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MISSING GRAINS

- *Post-Harvest Loss in Maize in Kakamega, Western Kenya*

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Abstract

Globally, around a third of all food produced is lost or wasted. This means a decrease in food available to meet global food demands, but also a loss in resources used for production, transportation and processing. With agricultural production currently facing new challenges including population growth and, increasingly, climate change, ensuring productivity and sustainability in agricultural practices becomes ever more important. Reducing food loss and food waste carries the potential to considerably increase the efficiency of the whole food chain and reduce the unnecessary waste of natural resources.

Maize is the main staple food in Kenya, contributing more than a third of daily caloric intake by the average Kenyan. The Western provinces are the so called “bread basket”, where most of the country’s maize is grown. This paper seeks to present a holistic view of the extent of, reasons for and challenges around post- harvest losses (PHL) in maize grain among smallholder farmers in Lugari District of Western Kenya. The empirical study involves 45 household interviews, four key informant interviews with stakeholders from both local and international institutions as well as two group discussions. It shows that losses in maize grain occur at all stages of the post-harvest value chain, summing up to a total loss of 8.6 % of the latest maize harvest. There is scope for improvements at each stage of post- harvest handling, but the analysis shows that the type of small scale farmers surveyed in this study are largely excluded from external actors’ initiatives aiming at PHL reduction. Considering that 80 % of the food produced in Kenya, as in most developing countries, is produced by small scale farmers, it is crucial that initiatives and extension services expand their reach to include all farmers. PHL reduction has not yet received sufficient attention on the institutional level, and even if its importance and potential contribution towards food security is increasingly recognised, it has not yet been sufficiently acted upon.

This study does not specifically seek to come up with generalizable practical solutions for PHL, but rather seeks to show that PHL needs to be tackled from a holistic and integrated approach, taking into account the local sociocultural and socioeconomic context. This is in line with the sustainable agricultural intensification approach, which forms the background of this study. The main goal of sustainable agricultural intensification is to increase productivity through increasing agricultural output in relation to unit of inputs as well as to undesirable outputs. This study argues that PHL reduction is an effective component of an integrated approach towards achieving the goal of sustainable agricultural intensification, and can have far- reaching impacts on food security and economic development.

Keywords: Kenya, maize, post- harvest losses, sustainable agricultural intensification

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Table of Contents		p.
▪	Front Page – Title, Picture	1
▪	Abstract and Keywords	2
▪	Acknowledgements	3
▪	Table of Contents	4
▪	Abbreviations and Acronyms	5
1.	Introduction	6
1.1	A Global Perspective on Food Waste and Food Loss	6
1.2	Objectives of the Study and Motivation	6
1.3	Afrint	7
1.4	Link to Development Studies and Human Geography	8
1.5	Scope and Limitations of the Study	8
2.	Background	8
2.1	Specific Aims	8
2.2	Research Questions	9
2.3	Definition of Post- Harvest Losses	10
2.4	Agriculture and Post- Harvest Management in Kenya and SSA	11
2.5	Maize	12
2.6	The regional setting: Kakamega- Lugari District	13
2.7	Overview of selected stakeholders relevant to PHL interventions	15
3.	Theoretical Background –	
	PHL reduction in a Sustainable Agricultural Intensification Framework	16
3.1	Sustainable Agricultural Intensification	16
3.1.1	Discussion	19
3.1.2	Critiques and Shortcomings	19
3.2	PHL in the context of Sustainable Agricultural Intensification	20
4.	Methodology and Data Collection	21
4.1	Household Interviews	21
4.1.1	The Questionnaire	21
4.1.2	Sampling for Household Interviews	22
4.2	Group Discussions	23
4.3	Key Informant Interviews	23
4.4	Challenges in Data Collection and Methodology	24
4.5	Ethical considerations	25
5.	Analysis and Results	25
5.1	Quantification of PHL, Mukuyu and Munyuki villages	26
5.2	Stages of PH management and Causes of PHL	26
5.2.1	Transportation	28
5.2.2	Drying	28
5.2.3	Shelling	29
5.2.4	Storage	30
5.2.5	Processing	30
5.3	Correlation Analysis	31

5.4	Indirect Causes of PHL	32
5.4.1	Individual factors	32
5.4.2	Community factors	33
5.4.3	External factors	34
5.5	Summary of Findings	36
6.	Concluding Remarks	37
▪	List of Literature	38
▪	Appendices	40

Abbreviations and Acronyms

CIMMYT	-	International Maize and Wheat Improvement Centre
EGSP	-	Effective Grain Storage Project (CIMMYT)
GD	-	Group Discussion
GoK	-	Government of Kenya
HYVs	-	High yielding varieties
LGB	-	Larger Grain Borer
NCPB	-	National Cereals and Produce Board of Kenya
PHL	-	Post- Harvest Losses
SSA	-	Sub- Saharan Africa
WRS	-	Warehouse Receipt System

1. Introduction

1.1 A Global Perspective on Food Waste and Food Loss

More than a third of the food produced globally for human consumption is estimated to be lost or wasted (FAO, 2011). Insufficient attention appears to be paid to this substantial global food wastage, and there is scope for improvements throughout the food chain. Food loss and waste occurs at all levels of the supply chain, “from farm to fork”. However, in high and middle income countries food waste is concentrated to the distribution and consumption stages and occurs mainly due to high requirements on aesthetic appearance and quality, while in low income countries the problem is rather concentrated to the early stages of the supply chain. “Waste” in this context refers to retail and consumer behaviour, while food “loss” occurs during production, post-harvest and processing stages- hence, it can be said that food waste is deliberate, while food loss is not. Food loss and food waste does not only mean a loss in terms of actual food itself, but also a loss in resources used throughout the value chain (Karmebäck, 2011, unpublished).

My ambition with this study that is based on my field research carried out in January and February 2013 is to contribute with specific insights into the amounts of and reasons behind post- harvest losses (PHL) in maize grain in Mukuyu and Munyuki villages in the Lugari-Kakamega district of Western Kenya, and to analyse these findings in the larger context of sustainable agricultural intensification.

After having been neglected for decades, the reduction of food loss and food waste is now back on the agenda. Especially in the last few years, the topic has received a sharp increase in attention. As late as in 2009 at the World Food Summit in Rome, nothing was even mentioned about food waste or food loss, and now, only four years later, it is an issue being more and more debated and thematized by media, governments and international organisations. For instance, the UNEP and the FAO just recently on June 10th, 2013, jointly launched a large international campaign called “Think. Eat. Save” as a call for action to reduce food waste and food loss and as an attempt to create a platform for news and resources on the topic (www.thinkeatsave.org). Although the importance of the topic has now been internationally recognized, it still needs to be increasingly acted upon by all stakeholders, for which an even larger focus as well as more research is needed.

The sustainable agricultural intensification debate will form the background of this study. Sustainable agricultural intensification aims at raising agricultural productivity simultaneously to reducing environmental impact. It argues that the level of yield increase needed to feed a growing population is dependent on issues of efficiency, distribution as well as population growth itself, and that challenges in food production need to be approached from a holistic perspective taking into account factors such as cultural attitudes and socio- economic context.

1.2 Objectives of the Study and Motivation

In contrast to other parts of the developing world, agricultural growth in Sub-Saharan Africa has been more or less stagnant in the past decades. This has resulted in a decline in per capita food production and an increase of food insecure people in the majority of the countries. Poverty in

Kenya, as in sub-Saharan Africa in general, is mainly a rural phenomenon and the majority of the population depend on small-scale, subsistence agriculture for their livelihoods (Andersson, 2008). An increased output of food production is hence a key not only to hunger reduction but also to broad-based poverty alleviation and development.

The purpose of the study is to create a holistic overview of the challenges of post-harvest handling and to identify factors at the farm and district level that affect post-harvest management strategies in Kakamega district in western Kenya. The empirical study involves four key informant interviews, two group discussions and 45 household interviews.

The main motivation of the study stems from the author's belief that few studies have estimated PHL in Kenya's maize production, especially when approached from a larger socio-economic and sustainability perspective. PHL reduction is not only a technical issue, but involves the larger socioeconomic context. In other words, households' PH handling of maize is dependent on their broader livelihood situations as well as on the cultural environment.

The starting point for this study was the claim put forward in the 2011 World Bank Report *Missing Food: The Case of Postharvest Grain Losses in Sub-Saharan Africa* that "promoting food security through PHL reduction can be more cost effective and environmentally sustainable than a corresponding increase in production" (World Bank, 2011: xiii). Understanding the levels of and reasons for PHL can help address productivity gains as well as save the unnecessary waste of natural resources.

1.3 Afrint

The households interviewed for the purpose of this study make part of the Afrint project, where the drivers of agricultural intensification and commercialization in nine countries in Sub-Saharan Africa, including Kenya, are researched. In Kenya, data was collected in 2002 (Afrint I), 2008 (Afrint II) and 2013 (Afrint III). Afrint has created a cross-sectional database of nearly 4000 farmers and a longitudinal database of almost 2500 farmers (Djurfeldt et al. 2005, 2011. see also <http://blog.sam.lu.se/afrint>). The aim of Afrint is to better understand the nature of the African food crisis, and the means of alleviating it. The project was started by a Swedish team of researchers from Lund University and Linköping University, and has sub-contractor teams in each of the nine countries included in the study. So far post-harvest food losses have not been readily explored in Afrint. Performing my research in connection to Afrint has hence enabled me to focus all time and resources on my specific topic, at the same time as the research was automatically situated in the larger discourse around food security and agricultural intensification.

The study has been planned and carried out with the help of both Kenyan and Swedish Afrint team members and builds on the already established local Afrint network in Mukuyu and Munyuki villages where primary household data was collected. In addition, secondary data from the Afrint database has been used in the form of village background information and previous Afrint publications (Andersson Djurfeldt, 2012; Andersson Djurfeldt et al, 2008; Djurfeldt et al, 2005; Djurfeldt et al, 2011; Karugia, 2003).

Data for this study was collected together with Zenah Abuti, Bachelor student in Agribusiness Management and Trade at Kenyatta University. We were paired up by our respective supervisors, who are both Afrint members of the Swedish and the Kenyan team respectively. Zenah Abuti is from Kakamega County herself and hence added valuable local knowledge to the data collection process. We collected primary data together, to then write our respective Thesis. Zenah Abuti's main focus is on maize grain losses in economic terms, while the angle that I have taken on the topic is from a sustainable intensification perspective including food security concerns and natural resource management. Although our common questionnaire in this way became more substantial, our distinct focus areas have throughout the data collection only added value to one another. Furthermore, performing the study together with Zenah Abuti has removed the need for a translator, and the issues associated with that.

1.4 Link to Development Studies and Human Geography

The issues at hand lie at the heart of Development Studies and the discipline of Human Geography- This study seeks to see PHL management in a holistic perspective, including cultural, geographical, socio- economic as well as technical matters. Human Geography as well as Development Studies are in themselves highly multidisciplinary, and hence pose the right backdrop for examining the complex interrelation of all these factors and existing practices. Furthermore, improvements in agricultural practices of small- scale family farmers are seen as crucial to pro-poor development (IFAD, 2010; World Bank, 2007). Hence, this study touches upon issues that are at the core of both Development Studies and Human Geography: Rural development, poverty, food security; and especially development geography in the field of smallholder farmer agricultural intensification.

