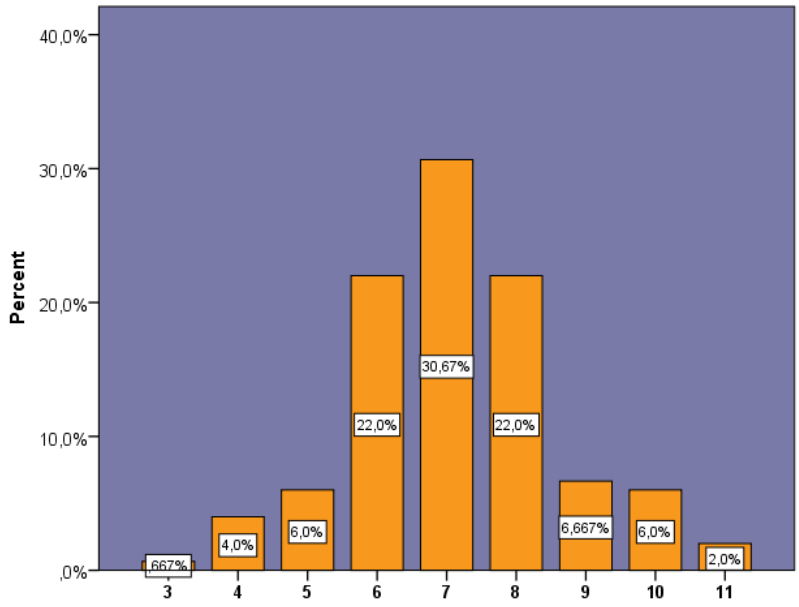

Figure 4.12: Average annual duration of maize in store (months)

While the mean proportion of output stored annually was 88.94%, the mean duration of storage for maize in the sample was 7 months (fig. 4.12). Most households (75%) used at least 74.5% of stored maize for home consumption

(including gifts). The share of stock used as animal feed was generally low, averaging 4%. The mean annual storage cost was CFA 2404 Francs and it was found that those with higher expected economic value of losses in store spent amounts as high to protect their maize from pest each year ($P < 0.05$). Worth notice, most farmers complained of poor efficacy of synthetic insecticide powders purchased from distributors in the local markets, but names of the inefficacious substances were completely unknown to many, just as norms for use of these chemicals. It was however argued in group discussions that 'Malathion' (fig.4.35) was the most sold in local markets and was susceptible to create pest resistance. Similar to the above described trend, those who used high proportions of their maize for income tended to invest significantly more money in storing this commodity than those who did not ($P < 0.05$).

Farm area occupied with maize and maize output varied with high significance ($P<0.05$) across Divisions; the Noun Division had larger maize farms and higher production, followed by the Bamboutos Division. An interview with the Regional Coordinator of the Programme for Support to the Maize value chain confirmed these findings, arguing that the flow of River Noun was the main catalyser of this trend, as the river's sides were much more fertile than other parts of land in the West Region.

No significant relationship between being a farmer in a certain Division and incurring high or low proportions of losses to pests was found ($P>0.05$), but a significant relationship was found between proportions of output stored and Divisions; precisely, farmers in Bamboutos and Noun Divisions had significantly greater proportions of output stored than other Divisions ($P<0.05$).

Maize was found to be the longest stored crop for 110 respondents while beans lasted for longer period in 40 surveyed households. More interesting, $X^2= 35.11$; df. =4 revealed that the longest stored crop differed significantly across Divisions (Table.4.5). The keeping of beans in store for longer periods than maize tended to be common to households mostly in the Noun and Mifi

Divisions, but none of the households surveyed in the Bamboutos Division reported such a practice.

Table 4.5: Relationship between longest stored crop and Division

		Division name					Total
		Noun	Bamboutos	Mifi	Haut plateau	Menoua	
Crop stored for the longest period in a year	maize	12	30	18	23	27	**110**
	beans	18	0	12	7	3	**40**
Total		30	30	30	30	30	**150**

Pearson correlation value (R= 0.315) showed a highly significant correlation between average proportion of output stored yearly and duration of maize in store, but no statistically significant correlation was found between proportion of losses due to pest and annual duration of maize in store. Whilst 41.33% of respondents used absolutely none of the protectants available in the market or alternative products, 44 % reported using mainly synthetic chemical insecticides sold in the nearest markets and 12% said they relied on both chemical and natural insect repellent substances to prevent grain damage by weevils. Only 2.66% made use of traditional protectants such as dried parts of plants, wood ash and/or soil substances to get rid of or repel insects, particularly the maize weevil "Sitophilus Zeamais". However, weevils were not the only pest associated with grain loss in store and so the principal method of general control for pests in store was found to be early cleaning of stores prior to transferring maize to these structures, with less than 10% of surveyed farmers using trap/guard against rodents (particularly the common mouse "Mus Musculus" and the black rat "Rattus Rattus").

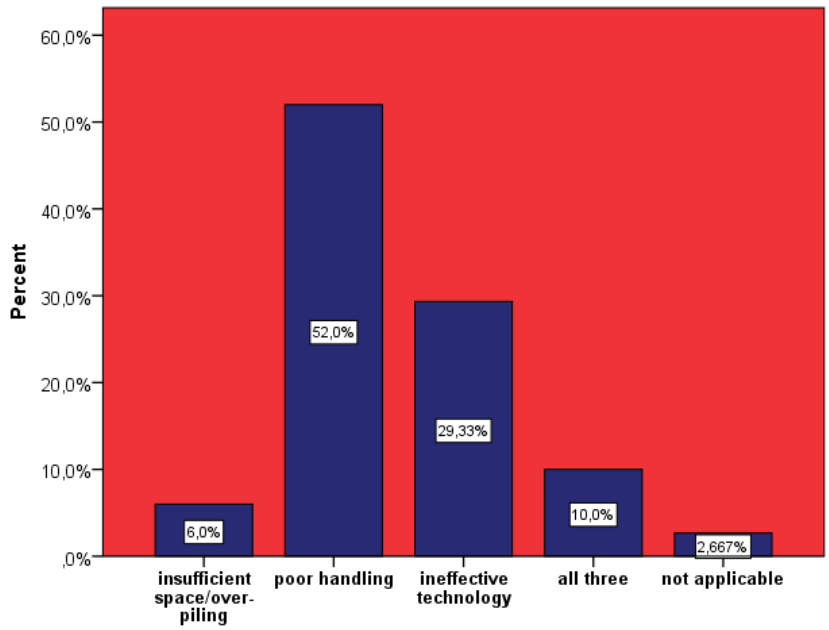

Figure 4.13: Major cause of losses in store

The principal cause of maize losses in store was poor handling (fig.4.13) and respondents who incurred no loss were those who used recycled plastic containers as main stores. One of the most interesting finding was the mean proportion of maize bio-deteriorated in storage: it was estimated at 30.69% of annual maize stock, which is slightly more than twice the average 15% estimates reported by the World Bank (2011). However, 75% of surveyed farmers estimated their average annual storage losses at roughly 40.2%. The mean percentage of stock loss due to insect damage was 12.36 %, while that of mould was 6.35% and rodent damage was estimated to 11.61%. This confirms findings from Abass *et al.* in Tanzania (2014), and Ny in Cameroon (2011) that insects are a serious cause of maize damage in store when compared with rodents or with moulds. The main motive for storing maize was found to be precautionary prevision or buffer against various types of shocks that might occur (53.33%), similar to other researchers' findings, namely Le Cotty et *al*. (2014), Park (2006), Cervates-Godoy, Kimura and Anton (2013) with respect to risk aversion and mitigation by small scale farmers. Those who stored maize until lean primarily for food self-sufficiency or food security motives constituted 24% of the sample, as against 14.6% who kept maize mainly to make an increase in

their revenue through sale of the commodity. Farmers who used high proportions of their stored maize for home consumption also incurred as high dry weight losses to pest (r=0.21), especially attacks by insects (r= 0.23). There was a positive correlation between proportions of stored maize for kept to ensure food security and quantitative maize losses in general and insect-caused losses in particular; but the trend was not same with losses caused by moulds or rodents.

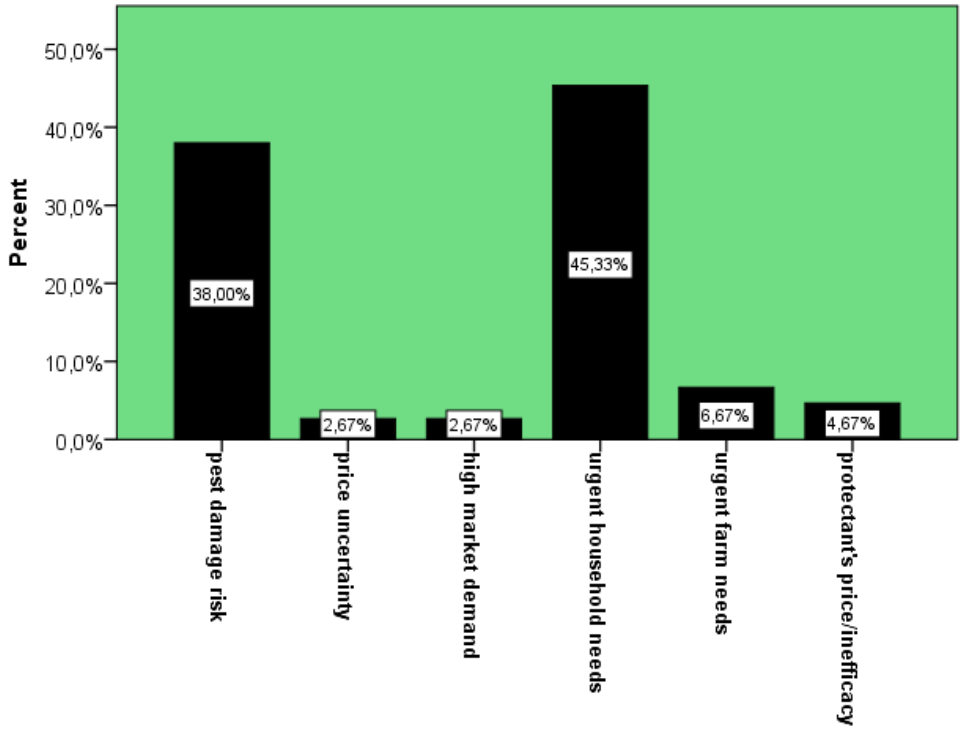

Figure 4.14: Major disincentive to storing maize

The main disincentives to holding maize grain until the following planting period were urgent household needs and pest damage risk (fig.4.14). The relationship between the main disincentive to maize stock holding and type of store used was found to be significant (X^2=85.9 df. = 20) for farmers. Most farmers who reported pest damage or urgent household needs used either ceiling or recycled plastic containers to store grain; and all those who highlighted protectants' inefficacy or price uncertainty used ceiling as store (Table 4.6). It is worth noting that most of the respondents (75%) who identified pest as main

driver of unplanned removal of grain along the storage period were using ceiling store maize. This is consistent with findings by Hodges *et al.* (2014).

