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Post-harvest losses reduction by small-scale maize farmers: The role of handling practices

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ABSTRACT

Concerns about food insecurity have grown in Sub-Saharan Africa due to rapidly growing population and food price volatility. Post-harvest Losses (PHL) reduction has been identified as a key component to complement efforts to address food security challenges and improve farm incomes, especially for the rural poor. This study analyses the role of recommended post-harvest handling practices in PHL reduction; and conducts a cost-benefit analysis of adopting practices associated with lower losses. The study finds that maize farmers lose about 11.7 percent of their harvest in the post-harvest system. About two-thirds of this loss occurs during storage. The study shows that adoption of recommended post-harvest handling practices is highly correlated with lower PHL. Lastly the study finds that the cost of implementing some of the recommended practices outweighs the benefits associated with lower PHL. It then discusses the reasons why some farmers may not adopt some of the practices and points out some contributions to the literature.

1. Introduction

Sub-Saharan Africa (SSA) remains highly dependent on agriculture in terms of its GDP share and employment[2] (IMF, 2015). It is estimated that crop production accounts for about 70 percent of typical incomes in this region, of which 37 percent is from grain crops (World Bank, 2011). However, 10–20 percent of the total grain produced in SSA suffers post-harvest physical losses (World Bank, 2011). This loss is valued at USD 4 billion[3] annually, which is equivalent to the annual calorific requirement of 48 million people (at 2500 kcal per person per day). Food losses in developed countries are as high as in developing countries. However, in the latter, the largest proportion of food is lost during post-harvest handling processes and storage; while in the former the food losses occur mostly at retail and consumer levels (FAO, 2011).

Investing in Post-harvest Losses (PHL) reduction, like any other investment, will be undertaken if the benefits outweigh the costs. To inform policy and facilitate optimal choices of mitigation approaches, a precise knowledge of the magnitudes of the losses, the drivers of the losses at each stage, and the net benefits of adopting mitigation practices is important (Affognon et al., 2015). Empirical literature seems to concur that the total PHL in cereals in SSA are high[4] and concentrated in the handling and storage stages (FAO, 2011; World Bank, 2011; Affognon et al., 2015). However, studies analysing the factors driving PHL at different stages of the post-harvest system and economic assessment of recommended PHL mitigating practices are scarce (Borgemeister et al., 1998; Meikle et al., 1998; Komen et al., 2006; Rugumamu, 2009; Kaminski and Christiaensen, 2014; Sheahan and Barrett, 2017). Moreover even these studies do not analyse the costs and benefits of adopting practices that are associated with lower PHL.

This paper aims to examine the role of recommended post-harvest handling practices in PHL reduction; and conduct a cost-benefit analysis of investing in PHL mitigation. To the best of my knowledge, this is the first study to assess the economic feasibility of post-harvest handling practices (apart from storage methods and treatment) in mitigating PHL among small-scale farmers in a developing country.

Over the past decade, substantial efforts and resources (including adoption of hybrid seeds and use of fertilizers) have been channeled toward increasing agricultural output and productivity to meet the growing demand for food in SSA. Nonetheless, the expansion of food production faces challenges such as limited land and water resources, increased weather variability, and difficulty in adapting to climate change (Aulakh and Regmi, 2013). This has raised the profile of PHL

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[2] The GDP share of agriculture in SSA is about 20–35% and it employs 60–70% of the population.

[3] This is out of an estimated annual value of grain production of USD 27 billion (for 2005–07). Qualitative post-harvest losses, excluded here, also have significant revenue effects due to losses in quality and market opportunities and impact on the nutritional value of the grain (FAO-World Bank, 2010).

[4] Variation may be observed across studies due to the metrics used (for example, calories versus weight), type of crop, and the stage in the food chain (Kaminski and Christiaensen, 2014).

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reduction as one of the means to reduce tensions between the necessary increase in food demand and the challenges in increasing production (FAO, 2011; Hodges et al., 2011). The key question is therefore, why farmers tolerate high levels of PHL. A traditional neo-classical economist would assume that farmers are rational profit maximisers and the levels of PHL observed are optimal. In that case, trying to intervene is merely imposing distortions. Low responses to interventions may be attributed to lack of economic incentives to reduce PHL, credit constraints (including high initial costs of pH technologies adoption), and social/cultural factors (World Bank, 2011; Kadjo et al., 2013).

Profitable investments in agricultural technologies including PHL reduction may be limited by several factors: information asymmetry; behavioural biases such as time inconsistency (Duflo et al., 2011) and risk and loss aversion (Kadjo et al., 2013); and failure to account for externalities. Farmers may not be fully aware of the factors driving PHL, the magnitude of the marginal effects of the drivers, and/or the marginal cost of mitigation. This uncertainty may deter risk-averse farmers from investing in PHL mitigation. With time inconsistent behaviour, initially individuals plan to adopt; but when the time comes to act, net benefits seem lower than anticipated at the time of initial take-up decision such that they may decide not to take up anymore. Later they may incur losses and decide to adopt while it is too late. In the case of externalities, the social and private optimal levels of mitigation will be different. PHL creates externalities such as unnecessary greenhouse gas emissions and resource scarcity due to production of food that is not consumed (FAO, 2011; World Bank, 2011; Aulakh and Regmi, 2013).

