Postharvest Loss of Maize and Grain Legumes in Sub-Saharan Africa:

Insights from Household Survey Data in Seven Countries

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Introduction

Improving staple crop production is widely viewed as crucial for increasing food security and reducing poverty in Sub-Saharan Africa (SSA). However, it is essential to recognize that food security challenges do not simply end at harvest (Affognon et al. 2015). Smallholder farmers in SSA face numerous challenges after their grain leaves the field. Farmers who store grain may experience significant quantity losses due to damage from rodents, insect pests, and mold, and subsequent price discounts for damaged grain (Kaminski and Christiaensen 2014; Kadjo et al. 2015; Kadjo et al. 2016). Part of the reason quantity loss occurs is that many farmers lack access to effective and safe storage technology, such as airtight (hermetic) storage bags or metal silos. These technologies have the potential to positively impact household welfare but are currently not available in many rural settings (Jones et al. 2011; Gitonga, et al. 2013). In addition, households may have their food safety and health jeopardized if they apply storage chemicals inappropriately or consume grain that has been infected with mold and aflatoxins (Hoffman and Gatobu 2014). All of these storage challenges undermine household income, food security and nutrition, food safety, and health.

The objective of this short report is to share results on Postharvest Loss (PHL) in maize from seven countries and legumes from six countries in SSA. Data come from surveys of randomly sampled households that were conducted in Ghana (300 households), Benin (360 households), Burkina Faso (767), Nigeria (2,010 households), Uganda (1,193 households), Tanzania (309 households), and Ethiopia (300 households).[1] The survey assessed storage practices, including use of storage technology, maize marketing practices, PHL and sources of PHL. PHL is the outcome of farmer behavior (use of storage technology and length of storage period) and the local environment (number of growing seasons per calendar year, whether there is rain at harvest, and pest pressure).

Prevalence and Causes of Postharvest Loss

Figure 1 presents the average of smallholder farmers-reported PHL during storage for maize and their most important legume crop.[2] PHL is measured as the percent of quantity stored that was lost in the previous season. We find that average PHL varies by country, reflecting the importance of local conditions on PHL. For maize, PHL varies from a low of 1.9% in Burkina Faso to a high of 6.9% in Tanzania. For legumes, PHL varies from a low of 1.3% in Burkina Faso to a high of 7.3% in Tanzania. Overall, the countries with the highest PHL are Tanzania, Ghana and Benin; Burkina Faso

**Dr. Corinne Alexander passed away in January 2016. She has left behind a valuable legacy in her excellent research, and will live on in our memory.*

[1] The Uganda and Nigeria samples are representative of the smallholder populations in the maize growing areas of the two countries. The samples from other countries are taken for the purpose of measuring adoption of hermetic technology. They are not nationally representative of the smallholder population.

[2] Legumes were not part of the survey in Benin.