1.5 Scope and Limitations of the Study

As each crop is unique in handling, crop- specific analysis is required, which is why this study only considers maize and no other crops or foods.

The stages of the maize value chain investigated in this study are transportation, drying, shelling, storage and processing. Although PHL can be influenced by decisions taken during the pre-harvest stage, this is beyond the scope of this study, as is waste occurring at the consumption stage. However, wherever explicative or relevant to the specific aims of this study, challenges from the pre- harvest stages or later stages of the value chain will be included.

2. Background

Interest in PHL reduction is not new: After the food crisis in the mid- 1970s, considerable resources were channelled towards PHL reduction for staple crops, and the matter was set into international focus by the UN (The World Bank, 2011: xi). But, once real commodity prices started to drop, this was connected to a shift in policy towards promoting food security through economic liberalisation and trade instead (The World Bank, 2011: xi). The importance of PHL reduction was forgotten until the recent financial and food crises together with the renewed

emphasis on agriculture put the topic back on the agenda. PHL reduction is increasingly seen as an important element to reduce food insecurity and is gaining recognition as a part of an integrated approach to reach agriculture's full potential and meet the world's increased food and energy needs. Furthermore, with climate change likely to increasingly affect yields (Thornton, 2012), PHL reduction becomes ever more important.

2.1 Specific Aims

During the literature review following up to the field study, a research gap was identified in the quantification of losses. Also, it was noted that previous research on the topic has often been narrow and focused on very few factors. For instance, much research has focused exclusively on the technical nature of PHL, while others have approached PHL from a purely economic perspective or only taken a few factors into account. In order to examine the complex web of factors connected to PH management, it is of central importance to establish the extent of and reasons for PHL. Hence, first of all this study seeks to estimate the amount of PHL in maize grain occurring among the surveyed maize farmers of Munyuki and Mukuyu villages. Then, it seeks to identify main determinants of PHL in maize and to present and discuss solutions for PHL reduction. For this, the relation between socio-economic factors on the household level, intra- village dynamics as well as external environments will be at focus.

2.2 Research Questions

The overarching research questions are:

- What factors are important in determining PHL in maize grain in Lugari District, and how can these factors be seen in the larger context of sustainable agricultural intensification?
- What does PHL mean for the economic development and broader livelihood situation of small scale farmers?

In order to answer these questions, a number of sub- questions need to be taken into consideration:

- How extensive are the post- harvest maize grain losses among the surveyed households in Lugari District, and where in the post- harvest value chain do they occur?
- Which factors can be identified as the key determinants of post-harvest maize grain loss, and what are the potentials for its reduction?
- How can these issues be seen in the context of other challenges in the value chain for maize specifically, and of sustainable agricultural intensification in general?

The household interviews, which form the main part of the empirical study, were focused on physical losses, but the environmental and economic costs of PHL are as central to this study as are the physical losses themselves. These other factors were central to the Key Informant

Interviews as well as the Group Discussions, and will furthermore be examined using a body of secondary literature.

2.3 Definition of Post- Harvest Losses

The following presents the definition of PHL as referred to throughout this study. This definition was developed to fit the scope, limitations and purpose of this study, after consulting various definitions in use such as the FAO definition (www.fao.org) and definitions of other previous studies (see for instance The World Bank, 2011).

*“Post- Harvest Losses mean a measurable quantitative and qualitative **unintended** loss in a given product which makes it unavailable or unfit for human consumption, occurring during any of the various phases of post-harvest handling. Hence, it does not refer to losses occurring prior to harvest, neither to weight losses as a result of drying, nor to theft. We specifically refer to the time frame from harvest until marketing or consumption.*

Examples: *Lost due to insects, rodents or microbial growth during storage, Lost during transportation, Unintentionally consumed by animals“*

(Karmebäck and Abuti, 2013)

Qualitative PHL can mean declining market opportunities and decreased nutritional value, while quantitative PHL directly refers to physical weight losses. The stress on “unintended” means that for example maize grains purposively fed to domestic animals are not counted as PHL.

During the household surveys, it was ensured that respondents had a clear understanding of what we mean with PHL through an extensive explication of our definition followed by time for the interviewee to ask questions as well as a check- question on our behalf to establish that the interviewee had understood our definition. It was made sure that farmers referred to physical and not economic losses when estimating their PHL in maize grain, and that only PHL occurring within the scope of the study, i.e. from harvest until marketing, was considered so that estimations did not include PHL occurring later or earlier in the supply chain, such as during the pre- harvest phase.

Defining PHL is a crucial part of any study on the topic, but also one of the most challenging. Delimitations and scope need to be thoroughly considered and well decided upon and the same definition has to be used throughout the whole research process. Quantifying PHL at each stage of the value chain is problematic not the least because the different reasons for losses are interlinked, and that losses occurring during one stage might be caused by conditions at an earlier stage. For instance, pre- harvest decisions about which seeds to use or time of planting impact on PHL later in the value chain and the various causes for PHL at each stage cannot easily be separated from each other. This furthermore renders comparisons across regions and between studies difficult, as various definitions are in use. For instance, the 2011 World Bank Report “Missing Food- The Case of Postharvest Grain Losses in Sub- Saharan Africa” distinguishes between *technical causes* and *governance- related causes* of PHL (The World Bank, 2011: xii), while the FAO distinguishes between indirect and direct causes (www.fao.org). CIMMYT defines three dimensions of PHL: Weight loss due to biological and physical factors, which are aggravated by socioeconomic factors; quality loss; and financial loss caused by the former two (Tadele Tefera,

CIMMYT, interviewed on Feb 12th, 2013). In some studies on PHL, no definition at all is given (see for example Bett & Nguyo, 2007).

The definition of PHL is hence one of the major challenges when it comes to studying PHL, and also a reason for why quantifying PHL is so problematic. This study has sought to present a clear definition of PHL that has been emphasised throughout the whole research process.

2.4 Agriculture, Marketing and Post- Harvest Management in Kenya and SSA

Similar to other SSA countries, agriculture forms the backbone of the Kenyan national economy, accounting for over 60% of the gross domestic product (GDP) and employing, directly or indirectly, 80 % of the active population (Wambugu et al, 215 in: Djurfeldt et al, 2011).

Despite an increase in both yields and areas cultivated, SSA has over the past five decades experienced a declining per capita food supply which can be explained through a failure to keep up with population growth (Andersson Djurfeldt et al, 2008: 75). In Kenya, the prevalence of undernutrition is estimated to 30 % (FAOSTAT, 2012). Around 80% of total agricultural output in Kenya comes from small-scale producers (Wambugu et al, 215 in: Djurfeldt et al, 2011), which shows the importance of improving small- scale practices in ensuring food security.

The context of agricultural production and marketing in Kenya has changed significantly over the past decades. Increasing competition from international markets following market liberalisation, the state's withdrawal from grain marketing activities and increased regional integration belong to the main changes. Before the liberalisation of the grain sub- sector in 1992, input and output markets were state controlled, with inputs being provided through the Kenya Farmers Association (KFA), and the marketing of farm products occurring through parastatals (Karugia, 2003: 36). For maize specifically, the National Cereals and Produce Board of Kenya (NCPB), at the time a parastatal and the main actor in grain marketing activities in Kenya, formed a reliable output market during this time, offering uniform prices.

Liberalisation has furthermore brought more private traders into input provisioning, which has undoubtedly rendered inputs more available to farmers (Karugia, 2003:36). But private traders' prices are generally higher than those set through the subsidised input provisioning scheme, and with little government control, inputs are furthermore at risk of being of low quality or even counterfeit, all of which may translate into reduced profitability for the farmers. Also, extension services by the Government of Kenya (GoK) have significantly declined with liberalisation (Karugia, 2003: 36). All of these issues are important to the context of PHL, as they are closely linked to the challenges connected to PHL reduction, and will be referred to in later parts of this paper.

Just as the context of agricultural production and marketing in SSA has changed during the past decades, so have the challenges around PHL reduction. Decreasing farm size, declining soil fertility, erratic weather patterns and the emergence of a devastating storage pest called the larger grain borer (LGB) are some of the challenges connected to PHL reduction that farmers in SSA face today (The World Bank, 2011: xi f.). Also, the increased use of high yielding varieties (HYVs) plays a role in PHL, as HYVs are more prone to PHL than traditional varieties due to

greater susceptibility to pest attacks because of the HYV grains being softer and hence more easily eaten (The World Bank, 2011: 5).

In addition to these changes, the recent years' rise in food prices has led to a policy reorientation aiming at decreasing the dependency on imports, which goes hand in hand with an increased focus on self-sufficiency (Djurfeldt et al, 2011: 107, 132). As put forward by Andersson Djurfeldt et al (2008), increased food grain production in SSA is connected either to extensification or intensification, with the former referring to substituting other crops with food grains or extending the total area under cultivation, and the latter meaning a rise in yields in a given area. In Kenya, almost all the arable land is already under cultivation (Kibaara, 2005: 2), which means that future increases in grain production will depend on yield improvement rather than on expansion in area under production (Karanja and Oketch, 1992, in: Kibaara, 2005; see also: Karugia, 2003: 1 f.), or on substituting other crops with grains. Without questioning the importance of agricultural intensification in meeting SSA's food deficit, this study tries to put PHL into focus as another issue playing a crucial role in ensuring food security. In addition to increasing yields through intensive as well as extensive growth in production where applicable, focus needs to be put on reducing PHL, as this carries great potential to enhance food security in a sustainable manner.

2.5 Maize

Maize (*Zea Mays* L.) is Africa's largest staple crop and the most important food staple in Kenya (Wambugu et al: 216). Globally, it is the most produced cereal (FAOSTAT) followed by rice and wheat, and besides being an important staple food in many countries, it is also used in animal feed and as a basic raw material in industrial applications for the production of starch, oil, alcoholic beverages, food sweeteners and fuel. The demand for maize in the developing world is expected to double between now and 2050 (CIMMYT & IITA, 2011: 2), which points to the importance of improving efficiency throughout the whole maize value chain.

The type of maize grown in Kenya is the white maize, which is biologically and genetically very similar to yellow maize. 90 % of rural households grow maize in Kenya (Kang'ethe, 2011: 16). Maize constitutes the basis for food security in Kenya, where more than a third of average daily caloric intake stems from maize (FAOSTAT; The World Bank, 2011: 5). However, there has always been a structural deficit in maize production in Kenya (Lilian Kirimi, Research Fellow at Tegemeo Institute, interviewed on Jan 11th, 2013). In real numbers the average annual per capita consumption of 98 kilograms (FAOSTAT) translates into between 30 and 34 million bags¹ of annual maize consumption for the overall Kenyan population. The total domestic production however is 24 to 28 million bags of maize per year (Kibaara, 2005: 1), meaning there is a deficit in national maize supply which is met with imports, the percentage of which is expected to be largely underestimated due to massive unreported cross border maize trade from neighbouring countries Uganda and Tanzania (Kibaara, 2005: 1).

