The Effects of Pre-harvest Practices on Food Loss in Gucha Sub-County, Kisii County, Kenya

Peter Gutwa Oino, Joram Kareithi, & Benard Sorre
Moi University
School of Arts and Social Sciences,
Department of Anthropology and Human Ecology
P.O Box 3900-30100
Eldoret, Kenya
oinogutwae@gmail.com, bsorre@yahoo.com,
jnkareithi@gmail.com

Abstract
One of the crucial and significant factors for ensuring a successful agricultural food production among smallholder farmers is pre-harvesting procedures. Pre-harvesting is considered the last step in agronomy that ushers in food harvesting, and should be approached as the first one in the post-production system, due to its impact on the amount of food loss and waste. In most rural areas of the world, little focus has been invested towards understanding how household food-resource handling procedures contribute to incidences of food insecurity. This paper investigates the effects of pre-harvest practices on food loss in Gucha Sub-County, Kisii County, Kenya. The paper is based on a study that focused on household food-resource handling procedures and food security in Gucha Sub-County. Qualitative and quantitative research techniques were used to collect data on pre-harvesting variable and the effect of this variable on food loss and eventual food insecurity in the study area. The study found that pre-harvest conditions and actions in the field can directly or indirectly lead to food losses at later stages in the chain, as differences in production and agronomic practices can result in different quality at harvest, different suitability for transport and, different storage stability and different shelf-life after harvest. In this regard, pre-harvest phase helps us in understanding the level of preparedness of the smallholder farmer in the next step, which is harvesting. It is the observation of the study that, if pre-harvesting is done well before the actual harvest, and smallholder farmers have knowledge on how to avoid pre-harvest losses, less food is going to be lost at harvest thus countering food insecurity.

Keywords: *Pre-harvest Practices, Food loss, Food Security*

1.0 Introduction

Food loss and waste is a major concern for most countries of the world. FAO (2012) defines food loss as a decrease of food production chain from harvest to consumption, in mass, of food that was originally intended for human consumption regardless of the cause. Approximately, one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. Food is lost or wasted throughout the food production chain, from initial agricultural production down to final household consumption (Gustavo et al. 2012). Food loss has been a major cause of food insecurity in many households, and it is blamed on household food-resource handling practices on the farm and household, which is influenced various factors among them are social factors.

In many studies such as Aschemann-Witzel et al. (2015); Evans (2011), food-resource handling procedures and in particular, social influences on food loss and waste have been given little attention. One of the crucial and significant factors for ensuring a successful agricultural food production among smallholder farmers is pre-harvesting procedures. Pre-harvesting is considered the last step in agronomy that ushers in food harvesting, and should be approached as the first one in the post-production system, due to its impact on the amount of food loss and waste. In most rural areas of the world, little focus has been invested towards understanding how household food-resource handling procedures contribute to massive incidences of food insecurity due to losses incurred during the process.

Although APHLIS (2014) found that the total food loss for cereals during pre-harvest and harvesting oscillate between 14% and 16% of the production, not much has been done to reduce food losses and waste. Shepherd (2012) findings reveal that pre-harvest losses occur before the process of harvesting begins, and may be due to insects, weeds and rusts. Magan and Aldred (2007) observed that in the case of maize, it is traditionally left to dry on the fields prior to harvesting through stoking for about 2-4 weeks. During stoking some losses are incurred through rodents, mainly rats and squirrels. The use of biological control with microorganisms, including fungi and bacteria, against plant pests and diseases has been found to be effective for reducing pre-harvest losses (Bayman, 2007). But, are the smallholder farmers in the study area aware of these? According to HLPE (2014), food pre-harvest conditions and actions in the field can indirectly lead to losses at later stages in the chain. Losses of significant produce at pre-harvest do not enter into the scope of definition of food loss. However, pre-harvest conditions and or operations can also indirectly lead to food loss at harvest or/and at later stages in the food production chain.