Table 4.6: Relationship between main disincentive to storing maize and main storage facility.

Count							
		Main storage facility					Total
		crib	ceiling	traditional granary/bin	polypropylene plastic bags	recycled plastic or metal containers	
Main disincentive to storing maize	pest damage risk	1	43	9	2	2	57
	price uncertainty	0	4	0	0	0	4
	high market demand	2	0	0	2	0	4
	urgent household needs	1	53	11	0	3	68
	urgent farm needs	0	5	5	0	0	10
	protectant's price/inefficacy	0	7	0	0	0	7
Total		**4**	**112**	**25**	**4**	**5**	**150**

Abass et al (2014) had similarly reported that household expenditure needs, cash needs for school fees and low storage capacity were the main disincentive to storing maize in maize-based farming systems in Tanzania.

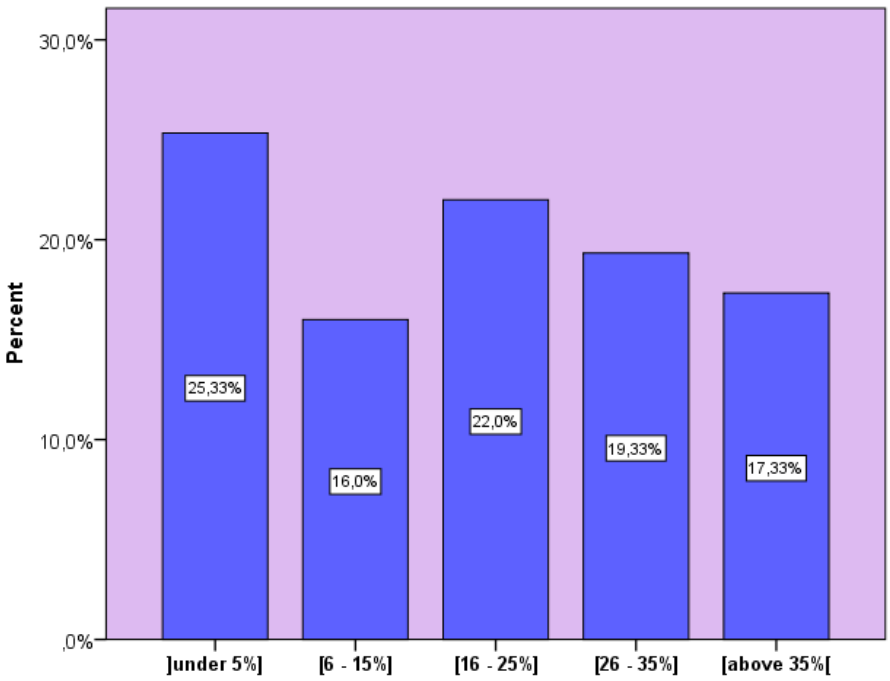

Figure 4.15: Proportion of stored maize left at planting period (%)

Surveyed households did not follow a homogenous trend as far as stock keeping is concerned. The proportion of stock left at the beginning of the month of March however shows that close to 74% of surveyed households held at least 6 per cent of their stock until lean period, with more than half of these farmers having up to 16% or more of their maize grain in store at the onset of the planting period (fig.4.15). Group discussions confirmed these findings and it seemed that there was no specific allocation of grain left at that period between the various uses a farmer could make of it. Nevertheless, many (53.3%) maize stock keepers admitted that the main reason behind holding stock until that period was for income security motives, even if it could end-up being used for other purposes. Only 10% reported getting to early March only with the quantity of maize seed for the planting period in store and no other maize reserve. Few kept maize stock until that period because of sales constraints, as demand and price were said to increase with time in all the surveyed areas.

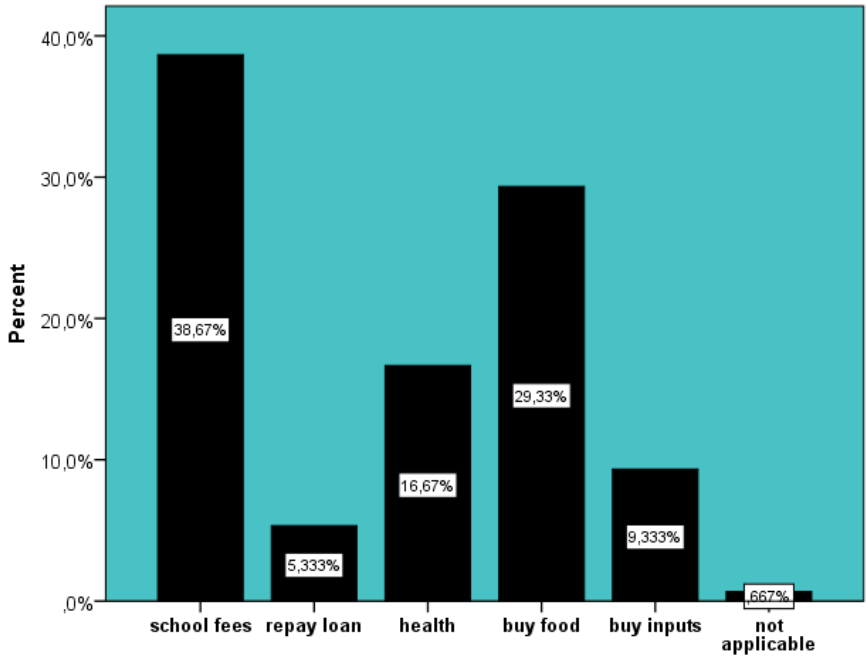

Figure 4.16: Main motive for sales of stored maize at the beginning of the planting period.

Respondents who sold maize from the beginning of the planting period were pushed mainly by education dues and food needs to do so, but some respondents actually preferred borrowing to meet their needs at the beginning of the post harvest period when prices for maize are very low, so that sales as from March would enable them to repay their credits (fig.4.16). Some others argued that only requirements for planting maize anew such as labour, herbicides or fertilizers were the main drivers of early march sales.

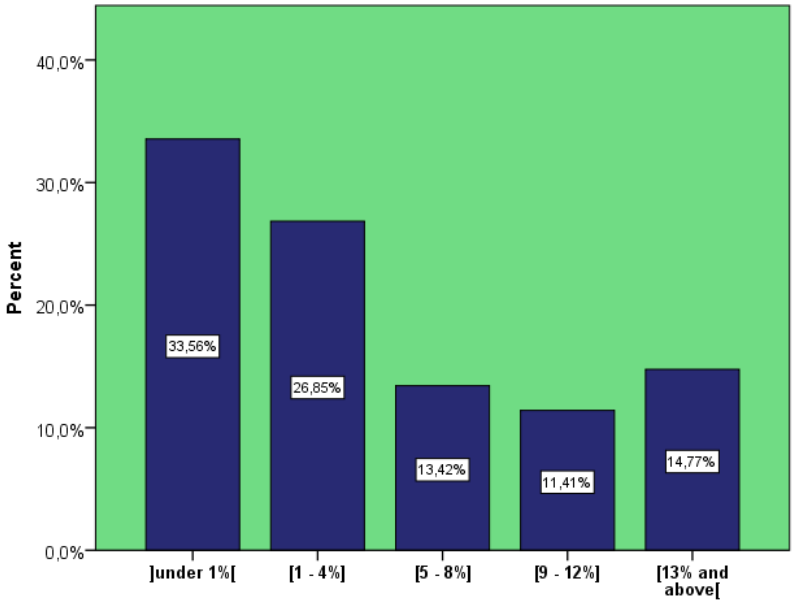

Figure 4.17: Level of price increase expected for largest maize sales

Many (33.56%) of the surveyed farmers were however instant sellers of maize grain (fig.4. 17) and less than 41% admitted that they wait until a 5 to 8 % increase in prices occur before carrying-out large maize sales.

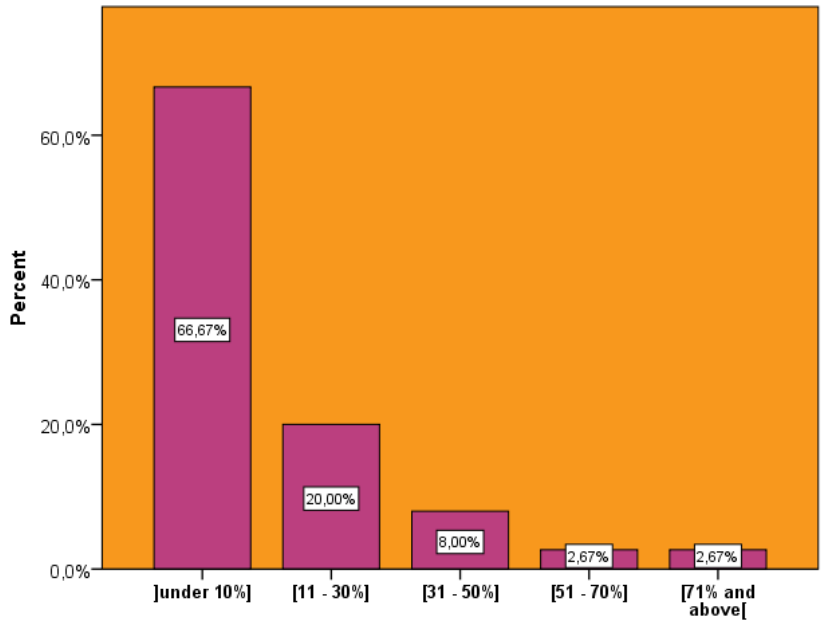

Figure 4.18: Average percentage of maize output sold within 3 months after harvest (%)

While very few respondents (5.34%) sold above half of their maize stock at the onset of the post harvest period, more than half of farmers surveyed would not sell more than 10% of their stock during that period, mainly pointing at low prevalent prices. Complementarily or as expected, a good number of respondents (70 out of 150) also sold less than 10% of their stock during lean period, whereas 19 farmers out of 150 would sell more than half of their stored maize from the beginning of March onwards. Close to 60% of respondents reported having 3 to 5 other crops on which they could rely to earn cash during post harvest period while waiting for prices to climb, while a little more than 43% had less than 2 crops to sell during that period. It was beans for a great deal of this category. More than 85 % of respondents sold their maize to small traders in the market, as these buyers were the most permanent in the various localities and markets. As they bought grain at very low prices and were very influential, most farmers (65.3%) perceived their price negotiating capacity as very low for

maize especially when dealing with these small traders acting mostly as intermediaries.