To summarise, availability of and access to adequate supplies of maize is generally equated with food security in Kenya. That is why maize was chosen as the crop to be studied in the first hand,

¹ Maize is measured in form of dried maize grain packed in bags, with each bag weighing 90 kg.

as this paper aims at shedding light on factors relevant to food security. In addition, all of the above also makes clear that maize in Kenya has a meaning that goes beyond its purely nutritional contribution as the country's main staple food. Changes in maize prices, policies and practices affect as good as all Kenyans, either as producers or as consumers. Maize is hence also a politically important crop, and especially in the current times with a very eventful political landscape in Kenya, ensuring adequate policies along all aspects of the maize value chain is crucial for political stability in Kenya.

2.6 The regional setting: Kakamega- Lugari District of Western Kenya



Fig.1. Location of Lugari District

The study was carried out in Munyuki and Mukuyu villages which both belong to the District of Lugari, Kakamega Sub County in Western Kenya. The villages were purposively sampled from within the Afrint village sample mainly due to the intensive cultivation of maize in this part of Kenya (more detailed information on the sampling procedure will be given in Section 4.1.2.).

The ecological base of Kakamega Sub County is rich and varied, with high temperatures, reliable rainfall and fairly fertile soils (Karugia, 2003: 5). Main agricultural activities are sugar cane production in the Western parts of the sub county and maize and bean production in the Northern parts, which includes Lugari District. Other activities are coffee plantation, sunflower production, livestock keeping, and to a smaller extent tea production (Karugia, 2003: 5), as well as, more recently and specifically for Lugari District, amaranth production and, to a smaller extent, soy bean production (MoA, 2013). For half the maize farmers interviewed (23 out of 45), maize is both a cash and a food crop, while the other half grows maize for subsistence purposes only.

Population density in Mukuyu and Munyuki villages is relatively low compared to the generally high level of population density prevailing in Kakamega Sub County (Karugia, 2003: 7). Lugari District's high annual rainfall of between 1000- 1600 mm (MoA, 2013) creates the need for all weather roads. While Munyuki village has fairly good connecting roads and market access, Mukuyu village has no all- weather roads, rendering accessibility of farm produce to markets more difficult and also costly for farmers (see Appendix 1 for detailed map of study area). Munyuki village has regular public transport, while Mukuyu does not (Karugia, 2003: 11). With regard to topography, both villages are located on flat and gently undulating slopes and flat terrain (Karugia, 2003: 11).

Both Munyuki and Mukuyu villages represent areas of high agro-ecological potential (Karugia, 2003: 7), with maize being an important cash and food crop. The main buyers of maize grain from small- scale farmers in the area, as in most of Kenya, are private traders, which stands in great contrast to the pre-liberalization period when the NCPB was the main grain buyer. Karugia's (2003) analysis of Afrint survey data from 2002 showed that although the farmers feel that the prices offered by private traders are too low, they are nevertheless of the view that the traders provide a useful and reliable market (Karugia, 2003: 36), which is in line with our impressions and findings from the survey data from Mukuyu and Munyuki villages.

As mentioned, liberalisation has furthermore increased the numbers of input suppliers, making inputs more available to farmers. However the higher prices that farmers have to pay now and the low quality of the inputs are major causes of concern to farmers (Karugia, 2003: 36). Furthermore, farmers do not always have the right knowledge of how to use inputs correctly (Jacklyn Bwanjila, Agribusiness Officer Lugari District, Group Discussion 1). Before liberalisation, the state was responsible for providing free regular extension services aiming at training farmers on correct handling. Also, this was how new agricultural techniques and strategies were introduced and spread. Currently however, extension services are irregularly provided or even absent in many villages around Kenya, with NGOs filling some of the gaps. This is connected to extension services having changed to being of demand- driven nature (Jacklyn Bwanjila, Agribusiness Officer Lugari District, GD1), which means that farmers themselves have to contact the local Ministry of Agriculture (MoA) office and demand training or information on the specific problem they are dealing with. Resulting out of the farmer's needs, field days called *barazas* are then organised at which extension services are offered. However, presence at these gatherings is often low (Chripin Munianganyi, Field Extension Officer, GD1). One reason for this could be that information about upcoming *barazas* does not always reach the farmers, as the current information sharing means are lacking structure on the local level, which has led to general confusion around agricultural strategies in place (Zackariah Avedi, Miller, GD1).

The analysis of the household survey shows that for Munyuki and Mukuyu villages specifically around half the farmers have not taken part in any extension services aiming at reducing PHL. The farmers that had received training had done so by either the MoA or by the One Acre Fund that has a sub-group in Munyuki village and with whom a Group Discussion was carried out as part of this study. Apart from this, there is a low presence of NGOs in the area. The importance of extending training programmes for farmers will be returned to in later parts of this study.

2.7 Selected stakeholders relevant to PHL reduction initiatives

Having gained renewed focus in recent years, the topic of PHL has been dealt with by a number of institutions in Kenya. Interventions in PHL reduction are now seen as an important element of the efforts of many agencies to reduce food insecurity in SSA. This section aims at describing selected ongoing initiatives and stakeholders relevant to the field of PH management in maize in Kenya, while later they will be discussed and put into context of the findings from this study. With members of these organisations Key Informant Interviews were carried out, or, in the case of the One Acre Fund, a Group Discussion (GD2).

One Acre Fund

The One Acre Fund was established in 2006 in Western Kenya, and uses a market-based system to enable one-acre subsistence farmers to escape poverty. The focal areas are the empowerment and increased negotiating power of local farmer groups, market facilitation and farm education provided by field officers, covering farmer training on adequate nutrient management and on post-harvest handling and storage. The Fund has established local Self Help Groups whose members meet on a weekly basis. Loans are provided in the form of farm inputs, and are paid back after harvest. Some inputs are also provided as charity, such as seeds or pesticides. During the Group Discussion carried out with the Munyuki village One Acre Fund group, farmers expressed that they benefitted greatly from being One Acre Fund members- They receive higher harvests despite using lower amounts of inputs. As of autumn 2012, the One Acre Fund has facilitated a tripling of raw harvest material per planted acre and a doubling of farm income per planted acre, after repayment (see more at www.oneacrefund.org, as well as The Montpellier Report, 2013: 9).

Effective Grain Storage Project (CIMMYT)

The Effective Grain Storage Project (EGSP) by the International Maize and Wheat Improvement Centre (CIMMYT) can be seen as a triangular cooperation between Central America and East and Southern Africa, facilitated by the Swiss Agency for Development and Cooperation. The initiative focusses on hermetic storage through the manufacturing and spreading of metal silos for grain storage, ranging from 100 up to 3000 kg's capacity. Following the success in aiding farmers to store grain of POSTCOSECHA, as the project is called in Central America, experienced Central American artisans were sent to Eastern Africa to train local artisans there in the production of the metal silos. These artisans are then in turn expected to train others on the production of metal silos, creating a pool of producers. Hence, in addition to the PHL reducing effects of storing in metal silos that prevent rodents and weevils from attacking the grains, the initiative also benefits the local economy. It creates an income opportunity for the manufacturer at the same time as their local production render the silos affordable to farmers.

In addition, the EGSP is also working on combatting the LGB through developing resistant varieties. According to Tadele Tefera (project leader EGSP, interviewed on Feb 12th, 2013), PHL doubled with the emergence of the LGB. Hence, the main focus of EGSP is on storage, as the

project has identified the main reason for losses as being losses occurring during storage (Tefera, 2013).

National Cereals and Produce Board of Kenya (NCPB)

Despite liberalisation having decreased its function in grain marketing activities, the NCPB still plays an important role in the grain market in Kenya, especially concerning storage. The NCPB stores large quantities of maize, beans, rice, sorghum and wheat. Due to high quality requirements at the point of intake, maize specifically can be stored to up to three to four years in the NCPB's facilities (Dickson Nyongesa, Manager of NCPB Kipkarren, interviewed on Jan 28th, 2013). The NCPB runs the so called Warehouse Receipt System (WRS), through which farmers can store maize as collaterals. Also, the NCPB plays a role during food scarcities. It holds the so called Strategic Grain Reserves on behalf of the government, which currently holds 8 million bags of maize countrywide in store to be used in the case of food shortages. The role of the NCPB in this is a logistic one and lies in transporting food from surplus areas to food deficit areas, with the government funding the transport. Then, on the local level, NGOs are responsible for the distribution.

3. Theoretical Background-

PHL reduction in a Sustainable Agricultural Intensification Framework

In order to position this research in a wider perspective the issue of PHL is here set in a Sustainable Agricultural Intensification (SAI, author's own abbreviation) framework. In addition to the more practical and to some extent technical matters that this study explores through quantifying PHL and investigating its causes, this section presents a broader perspective in which to abstract the significance of PHL reduction.

3.1 Sustainable Agricultural Intensification

Globally, increases in population growth, income growth in many low income countries, dietary changes, urban growth, urbanisation and environmental challenges including climate change pose new challenges for food production. Achieving efficient and productive agricultural land use while conserving biodiversity is a challenge in developed and developing countries alike (Tschamntke et al, 2012: 1). While the effect of production and productivity on food prices has been a core area of concern for food and commodity economists, especially in the last five years since the first food price spike in 2007/08, the indirect negative environmental consequences of the way we produce food have received less attention (Garnett & Godfray, 2012: 24). Agriculture currently causes 30–35% of global greenhouse gas emissions (Tschamntke et al, 2012: 4), and its role in loss of biodiversity and soil and land degradation are by now well- known and much written- about issues.

In addition to environmental considerations of food production, under-, mal- and overnutrition and related diseases and developmental impacts are a harsh reality, the latter of which is no

longer only a “rich world problem” (Garnett & Godfray, 2012: 40). All of this points to the need of a new way of producing, using and thinking about food.

While conventional agricultural intensification is focused on raising yields, the goal of sustainable agricultural intensification is rather to achieve a union between sustainability and productivity (Garnett & Godfray, 2012: 6). Simple and single metrics such as volumes or kilocalories are commonly used to measure success in agriculture, and by these measurements conventional monocultural systems tend to score highly- Sustainable intensification however points out the risks of focussing on such simple measures of efficiency, and tries to shed light on the need for broader approaches and the advantages of multiple outputs and outcomes on the farm level.

In the global debate around intensification, Sub- Saharan Africa holds a distinctive position- nowhere in the world is the gap between actual yields and potential yields as high as in SSA (Djurfeldt et al, 2011; IFAD, 2010) The generally low yields achieved by farmers all across the sub- continent point to the crucial need for intensification. This is both bad and good news, as the opportunities for improving environmental and productivity outputs simultaneously are largest in agricultural systems that currently hold low levels of production (Garnett & Godfray, 2012: 51). Here, the potential of productivity increases to be based on new, eco- efficient strategies is high, and agricultural policies can seek to counteract known negative environmental impacts already in early stages of implementation.

Intensification is commonly associated with systems that rely heavily on high levels of inputs such as fertilisers, water and pesticides, many of which come from, or are produced using, non-renewable resources. But, in the context of SAI, *intensification* is better understood in terms of ‘environmental factor productivity’ or ‘eco-efficiency’, which Garnett & Godfray (2012:15 f.) define as “the efficiency with which inputs are used relative to desired outputs; and the desired outputs achieved from the system in relation to the undesirable outputs. The goal of sustainable intensification is hence to raise *productivity* (in contrast to increasing *volume of production*) while reducing environmental impacts. This means increasing yields per unit of inputs (including nutrients, water, energy, capital and land) as well as per unit of ‘undesirable’ outputs (such as greenhouse gas emissions or water pollution)” (Garnett & Godfray, 2012: 14). Hence, the ‘need’ for sustainable intensification can in this way be seen as independent of the ‘need’ to produce more food.

