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Post-harvest food losses in a maize-based farming system of semi-arid savannah area of Tanzania

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ABSTRACT

An assessment of post-harvest handling practices and food losses in a maize-based farming system in semi-arid areas of Central and Northern Tanzania was carried out in 2012. Seventeen crops were mostly cultivated by the farmers in the surveyed areas; maize (32%), sunflower (16%) and pigeon peas (12%) were the most cultivated while maize was the most stored. There are at least 7 months between two harvest seasons of each crop; while farmers sold the crops soon after harvest to cater for household expenditure (54%) and school fees (38%), the market prices increased significantly ($P \leq 0.05$) within six months of storage. Most processing activities (winnowing, dehulling, drying, sorting and shelling) were carried out manually, almost entirely by women, but mechanized processing for maize, sunflower, millet, and sorghum were commonly practiced. Quantitative post-harvest losses of economic importance occur in the field (15%); during processing (13–20%), and during storage (15–25%). The main storage pests responsible for the losses are larger grain borers (*Prostephanus truncatus*), grain weevils (*Sitophilus granarius*) and, the lesser grain borer (*Rhyzopertha dominica*). Most of the farmers considered changes in weather (40%), field damage (33%), and storage pests (16%) as the three most important factors causing poor crop yields and aggravating food losses. However, survey results suggest that the farmers' poor knowledge and skills on post-harvest management are largely responsible for the food losses. 77% of the surveyed farmers reported inadequate household foods and 41% received food aid during the previous year. Increasing farmers' technical know-how on adaptation of the farming systems to climate variability, and training on post-harvest management could reduce food losses, and improve poverty and household food security.

1. Introduction

More than 70% of the sub-Saharan African population is directly involved in agriculture as the primary source of income and food security. Therefore, growth in agriculture production and productivity are critical for eradicating extreme poverty and hunger in the continent. However, sub-Saharan African agriculture productivity and the per capita value of agriculture output is the lowest in the world (FARA, 2006). Despite the low total agricultural productivity, post-harvest losses of the food being produced are significant (World Bank et al., 2011).

Post-harvest and marketing system is a chain of interconnected activities from the time of harvest to the delivery of the food to the consumers. Agricultural commodities produced on the farm have to undergo several procedures like harvesting, drying, threshing, winnowing, processing, bagging, storage, transportation, and exchange before reaching the final consumer. The primary role of an effective post-harvest system is to ensure that the harvested food reaches the consumer, while fulfilling customer satisfaction in terms of quality, volume and safety. Post-harvest losses in the developed countries are lower than in the developing countries because of more efficient farming systems, better transport infrastructure, better farm management, and effective storage and

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processing facilities that ensure a larger proportion of the harvested foods is delivered to the market in the most desired quality and safety. For the low income countries, pre-harvesting management, processing, storage infrastructure and market facilities are either not available or are inadequate (World Bank et al., 2011).

Post-harvest loss in terms of value and consumer quality attributes can occur at any stage between harvest and consumption. The major physiological, physical and environmental causes of post-harvest losses are high crop perishability; mechanical damage; excessive exposure to high ambient temperature, relative humidity and rain; contamination by spoilage fungal and bacteria; invasion by birds, rodents, insects and other pests; and inappropriate handling, storage and processing techniques (World Bank et al., 2011). Losses may be aggravated by poor infrastructure, harvesting methods, post-harvest handling procedures, distribution, sales and marketing policies (World Bank et al., 2011). According to Tyler (1982), the economic importance of the factors leading to high post-harvest losses varies from commodity to commodity, season to season, and the enormous diversity of circumstances under which commodities are grown, harvested, stored, processed and marketed. In Eastern and Southern Africa alone, post-harvest losses are valued at US $1.6 billion per year, or about 13.5% of the US $11 billion total value of grain production (World Bank et al., 2011). Indeed, this calls for more reliable and verifiable data on post-harvest losses (Obeng-Ofori, 2011).

Post-harvest losses in Africa are often estimated to be between 20 and 40% (World Bank et al., 2011). Such losses are a combination of those which occur on the field, in storage, during processing and other marketing activities.