More than 98% of respondents admitted they had never received any training concerning post harvest handling, while those who had benefited from training specified that it was mostly on drying and use of protectants. In the sample, 91.33% of farmers were not benefiting from extension workers' services from either the state, Non-governmental organizations or private companies; most ignored if an agricultural extension unit was available in their village or not. However, 6% and 2% reported getting extension services from the state and Non-governmental organizations respectively. As expected, 99% of surveyed farmers had never received any subvention to facilitate or improve post harvest handling. Also worth mentioning is the average quantity of maize that was bought in a year. Harvest precautions to reduce loss such as early harvest and grain sorting were a common practice for more than 85% of surveyed farm households and close to 97% had no equipment to process maize into another product, whatsoever. Those who had small archaic mills used the latter to get maize flour that was immediately consumed within the household. It was found that half of surveyed households would not buy maize in a year, while the other half bought between 3 and 180kg of maize each year when maize grain produced was not enough to meet consumption needs. When asked to rate their behaviour vis a vis storage, only 7 respondents out of 150 viewed themselves as risk lovers, while 70 farmers argued for risk aversion, and a little more than 67 believed they were neutral to risk. 6 farmers had no idea where they could be categorized. These findings are somehow consistent with our null hypothesis as will be commented in the fourth part of this chapter.

4.2 Major post-harvest risks perceived by maize keepers

Shocks or factors that might cause losses in cash or in kind to a maize stock keeper and that might prevail along the period from maize harvest to sales were

classified into five groups and farmers were asked to identify in each group or add to the proposed answers, those shocks they were most likely to suffer from during that period when maize was kept in their store.

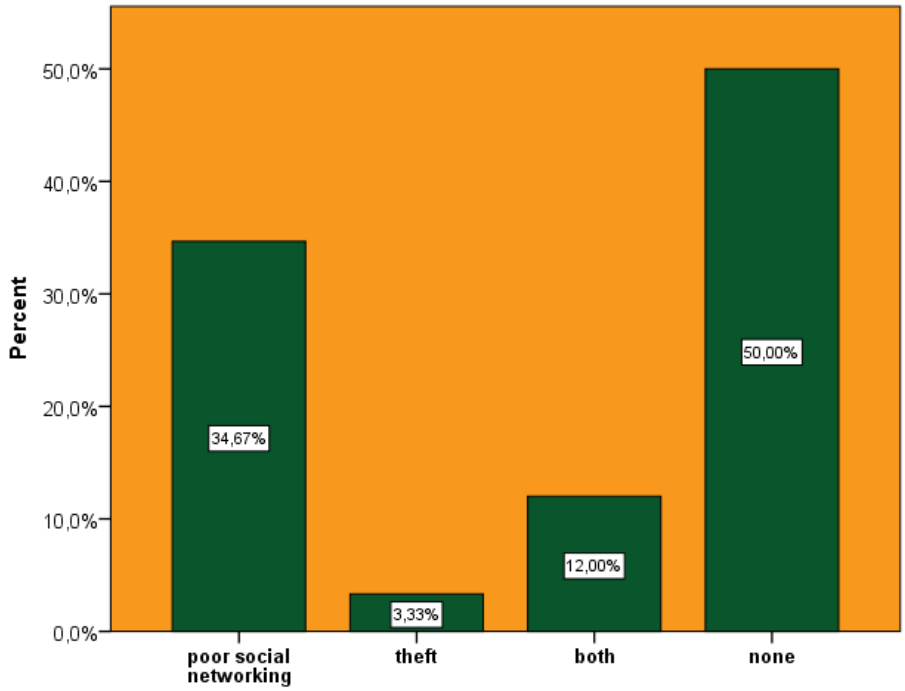

Figure 4.19: Social risks faced along the post-harvest period.

Half of respondents reported that all possible social shocks were unlikely to have an influence on their maize storage patterns, while close to 35% identified poor social networking as a factor that would lead to financial insecurity and thus precipitate early sales or at low rates (fig.4.19). Those who perceived this risk as the most likely also argued that adhering to a farmers' association or to a Rotating Savings and Credit Association would enable one to get advice and share experience so as to benefit from better post-harvest handling and sometimes collective sales to higher bidders than middlemen. Again, collective purchase of chemical insecticide powders was found to be cheaper than for farmers buying as individuals. Social risk was a concern in the same fashion across Divisions ($P>0.05$). The Kruskal-Wallis test showed no significant relationship ($P>0.05$) between the share of agricultural income in annual income and the types of social risks most pertinent to households surveyed.

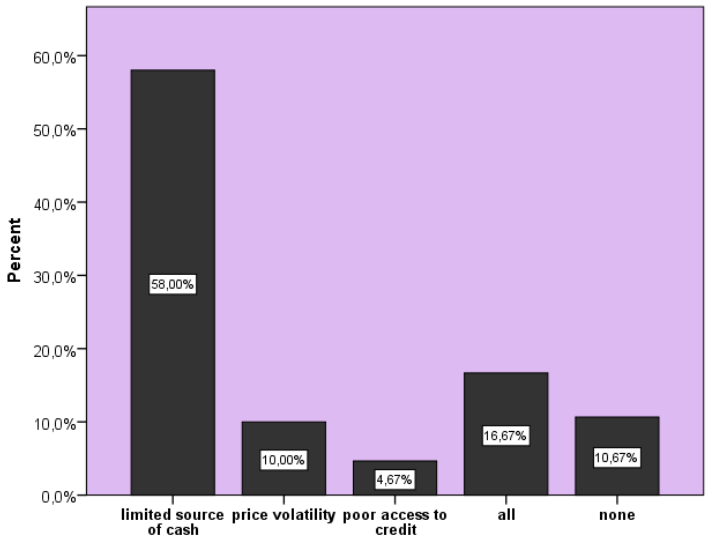

Figure 4.20: Economic risks faced along the post-harvest period.

Among farmers who perceived an effect of economic shocks on their stock holding, 58% were affected mostly by limited solvency during post harvest period, and those who reported price volatility as the shock most likely to generate loss were in general market oriented stock-holders (10%). Poor access to credit was the greatest preoccupation for 4.67% of respondents and a little more than 16.67% said to have equal loss as a result of all three economic factors, that is whether limited sources of cash, price volatility and poor access to small loan. 10% however reported that none of the proposed categories and/or other non described economic shocks that used to prevail during maize storage period was likely to cause a loss to their maize storage (fig.4.20).

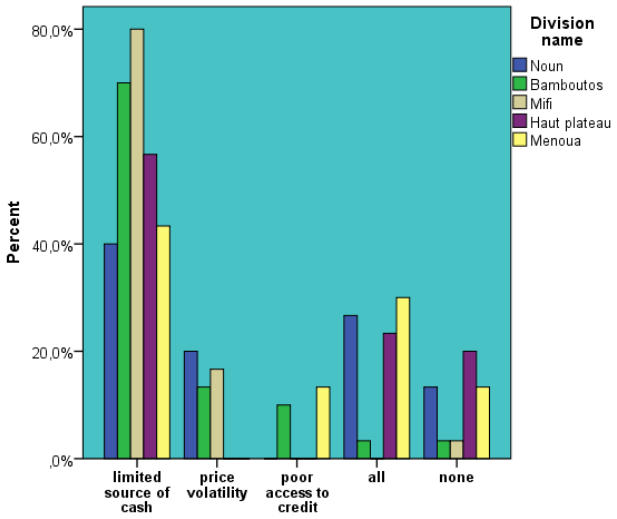

Figure 4.21: Economic risks faced along the post-harvest period in Administrative Divisions.

There was a significant relationship between Divisions and major post-harvest economic risks faced by respondents (P<0.05).Whereas only one household in Bamboutos and Mifi Divisions would not face post-harvest economic risks, up to 6 households in the Hauts-plateaux were not likely to face either limited source of cash, poor access to credit or price volatility along the period when maize stock was kept. The main justification behind this trend was the use of maize in the Hauts-Plateaux, which was generally home consumption, as compared with consumption and sales for the other Divisions. Having none of these risks in a household was therefore associated with the Division of residence (fig.4.21).

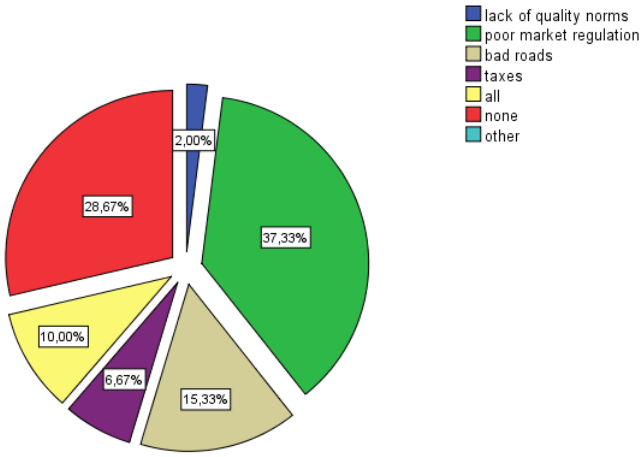

Figure 4.22: Institutional risks faced along the post-harvest period.

Maize stock holders who identified institutional risks as part of what caused losses along the storage period described many sources of risk. Many farmers (37.3%) pointed to poor market regulation, notably because of the prevalence of unfair commodity pricing especially when looking at the bulk of burden linked to maize production, drying and sales. Beans had higher prices than maize at all seasons, despite their low levels of labour and other inputs requirements. MINADER Ouest (2014) gives evidence to these claims, as it reports estimates of average annual prices in 2013 for 18 kg of maize (CFA 3117 Francs) and for 18kg of beans (CFA7420 Francs). The invasion of local markets by

intermediaries was also an issue, as these buyers set same rates in many different markets at various periods of the year. Bad roads was the major institutional problem along the storage period for 15.3% of farmers who incurred added transportation costs to market their maize and therefore got less returns. Whereas 28.6% said to be vulnerable to none of potential institutional shocks, 10% of respondents viewed all of the proposed risks to influence their maize storage in an equal fashion (fig.4.22). Taxes and lack of norms to control quality were the most important sources of risks for 6.67% and 2% of respondents respectively. Those who selected lack of norms to ensure the setting of maize prices according to grain quality as the main shock were fewer.

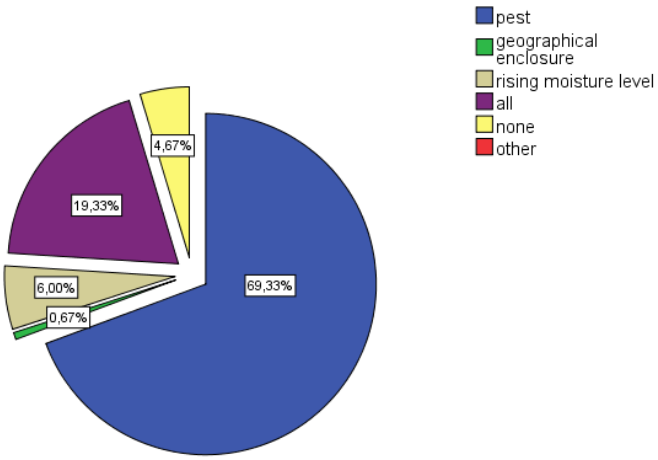

Figure 4.23: Nature-made risks faced along the post harvest period.