Just as PHL reduction has increasingly gained recognition as a part of an integrated approach to reach agriculture’s full potential in recent years, sustainable intensification is a term now much used in discussions around the future of agriculture and food security. It has only become common in the last few years, following the publication of the UK Royal Society’s influential report *Reaping the Benefits - Science and the sustainable intensification of global agriculture* in 2009 that explored the future of crop production, and a number of later major scientific and policy reports. However, the term actually dates back to the 1990s, and has its origin in the context of pro-poor, smallholder oriented African agriculture (Garnett & Godfray, 2012: 8).

In addition to pointing out environmental costs of conventional intensification, the SAI approach also recognizes that contemporary food usage is inefficient with globally around a third of all food lost or wasted throughout the value chain (Tschamntke et al, 2012: 1). The SAI

approach recognizes the importance of religious and ethical attitudes in driving decisions around agricultural practices (Sodhi and Ehrlich, 2010, in: Tscharrntke et al, 2012:4)- Values, just as natural and social issues, have a rightful place in how society develops agricultural and land use policy (Garnett & Godfray, 2012: 33). Furthermore, especially in environments dominated by smallholder farmers, the development of the human capital is seen as the core of sustainable intensification (The Montpellier Report, 2013: 30). More efficient and sustainable use of available resources is a global challenge, but the appropriate responses need to be context-specific (IFAD, 2010: 148). The ‘optimum’ level of productivity increase will vary with context and the task at the local level is to consider how yields can be increased in ways that enhance sustainability (Garnett & Godfray, 2012: 14).

While it is common in the international policy arena to present particular stipulated levels of global production based on population increases (i.e. at the World Food Summit 2009, it was decided to increase food production by 70% till 2050), SAI proponents would rather argue that what we do to address issues of efficiency, distribution, supply, demand and waste as well as demographic policy itself will influence how much of an increase in food production is needed, with the appropriate balance of actions on these various fronts varying by region and by socio-economic context. The line of argument goes that the greater the success in these other areas, the less need there will be for raising yields in order to increase food supplies. Some SAI proponents would even argue that the goal of sustainable food security for all is not possible without actions on these fronts (Garnett & Godfray, 2012: 14).

The “More Food Critics” within the sustainable intensification debate argue that the notion that more food production is actually needed is part of a problematic mindset that privileges ‘more’ over ‘fairer’ and ‘wants’ over ‘needs’ (Garnett & Godfray, 2012: 12). They argue that instead of focussing on increasing yields per se, priority should instead be on improving governance, which will influence the affordability of and access to food, and on reducing food losses and food waste throughout the supply chain (Garnett & Godfray, 2012: 12 f.). PHL is an often- forgotten factor that exacerbates food insecurity (The World Bank, 2011: xi). However, increases in food supply on themselves do not guarantee increases in food security but need to be supplemented by supporting policy measures and economic development, as hunger is most often a consequence of a lack of economic access to food rather than a lack of supply (Garnett & Godfray, 2012: 12, 24). Food security and food sovereignty need to increase in areas “where the hungry live” (Tscharrntke et al, 2012: 5) and need to be based on robust, eco-efficient approaches and on intensification that increases sustainable productivity.

It is in this context important to note that the sustainable agricultural framework can be equally applied to large- scale industrial intensive agriculture of e.g. the US or the EU, as to smallholders in a developing country trying to increase their output (The Montpellier Report, 2013: 12). In the context of responsible and efficient use of inputs, for example, this would mean a decrease in application for farms in other parts of the world, while for many farmers in SSA who use none or little of these inputs, a prudent and precise increase in their use can intensify production without sacrificing sustainability (The Montpellier Report, 2013: 32). Currently, farmers in SSA use around 13 kg of nutrients per hectare, in contrast to 100 kg/ ha in Europe and Central Asia, or 190 kg/ ha in East Asia and the Pacific (The World Bank, 2007: 52). But, as important as it is

that African farmers need to use more fertilisers, they also need to have the adequate knowledge on application of these fertilisers (The Montpellier Report, 2013: 13). This points to the holistic approach through which SAI tries to tackle current dilemmas in food production and sustainability, by recognizing the need for different approaches in different contexts and by placing human capital in the centre.

3.1.2 Discussion

Sustainability is an often misused and generally overused term. For some it denotes purely environmental goals, which themselves of course are multiple, while for others it also encompasses – as in the original Brundtland definition (“development that meets the needs of the present without compromising the ability of future generations to meet their own needs”) – social, economic and ethical dimensions (Garnett & Godfray, 2012: 16).

The Montpellier Report (2013) defines *intensification* in the following way: “In simple terms intensification can be defined as producing more units of output per units of all inputs and through new combinations of inputs and related innovations. It involves improving physical input-output relations and increasing the overall efficiency of production. Defined in this way, intensification results in greater amounts of output, whether of food produced, the income generated or the nutrition received by consumers of the farm’s produce.” (The Montpellier Report, 2013: 8). Taking this as a starting point, the step from *intensification* to *sustainable intensification* is that of distinguishing between desired outputs and undesired outputs, and seeking to increase yields per unit of input both in relation to desired outputs as well as to undesired outputs that impact negatively on the environment. Furthermore, as already mentioned sustainable intensification is not necessarily aiming at raising the *volume of production* per se, arguing that the need for increased total output is highly context- specific and dependent on a number of other factors, but rather on raising *productivity* at the same time as reducing negative environmental impacts. All of the above is how sustainable agricultural intensification is defined and referred to throughout this paper.

3.1.4. Critiques and Shortcomings

But, the term is not without controversy, and is, like any concept, neither lacking critics. Some may simply view the goals of intensification and sustainability as being incompatible, while others fear that the drive to increase yields will take precedence over ensuring sustainability (Garnett & Godfray, 2012: 15 f.). Others fear that sustainable intensification might be used as a “Trojan Horse” for more biotech and genetically modified organisms (see Garnett & Godfray, 2012: 10), as these might carry the potential to achieve goals set through SAI. SAI is generally not against GM or biotech.

Also, a shortcoming often pointed towards is that while the SAI debate is focussed on increasing productivity, it does not address of *what*. While other related concepts promote a certain type of foods, such as the agroecology movement emphasises the importance of local and indigenous food, or the organic movement pushes for food produced without pesticides, herbicides and inorganic fertilisers, the discussion of sustainable intensification does not advocate for any certain type of food (Garnett & Godfray, 2012: 16). This can be seen as a failure, but also as a

strength, especially when following the line of argument that both changes in agricultural practices as well as the desired outcomes of agriculture should be seen as something highly context-specific. SAI then rather provides a framework for what mix of approaches and foods produced will work best dependent on the context.

Another often raised critique, as with many approaches entailing the concept of *sustainability*, is its vagueness. No matter in which way defined, *sustainability* is an issue so complex that its complexity might render it vague, which can potentially halt the progress towards its own achievement. Determining more exact targets is an intensely political process and involves consideration of many non-environmental aspects of food production (Garnett & Godfray, 2012: 27). It is not yet clear what sustainable intensification might look like on the ground, how it might differ amongst production systems and how inevitable trade-offs should be dealt with. But, as pointed out by Garnett & Godfray, there is an emerging and growing body of work exploring what the implementation of SAI looks like in practice and, with all its imperfections, sustainable intensification is already contributing to new ways of thinking on food production (Garnett & Godfray, 2012: 8, 18).

3.2. PHL in the context of Sustainable Agricultural Intensification

As is shown in the previous section, SAI is still a comparatively new concept in need for further definition that will look different in different settings. So how does it fit into and what does it mean for this study?

As has been made clear, sustainable food security requires actions on multiple fronts. On the supply side more food will need to be produced with much less negative environmental impact. The food system needs to be more efficient by improving governance and reducing food losses and waste throughout the food chain, from “farm to fork”. No one of these actions on its own is able to achieve sustainability and security in the food system (Garnett & Godfray, 2012: 50).

This study seeks to approach one specific issue within the SAI debate, namely post-harvest losses, through studying the maize value chain in a certain region in Kenya. The main goal of SAI is to increase productivity through increasing yields in relation to unit of inputs as well as to undesirable outputs. It can be argued that PHL reduction is an effective means of achieving this goal, as PHL incorporates a direct loss in output and its reduction can to a large part be realised without the need for more inputs. This specific topic under study is however sought to be approached from a wider perspective, taking into account the broader household situation, community dynamics as well as the external environment. Some of the factors included in this study might at first sight not seem directly linked to the issues at hand, however the analysis will try to show the interrelation and interdependencies of different elements of the farm system with the broader sociocultural and external environment. Although much can be done with existing knowledge, there is a need for more research that takes a more systemic approach to food production. Greater understanding of how the various elements of complex systems interact is needed.

4. Methodology and Data Collection

This study uses a mixed methods approach to data collection as well as to data analysis. Quantitative data was collected through the household surveys, and qualitative data through the semi- structured Key Informant Interviews and Group Discussions. In this study, the quantitative part generally serves to answer the questions of “what”, while the qualitative approach answers the “why” (Bryman, 2012: 407 f.). Quantitative and qualitative data hence complete each other and serve to give a full picture of the understanding of PHL challenges.

The time of the data collection was January and February 2013. The timing was hence not long after harvest that takes place around late October in our chosen district, and just before the Kenyan presidential elections in March 2013. Prior to interviews it was made sure that all respondents agreed on their responses being used for my thesis. In addition, the Key Informants and participants of Group Discussion 1 (see Section 4.3) agreed on being quoted by name.

4.1 Household Interviews

Questionnaire interviews were held with 45 smallholder households with the main focus on physical losses. Most of the household interviews were held in Kiswahili or Kiluhya by Zenah Abuti, and only around one out of five was held by me in English or partially in English with Zenah Abuti’s assistance in Kiswahili or Kiluhya where needed. Each interview lasted on average between 35- 45 min. Statistical analysis of the collected data was later on conducted using Statistical Package for Social Sciences (SPSS).

Many farmers said after the interview that only through the survey we had educated them about the problem and presence of PHL, and that they now understand there are possible gains to be made if PHL is reduced. Some were saying they would pay more attention to PHL next year, both to try to reduce it as well as to measure their loss. This shows that they care and are perceptive to more information and training on the topic, and that they want solutions.

4.1.1 The Questionnaire

Building my study on the already existing Afrint database enabled me to focus my data collection, as the Afrint database already provides me with household characteristics and necessary background information. The questionnaire used for household surveys could hence be formulated highly targeted, without fearing to miss out on relevant information.

The household questionnaire is partially pre- coded and aims most importantly at trying to establish the farmers’ own estimations of extent and challenges around PHL on the farm level. The questionnaire forms the main part of the empirical study. It includes 28 questions, with two filter questions to skip questions for those farmers who do not store or sell maize (see Appendix 2 for Household Interview). Q1- Q3 are focussed on production and usage and Q4- Q14 on storage and drying, before moving on to commercialisation (Q15- Q18). After this, a thorough definition of PHL was given to the farmers, followed by the section of the questionnaire covering causes of PHL, amount of PHL at the various stages of PH handling and measures and strategies taken to minimize PHL (Q19- Q28). At the end of each interview, respondents were

asked to give us an estimation of the total PHL in maize occurring on their farm at all stages of PH handling, to cross- check earlier answers.