In countries like Nigeria and Bangladesh (Kumar & Kutali, 2016), food loss especially on cereals at pre-harvest periods is prevalent. Florkowski et al. (2009) have found that agronomic factors where pre-harvesting partly lies precipitating post-harvest food losses in terms of quality and quantity include choice of crop varieties for production, fertilization and/or nutrient management, water management, pest and disease management, drainage system, staking, transport preparations and bagging. Biological factors and environmental factors in pre-harvest period can also lead to failure in attaining desirable quality during crop production, which may lead to a high percentage of food losses (Oerke, 2006). However, accurate estimates of agricultural losses caused by insects during agronomic activities are difficult to obtain because the damage caused depends on a number of factors related to environmental conditions, the plant species being cultivated, the socioeconomic conditions of farmers, and the level of technology used (Oliveira et al. 2014). Apparently, food losses owing to these attributes vary according to the different types of cultivation, seasons and different production strategies, availability and extent of agricultural extension services for farmers.

Although there have been some studies on post-harvest, few attempt to estimate total food loss and waste on-farm or during pre-harvest are evident. Additionally, there are few peer-reviewed food loss and waste studies (Muth et al. 2007). According to AGR (2016) smallholder farmers mostly in rural areas continue to lack access to knowledge about current agronomic best practices in an effort to reducing food loss and waste. The barriers to extension on a large scale continue to pose a great challenge. For instance, Gandhi (2016) notes that extension agents are too few, with farmers growing many varieties of crops and speaking too many languages for service providers to develop and apply a standard

mechanism and transportation infrastructure is inadequate, making it difficult for extension agents to reach rural communities.
Ousmane et al. (2016) on the other hand quips that agro-input companies, have the input products needed, but face challenges in reaching smallholder farmers who live mainly in remote and hard to reach places. From the above review, agronomists and extension agents, quite often lack a platform on which to record farm and crop data that could help other value chain actors and the end result is a vicious cycle of misinformation, misuse of resources, low productivity and crop loss despite high input costs, and a disconnected, under-performing value chain system.

Despite food loss and waste in agronomic and pre-harvest stage, many studies haven't focused on pre-harvest strategies that can reduce it. For instance, a recent upsurge of interest has been on post harvest loss of cereals, which have even led to the development of the African Postharvest Losses Information System (APHLIS)-2010, which include a network of local experts, a loss calculator and a free access database of key information to help understand the extent of food loss and waste (Hodges et al. 2010). Notwithstanding the progress made in achieving reduced food loss at pre-harvesting phase, few governments have substantive programs to monitor and systematically evaluate the losses at pre-harvest stage in the food production chain and Kenya is one of the countries that have done little, as there exist inadequate interventions on types of cultivation, unavailability of agricultural extension services and pests management systems. This is the reason why, data on food losses experienced during pre-harvest stages are extremely scarce and scattered in the scientific literature.

The research on this paper was conducted in Gucha Sub-County which has 19,645 households. Kisii County is situated in Western Kenya. As per the 2009 census, it has a population of 1.5 million with, 245,029 households and covering an area of 1,317.4 sq. km. The population density stands people per sq. km and about 51% people live below poverty line, while 85% of the total populations living in rural areas, and 90% depend mainly on crop production for their livelihood (KNBS, 2010). The study used a survey research design to give descriptive accounts of the various situations observed on household food-resource handling in Gucha Sub-county. The researcher employed interview schedule, key informant interview, focus group discussions and direct observation as the main methods of data collection. Purposive sampling was used to select participants in the in-depth interview methods. Data was analyzed using both qualitative and quantitative techniques.

This paper therefore, investigated the influence of pre-harvest practices on food loss in Gucha Sub-County, Kisii County, Kenya. One of the crucial and significant factors for ensuring a successful agricultural food production among smallholder farmers is pre-harvesting procedures. Pre-harvesting is considered the last step in agronomy that ushers in food harvesting, and should be approached as the first one in the post-production system, due to its impact on the amount of food loss and waste. In a focus group discussion, smallholder farmers shared that for maize to be ready for harvesting, it has to be left to dry in the field until all the leaves of the maize plant turn brown. It was also shared that the maize is mature and ready for harvesting when the silky hairs come out of the top of the maize cob turn to brown and a black coloured line forms at its point of attachment on the cob. As well, the maize cobs ready for harvest should face downwards as an indication that moisture content has reduced to required levels. This is shown in Plate 1.1 below.