As expected nature-induced risks were perceived to be very important. Pest (especially the damage made by rodents in maize stores and the lack of traps or failure to use efficacious trapping technology) was regarded as the most important (69.33% of farmers). Other farmers (19.33%) added to this the risks of geographical enclosure or remoteness from those markets where better rates could be obtained for their maize and mould attack in store due to rising moisture (fig.4.23). This was underlined mostly by farmers in villages like Baladjeutsa and Bachio in the Bamboutos Division. The rising moisture factor was mainly as a result of the use of poor drying technology or very high water

content of maize which was as a result of lack of transportation facilities as the harvest was often left for a long time under rain in the farm, awaiting transportation. A rise in moisture levels in store was the main preoccupation for 6% of farmers. Results of focus group discussions indicated that this problem was more critical to those farmers lacking firewood to produce enough smoke so as to dry maize piled on their ceilings. Only 4.67 % of farmers, among whom those who dried their maize properly before storing in recycled plastic containers were free of nature-induced risk.

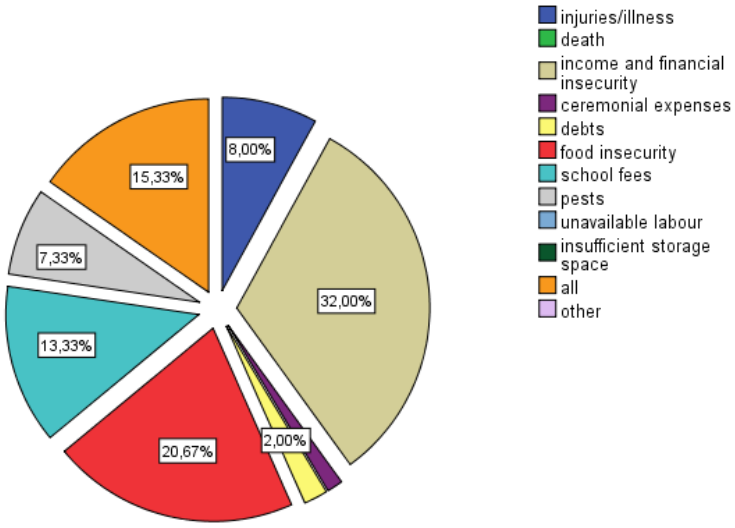

Figure 4.24: Personal risks faced along the post-harvest period.

A wide plethora of sources of risks were identified by farmers surveyed as far as personal risks that affect maize post-harvest management are concerned. 32% of respondents however pointed to low or insufficient income as the most pertinent, followed by food insecurity (20.67% of respondents), those who perceived all personal risks to have same importance (15.33%) and those who found difficulties holding stock as planned because of school fees due. Injuries and illness was also a concern for close to 8% of farmers surveyed while incapacity to control pest damage was an issue for 7.33%. Ceremonial expenses and debts in general were not a great concern for many (fig.4.24) given that only 2% saw it as a major preoccupation.

4.3 Effects of perceived risks on storage patterns in surveyed households

4.3.1 Effects of social risks on storage patterns

No significant association was found between type of store used and type of social risk faced along the post-harvest period (P>0.05). Social risks were however found to differ significantly with the longest stored crop in a year (P<0.05) as majority (67%) of those who stored maize longer than beans were those farmers less likely to incur loss as a result of one social shock or both poor social networking and theft (Table 4.7).

Table 4.7: Longest stored crop and social risks faced along the post harvest period

Count				
		Social risk faced along the post-harvest period		Total
		One or both	none	
Crop stored for the longest period in a year	Maize	49	61	110
	beans	26	14	40
Total		**75**	**75**	**150**

No significant relationship was however found between the main disincentive to maize storage and social risk (P>0.05). The choice of protectants against pest was also not significantly different with respect to social risk (P>0.05).

A significant relationship between the level of price increase expected for largest sales and social risk (P<0.05) was found. Most (70%) of those who were not likely to incur losses as a result of a social risk tended to carry-out early sales, as compared to those who perceived one or both social risks identified in the study area (Table 4.8). However, proportion of losses expected in store per year did not vary with perceived social risk (P.>0.05)

Table 4.8: Social risks and levels of price increase expected for largest sales.

Count						
		Social risks faced along the post-harvest period				Total
		poor social networking	theft	both	none	
Level of price increase expected for largest sales (%)	]under 1%[	9	2	9	30	50
	[1 - 4%]	15	0	3	22	40
	[5 - 8%]	6	1	1	12	20
	[9 - 12%]	9	0	3	5	17
	[13% and above[	13	2	2	5	22
Total		**52**	**5**	**18**	**74**	**149**

Again there was no significant difference between those who were influenced either by poor social networking, theft or both and those who were not, as far as the number of crops other than maize sold for cash income during post harvest period was concerned (P>0.05). Duration of maize in store just as the length of the hunger period was equally not found to differ across households with dissimilar perceptions of social risk (P>0.05). Whether a household expected a social shock or not during the storage period did not have an effect on the proportion of maize stock left at the beginning of the planting period, or on the main cause of loss in store (P>0.05). Those who faced no social risk however stored smaller proportions of their maize output each year than those who faced at least one (p<0.0.5).

Neither the state of the store nor the proportion of stock kept for cash income was significant with social risk (P>0.05). The relationship between annual storage costs and social risk was also not found significant (P>0.05).

4.3.2 Effects of perceived economic risks on storage patterns

Perceived economic risks had no significant effect on the type of store used or on the proportion of dry weight losses incurred across respondents (P>0.05).

Equally, perception of an economic risk or none was found to have no significant effect on the state of the store available across households (P>0.05). A significant negative relationship (P<0.05) was nevertheless found between proportions of maize stock kept for earning income and most likely economic shock. Majority (62%) of the respondents who selected one economic shock or the other stored less than 10% of their maize purposefully for sales.

Economic risks did not make a significant difference in the proportions of stored maize left at planting period accross households surveyed (P>0.05). However, most farmers (59%) who identified at least an economic shock as major threat to their stock keeping patterns were motivated by the need to make precautionary savings whereas majority (74%) of those who weren't likely to incur loss as a result of economic shock during storage were storing maize basically for food security motives(p<0.05).

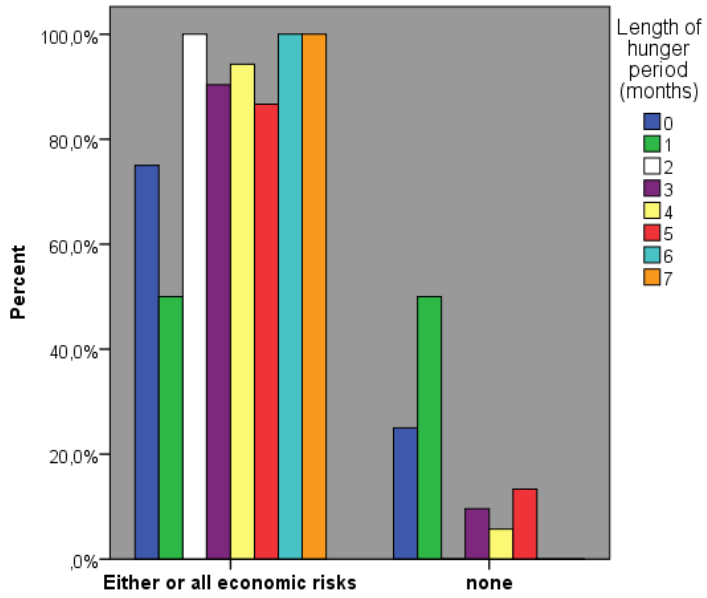

Figure 4:25: Length of the hunger period and economic risks

As expected, those with an economic shock to manage during the storage period had hunger periods that on average last significantly longer (P<0.05) than those who had no perceived economic risk (fig.4.25). We found no significant relationship between duration of maize in store and likelihood of economic risk (P>0.05). Similarly no statistically significant association between perception of

an economic risk and percentage of output stored at the beginning of the post harvest period was found (P>0.05). No significant association was found between longest stored crop and the likelihood of an economic shock that would impede on storage for maize keepers (P>0.05). Also, the share of stock used for home consumption did not vary significantly with economic risks (P>0.05).

Whereas no association was found between average amount spent on storage per annum and perception of economic risks, the main disincentive to storing maize was significantly different (P<0.05) across economic risks. Majority (68%) of farmers free of economic risk were concerned with pest damage as main disincentive to store more than with any other whilst most households (58.5%) that were likely to suffer from an economic shock tended to be preoccupied with urgent households needs and only 34% had pest damage as a major disincentive to storing their maize (Table 4.9).

Table 4.9: Relationship between economic risks and main disincentives to storing maize

Count				
		Economic risks faced along the post-harvest period		Total
		One or all economic risks	None	
Main disincentive to storing maize	pest damage risk	46	11	57
	price uncertainty	2	2	4
	high market demand	4	0	4
	urgent household needs	65	3	68
	urgent farm needs	10	0	10
	protectant's price/inefficacy	7	0	7
Total		134	16	150

It was also found that limited sources of cash or any other economic shock would push 42% of maize stock keepers to rely mainly on commercial

insecticides as means of pest control in storage units (P<0.05), while the methods used by other stock keepers who were not endangered by economic shocks as far as maize storage is concerned varied greatly.

The level of price increase expected for largest sales and the share of output sold at the beginning of the post harvest period, just like the main motive for carrying-out sales of stored maize at the beginning of March (lean period), were not found to be significant with perception of economic risks (P>0.05). Nonetheless, proportion of maize stock sold during lean period was found to be significantly lower (P<0.05) for the majority (75%) of households that were unlikely to suffer from an economic shock during the post harvest period or storage time (Table 4.10) compared to proportions sold by majority(56%) of those who weren't.

Table 4.10: Relationship between economic risk and average percentage of output sold during lean period.

Count				
		Economic risks faced along the post-harvest period		Total
		At least one economic shock	none	
Average percentage of output sold during lean period (%)	]under 10%]	58	12	70
	[11 - 30%]	44	0	44
	[31 - 50%]	13	4	17
	[51 - 70%]	9	0	9
	[71% and above[	10	0	10
Total		**134**	**16**	**150**

4.3.3 Effects of perceived institutional risks on storage patterns

There was a highly significant difference between those who perceived one institutional risk or all as likely and the percentage of maize sold for cash. Those who were not likely to bear the costs of a shock related to institutions' failure sold significantly lower ($P<0.05$) and consumed significantly higher ($P<0.05$) proportions of their maize held in store as compared to the majority of those who were. The proportion of dry weight losses was also found to depend significantly on whether a maize stock keeper would face an institutional risk or not ($P<0.05$). Precisely, majority (71%) of those who perceived no risk incurred higher proportions of losses compared to majority (64%) of those who did perceive one or all institutional risks identified in the study area as a major threat. Also, a highly significant effect of institutional risk was found on the quantity of maize stock left at planting period as the majority (66%) of those who perceived one or all institutional risks as likely to occur and cause harm along the storage period had significantly higher ($P<0.05$) proportions of their stock remaining at the beginning of planting period compared to majority (74%) of those who perceived none of the identified as shocks likely to affect their maize storage practices (Table 4.11).