4.1.2 Sampling for household interviews

The households surveyed for the purpose of this study all make part of the Afrint project. Within Afrint, village sampling followed a multi stage purposive sampling design. In Kenya, Afrint includes a total of ten villages, five of them in Nyeri District and five in Kakamega District. Each of the ten villages comprises 30 households. Villages were chosen based upon variability in agro-ecological potential and differences in levels of market access and population density (Karugia, 2003:3). Within the villages, households were randomly selected, and hence include a mix in terms of household characteristics. As the Afrint sample is statistically representative at the village level, this study can also claim representativeness on the village level, as all Afrint households were originally included in the sample (for more details on Afrint sampling procedure, see Djurfeldt et al, 2011:10 ff.). It will however not necessarily be representative of maize farmers in other parts of the country, as the challenges of PHL vary with climatic conditions and geographic location. Nevertheless, I hope that insights into post- harvest management practices derived from this study will be of value for other contexts as well, not the least as a ground for further research on PHL.

For this study, Mukuyu and Munyuki villages were purposively sampled from within the Afrint village sample, after consultation with both the Kenyan and the Swedish Afrint team. The choice of the Kakamega- Lugari sub county in the first hand was based on the intensive cultivation of maize in this part of Kenya. Farmers in Lugari Sub County are also more often commercialized as far as maize is concerned than farmers in other areas of Kenya where maize is grown for subsistence purposes. The relatively higher degree of commercialization presents important aspects for studying PHL in maize, as it offers opportunity to study the potential impact of commercialisation on PHL.

Within the sub county, Munyuki village was chosen to represent an area with a fairly good market access in view of its proximity to markets such as Lumakhanda town (the Sub County headquarters), Kipkarren River market (a very vibrant maize market on the Kenya-Uganda highway), Turbo market and Eldoret town (also vibrant maize markets on the Kenya-Uganda highway) (see Appendix 1 for detailed map of study area). Mukuyu village in return was chosen to represent an area with poor market access. The village is difficult to reach and has no all-weather roads.

Within these two villages, all Afrint households were originally included in the sample, which means a total of 52 households, as 8 households had already been excluded since the first Afrint survey was held in 2002 due to death or relocation. In two households no one was at home, even after several visits, a further two could not be surveyed because they had not yet shelled their maize and would hence not be able to answer the full survey, and one had not harvested anything at all this year. These households were not compensated for, and hence the final sample includes 47 households. Of these, two were furthermore purposively excluded from the sample after surveys had already been undertaken, a decision based on our impression that this could not be counted as valid data, which will be further explained in the section “Challenges in Data

Collection and Methodology”. The final sample hence includes 45 households, 22 from Munyuki and 23 from Mukuyu village.

4.2 Group Discussions

Two group discussions were carried out in Lugari District. Group discussions enable the participants themselves to bring issues that concern them to the surface, as most of the control of the discourse is handed over to the participants (Bryman, 2012: 503). This procedure created a counterpart to the more strictly held household surveys. In contrast to the Key Informant Interviews, all the participants in the group discussions work locally in Lugari, and could hence give a grassroots perspective on the topic. In addition, since the group discussions were conducted at the end of each week spent in either village, they also provided a valuable opportunity to complement, triangulate and elaborate earlier findings.

One of the groups involved different players in the maize value chain in Lugari District. The participants included three agricultural officers, one miller, one village elder, one *bodaboda*² transporter and two women group leaders, one of whom had also been involved in cereal banking initiatives (See Appendix 3 for List of participants). This group discussion is referred to as GD1. The other group discussion was with Munyuki village’s One Acre Fund group. This one is referred to as GD2.

The sessions were started with an introduction of our study, followed by the participants’ introduction of themselves. GD1 lasted approximately two hours, and GD2 around one hour. The GDs were conducted in a semi- structured way. Questions covered losses occurring at other stages of the maize value chain than the household level, the extent and nature of PHL and how it is dealt with on the local level.

4.3 Key Informant Interviews

A total of four Key Informant interviews were carried out with relevant stakeholders from both national and international organisations. The aim of these interviews is to see the topic on a broader scale and to give examples of ongoing initiatives aiming at PHL reduction in Kenya. All of the interviewees agreed to be cited for the purpose of this paper. They were selected based on their position or expertise relevant to the topic under study:

- Lilian Kirimi from the Tegemeo Institute of Agricultural Policy as a specialist on maize
- Tadele Tefera from the CIMMYT as the project leader of the Effective Grain Storage Project
- Andrew Karanja as a Senior Agricultural Economist at The World Bank
- Dickson Nyongesa as the Manager of the NCPB Kipkarren, the NCPB Depot closest to the interviewed households (see Appendix 1 for location of NCPB Kipkarren)

Interviews were of semi- structured character and questions varied depending on the interviewee.

² A *bodaboda* is a motorbike- taxi and a common mode of transportation in East Africa, both for persons as for cargo

4.4 Challenges in Data Collection and Methodology

Despite efforts over the years to develop acceptable techniques for measuring grain losses, this remains an imperfect science. I am aware of the problem of relying on retrospective accounts, since perception is always selective and people tend to forget details over time (Chambers, 1997: 57, 88), but have nevertheless chosen this approach since it is the only one available for the type of study carried out. Afrint data is also gathered based on retrospective accounts, which is why this approach was chosen in the first place.

As already mentioned, two households were excluded from the sample after surveys had already been undertaken. This decision was in one case based on that the interviewee, the 19- year old daughter who had just recently finished high school and who was the only one at home after several visits to the household, had herself never been involved in the handling of maize and was hence only guessing the answers from what she had heard her mother talk about. The other case was a farmer we believe substantially exaggerated his losses, as he might have thought we were seeking to reimburse and help those farmers who had experienced high losses.

This leads to Robert Chambers' work, who argues there are major obstacles for researchers and development practitioners against perceiving the nature and extent of rural poverty in developing countries (Chambers, 1981: 1). These obstacles are interlinked and of reinforcing character to each other and result in a misperception and/or underperception of rural poverty. The biases are: Spatial biases, project biases, person biases, dry- season bias, biases of politeness and timidity, and professional biases. I have during my study done my best to avoid these biases, but nevertheless some of them are difficult to counteract. The study was carried out a few months after the harvest which was necessary due to the topic of the study investigating post- harvest challenges. Difficulties encountered by farmers and transporters during the rainy season were hence not directly seen but only told about. Also, the farmers are generally more "well- off" shortly after the harvest, as many of them have recently sold their output and in this way generated some income. I would not argue that Mukuyu and Munyuki villages fall under Chambers' definition of "project bias" (Chambers, 1981: 6 f.), as the NGO and Government of Kenya presence is low in these villages, which is also why they were chosen to make part of Afrint in the first place, as Afrint seeks to include a mix of villages in terms of general village characteristics, agro- ecological potential and market access (see Djurfeldt et al, 2011:11 ff. for more information on Afrint sampling procedure, and Karugia, 2003: 6 ff. for general Afrint village characteristics). At this point I would like to mention though that Kenya as a country probably would fall under Chambers' perception of "project bias": Kenya is a well- visited country by foreign researchers and the international presence is high, and just as Chambers mentions, "research generates more research" (Chambers, 1981: 6), as students and scholars read about certain projects and then decide to perform their own studies on them.

It is difficult to prevent the creation of hierarchical structures - Even though we always tried to make clear that the purpose of our study was to listen and learn, people tended to expect us to be experts who were bringing solutions to them. This, as well as difficulties with biases of timidity, were at least to some extent eased by the fact that the study was carried out together with Zenah Abuti, who is from the area and speaks both Kiswahili and the local language

Kiluhya, which created a less intimidating atmosphere for the farmers than if I had come there on my own as a white researcher.

Another challenge included cultural norms around gender relations and could fall under Chamber's "person bias". In SSA, women are responsible for 90 % of the work involved in processing food (The Montpellier Report, 2013: 30). But, it is a cultural norm that the man is the one to be interviewed if he is at home, although it in most cases is the woman who does most of the post- harvest handling of the maize. In our sample, 28 respondents were female and 17 male. Despite most men interviewed nevertheless had a fairly good overview of and some were directly involved in most steps of the PH handling themselves, we perceived the women as being more able to give us accurate data. However, we did not try to influence who would answer our questionnaire, but let the household members themselves decide so as to not intervene in intra-household relations and structures.

4.5 Ethical considerations

"I want to appreciate this study because it enables farmers to be aware of the losses that they could be incurring without actually knowing. Because some farmers [...] take it as an acceptable loss."

(-Jacklyn Bwanjila, Agribusiness Officer Lugari District, GD1)

As already mentioned, not all farmers were aware of the "phenomena" of PHL as such prior to the study- Many farmers did not really see PHL as a problem, but rather accepted it as part of the chain and an inevitable component of PH handling. Also, many respondents started by answering our questions from a rather economic perspective, and we had to explain that what we were interested in was the physical loss. But when the farmers added the losses from the different stages towards the end of the interview (Q27), they generally realised that the total loss was rather substantial and that there were potential gains to be made if solutions were sought for. Anyway, although we tried our best to explain the definition of PHL in a neutral way and not to influence farmers during the interview, there is a danger that PHL becomes a problem in their eyes because we point it out as a problem. However, as the household interviews were of quantitative character, we don't expect it to have impacted on the data itself, as the answers to be given are rather detached from any emotional connotation.

5. Analysis and Results

In the following, results from data analysis will be presented. First, the quantification of losses will be presented. Then, results from correlation analysis are shown, before moving on to main causes and the reasons for losses occurring at each stage of post- harvest management.

However, even though post- harvest loss as such is to a large extent a technical problem, this study has seen that the condition of PHL to a great deal is a function of social, economic and political processes, which is why the analysis then moves on to presenting individual, community and external factors influencing post- harvest management. As mentioned previously, definitions of previous studies are generally divided into direct or indirect causes of PHL, or technical and governance- related causes. This analysis seeks to further deepen the body of knowledge on

causes of PHL through taking into account and distinguishing between individual factors, community factors, and external factors.

5.1 Quantification of PHL, Mukuyu and Munyuki villages

First of all, those responses that were not already coded in the questionnaire were post-coded (Bryman, 2012: 248 f.). Out of the 45 surveyed households, all apart from one agreed on that losses occur on their farms (Q19).

The total losses of PHL occurring in the surveyed farming households in Mukuyu and Munyuki villages are calculated as a percentage of total production, which represents the sum of the estimated PHL from all stages (shown in yellow in Fig.2.) added to the number of harvested bags (Q2, measurement: 90 kg bags of dried maize grain, shown in blue in Fig.2.).

The analysis showed that on average, **8.6 %** of total harvest is being lost during post-harvest handling in the 45 households in Mukuyu and Munyuki villages. In real terms this means a loss of around 41 bags (or 3667.5 kg of maize grain) for the 45 households, with the final production being 434.5 bags when not accounting for the lost maize. Considering that the average Kenyan's annual per capita consumption is 98 kg of maize, the amount of maize lost during PH handling in these households only would be enough to cover the annual maize consumption of around 40 persons. In economic terms, it means a loss of up to 6100 Kshs (~70 \$/ 450 SEK) for some households with high estimated PHL, with 2400 Kshs (175 SEK/ 27 \$) being the average price farmers receive for one bag of maize (Q18). To set this in perspective; the fee in secondary school in Kenya is generally around 13.000 Kshs per term. Hence, PHL represents financial losses at both ends, both in terms of wasted inputs and resources but also in terms of missed income opportunity.