Plate 1.1: Dried matured maize with cobs upside down ready for harvesting (July, 2016)

It was shared by research participants that maize becomes mature and acceptable for harvest when the kernels reach the hard dough stage. At this stage, the kernels are full, hard and have reached their natural colour. One participant said: "one can confirm whether maize is ready for harvesting by scratching the kernel with a fingernail or pressing hard; if the maize is hard, then it is ready for harvesting" (Male participant, 59 years). Another important indicator was the presence of many birds, rodents, and pests visiting the farms to feed on matured maize.

2.0 Predisposing Factors to Pre-harvest Food Losses

The researchers were interested to know whether birds, rodents, pests and thieves led to maize loss on the farms before harvesting. Seventy four percent (74%) of the respondents mentioned rodents, 58% said pests and birds, and 57% mentioned theft. For the respondents who mentioned rodents as a source of maize loss, they shared that this was a persistent cause of food loss in the pre-harvest period. As maize cobs are drying, they are traditionally left prior to harvesting through stoking, or left standing in the mother plant in the fields for 2-3 weeks. This is the time rodents invade and feed on the matured maize cobs. This is confirmed by Magan and Aldred (2007) that during stoking about 5% of maize loss is incurred through rodents, mainly rats and squirrels.

During a focus group discussion, participants said that they employed control measures particularly when only rodent symptoms were seen and/or when damage was observable. This means that food loss has already occurred. Some smallholder farmers used acute rodenticides because of the perceived efficacy. However, to some, it was not affordable. To smallholder farmers who could not afford rodenticides, they preferred controlling the rodents such as rats using manual traps. The above finds are also confirmed by the Kenya's Ministry of Agriculture which reported in the year 2008 that in Western Kenya, food crop damage by rodents was between 1% and 5% (GoK, 2009).

On theft cases, food loss was rampant when maize in a particular farm matured earlier or later

than others as passersby could steal maize from the farms. Discussants in a focus group discussion shared that smallholder farmers were forced to organize individual and community security and/or neighborhood watch for maize crops especially when they are mature and drying on the farm. However, as a mitigation strategy in minimizing maize theft, smallholder farmers encouraged same time group planting and harvesting. Although, other smallholder farmers could not afford same group planting due to unavoidable circumstances such as lack of inputs like maize seeds and fertilizer for planting. Therefore, this group of smallholder farmers could wait until they purchase inputs, and then plant later. This led to varied time of harvesting.

A visit to various farms by the researchers would show farms that are fenced using timber logs, barbed wire, live fence, and even in some cases, there was physical surveillance of the crops by the owners of the farms. This implied that the smallholder farmers needed additional finance to manage maize on the farm before harvest. To other smallholder farmers, extended pre-harvest field drying was required to ensure good preservation since, harvesting before drying increases the risk of maize grain loss through moulds and the rotting of some of the seeds. The study however, observed that many smallholder farmers wait for too long to start harvesting given that they lack suitable drying facilities. According to a key informant:

> If drying facilities are not available in the homestead, harvesting is delayed by the smallholder farmer until the moisture content in the maize grain is reduced to 15-20%. The rate of drying on the maize plant will depend upon weather conditions during the season (Male Participant, 64 years).

From the above finding, leaving maize to dry on the farm for too long will expose it to other vulnerabilities such as attack from pests. However, as Alakonya et al. (2008) observes such delay may expose maize to other vulnerabilities, which include; theft, rotting incase it is raining, hence food loss on the farm. This was also evident in a study by Oerke (2006) who found that the pre-harvest maize damage attributed to pests is estimated to be 26–29% in mass of soybean and 31% in maize. On theft cases, the study found that some smallholder farmers hired security guards to provide security on the farm. In other cases, family members especially husband and boys if available were required to provide security on the farm to prevent maize from theft by neighbors and passersby. This finding was supported by one of the agricultural extension officers in the study area who observed that:

> Smallholder farmers in Gucha sub-county use their traditional knowledge in agronomic practices without consulting us…they leave their maize in the field beyond physiological maturity to allow it dry in order to facilitate direct storage into the store without sun drying (Male informant, 49 years).