Table 4.11: Institutional risks and proportion of stock left at planting period (%)

Count				
		Institutional risks faced along the post-harvest period		**Total**
		Either one or all	none	
Proportion of stock left at planting period (%)	]under 5%]	18	20	**38**
	[6 - 15%]	18	6	**24**
	[16 - 25%]	27	6	**33**
	[26 - 35%]	23	6	**29**
	[above 35%[	21	5	**26**
Total		107	43	**150**

Type of maize store used, state of the store were not found to differ across respondents who gave dissimilar answers with regard to likelihood of an institutional shock or none (P>0.05). However, it was found that a great majority (67%) of those who were not likely to be influenced by one institutional risk or the other in storing maize tended to keep maize until March for food security motives whereas a great majority (68%) of those who were, preferred keeping reserves in order to earn income when necessary (Table 4.12).

Table 4.12: Institutional risks and main motive for keeping stored maize until the following planting period.

Count				
		Institutional risks faced along the post-harvest period		Total
		Either or all	none	
Main motive for keeping stored maize until March	seed	8	7	15
	income security	73	7	80
	food security	21	29	50
	sales constraints	4	0	4
Total		106	43	149

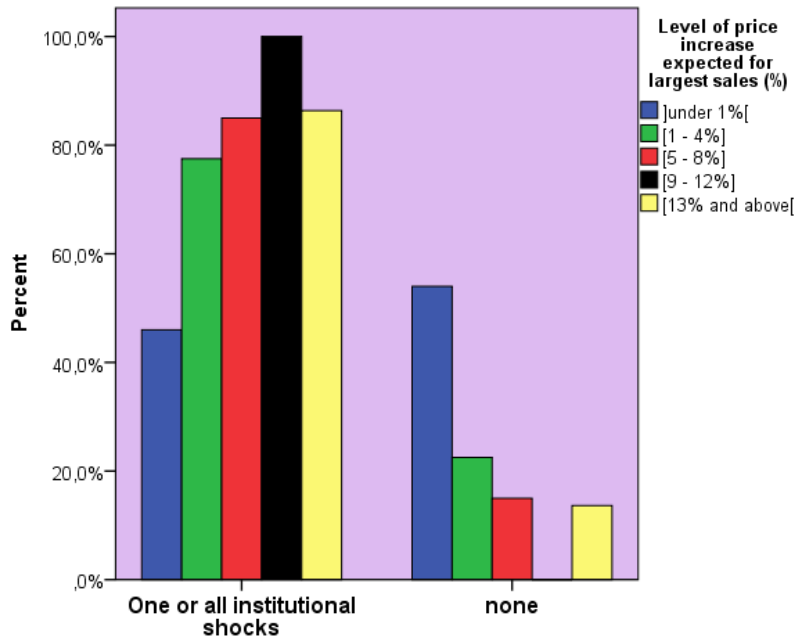

Figure 4.26: Institutional risks and level of price increase expected for largest sales.

A great majority (85%) of those who had no threat of institutional risk were selling the largest shares of their output when prices were significantly lower (P>0.05) that is 1-4% increase as compared to those (53%) who were likely to have their storage threatened by an institutional risk and who waited for at least 5 to 8% increase in prices (fig. 4.26). Similarly, most farmers (60%) whose storage was not likely to be threatened by an institutional shock wouldn't sell more than 31% of their stored maize during the lean period whereas the opposite was true for those who were under risk (P<0.05).

No significant relationship (P>0.05) was found between either storage costs, main means of pest control in store or main disincentive to store maize along the storage period and likelihood of institutional shock. Equally not statistically significant (P>0.05) was the effect of institutional risks on the percentage of total maize output stored and on the duration of maize in store.

4.3.4 Effects of perceived nature-induced risks on storage patterns

The independent-samples Man Whitney U test showed no relationship (P>0.05) between most likely nature-induced shock (P>0.05) and duration of maize in store per year, proportion of total output stored at the beginning of post harvest

period, proportion of losses incurred due to pest damage, quantity of stored maize used for home consumption or cash earning, average annual storage cost and finally length of the hunger period in all households.

There was also no difference (P>0.05) among stock-keepers under risk and those free of nature-induced risks with respect to type of store used and state of these stores. However, whilst 43% of those who were not likely to face a nature-made shock during storage argued for protectants' inefficacy and price as the main disincentives to storing maize, 43% of those who were, pointed at urgent household needs as their main constraint(Table 4.13). Therefore, there was a significant relationship between nature-made risk and main disincentive to storing maize (P<0.05).

Table 4.13: Relationship between nature-made risks and main disincentive to storing maize

Count				
		Nature-made risks faced along the post-harvest period		Total
		Either one or all	none	
Main disincentive to storing maize	pest damage risk	55	2	57
	price uncertainty	4	0	4
	high market demand	4	0	4
	urgent household needs	66	2	68
	urgent farm needs	10	0	10
	protectant's price/inefficacy	4	3	7
Total		143	7	150

The main motive behind holding stock of maize was not different across respondents with respect to the most likely nature-induced shock (P>0.05). The means used to control pest in store were the same across categories of nature-induced risks identified by respondents (P>0.05).

Also, the expected incremental increase in maize prices for largest sales weren't significantly different (P>0.05) for stock keepers under nature-made risk and those free of this type of risk. Average proportions of total output sold during lean periods were also not significantly different across respondents (P>0.05).

One important finding was the significant effect of perceived nature-induced risks on the number of crops other than maize to rely on during post harvest period and thus along the duration of maize storage (P<0.05). Those having no nature-made shock to face during post harvest period had less than two crops to sell for cash while majority (59%) of those who were likely to incur such shocks were prepared to sell about 3 to 5 crops other than maize to earn cash during that same period (Table 4.1).

Table 4.14: Nature-made risk and number of other crops sold post-harvest.

Count				
		Most likely nature-induced shock		Total
		Either one or all	**none**	
Number of other crops sold post-harvest to earn income	**[less than 2]**	56	7	63
	[3 - 5]	85	0	85
	[6 - 8]	2	0	2
Total		143	7	150

4.3.5 Effects of perceived idiosyncratic risks on storage patterns

All households identified at least one personal shock that was likely to negatively affect their maize storage patterns and none was free of this type of risk. Independent samples One-Way Analysis of variance showed a highly significant effect of perceived personal risks on the major constituents of the

storage activity in the households surveyed. The main type of store used differed significantly (P<0.05) across respondents, but a great majority (74%) of farmers who would be influenced by financial risk, food insecurity risk or by the risk of lacking money to pay school fees were using ceilings to store their maize.

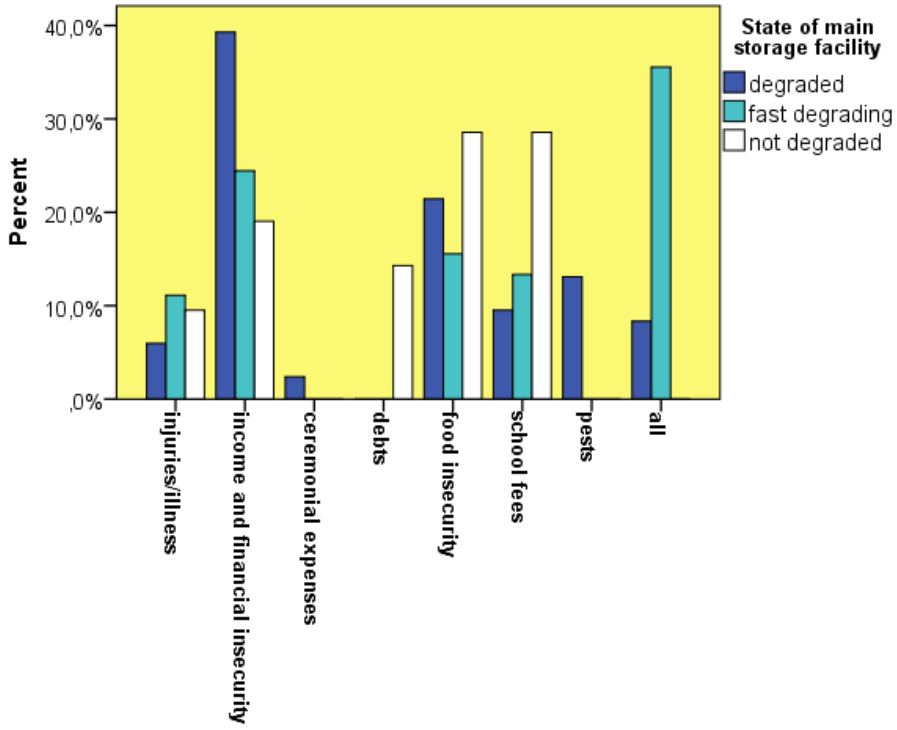

Figure 4.27: Personal risks and state of the main storage facility.

Also found significant(X^2=56.6; df.=14) was the effect of likelihood of personal shock on the state of the store used by farmers, as the majority of those who were likely to have a shock affect their storage (56% of respondents), especially income or food insecurity owned degraded stores (fig.4.27) followed by those whose stores were fast degrading (30% of respondents), as compared to others who did not identify these shocks as major ones.

74% of the respondents who identified income and financial insecurity, food insecurity or lack of money to pay school fees were keeping maize in store for 6 to 8 months per year; these durations were longer than for those who perceived other types of personal risks. Thus it was found that perceived personal risks had a significant effect on the duration of maize storage (P<0.05).

The effect of perceived post harvest risks on proportions of output stored yearly was also highly significant, as 76% of maize stock holders who pointed especially at food, income or financial insecurity as major personal risks stored more (90%) of their harvested maize than those who were more concerned with other idiosyncratic risks ($P<0.05$). The percentage of maize stock consumed within the producers' homes across perceived personal risks was significantly different ($P<0.05$). 78 per cent of households that perceived food insecurity as likely consumed significantly higher proportions of their stored maize than 57% of those who were more affected by other types of personal risks. The trend was similar with proportion of total stock sold to earn cash ($P<0.05$) given that the majority (72%) of respondents unable to pay school fees sold greater proportions of their maize to earn income than majority (54%) of those who were more affected by other idiosyncratic risks. The effects of personal risks perceived were not significantly different across average annual storage costs in the sample ($P>0.05$). Nevertheless, half of those who were likely to incur loss in the process of storage as a result of income or financial insecurity viewed urgent household needs as the major disincentive to implementing their storage plans ($P<0.05$). We also found that the most likely idiosyncratic shocks were significantly associated ($P<0.05$) with the kind of pest control method chosen by maize farmers in store; 55% of those who perceived pest damage risk as major personal shock likely to cause harm relied on commercial insecticide powders while others (45%) used varied means. The proportion of stored maize lost due to insect damage varied greatly across farmers, but those who would lose more than 25% of their stored maize were in majority (68%) those affected by illness, injuries, financial insecurity, food insecurity and poor capacities to control pests as the main idiosyncratic shocks ($P<0.05$).