In this study, survey data collected from 420 maize[5] farming households in a rural district in Tanzania is used to analyse the role of recommended post-harvest handling practices in PHL reduction and do a cost-benefit analysis of adopting such practices for PHL mitigation. The study finds that, first, the levels of PHL experienced by maize farmers are 11.7 percent of the amount harvested. This includes 2.9 percent lost during the processes before storage, 7.8 percent during storage and 1.0 percent during marketing. The value of the losses is estimated to be USD 58.9 per household, which is about 1.2 times the median household monthly income. Second, results show that recommended post-harvest handling practices are highly correlated with lower levels of PHL. Finally, the cost-benefit analysis shows that the adoption of some of the recommended practices is on average economically beneficial, while in other practices the costs outweigh the benefits. The study discusses the puzzle why some farmers still do not adopt PHL mitigation practices and points out some contributions to the literature.

The rest of the paper is organised as follows: Section 2 presents an overview of post-harvest losses; and provides the conceptual framework; Section 3 describes the data; Section 4 describes the estimation strategy and presents the results; and Section 5 is the conclusion.

2. Literature overview and conceptual framework

Post-harvest loss is defined as measurable food loss in the post-harvest system (Hodges et al., 2011). Food loss occurs when food is taken out of the supply chain at any stage (Bellemare et al., 2017). The food lost either goes to the landfill, diverted back into the food supply chain, or recovered for nonfood albeit productive uses. Bellemare et al. (2017) defines food waste as the portion of food loss that is never recovered for any kind of productive use, whether food or nonfood, and ends into landfill. Post-harvest system refers to a chain of interconnected activities from the time of harvest to the time the food reaches the end consumers (World Bank, 2011). In the case of cereal, the chain comprises activities such as harvesting, shelling, drying, storage, packaging, transportation, milling and marketing. In our case, we study maize losses during pre-storage processes (shelling, drying and transportation), storage, and marketing.

Maize, the focus crop in this study, is the main staple food for most of SSA. In Tanzania, the area planted with maize occupies about 47 percent of the total area planted with annual crops, and maize comprises about 72 percent of total cereals production in the country (TNBS, 2012). The crop contributes about 35 percent of the daily calorific intake in Tanzania. Higher PHL in maize would therefore imply a significance loss of food in the country, wastage of scarce resources and negative effects to the livelihoods of many households.

The African Post-Harvest Losses Information System (APHLIS)[6] estimates that PHL of maize (from harvesting to marketing) in SSA has been around 18 percent in the period between 2009 and 2013. In Tanzania, according to Tanzanian Markets-PAN (2013), PHL in maize was on average 15.5 percent of the total production of maize between 2003 and 2007. The study by Alliance for a Green Revolution in Africa (AGRA)[7] in 2013 showed that maize losses in Tanzania differ between large and small farmers, with losses experienced by large farmers recorded at 6 percent and those by small farmers at 11 percent. The level of storage losses in maize also depends on whether or not the area is infested with the large grain borer (LGB).[8] Reported storage loss figures for areas infested with maize LGB are double those of areas without LGB (Hodges, 2012).

A few studies have been conducted to analyse the factors driving PHL. Komen et al. (2006) examined the role of different farm level storage structures on maize grain losses in Kenya and they found no significant difference among different methods. The highest estimated losses were reported in cribs (8 percent) followed by baskets (5 percent) and the lowest losses were experienced in grains kept in houses (4 percent), which could be attributed to close monitoring. Borgemeister et al. (1998) studied the effect of harvesting maize late after physiological maturity on grain losses in Benin. They found that leaving the maize in the field for extended periods after physiological maturity resulted in severe grain losses after eight months of storage. The grain loss was mostly attributed to LGB. On the other hand, they found that early harvested maize had a higher proportion of mouldy grain, increasing the chances of rotting.

Other studies have analysed the role of more than one practice. Kaminski and Christiaensen (2014) found that maize PHL increase with humidity and temperature, and decline with better market access, post primary education, higher seasonal price differences and possibly also with improved storage practices. Rugumamu (2009) found a positive correlation between the adoption of strategies by recommended Post-harvest Action Plan namely drying cobs, shelling, drying grains, winnowing and pesticide application, and reduction of post-harvest losses of maize. On the other hand, the study by Magan and Aldred (2007) showed that pre-harvest practices such as proper selection of maize hybrids by avoiding soft kernel hybrids, timely sowing, timely harvesting and effective control of pests such as maize stalk borer, reduce PHL.

Despite analysing the role of PHL mitigating practices, none of the above studies analysed the cost of adopting desirable practices relative to their benefits. Only one study by Meikle et al. (1998) has analysed the economic effectiveness of using insecticides for treating stored maize in Benin. Taking into account market price, pesticide costs, percentage grain damage and weight loss, this study found that treating

[5] Maize is the most important crop in SSA. Out of a total annual grain production in SSA of 112 million tons, maize contributes 40% (World Bank, 2011).

[6] The APHLIS was created within the framework of the project ‘Postharvest Losses Database for Food Balance Sheet Operations’, initiated and financed by the European Commission's Joint Research Centre, led by the national natural resources experts.

[7] AGRA is an organization dealing with improving agricultural products and supporting local farm owners and labour in Africa. It is funded by the Bill and Melinda Gates Foundation and the Rockefeller Foundation.

[8] The larger grain borer (Prostephanus Trancatus) is a storage pest introduced into Africa from Central America in the late 1970s. It is now widely recognised as the most destructive pest of stored maize and dried cassava in Africa and has been associated with significant increases in storage losses (Boxall, 2002).