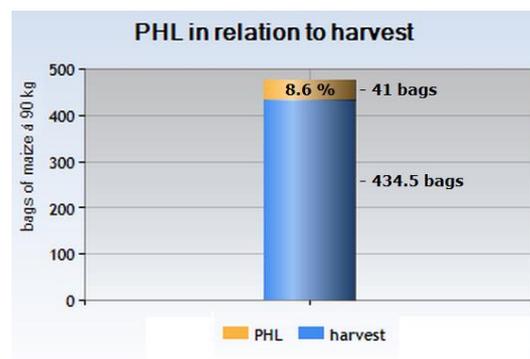


Fig.2. PHL in relation to harvest, all surveyed households

5.2 Stages of PH management and Causes of PHL

The scope of the study is from the exact time of harvest until processing, which in the case of maize means milling. At each of the stages in between, which are transportation from the field to the homestead and to value addition facilities, reoccurring drying, shelling and storage (the maize

is stored in form of dried maize grains) as well as during processing, maize is lost.

harvest - transportation - drying - shelling - drying - storage - transportation - processing

Stages of PH management of maize

When farmers were asked which stage they perceive as the stage where most losses occur (Q20), there was no major consensus as to which stage causes most PHL: 14 out of 44 respondents answered “drying”, followed by “shelling” with 13 respondents, “transportation from field to homestead and to value addition facilities” with 9 respondents and “storage” with 8 respondents.

This goes against the widespread view of storage as being the stage in PH management where the largest losses occur. The three researchers interviewed for this study also all mentioned losses occurring during storage as the main contributor to PHL, with poor storage facilities that makes the grain susceptible to rodent and weevil attack stated as the major issue (Karanja, 2013; Kirimi, 2013; Tefera, 2013). When adding the estimation of losses occurring at each stage for all households (see Fig.3), transportation is the stage with the highest total loss (1059 kg, or around 12 bags for all households), followed by drying (985 kg/ 11 bags) and shelling (940 kg/ 10.5 bags). Surprisingly, storage, which has so far been the centre of much research on PHL as it is perceived as the most problematic stage, shows the lowest total PHL (348.5 kg/ ca. 4 bags). This is of course influenced by the fact that the survey was carried out in January when the maize had only been stored for around two months and hence the chance of maize being infested by microbial growth or the LGB, which are the main contributors to storage losses, are comparably low. The estimation of PHL at 8.6 % of total harvest would probably have been higher, had we performed the study at a later stage when maize had been stored for longer. When asked generally about the main cause of PHL (Q21.) as distinct from stages at which PHL occur, around half of the farmers (23 respondents) chose “Insects” with the specification of LGB as the main cause of PHL. This points to the high occurrence of LGB in the area over the past years. Nevertheless, despite the storage stage undoubtedly posing challenges for reducing PHL, these findings show that research on PHL must follow an integrated approach and increasingly include all stages of the PH value chain, as losses occur during all stages of the post- harvest value chain. Innovations to tackle post- harvest loss are needed at all stages- Too much focus has so far been on a few components of the complex issue of PHL.

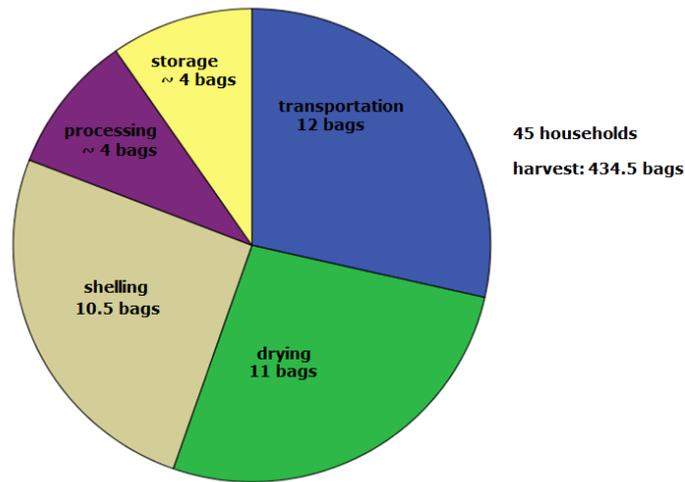


Fig. 3. Farmers' estimation of losses by stage, total amount of all households

In the following, a short outline of the losses occurring at each stage will be specified

5.2.1 Transportation

First of all, maize needs to be gathered in the field following harvest. During this process, maize is being thrown and hence shatters. Then, harvested maize, which is here still on the cobs, needs to be carried from the field to the homestead. This is most commonly done through carrying on the head. And as was often told during the household interviews, in case some of the maize falls down, the person carrying does not have the possibility to pick it up again, as there is still a heavy load on the head. Also when maize is being transported on an oxcart, or, as was only the case in one household, with a hired trailer, losses occur due to overloading as well as because of bad roads. At later stages, when maize is being sold, it is most commonly transported by *bodaboda*, and as pointed out by the *bodaboda* transporter during GD1, there is then no protection against rain. He also pointed out overloading as a reason for losses, as the bags then easily get damaged and maize pours out without the driver's knowledge. However, farmers prefer to get as much as possible transported at once, due to the cost of hiring a *bodaboda*.

Also when the dried maize is being taken to the miller, which occurs according to household consumption needs in small quantities, maize is being spilled. This task is often performed by children, who may not be very attentive to the spillage.

5.2.2 Drying

Drying is a labour- intensive stage, as the maize needs to be put out to drying several times before reaching the right moisture content. Drying occurs at several stages of the PH handling, both when the maize is still on the cobs, as well as after shelling. It is critical that maize is properly dried on the farm level, as it otherwise easily leads to losses at later stages of the chain (Kirimi, 2013).

Maize is dried through exposure to the sun. Most commonly, it is spread on canvas, as can be seen in the picture below. This is the technique used by the majority (27 out of 45) of farmers

from our sample (Q6). The second most common drying technique was spreading directly on the ground (9 respondents). Despite the disadvantage of maize absorbing the ground moisture when dried directly on the ground, farmers had to use this technique due to a lack of finances to buy a canvas. The cost of a canvas (20x25 ft) is 30,000 Kshs (=2200 SEK/ 340 \$), which is a lot of money for most of the farmers. Maize that is not properly dried will be more prone to insect infestation and microbial growth during storage.

Furthermore, the quality of the maize is negatively impacted when maize cannot be saved from rain on time, and with the increasingly erratic weather patterns occurring over the past years this has become a worry for farmers (Kirimi, 2013) (for example, it unexpectedly rained heavily in Kakamega on a number of occasions during the time of our data collection in January. December and January are usually dry months and hence traditionally when the drying occurs).

The losses occurring at the drying stage itself are however mainly domestic as well as wild animals eating from the maize laying out to dry, as well as maize being spilled on the ground during spreading and gathering. Furthermore, even when properly dried, the methods at use expose the maize to contamination from the surrounding environment (Kirimi, 2013), such as from insects, animals and air- borne contamination.



Img.1. Maize being dried, Mukuyu village

5.2.3 Shelling

Shelling is almost exclusively a manual process performed by women. Losses occur as maize grain splinter during the process of shelling, and needs to be sorted out as they are then not fit for storage. This is the type of loss that can be referred to as a “qualitative loss”, as it still can be used for other than the initially intended purpose (e.g. purposely fed to domestic animals). Another commonly used method for shelling is that of beating by stick, to make the maize grains

come off the cobs. Despite this being quicker than hand shelling, it also makes the maize more prone to contamination, as the grains easily crack using this method.

Shelling with a tractor is by far faster than shelling by hand. But even when maize is shelled through this mechanized process, which again was only the case in one of the interviewed households, losses were reported as the maize shatters, which was also confirmed during GD1 (Janet Anzeze, Cereal Banker and Women Group Leader) as well as by the One Acre Fund members at GD2.

5.2.4 Storage

The causes of losses during storage are mainly infestation by pests or insects (especially the LGB), and microbial growth (rotting). Farmers traditionally use very open storage structures to allow free airflow and continuous drying, but due to reoccurring cases of theft farmers now prefer to store their maize in their living houses, and even in their bedrooms (Kirimi, 2013). 43 out of 45 farmers stored their maize in their living houses (Q8). This impacts on the proneness to losses in terms of the higher humidity caused by humans and domestic animals, as well as the lower aeration inside the houses.

Furthermore, many farmers expressed insecurity around the proper way to apply pesticides. If pesticides are not applied properly, maize is more easily attacked by pests and insects. Another widespread issue posing a challenge not only for maize storage, but also for production, is that of counterfeits. Counterfeits in seeds, agrochemicals and fertilisers are common in Kenya, and the responsible Pesticide Control Board is not doing enough to monitor the market for counterfeits (Karanja, 2013). Ineffective, fake pesticides are even worse than using no pesticides at all, not only because the farmer has spent tight finances on buying them, but also because other measures and strategies aiming at preventing losses might not be taken due to the reliance on the effectiveness of the pesticides. The situation is the same for fake seeds- farmers are hurt first through the cost of buying the seeds, and then even more as they have nothing to harvest.

In addition, 44 out of 45 farmers store their maize in synthetic bags (Q7). Despite being well aware that storing in sisal bags is superior in terms of aeration, farmers have to use synthetic bags due to the unavailability and higher cost of sisal bags. Only one household used a mix of sisal and synthetic bags.

5.2.5 Processing

The miller present at GD1 estimated the losses occurring during milling to up to 1.5 kg for each 8 kg milled, and identified the main reason for losses in that maize simply remains in the machine and spreads in the air onto the walls during the milling process. This is due to the type of mills used which are often old and not very efficient (Karanja, 2013). Also, the winnowing of the maize that needs to be done before milling causes losses.

5.3 Correlation Analysis

Data was here matched with own collected data as well as already existing Afrint data, to see if there is any significant correlation (Bryman, 2012: 164, 370) between the household characteristics and the level of PHL. PHL is here referred to as the estimations from the different stages counted together. The Afrint data referred to was collected in 2002 and 2008, as the data for 2013 was collected after this study was conducted, and has not yet been computerised.

No correlation could be established between selling maize (Q15) and amount of PHL (see Fig.4). Neither could a lower amount of PHL be related to farming households that had taken part in initiatives by external actors aimed at reducing PHL (Q25) (see Fig.4). This potentially points to an insufficiency in the training received. As already mentioned, the One Acre Fund members during GD2 described how their yields had increased and also how their financial situation had improved due to their participation in the One Acre Fund group, which is also backed through official reports on One Acre Fund's achievements (see Montpellier Report, or www.oneacrefund.org). But, the analysis showed that being part of the One Acre Fund was neither positively nor negatively related to amount of PHL occurring in the households. Despite the sample being too small to be able to draw conclusions, one might assume that efforts are more focussed towards increasing yields. The One Acre Fund deals with PHL reduction initiatives as part of their training, but the topic might not yet have received enough attention.