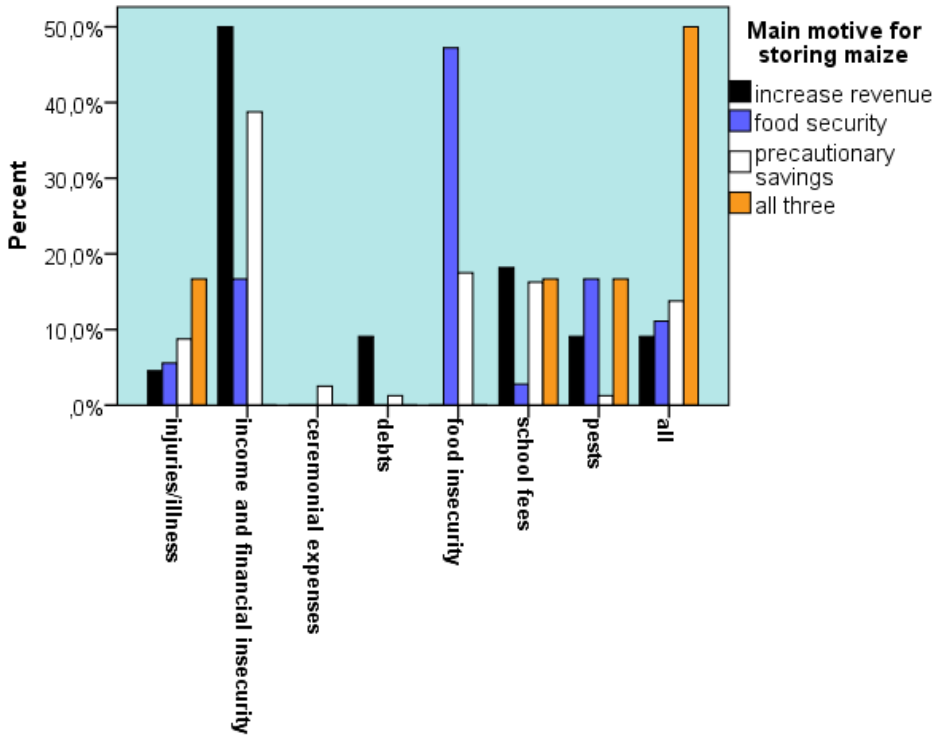

Figure 4.28: Personal risks and main motive for storing maize.

Results also indicated a significant relationship ($P<0.05$) between personal risks and the main motive or reason for storing maize (fig. 4.28). The need to make precautionary savings was identified as the main motive for storing maize for the majority (72%) of respondents who were susceptible to suffer from income insecurity, food insecurity or limited capacity to pay school fees along the period of maize storage. 84% of respondents who stored maize mainly for food security purposes were susceptible to suffer more from food insecurity, financial insecurity or pest attack. Among those who stored maize with the aim of increasing their revenue, 86% did so because their stock keeping practices would be negatively affected by shocks like financial insecurity, limited capacity to pay school fees, debts or pest attacks. Half of the respondents who perceived all personal shocks as likely to affect their maize storage practices had a combination of all motives for storing maize. Each reason for storing maize was therefore significantly related to the type of personal risk one was likely to deal with along the period of storage (fig.4.28).

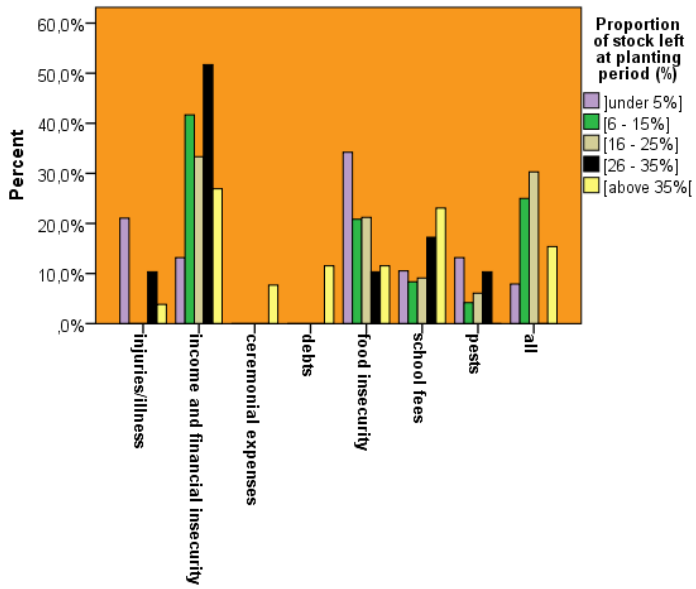

Figure 4.29: Personal risks and proportion of stored maize left at the following planting period.

Average proportion of stock left at planting period also varied significantly ($P<0.05$) across farms surveyed, and majority (52%) of those who were left with more than 35% of their stock at that period were those under threat of income and financial insecurity as well as those threatened by limited capacity to pay school fees (fig.4.29). Noteworthy, most (58%)of those who were likely to suffer most from food insecurity or illness along the post harvest period had smaller shares (less than 5%) of their maize left at planting period than those who were not.

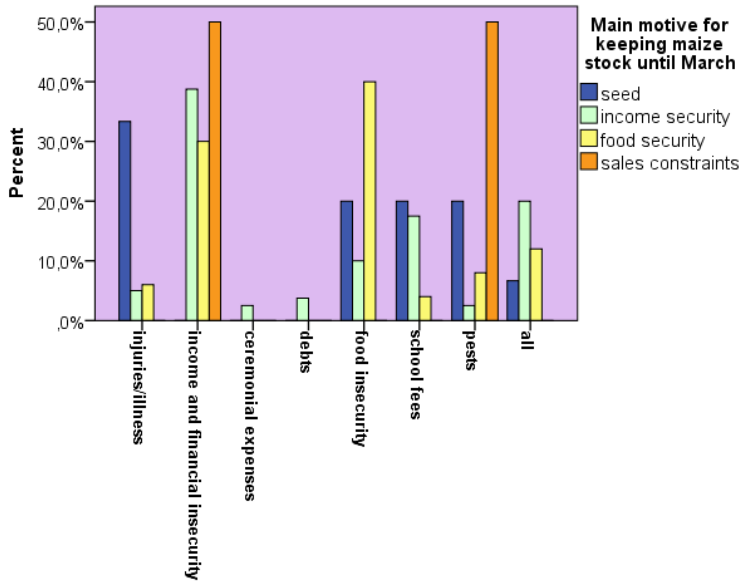

Figure 4.30: Personal risks and main motive for keeping maize stock until the following planting period.

Complementarily, the predominant motives for keeping stock until the beginning of March for those who identified income insecurity or food insecurity as the most likely risks (fig.4.30) were income and financial security (32% of respondents) and food security (20%).

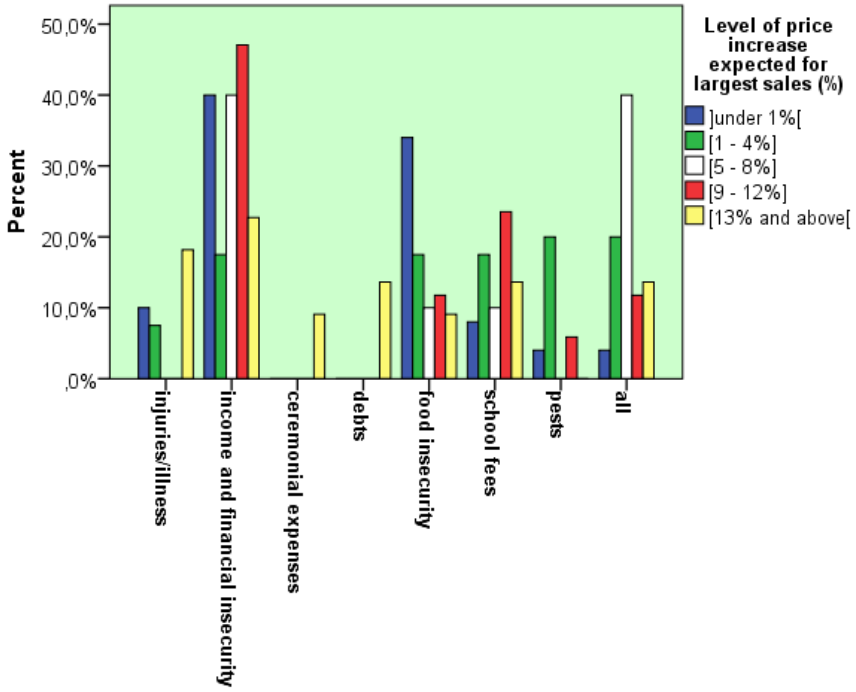

Figure 4.31: Personal risks and level of price increase expected for largest sales.

Whether a household would incur loss in executing its plans as far as storage is concerned was found to depend significantly ($P<0.05$) on the level of price increase it waited for before making the largest sales in a year. Thus, households that sold much of their maize when prices had risen by less than 1% were for most (76%) influenced by the risk of income and financial insecurity or by food insecurity (fig.4.31). Also, most (72%) households selling when prices have increased by 9-12% were likely to be threatened by income insecurity or lack of money to pay school fees during the storage period.

Majority (84%) of those who sold maize to buy food at the beginning of the lean period did so as a result of an influence from food or financial insecurity.

Two important findings though indirectly concerned with storage were that, having longer period of hunger was significantly associated ($P<0.05$) with being likely to have a personal shock, especially that of income and financial

insecurity, limited capacity to pay school fees or food insecurity. Again, the relationship between the number of crops sold during post harvest period to earn cash was also found be significantly ($P<0.05$) related to the perception of personal risks, as most (56%) of those who perceived one or all tended to sell many more than those who did not, that is 3 to 5 crops other than maize at that period. This was especially the case for those who reported to be under threat of income and financial security.