In West Africa, farmers store their crops in homes, on the field, in the open, jute or polypropylene bags, conical structures, raised platforms, clay structures and baskets (Motte et al., 1995, Addo et al., 2002; Ofosu et al., 1995; Hell et al., 2000). In East and Southern Africa, farmers store crops in small bags with cow dung ash, in wood and wire cribs, pits, metal bins, wooden open-air or roofed cribs, and in raised platforms and roofed iron drums enclosed with mud (Wambugu et al., 2009; Kankolongo et al., 2009). The larger grain borer *Prostephanus truncatus* (Horn), grain weevil *Sitophilus granarius* (L.) and the lesser grain borer *Rhyzopertha dominica* (F.) are some of the predominant food grain storage pests in Africa (Bourne, 1977; Dick, 1988; Holst et al., 2000; Hodges, 2012). Unfortunately, farmers and crop handlers, especially women, do not have adequate information on proper crop harvesting and handling methods, resulting in significant damage by insect pests during storage and marketing (Rugumamu, 2009; Kereth et al., 2013). In addition to storage losses, losses during crop processing could be significant. Calverley (1996) showed that losses during harvesting/drying ranged from 6 to 10% for maize in some African countries: about 7% for rice in Madagascar, 4.3% in China and 4% in many Asian countries. Harvesting, drying and threshing losses reported for sorghum and millet were 11.3% and 12.2% respectively, while losses of 3.5% and 4.5% were recorded in Zambia and Zimbabwe respectively, for maize dried on raised platforms (Calverley, 1996). Threshing and shelling losses in smallholder manual methods for Zimbabwe was estimated at 1–2.5%, while it was 3.5%, where mechanized shelling was done (Hodges, 2012). Losses for rice during threshing were 6.5% and 6% in Madagascar and Ethiopia respectively, and were 2.5% and 5% respectively during winnowing in the same countries (Hodges, 2012).

Hodges (2012) also estimated quantitative grain losses (prior to processing) to be in the range of 10–20%, but losses of over 50% in cereals and up to 100% in pulses have been reported by other investigators (Obeng-Ofori, 2011). In Tanzania, the maize weevil *Sitophilus zeamais* Motshulsky causes significant damage, although new studies showed that some maize varieties are more resistant to attack (Rugumamu, 2012).

Identifying best practices and innovative arrangements for increasing agricultural productivity to improve income and nutrition of farm households is a priority of most African countries. For this reason, improving post-harvest management systems is a priority for farmers and policy-makers (Rugumamu et al., 1997). New technologies and improved post-harvest management knowledge are required by the farmers. However, the report of Kimenju and de Groote, (2010) on the technological and economic implications of new maize storage techniques in Kenya emphasized that economic analysis should be carried out before introducing new techniques to farmers.

The agricultural transformation programs in many African countries give priority to post-harvest processing of crops such as rice, cassava, millet and sorghum, following a value chain approach. The National Strategy for Growth and Reduction of Poverty (NSGRP, 2005) and the current policy on Agriculture First ("*Kilimo Kwanza*") in Tanzania (MAFSC, 2009) underscore the importance of reducing post-harvest losses. However, the financing and actual institutionalization of post-harvest storage and loss prevention strategies are still negligible compared to primary production-related activities. There is an ongoing debate among scientists, policy makers and development agencies about the merits of agricultural intensification, whether it will improve or worsen food security and poverty of the households that lack the capacity to preserve their excess production (Greeley, 2008). A possible higher cost of intensification with possible higher post-harvest losses may reduce the total farm profitability for the smallholders. For this purpose, the extent and causes of post-harvest losses of smallholder farmers need to be established. Additionally, appropriate interventions must be identified for each farming system as part of a broader agriculture intensification program aiming to increase food security, nutrition and rural livelihoods. Therefore, the specific post-harvest characterization of each farming system would be required.

This paper presents the results of an audit of post-harvest practices and constraints in a maize-based farming system in the semi-arid area of Central and Northern Tanzania. The purpose was to identify the factors that contribute to post-harvest losses and the general food insecurity of smallholder farmers, and to propose strategies for improving smallholder food security in similar farming systems in Africa.

2. Material and methods

A cross-sectional survey approach was used to collect data from fifteen communities in the semi-arid areas comprising two regions of central and northern Tanzania; Dodoma and Manyara. These regions constitute one of the most food insecure areas of Tanzania. Questionnaires with open and closed-ended questions were used to elicit responses from 333 households. The data collected included the dominant socio-economic and farming system characteristics; crop importance; methods of processing, storage and marketing practices; farmers' knowledge of the causes of post-harvest losses and loss prevention measures; and perceptions of farmers about the causes of food insecurity. Crop losses were estimated by relying on the traditional knowledge of the farmers to recall the extent and relative losses that occur for each crop and at each stage of post-harvest handling: harvesting, transportation, drying, threshing, processing and storage (Teshome et al., 1999). The individual household interviews were complemented with 15 focus group interviews, one in each village, to validate the loss assessment and other questionnaire survey information. In total, 270 farmers made up of village leaderships, youth, women and village cooperative groups, took part in the focus group discussions.