From the above evidence, smallholder farmers apply traditional knowledge they possess for local level decision making in food-resource handling processes. This concurs with De Irala-estevez (2000) who noted that indigenous knowledge is about the common sense ideas and cultural knowledge of local people concerning day-to-day life. The study observed that indigenous knowledge for smallholder farmers is critical to the way households determine their daily food-resource handling practices and cope with daily living.

3.0 Reciprocal Food Exchange

Reciprocity is one of the main strategies employed by smallholder farmers to ensure maize

availability. In this study, reciprocity is a non-economic mechanism that is used to provide food-resources to those who are unable to fully participate in their food needs at a given time. As asserted by Lomnitz (2002), households create adaptive mechanisms to counter food harvesting deficits and the shortcomings of market systems, and the farming households in Gucha sub-county are no exception. The researcher observed that smallholder farming households in the study area, sharing of food-resources are done at household level rather than communally.

The informal systems used by households in accessing food are currently fading away because of economic challenges experienced by majority of households in the study area. This has forced many smallholder farmers to work independently thus, moving away from collectivity. One participant narrated that: "Nowadays it is not easier to share food like before (old times), because people are faced with many economic challenges such as scarcity of land for farming and inadequate income" (Male participant, 45 years). Additionally, some households have taken advantage of intimate bonds and reciprocity and do not work hard in their own farms, hoping that they will be considered by those who have plenty. This has reduced the willingness of people to help in times of need.

4.0 Social Factors

Food loss and waste is a major concern for most countries of the world. It has been a major cause of food insecurity in many households, and it is blamed on household food-resource handling practices on the farm and household, highly influenced by social factors. In many studies such as Aschemann-Witzel et al. (2015), food-resource handling procedures and in, particular, social influences on food loss and waste have been given little attention. This study holds that food loss and waste cannot be addressed well without ground breaking research on micro-context environments (that is households) where major food-resource handling activities take place. This is because in the micro-environments, it is the cultural knowledge that informs people's norms, customs, values and habits in relation to food-resource handling processes.The research was interested in finding out how social factors influence pre-harvesting process among respondents in the study area. Out of 377 respondents, 294 (78%) of them were influenced by household type, 266(69%) were influenced by family lifestyles, 211 (56%) were influenced by individual behaviors and perceptions of and expectations towards foods, On individual's behavior, it was shared that eating and the perceptions of respondents' consumption behavior were critical factors influencing harvesting before time, which eventually led to food loss and waste in the study area. For instance, on household type, large households were forced to cook a lot of food in the house because all members must get satisfied and some food must remain on the plate. A key informant said that: "once the food cooked is eaten, it should remain as a sign of satisfaction, if it does not remain especially for the case of children it is believed that the children are not satisfied" (Male informant, 46 years). Therefore, this study maintains that households' social behavior influences the amount of food lost or wasted. However, this aspect is widely ignored by most food security interventionists and studies.

5.0 Hastened Harvesting

Before maize has dried for harvesting, some smallholder farmers especially those who are faced with chronic hunger hastened maize harvest. In this study, hastening harvest is the process of removing maize from the fields before it is ready for harvesting. The researcher was interested to know whether all respondents engaged in 'ogotobora' (early harvesting) or not. Findings indicated that 249 (66%) of the respondents had engaged in this practice season in season out, whereas 128 (34%) of the respondents waited until the right time to harvest.