4.4 Implications of the results

From the above findings, it is clear that post harvest sources of risk in agriculture as argued widely in literature, are seen to have an influence on small farmers' storage in the study area. Moreover, all perceived post harvest risks have been found to have a significant effect on one or more of the constituents of storage, be it on proportion of output stored, on duration of maize in store per annum, on the proportion of that stock used for home consumption, that used for income, on annual cost of storage, on the type of store used and the state of this storage unit, on the main disincentive or motive for storing maize, on the main means used to control pest, main motive for keeping stock until planting period and main motive for sales of stored maize during that period, on the proportion of stock left at the beginning of the planting period, on the proportions of output sold at the beginning and at the end of the post harvest period, on the level of price increase expected for largest sales, on the number of other crops relied on to earn cash at post harvest period and on the choice of crop to store for the longest period in a year. Though the last two dependent variables tend to be odd in maize storage, they were included to verify or control for the real effect of the risks identified on the other dependent variables. We equally looked at the effects of each category of perceived risks on the proportions of damage by insects, moulds or rodents.

Nevertheless, personal risks, especially the risk of running income or financially insecure during post harvest period and specifically along the period of storage, combined with the risk of food insecurity had an incomparable effect on the constituents of storage vis a vis other types of risks perceived by surveyed maize stock keepers. This confirms the views of authors like Lins, Gabriel and Sonka (1981) and Yoo and Giles (2002) that grain storage by small scale farmers depends greatly on their financial capacity to handle potential shocks along the process. Also, it was observed that a major preoccupation with regards to personal risks was education or school fees that led to many farmers selling early but also keeping considerable shares of their maize stock to earn cash when prices are higher. This attitude is conform to that of expected utility maximization described in the theoretical framework above, as most of these stock keepers valued the utility of holding stock and thus made precautionary savings the rule as motive for storage. This is consistent with the opinion of Park (2006) that a positive relationship exist between the degree of income insecurity risk and proportion of grain stock held in poor farm households.

We found that perceived risks, even the risk of pest damage, as opposed to findings of Kadjo *et al.* (2014) had a negligible effect on the type of store used across respondents; worse even, majority of those who were likely to be subjected to personal shocks along the period of storage used the least effective technology (ceiling) which were in majority found degraded. This does not only allow us to believe that farmers are often risk neutral with regard to technology to use, but we also make an argument for the unavailability of improved technologies, highlighted by many farmers during the survey. As they tended to incur higher dry weight losses with time, most sought to improve their storage practices, but with the issue of inefficacious protectants sold on the local market, combined with the disappearance of knowledge on traditional protectants for storing grain, many farmers are now viewing use of protectants as an elective option, despite increasing levels of damage. We however affirm these authors' view that farmers that are market-oriented tend to keep stock for longer periods,

despite the losses to pest. These farmers also tended to have better price negotiating capacity than others, and were the most likely to have a shock related to income and financial security in our sample. Contrary to the findings of Kadjo *et al.* (2014), we found that the percentage of harvested maize stored within three months after harvest did not always tend to vary with technology used to store, including the type of store, the state of this store and the costs of storage each year. These findings appeals to the limited applicability of their model.

If poor networking and theft, identified as major social risks had a negative effect mainly on proportions of output stored, this was seen by participants of group discussion to follow a logical trend, as people would not want to forego instant opportunities when they are not certain that they would encounter others because of their poor integration within social groups or the threat of theft. The choice of beans as longest stored crop or the expecting of higher level of price increase for large sales by these households was as a result of their vulnerability and thus the necessity of a buffer against such social shocks.

In general, farmers were found to refrain from integrating social groups because of growing mistrust especially with regard to group funds management; the non significant effect of poor social networking on other storage patterns could however be explained by the fact that most surveyed households feared facing the market without support from an institution like a Common Initiative Group that would ensure at least good training or insecticides to handle grain in a way that maintains quality.

Another important aspect was the way households under threat of losing money or grain as a result of an economic, nature-induced or institutional shock would carry-out sales of maize during harvest and lean period even if in the process of keeping they were constrained by urgent household needs to reduce the quantities to be sold. Also, they tended to incur lower levels of dry weight losses. These households unexpectedly developed resilience mechanisms that

led to avoidance of early sales, keeping of maize stock mostly for precautionary motives/as a buffer and making large sales when prices are high.

Generally our results indicated that almost all types of post harvest risks perceived in the study area have a significant relationship with the main disincentive to store (it was generally urgent household needs for those likely to have a shock) and the number of crops other than maize sold to earn cash during post harvest period (it was generally greater for those likely to be threatened).

As the findings revealed, 70% of farmers surveyed viewed themselves as risk averse while 67 believed they were risk neutral. We may not easily explain these self-rated attitudes, but we find these subjective attributes consistent with our argument that in general, farmers are harmed by shocks along the post-harvest period and while storing grain, but strategies designed to manage such shocks makes them less vulnerable; they do indeed carry-out some post harvest activities, storage included as risk neutral individuals given that many do not choose the storage technology or cost according to expected losses or gains but they however allocate the stock to various uses in a way that is sensitive to the strength of the resilience strategy put in place. In other words, our findings brings to light the tendency that maize stock keepers have towards defying or overcoming perceived threats to storage, especially those threats emerging from within the household, termed personal risks. This therefore complicates the debate as to whether farmers' storage practices are influenced by risks, given that we may not easily backup the argument that post harvest risks generate better storage patterns in small farms. Nevertheless, our regression model was found highly significant with ordinal regression analyses.

4.5 Limitations of the study

A main limitation of this study was the poor distinction between seed, food and income shares in the proportions of output stored or in the stock left at the beginning of planting period; given that many maize stock keepers did not make any clear cut difference between these uses, stock left was considered in its

entirety for analysis of variance or of correspondence with perceived risks. Data did not always follow the normal distribution curve, this is why statistical analyses consisted often of non-parametric tests and reliance on Cross tabulations to examine relationship between variables, especially when they were basically nominal. This undermines the generalisation or prediction capacity of this study. Observation as a research tool was carried-out in less than ¼ of surveyed households due to time constraints and thus limited evidence was available concerning estimates of stock and other storage patterns described by respondents.

It was not an easy task for farmers to recall or to predict/estimate quantities/proportions, given that account holding is uncommon to small scale farmers. Estimates of storage costs were also hardly obtainable since depreciation/paying-off of stores made of local materials could not be easily established with empirical tools/evidence. Again, sample size was not chosen according to total population of maize farmers in each Division or in each village where survey took place because these figures were not available in administrative units concerned. Participation to focus group discussions was poor in both of the two villages were this was done despite the choice of most suitable days for the meetings. This somehow impedes on reliability of clarifications made by the few who were available and who contributed to talks. When testing for the effects of perceived risks on storage, personal risks were found to be applicable to all respondents, unlike other categories of risk. This therefore prompted the use of a different method for examining the contribution of this risk to storage practices or patterns; it consisted mainly of comparing the variance in majority of respondents for each of the identified personal risk with majority of respondents for each storage activity/practice to determine levels and directions of changes. Lastly, the use of adequate proxies pertaining to risk in order to account for the effect of post-harvest risks on storage was not always effective or possible.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1. Summary of findings

In all households different types of post-harvest shocks were likely to affect maize storage. The most pertinent in each category (social, economic, institutional, nature-made and personal) were poor social networking, limited or few sources of cash income, poor market regulation, pest attacks and financial insecurity. Households exposed to the same kinds of risks also displayed similar characteristics: they had limited access to small credit, low contributions of off-farm income to annual income, smaller maize farms, longer hunger periods, degraded traditional stores and archaic storage systems, few crops other than maize to sell for cash and few sources of cash that could help respond to urgent households needs during storage while waiting for better prices to prevail on the local markets. Idiosyncratic risks more than any other type of risk were found to have a significant effect, a positive one on storage practices, especially on the share of initial maize stock kept to meet major income needs. Thus, we could deduce that farmers exposed to idiosyncratic risks or shocks along the maize post-harvest period do mitigate the expected negative effect of these adversities through implementation of sound storage practices.

5.2. Conclusion

This study has examined the effects of post-harvest risks proxied by shocks perceived to be the most likely, on storage proxied by some of the major constituents of the activity of keeping maize for future use in smallholder households sampled in the West Region, Cameroon. Using stock management patterns, it has been proven that all five categories of risks perceived/identified

in the study area had different effects on the percentage of maize output left at the beginning of the new planting period that is towards the end of the post-harvest period. However, personal risks or risks that emanate from likely shocks at the level of the household, what we termed 'idiosyncratic shocks' in the literature had overwhelmingly positive effects on storage.

This emphasises the importance of mitigation, adaptation, or more interesting resilience developed by smallholders to reduce their exposure or their vulnerability to shocks whose magnitude do not outweigh their handling capacities. More than 48% of those who were likely to run short of income in general, but in particular money to pay school fees were left at the beginning of the new planting period with an estimated 26 to 35 per cent of the initial maize stock, pretty much when compared to those who were not under threat of income or financial insecurity during the period of storage. Thus, small scale farmers are less likely to vary in their response to "micro" risks than to "meso" and "macro" risks, which are those risks against which informal strategies at the individual level would only produce a limited outcome. These include risks related to the institutions in place, risks pertaining to nature, risks linked to society and social links, and risks driven by the type of economy and market organization prevailing in the area.

5.3 Recommendations

The findings made in this study have a number of policy implications. First, the risk management strategies of smallholder farmers need to be improved or to evolve from informal to more recognised and formal ones. This means that those farmers likely to suffer from income and financial insecurity when storing cash crops need to benefit from strategies such as improvement of access to loans instead of relying only on subsistence crops to earn cash along that period. This may surely improve capacity to pay ones' children school fees, as this was an issue to many households surveyed. Major catastrophic shocks such as those

related to poor market regulation, price volatility and pest damage should be prevented and in case they happen, must be handled conveniently by the Government as well as by other stakeholders.

Secondly, post-harvest risks do not always yield the expected outcome with regards to storage because farmers do not have the same capacities to mitigate, transfer or adapt to them. This suggests that development agents need not to focus only on improving storage structures and practices in areas where the need seems to be perceived, but the level of poverty and most importantly income insecurity should be examined critically before training farmers on sound storage practices.

Thirdly, farmers are neutral to the risk of pest damage in store because they are left with no alternative to coping with this shock given the growing inefficacy of commercial insecticide powders and traditional methods of pest control. This should bring incentive for the Government to control quality of those products sold on local markets and ensure that farmers are protected by norms of quality to get consistent prices for their maize. This shall give them motivation to continue supplying the markets not necessarily as a sine qua non for the survival of their livelihood but also as a way of participating to the good health of consumers through adoption of health-friendly storage practices.

5.4 Further areas for research

Although risks in general have been reported to have a negative impact on households that earn their living mainly from small scale farming, such findings seem to be erroneous in the case of small maize farm households in the case of the West Region of Cameroon as this research's results show. Further research therefore needs to dwell on understanding which, why and how resilience mechanisms developed by these farmers help them to dodge or withstand the effects of threats they themselves perceive to affect their storage practices.

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APPENDIX 1

Questionnaire survey

This questionnaire is to provide information to Mbouogning Teugnoua Floriane. She is a student enrolled at the Pan African Institute for Development. She is carrying-out research on effects of post-harvest risks on storage in smallholder maize farms of Cameroon West Region to produce a thesis. All information given by respondents shall be kept confidential.