Correlations				
		total PHL (all stages added by interviewer)	Do you sell maize?	Have you benefitted from any initiatives by external actors aiming at improving PH management ?
total PHL (all stages added by interviewer)	Pearson Correlation	1	-.110	-.107
	Sig. (2-tailed)		.479	.490
	N	44	44	44
Do you sell maize?	Pearson Correlation	-.110	1	-.289
	Sig. (2-tailed)	.479		.057
	N	44	45	44
Have you benefitted from any initiatives by external actors aiming at improving PH management?	Pearson Correlation	-.107	-.289	1
	Sig. (2-tailed)	.490	.057	
	N	44	44	44

Fig. 4. Correlation analysis between selling maize, participation in PHL reduction initiatives and total PHL (SPSS)

The age of the head of household did not show any significant correlation with PHL (Fig. 5). However, a correlation was found between gender of household head and amount of PHL (Fig. 5), with female headed households generally showing lower levels of PHL than male headed households. The correlation is two-tailed and significant at the 0.05- level. To reassure that the correlation is not caused by male headed households generally having a higher harvest and hence also naturally higher PHL, gender of household head was also correlated with amount of harvest

(Q2), but here, no correlation could be found (Fig. 5). Hence, it can be said that female headed households are less likely to incur PHL than male headed households.

Correlations

		Sex of head of household (c112)	Age of head of household (c114) ___ years	Educational level of farm manager? (c117) ___ years	total PHL (all stages added by interviewer)	How many bags of maize did you harvest during the last one year?
Sex of head of household (c112)	Pearson Correlation	1	.004	-.307	-.324	-.122
	Sig. (2-tailed)		.976	.027	.032	.430
	N	52	52	52	44	44
Age of head of household (c114) ___ years	Pearson Correlation	.004	1	-.241	-.264	-.151
	Sig. (2-tailed)	.976		.085	.084	.328
	N	52	52	52	44	44
Educational level of farm manager? (c117) ___ years	Pearson Correlation	-.307	-.241	1	.386*	.323
	Sig. (2-tailed)	.027	.085		.010	.032
	N	52	52	52	44	44
total PHL (all stages added by interviewer)	Pearson Correlation	-.324	-.264	.386**	1	.368
	Sig. (2-tailed)	.032	.084	.010		.013
	N	44	44	44	45	45
How many bags of maize did you harvest during the last one year?	Pearson Correlation	-.122	-.151	.323	.368	1
	Sig. (2-tailed)	.430	.328	.032	.013	
	N	44	44	44	45	45

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Fig. 5. Correlation analysis between sex, educational level and age of household head, total PHL and harvest (SPSS)

Educational level of farm manager and PHL also showed a significant correlation (significant at the 0.01 level, 2- tailed, see Fig.5). Surprisingly, the data showed that the more years spent in school, the higher the PHL. Here again, a correlation was also run between educational level of farm manager and amount of harvest. It showed a significant correlation (significant at the 0.05- level, see Fig.5), which explains the higher PHL- the data shows that the more educated, the higher the harvest, which is naturally also connected to higher PHL in real terms.

5.4 Indirect Causes of PHL

5.4.1 Individual factors

“The first thing is planning. [...] But, people here never plan.”

(- Millicent Bundé, Home Economics Officer Lugari District, GD1)

“It’s because of the poverty.”

(-Jacklyn Bwanjila, Agribusiness Officer Lugari District, GD1, on the lack of planning structures and the arising immediate need for cash)

Much of what contributes to post- harvest losses is caused by financial constraints on behalf of the farmer. The last question of the household survey (Q28: *What do you think you could improve or change in your post- harvest handling of maize, in order to reduce your PHL?*) aimed at finding out where farmers themselves saw the greatest potential of a change towards PHL reduction. The question was asked in the form of an open question (Bryman, 2012: 246), and answers were coded subsequently. The

majority of responses (22 out of 45) could be summarised under “financial constraints”. Farmers expressed that if they had the adequate funds, they could hire labour, buy the necessary inputs, build better storage structures, and raise the wages of the hired labour force in order to also raise the motivation to do a good job. Also, it was often mentioned that an improved financial situation could allow for the post- harvest handling to happen on time. In order to curb losses, it is important that farmers can perform all the steps of post- harvest handling timely and with the adequate labour force, as a delay of any one step in the process will impact negatively on the quality of the maize, and hence raise the likelihood of losses to occur. The second most common answer was simply “I don’t know” (14 out of 45). Despite being their own “experts” on agricultural practices, farmers often feel helpless when confronted with productivity challenges like these. This again points to the need of establishing platforms and programmes for education and training.

Analysis of time of and reasons for selling maize (Q16) for the 23 farmers out of the sample that do sell maize showed that most farmers (17 out of 23) sold their maize within the first two months after harvest. They did so because of a pressing need for cash. Hence, findings from this study are not consistent with what is said on the EGSP webpage that: “Ideally, the harvest provides the family with months of food. However, when weevils, rats, or other pests invade the storage farmers must often sell whatever they can, immediately” (www.cimmyt.org). Answers from the open question around why maize was sold at the time indicated (Q16→) could be coded into two major categories: because of household needs (13 out of 23) or due to cash needs for school fees (7 out of 23). Hence, selling maize shortly after harvest when prices are low does not occur due to a fear of storage losses as is commonly assumed, but rather because of immediate cash needs. Adding to this is that most maize farmers in Kenya who sell maize are net buyers of maize (Karanja, 2013; Kirimi, 2013). Maize is sold shortly after harvest when prices are low, and then, according to household consumption, needs to be bought back later when prices are higher (Karugia, 2003: 39). These cash flow issues might be more relevant when it comes to PHL reduction than commonly recognized, considering the identification of financial constraints as the major area for a potential improvement in PH handling.

However, farmers, just like any other producers, are rational cost- benefit thinkers. Investing in reducing losses might not be profitable, as the gain in terms of prevented losses might not outweigh the costs in terms of time and inputs. This means that farmers can only be expected to adopt new technologies and practices if they believe that the gains will be high enough to cover the costs. Changes that could benefit both the environment and smallholder productivity are thus not likely to be adopted if motivating policy measures are lacking. This is linked to the price offered for maize, which farmers generally consider too low. Price policies must recognize the need for a fair and reliable profit on behalf of the farmers, for which the right mix of price stabilisation policies must be identified and implemented (Karugia, 2003: 39).

5.4.2 Community factors

“You can educate the farmers [...], but that will not be very effective. The issue here is where they can come together.”

(-Andrew Karanja, The World Bank, on storage systems)

Not a single one of the farmers surveyed used a shared storage facility (Q10). When asked about the possibility of organizing a community store, all farmers present at GD2 answered unified that they prefer private storage, due to trust issues about storing in common places.

As important as tackling theft issues on the local level is hence to offer credible alternatives to in-house storage. For instance, Cereal Banking³, despite a number of weaknesses, has proven a good strategy not only for reducing losses as grain is kept in proper stores, but also to increase the marketing and bargaining power of the group, if managed well (World Bank, 2011: 16). During GD1, Janet Anzeze (Cereal Banker and Women Group Leader) described how her and her group had fetched much higher prices through cereal banking. Farmers need to hear about these positive outcomes of already established collective storage initiatives, in order to create trust to these kinds of initiatives and understand potential gains. Despite claims that the local Ministry of Agriculture branch encourages Cereal Banking (Millicent Bundé, Home Economics Officer Lugari District, GD1), not enough seems to have been done to inform and support these kind of initiatives.

However, security and trust issues as well as the potential benefits of collective storage are some of the few areas within PH handling that have been extensively researched and written about (see for example World Bank, 2011). A less thematized factor is that of social expectation – when stored maize is visible to household visitors, they expect to be gifted, especially if they are relatives (Janet Anzeze, Cereal Banker and Women Group Leader, GD1). This was pointed out by Jacklyn Bwanjila (GD1, Agribusiness Officer Lugari District) as a reason for why farmers are sceptic towards modern stores. Hence, any institution aiming at creating better storage systems for farmers needs to keep this in mind, in addition to the already mentioned fear of theft and trust issues, as farmers are unlikely to adopt any new strategy inflicting with societal concerns like these. As mentioned in the 2011 World Bank report “The socioeconomic components of postharvest projects should not be small, underfunded afterthoughts, but key drivers.” (WB, 2011: xiv).

5.4.3 External factors

As already mentioned, PHL are often tolerated because of a lack of economic incentive to reduce them. Kirimi (2010) argues that current structures do not create any incentives for farmers to store maize, neither to produce high quality maize as quality is rarely rewarded with greater returns when selling through small scale marketing channels (Kirimi, 2010: 38, 47). Also, as mentioned by Andersson Djurfeldt (2012: 2), raising land and labour productivity- to which a reduction of PHL belongs when following the SAI approach- through expensive inputs makes little sense if producer prices are low or unpredictable. Despite being the country’s by far most important staple food, the maize sector is not very dynamic- intensification rarely occurs through growing staple food crops, but rather by switching to other more profitable crops (Karugia, 2003: 27). However, diversification could contribute to improvements in the households’

³ Cereal banking is a system where poor communities are assisted in storing food throughout the year, helping the community to overcome and balance the boom and bust cycles in agriculture. In cereal banking, farmers form their own marketing associations to inspect, bulk, store and trade grains. This approach allows for longer and better storage and for marketing at favourable prices to large scale buyers during grain shortages, all of which leads to greater control by the farmers over their own produce and budgets.

economic situation, which in turn could have positive impacts on PH management in general, following the analysis above.

After interviews and analyses of selected ongoing initiatives in the field of PH management, it was noted that few initiatives were in fact aimed at the kind of households and their challenges dealt with in this study.

For instance, the Effective Grain Storage Project (metal silos) is targeted towards farmers that already store maize for longer periods- When asked about how areas for implementation were selected, project leader Tefera answered that first of all, areas were selected based on occurring storage losses, estimated through surveys. Within these areas then, farmers who store for 6 months or longer were considered for the EGSP. Considering our sample, there was only one household that stored maize for longer than 6 months. The majority of food in Kenya is produced by small scale farmers, many of which have immediate cash needs that prevents them from longer storage. It is this pressing need for cash that needs to be overcome in order to improve overall handling and financial situation of households, but if projects aim mainly at those farmers that are already somehow better off, the ones most in need will have an even harder time breaking the “vicious circle”. However, as the project goes on, the metal silo technology will hopefully spread and become accessible to more farmers than the ones chosen through the EGSP’s selection methods.

Furthermore, despite the NCPB having vast and high standard storage opportunities (Songa & Irungu, 2010: 4 f.), accessible to farmers through the Warehouse Receipt System, it is not a solution for small scale farmers (Nyongesa, 2013; Karanja, 2013). There are clearly advantages of standardisation and quality – if it wasn’t for strict intake procedures determining the right moisture content and checking for foreign matter, maize could not be stored for as long. But small scale farmers are not yet rife to meet the requirements and standards demanded by the NCPB (Jacklyn Bwanjila, Agribusiness Officer Lugari District, GD1). But more importantly, it can take several months until farmers are paid, which most farmers do not have the financial capacity to overcome. As expressed by the miller present at GD1 (Zackariah Avedi), farmers would rather accept losses on farm during storage, than to store at the NCPB where they don’t get paid promptly. However, even comparably well- off farmers do not consider the NCPB, as it does not make economic sense storing maize there considering the transaction costs in terms of transportation and the generally not much higher price offered through this system (Jacklyn Bwanjila, Agribusiness Officer Lugari District, GD1). When asked for the reason for not storing maize at the NCPB, most farmers (33 respondents) considered their harvest too small for storing at the NCPB, while others did not know about the option (4) or considered the transaction costs too high (5). However, the minimum intake is only one bag (Nyongesa, 2013), which points at misinformation or lack of information reaching the farmers. Kang’ethe (2011) argues that the Warehouse Receipt System is one of the best mechanisms available for smallholder farmers to overcome seasonality and storage challenges, and that the reason it is not yet being used extensively is because smallholder farmers are not aware of its value (Kang’ethe, 2011:39). However, this analysis shows that despite clear advantages of such a system, it is at the moment not a solution to smallholder farmers, as they are simply not ready to meet the required quality standards and high transaction costs.