From the above analysis, ogotobora is a practice that is commonly used to bridge the gap between agronomy and harvesting periods in the study area. The operation entails removing maize grains (green cobs) otherwise not mature from the field and sun drying it until it is suitable for milling. Other smallholder farmers could sell green maize cobs to vendors to get money in return to purchase maize grains from the market for milling. The maize vendors then boil the green maize or roast it for selling.

The households that hastened harvest gave various reasons for this practice. For instance, respondents explained that they were forced to remove green maize from their farms due to a number of reasons: Fifty two percent (52%) of the respondents said that they ran out of food stock. Twenty six percent (26%) were not able to purchase more food to wait until maize dries well, while 22% did not find enough food in the market to purchase for household consumption. For the respondents who had run out of stock and were not able to purchase food from the market, they did not have enough money to buy food for the household. The study observed that, when the actual harvest time reached, these respondents had less to harvest. From the researcher's observation, hastened harvest makes maize grains to shrink, since it has not dried well on the farm hence, quality loss.

One participant explained that since he engaged in ogotobora, his actual output fell far below the normal harvest expected. This is for the reason that, soon after the harvest, his granary was empty again. But for him, ogotobora is a coping strategy, which cannot be ignored as it enables households to meet their immediate food needs just before the actual harvest begins. However, it is the observation of the study that ogotobora is a food loss and waste endeavor since more maize cobs/grains are used due to shrinkage when sun drying unlike when maize could have been used had it dried naturally on the farm.

During focus group discussions, it emerged that before harvesting, all equipment such as granaries and transportation containers that will hold maize grains as it moves from the field to the homestead for storage should be thoroughly cleaned prior to harvest to minimize mould and pest infestations and protect the purity of individual maize grains. Additionally, a smallholder farmer needs to prepare well in advance a place where to keep the cobs clean and dry in order to avoid fungal infestation. It was also shared that containers used to carry maize such as baskets, carts, wheelbarrows and bags have to be cleaned to remove dirt and old grains and cobs.

During interviews, one of the participants explained: "for the tools to be clean, they have to be treated with boiling water to kill pests and/or their eggs" (Male respondent, 48 years). From this finding, it is implied that this is done in order to avoid infection of new maize grain by pests and their eggs. However, observation on some smallholder farmers through their expression during focus group discussions showed that they did not have skills and were unable to effectively prevent or control field losses. This is also confirmed by World Bank (2011) that for the low income countries, pre-harvesting management knowledge is limited hence, eventual food loss. In this study, it is observed that such loss is invisible that the smallholder farmer realizes it during harvesting time.

6.0 Labour Organization

Before a household decides to harvest, it has to organize labour in advance. Where family members are not enough to do harvesting, the household will have to ask for help from their neighbors or hire. One of the participants narrated that: "in some cases during harvesting, you

find that you do not have money, but you can compensate neighbors' time by providing food and local brew" (Male participant, 48 years). This implies that the maize cobs/grains to be harvested are going to be less if it is shared with those who are going to provide labour during harvesting. The above findings are in agreement with Takane (2008) study in Malawi where he found that apart from family labor available within the household; labor exchanges among relatives that involved other households and even outsiders are also practiced. In some cases, laborers are paid in cash and if the household did not have cash, labourers are paid in kind-usually-in form of maize and/or cooked food. One important observation made during the study was that poor agronomic and socio-cultural practices in food handling, general lack/inadequate information on good production, and pre-harvest handling practices determine qualitative and quantitative food loss for smallholder farmers in the study area.

7.0 Conclusion and Recommendation

From the foregoing discussion, it is evident that pre-harvesting is an important aspect in the food production chain and more in food security. Pre-harvest conditions and actions in the field can indirectly lead to losses at later stages in the chain, as differences in production and agronomic practices can result in different quality at harvest, different suitability for transport, different storage stability and different shelf-life after harvest. In this regard, pre-harvest phase helps us in understanding the level of preparedness of the smallholder farmer in the next step, which is harvesting. It is the observation of the study that, if pre-harvesting is done well before the actual harvest, and smallholder farmers have knowledge on how to avoid pre-harvest losses, less food is going to be lost at harvest thus reducing food insecurity gap.

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