Questionnaire number: _____

Date of collection: _____

1. Division

   1- Noun 2- Bamboutos 3- Mifi 4- Hauts-Plateaux 5- Menoua

2. Village name: _____

3. Possess a functional cell phone? 1- Yes 2- No contacts:

A- Household's socio-demographic characteristics

4. Age of the respondent 1-[under **30**] 2-[**31**-**40**]

3-[**41** - **50**] 4-[**51**- **60**] 5- [**61 – 70]** 6- [**71** and above]

5. Sex of the respondent: 1- Male 2- Female

6. Sex of the household head 1- Male 2- Female

7. Respondent's level of Education

   1- No formal education 2- Not completed primary 3- Completed primary

   4- Not completed Secondary 5- Completed secondary

8. Main breadwinner of your household 1- Father 2- Mother 3-child 4- relative

9. Household size (number of people living from household head's income)

   1-[**1** - **4**] 2-[**5** - **8**] 3-[**9** - **12**] 4-[**13** - **16**] 5- [**17** and above]

10. Number of school-going people in the household 1-[**0** – **3**] 2-[**4** – **7**] 3-[above 7]

B- **Farm and household's socio-economic features**

11. Average household annual income _____

12. Share of agricultural income in annual income _____

13. Share of maize revenue in the annual income (%) _____

14. Share of beans revenue in the annual income (%) (if applicable) _____

15. Average annual agricultural expenditure _____

16. Average amount of annual household savings _____

17. Average amount of cash savings at the beginning of September _____

18. Average value of yearly remittances _____

19. Annual value of retirement or indemnity pension (if applicable) _____

20. Share of off-farm income in total annual income_____

21. On what type of land do you carry-out most of your farming activities?

1- Rental 2- Purchased Land 3- Inherited 4- Family Owned 5-sharecropping

22. Total area of farm owned (in Hectares) _____

23. What is the utility of livestock to you?

1- Consumption 2- Purchase/provide farm inputs 3- Pay Fees and Other Annual Dues 4- Respond to urgent cash needs. 5- Other (specify) _____

24. Average share of livestock revenue in agricultural income (%) _____

25. On which crop other than maize do you rely for income?

1- beans 2- garden crops 3- potatoes 4- cassava 5- groundnuts 6- other (specify) _____ 7- fruits 8- none

26. How accessible to you is small/micro credit/loan?

1- Zero access 2- Poor 3- Medium 4- High

27. If zero or poor access, why? 1- Poor savings 2- Lack of collateral 3- other _____

28. Main motive for borrowing

1- Feeding 2- Health 3- Education 4- Clothing 5- Inputs 6- Other

29. Where do you rank maize among other livelihoods you pursue, in terms of profitability /how profitable is maize to you? 1- High 2- Medium 3- Poor

30. How long are the hunger periods for your household? (months) _____

C- Maize farm management characteristics

31. Average maize output/year (in kg) _____

32. Farm area occupied by maize (in Hectares) _____

33. Harvest maize first or second season? 1- First 2- Second 3- Both

34. Have you experienced any increase in maize yields last two years? 1- Yes 2- No

35. If yes, main factor that contributed to this increase

1- New Crop Technology 2- New Farming Practices 3- Access to Greater Capital/Investment 4- Reduced Shocks 5- Increased Labor

36. Had you last 2 years any contract with a buyer of maize? 1- Yes 2- No

37. Had you last 2 years a contract with a buyer of other farm products? 1- Yes 2- No

D- Storage system and practices

38. Main storage facility 1-Crib 2- Ceiling or Roof 3- Barn (magasin)
4- traditional granary/bin 5- Plastic silos 6- Metal silos 7- Improved storage bags
8- polypropylene plastic bags 9- Recycled plastic or metal containers.

39. Percentage of total maize output storable on farm (%) _____

40. State of Available main storage facility
1- Not degraded 2- Fast degrading 3- Degraded

41. Age of the storage facility? (years) _____

42. Type of drying facility: 1- tarpaulin 2- none 3- crib 4- ceiling/attic

43. Average duration of maize in storage unit in a year (months) _____

44. Average % of total output stored/in store at the beginning of October _____

45. Average proportion of losses in total maize stock per year (%) _____

46. (If applicable) contribution of group membership to storage improvement 1- None
2- effective technology 3- Better access to protectants 4- planning 5- all

47. Which crop do you store for the longest period?
1-Maize 2- Beans 3- Potatoes 4- Cassava 5- Groundnuts 6- other

48. Percentage of stored maize used for household consumption (%) _____

49. Percentage of stored maize used for animal feed (%) _____

50. Percentage of stored maize for sales/cash income (%) _____

51. Average annual maize storage cost (in Fcfa) _____

52. Main disincentives to storing maize (what makes you avoid/limit maize storage)?
1- Size of store 2- Pest damage risk 3- Price uncertainty 4- High market demand
5- Urgent household needs 6- Urgent farm needs 7- protectants price/inefficacy
8- other_____ 9- none 10- all

53. Main means of pest control in store:
1-None 2- Proper drying 3- Chemical insecticides 4- Traditional insect-repellent plants and substances 5- Air-tight containers 6- Insect-proof store 7- immediate sale
8- Regular cleaning of sore 9- Grain sorting 10- trap/guard 11-all

54. Which type of main protectants do you apply on stored maize against pest?
1- Commercial chemicals 2- herbs 3- ash 4 – all three 5- None

55. If applicable, what is the main cause of your storage losses?
1- Insufficient space (over-piling) 2- poor handling
3- ineffective technology 4- all three 5- other_____

56. Approximate value of annual loss in cash (Fcfa) _____

57. Insect damage in maize store (% of total stock) _____

58. Mould damage in maize store (% of total stock) _____

59. Rodent damage in maize store (% of total stock) _____

60. Rate your knowledge about improved post-harvest practices (harvesting, sorting, drying, protectants use and storage) 1- Poor 2- Fair 3- Good 4- Excellent

61. Which modern storage instruments do you mainly use 1- None 2- Super bags 3- Silos 4- recycled plastic containers 5- other _____

62. If none why? 1- cost 2- locally unavailable 3- skepticism 4-ignorance

63. If applicable, for how long have you used modern storage equipment (years) _____

64. Effect on your maize. 1- no effect 2- maintained quality 3- lower quality

65. Main motive for storing maize 1- Increase revenue 2- Food Security 3- Precautionary savings 4- all three 5- other _____

66. Average proportion of maize stock you are left with at planting period (%)
1-[under 5%] 2- [6 - 15%] 3- [16 - 25%] 4- [26 - 35] 5-[above 35%]

67. If applicable what is the main motive for keeping it up to that period? 1- Seed 2- income security 3- feed 4- food security 5- sales constraints 6- other

68. Rate your maize storage practices. 1- Poor 2 -fair 3- good 4- very good

E- Maize Sales at post harvest period

69. Main motive for sales of stored maize at the beginning of the lean period.
1- School fees 2- Repay loan 3- Health 4- buy food 5- buy inputs 6- other____

70. Which level of incremental increase in maize prices makes you remove the largest share of your maize from the store for sales motives (if applicable)?
1- (Under 1%) 2-(1%-4%) 3- (5%-8%) 4- (9%-12%) 5- (13% and above)

71. Average % of output sold within the 3 months following harvest
1-[under 10%] 2- [11 - 30%] 3- [31 - 50%] 4 - [51 - 70] 5- [71 and above]

72. Average proportion of maize stock sold during the lean period (from March to June)
1-[under 10%] 2- [11 - 30%] 3- [31 - 50%] 4 - [51 - 70] 5- [71 and above]

73. How many crops other than maize do you sell to earn cash at post-harvest period?
1-**[less than 2]** 2 - **[3 - 5]** 3- **[6 - 8]** 4- **[9 and above]**

74. Evaluate your price negotiating capacity 1- low 2- medium 3- high

75. Costs of transportation to the nearest market with 20 kg of maize (Fcfa)
1-[under 200] 2- [201 – 400] 3- [401 - 600] 4- [601 – 800] 5- 801 and above

76. Where do you most often sell your stored maize? 1- Farm gate 2- market 3- home

77. Who are your largest maize purchasers at postharvest period? 1- small traders 2- feed manufacturers 3- livestock breeders 4- direct consumers 5- other buyers

78. What income loss is more important to you as far as stored maize is concerned 1- loss caused by price fluctuation 2- loss caused by pest 3- theft 4- all three 5- none

F- Post harvest risks perception

79. The most likely social shock that provokes unplanned decrease in maize stock.
1-poor social networking 2- theft 3- both 4- none 5- other _____

80. The most likely economic shock that provokes unplanned decrease in maize stock.
1- Limited sources of cash 2- price volatility 3- lack of /poor access to credit/insurance 4- all 5- none 6- other _____

81. The most likely institutional shock that provokes unplanned decrease in maize stock.
1-Lack of norm of quality 2-poor market regulation 3- bad roads 4- high taxes 5- all 6- none 7- other _____

82. The most likely nature-induced shock that provokes unplanned decrease in maize stock.
1- pest 2-geographical enclosure 3- rising moisture level 4- all 5- none 6- other

83. The most likely personal shock that provokes unplanned decrease in maize stock.
1- injuries/illness 2- death 3- income and financial insecurity 4- ceremonial expenses 5-debts 6- food insecurity 7- lack of school fees 8- pests 9- unavailable labour 10- insufficient storage space 11- all 12- Other _____

84. In which of these fields have you received training for post harvest management?
1- Equipment 2-drying 3- scaling 4- use of protectants 5- all 6- none 7-planning

85. Which among these harvest precautions do you use? 1- early harvest 2- sorting out healthy cobs from infested ones 3- none 4- all

86. Type of equipment available on your farm for processing of maize:
1-None 2- Archaic 3- modern 4- both archaic and modern

87. Who do you receive agricultural extension services from?
1-Private sector organizations 2- State 3- NGOs 4- none

88. If none of these, why? 1- unavailable 2- costly 3- ignorance 4- other reason

89. Average quantity of maize purchased in a year (kg) _____

90. Value of subvention ever received to improve post harvest handling
1-[**0** – **1000**] 2- [**1001** -**3000**] 3- [**3001** – **5000**] 6- [**5001** – **7000**] 7- above 7001

91. How do you perceive your behaviour towards post-harvest risks in general?
1-Risk loving 2- risk avoiding 3- risk neutral 4- no idea

APPENDIX II:

Pictures

Figure 4.32: Maize cobs drying by hanging in Mifi Division

Figure 4.33: A maize crib in the Noun Division

Figure 4.34: Traditional granary in the Menoua Division

Figure 4.35: Drying rodent, weevil and mould-attacked maize on tarpaulin in the Menoua Division

Figure 4.36: Commercial Insecticide Powder 'Malathion'