Farmers prefer to sell to traders at comparably lower prices as they pay immediately (Karugia, 2003: 35); government agencies delay payments for long periods and are often incapable of handling in the wait for funds. Despite not being a parastatal any longer since liberalisation, the government is still the owner of the bulk of maize at the NCPB, as they subsidise purchases and hence offer higher prices than the NCPB itself as an institution. The NCPB has become like a sort of “government institution in the private sector” (Nyongesa, 2013), and it is in need of reform (Karanja, 2013). According to Karanja, the NCPB needs to start partnering with the private sector, which currently shies away from any investments in the grain sector because of the uncertainty around market prices, on which the government still has a large influence through the NCPB. Karanja generally sees the solution for most of the challenges around PHL in the private sector: “Eventually, it is the business side of it which will drive the whole thing” (Karanja, 2013). He sees the role of the government in creating an environment conducive for the private sector to invest in PH solutions. Tefera adds that there is currently an imbalance in the government investing heavily in the production side and not in PH technology at all (see also Kang’ethe, 2011), which is an area where the CIMMYT tries to influence policy makers. In summary, this might be an explanation for the low spread and adaptation of PH solutions, as the private sector shies away from investments due to the uncertainty in profitability, and despite some investments, the government has so far not been prioritising PHL reduction initiatives and solutions enough.

However, as important as development and implementation of PH solutions are adequate training and access to information. For this, farmers should not only be informed (which does not even seem to be the case at the moment) about so called barazas, but also *encouraged* to come to them.

5.5 Summary of Findings

8.6 % of maize harvested during the last season by the interviewed maize farmers in Kakamega-Lugari District in Western Kenya was lost during post- harvest handling. Losses occur at all stages of PH handling. The reasons for losses are complex and diverse and farmers’ post- harvest management techniques are determined by a variety of interacting factors.

So far, research has often focussed on only a few components of the challenges around PHL. This study argues that the importance of storage has so far been overemphasised in research and publications on PHL, as substantial losses occur during all stages of PH handling.

One of the main findings of this study is the importance the financial situation of the households plays in determining PH handling. Farmers themselves argue that if they had the adequate funds, they could contribute much to PHL reduction in maize grain, as much of what contributes to PHL is caused by a lack of finances e.g. to hire the needed labour force, to do the PH handling on time or to buy necessary inputs and materials. Efficient output markets are crucial, and so are input markets, where smallholders can buy high quality inputs in required quantities and at affordable prices. In addition, input supply needs to be more state- controlled in order to combat counterfeit.

As to which households are more likely to incur PHL, female headed households show lower PHL than male headed households. Commercial farmers are not more or less likely to incur losses than subsistence farmers.

Training on PHL is either lacking or of low quality. On the institutional level, the importance and extent of PHL seems not yet to have been fully recognized, and if recognized, not yet sufficiently acted upon. The low and unstable price of maize is generally a problem, as it both reduces the profitability of PHL reduction, but also prevents the private sector from investing in the grain sector.

6. Concluding remarks

Agriculture practiced under smallholder farmer-dominated landscapes is currently the backbone of food security in Kenya. Maize is by far the country's most important staple crop- access to adequate supplies of maize is in Kenya generally equated with food security.

This study shows that losses occur all along the post- harvest value chain for maize among the interviewed smallholder farmers in Lugari District of Western Kenya. The losses incurred mean a physical loss which translates to an economic loss. A reduction in losses would mean an increase in total output and hence a potential increase in income for those who already sell maize, but also for those whose harvests have so far been too small to sell any surplus. Overcoming financial constraints is crucial to improving PH handling, but the current scenario rather traps smallholder farmers in a “vicious circle” in which farmers lack economic means for improving PH handling and reducing losses. It is crucial that technologies and practices aiming at PHL reduction reach the farmers, and that these are congruent with existing farm systems and consistent with smallholders' constraints. Technologies and practices need to be socially sensitive and culturally acceptable, as their adaptation is otherwise unlikely.

Apart from the economic implications, reductions in PHL would also mean a reduction in the loss of natural resources and wasted inputs. PHL reduction can help to close the gap in domestic maize production, which is currently met with expensive imports. It also holds the potential to contribute towards food security, as rural areas where food is produced are, ironically, often “where the hungry live”. The potential gains of reducing PHL hence go far beyond the household level.

This study tries to show the need for food waste and food loss to be incorporated into the general discussions around the future of food consumption and production. The sustainable agricultural intensification approach has already recognised this need, and this study presents a practical example which shows the extent of and challenges connected to specific food loss, but also its potential impacts on economic development, environmental sustainability and food security.

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Appendix 2 - Questionnaire

Post- Harvest Maize Grain Losses Study

Zenah Abuti, Kenyatta University & Vera Karmebäck, Lund University

Jan- Feb 2013, Lugari District, Kakamega County

Household interviews

Afrint Household ID:

Name of household:

Village name:

Munyuki

Name of interviewee:

Position within household:

Age:

Gender: (m) (f)

Production

Q1. Do you grow maize?

- (a) Yes (b) No

Q2. How many bags did you harvest during the last one year?

Q3. Please indicate how many bags were used for the following purposes during the last one year:

- (a) Sold: _____ bags
(b) Household consumption: _____ bags
(c) Remitted: _____ bags
(d) Animal feed: _____ bags
(e) Worker's payment in kind: _____ bags
(f) Others: _____

Storage before marketing

Q4. How much of the harvested maize is stored, i.e. not sold or used within the first two weeks after harvest?

- (a) All
(b) More than half
(c) Half
(d) Less than half
(e) Nothing is stored after harvest (e.g. everything is sold/used within the first two weeks after harvest)

➔ If (e), please proceed to **Q13**.

Q5. How is maize stored immediately after harvest, before drying? | **Specifications:**

- (a) In sisal bags _____
(b) In synthetic bags _____
(c) Spread on canvas _____
(d) Hanging _____
(e) Others: _____

Q6. How is maize dried?

- (a) Spread on canvas
- (b) Spread on polythene paper
- (c) Spread on tarmac
- (d) Spread on concrete floor
- (e) Spread on the ground
- (f) Using a drier
- (g) Others: _____

Q7. How is maize stored after drying?

Specifications:

- (a) In sisal bags
- (b) In synthetic bags
- (c) Spread on canvas
- (d) In metal silo
- (e) Hanging
- (f) Others: _____

Q8. Where is maize stored?

- (a) In traditional granary
- (b) In living house without improved structure
- (c) In living house with improved structure
- (d) Rented facility, please cross if NCPB storage: ()
- (e) Others: _____

Q9. How long after harvest is maize typically stored before being sold or used?

Q10. Are the storage facilities shared or private?

- (a) Shared (b) Private

Q11. Have there been any changes to these storage methods (referring to both facilities and modes of storage) in the last decade?

Q12. Are there any challenges/ problems/ constraints for storing maize?

- (a) Lack of finances to build or to rent storage facilities
- (b) Lack of finances to buy pesticides
- (c) Inefficacy of pesticides
- (d) Uncertainty in profitability and market prices
- (e) Theft
- (f) Others: _____

Q13. Do you think the people that handle the maize after harvest have the requisite knowledge on proper handling?

Q14. What is the reason for not storing at NCPB? (Unless otherwise indicated at **Q8.**)

Commercialisation

Q15. Do you sell maize?

- (a) Yes
- (b) No

➔ If (b), please proceed to **Q19**.

Q16. When do you normally sell maize?

(a) Within the first two weeks after harvest

(b) Later. ➔ Please indicate: _____

➔ For both (a) and (b): Why?

Q17. How do you get information on market prices for selling maize?

Q18. What was the minimum and maximum market price for selling a 90kg bag of maize in the last one year?

Post-Harvest Losses (PHL)¹

Q19. Do you lose any maize grains during post- harvest handling?

Q20. In your view, where in the post- harvest maize value chain do the major losses occur?

- (a) Transport from field to home and to value addition facilities
- (b) Drying
- (c) Shelling
- (d) Storage
- (e) Processing

Q21. In your view, what is the main cause of post- harvest maize losses?

- (a) Rodents () **Specification:** _____
- (b) Microbial growth () _____
- (c) Insects () _____
- (d) Poor storage structures () _____
- (e) Poor handling () _____
- (f) Eaten by domestic livestock () _____
- (g) Others: _____

Q22. How much do you estimate was lost during the following stages of PH management in the last season?

Specification:

- (a) Transportation from field to home and _____
to value addition facilities: _____ kg _____
- (b) Drying: _____ kg _____
- (c) Shelling: _____ kg _____
- (d) Storage: _____ kg _____
- (e) Processing: _____ kg _____

Q23. What measures and strategies do you take to minimize PHL, if any?

Q24. How efficient and effective are these measures and strategies in preventing losses?

Q25. Have you benefitted from any initiatives by external actors, such as the Ministry of Agriculture, NGOs or any other institutions aiming at improving PH management? Give examples: Such as extension training of workers, workshops, provision of hand shellers, dryers on the community level, moisture meters. Please name the institution and how.

Q26. How many bags of maize could not be used for the initially intended purpose, but were instead used in another way, such as marketing at a lower price or given to animals?

Q27. Taking into account all the maize you harvested and the losses incurred, please estimate how many bags of maize were you not able to use due to post harvest losses? (incl. maize indicated at **Q.26**)

Q28. What do you think you could improve or change in your post- harvest handling of maize, in order to reduce your PHL?

¹ At this point the farmer is given an explanation of how we define PHL: Post- Harvest Losses mean a measurable quantitative and qualitative **unintended** loss in a given product which makes it unavailable or unfit for human consumption, occurring during any of the various phases of post- harvest handling. Hence, it does not refer to losses occurring prior to harvest, neither to weight losses as a result of drying, nor to theft. We specifically refer to the time frame from harvest until marketing or consumption.

Examples: Lost due to insects, rodents or microbial growth during storage, Lost during transportation, Unintentionally consumed by animals

Appendix 3 - GD1 List of Participants

	Name	m/f	Position
1	Chripin Munianganyi	m	Field Extension Officer, Lugari
2	Zackariah Avedi	m	Posho Miller
3	Moses Galler	m	Transporter
4	Janet Anzeze	f	Cereal Banker & Women Group Leader
5	Rose M Indusa	f	Farmer & Women Group Leader
6	Ephraim Adelli	m	Village Elder
7	Millicent Bundé	f	Home Economics Officer, Lugari
8	Jacklyn Bwanjila	f	Agribusiness Officer, Lugari