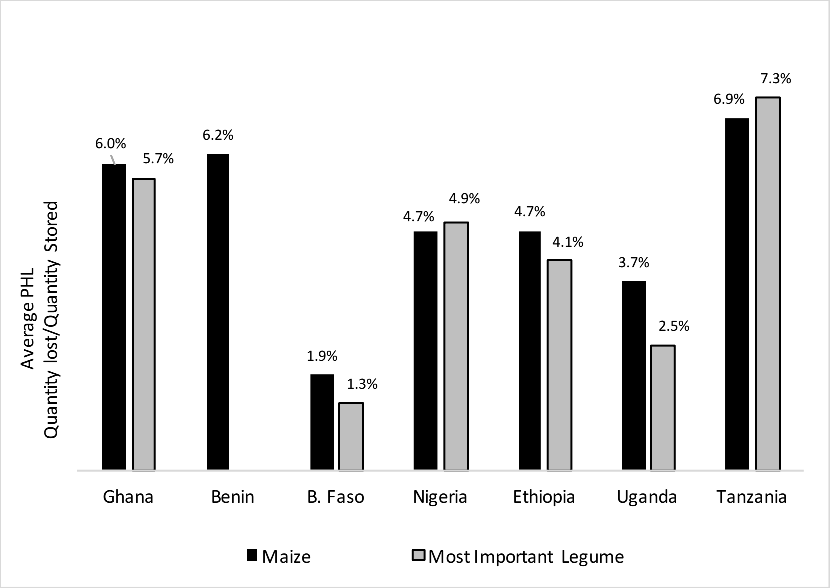

Figure 1: Average Actual Postharvest Losses in Storage

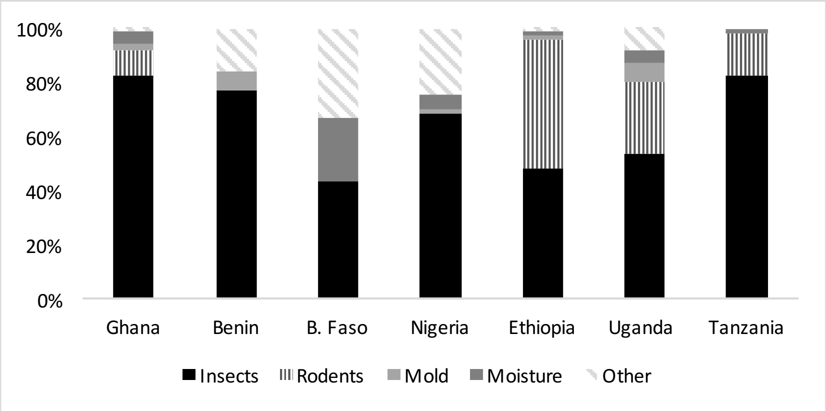

Figure 2: Major Sources of PHL in Maize Storage

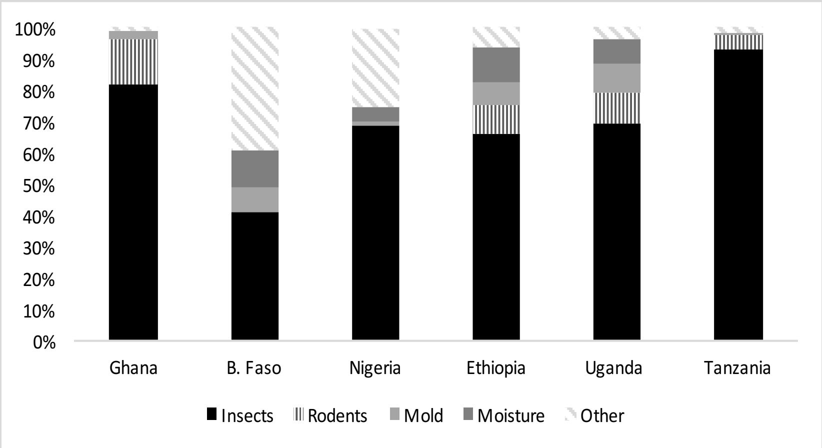

Figure 3: Major Sources of PHL in Legume Storage

has the lowest PHL, while Uganda, Nigeria and Ethiopia report relatively moderate levels of PHL.

To better understand what is driving PHL for maize and legumes, we asked the smallholder farmers in our surveys to report the major source of PHL in storage. Figure 2 presents the major sources of PHL in maize storage, and Figure 3 reports the major sources of PHL in legume storage. For both maize and legumes, insects are the most reported major source of PHL. (For Benin and Nigeria, farmers were not asked specifically about rodents, so these responses are grouped into the "Other" category.) Notably, the three countries with the highest overall PHL in maize and legumes also report the largest challenges with insects. For example, over 80% of farmers in Tanzania and Ghana report that insects are the major source of PHL for both maize and legumes, and over 75% of farmers in Benin report that insects are the major source of PHL for maize.

By comparison, the countries with lower PHL are more likely to report important sources of loss in addition to insects. For Ethiopia, Uganda and Nigeria, the second and third most reported major sources of PHL are rodents and moisture (rodents are the most common response in the "Other" category in Nigeria).

Adaptation Strategies to Reduce Postharvest Loss

Applying storage chemicals, selling soon after harvest (likely at a low price), and adopting improved storage technologies are choices smallholders may make to reduce PHL. Figure 4 on page 3 presents the percent of smallholders that applied storage chemicals to their crops — from a low of 5% for legumes in Burkina Faso and 12% for maize in Uganda, to a high of 77% for maize in Ethiopia.

Figure 5 on page 3 presents the average storage time in weeks, for both maize and legumes, by the intended use, either for home consumption or market sale. Note that in all cases except for legumes in Ghana, the storage time is much longer when the intended use is home consumption.

Figures 6 on page 3 and 7 on page 4 present the smallholder farmers' use of storage technology for maize and legumes. The most commonly

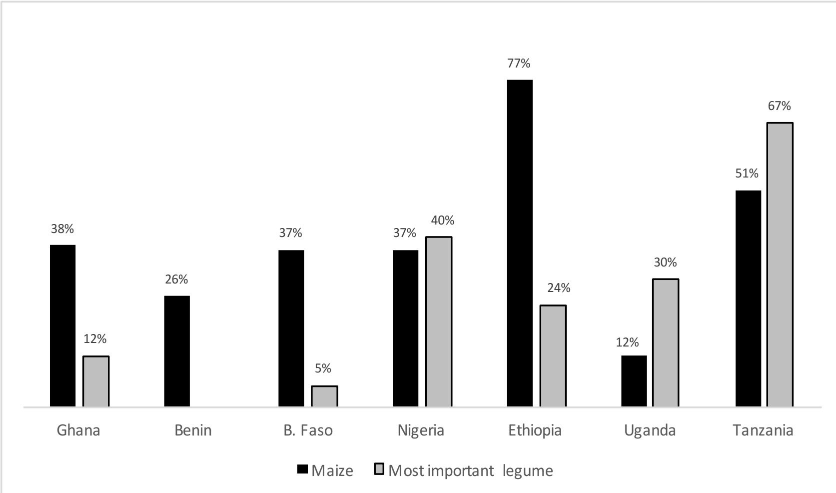

Figure 4: Percentage Applying Storage Chemicals

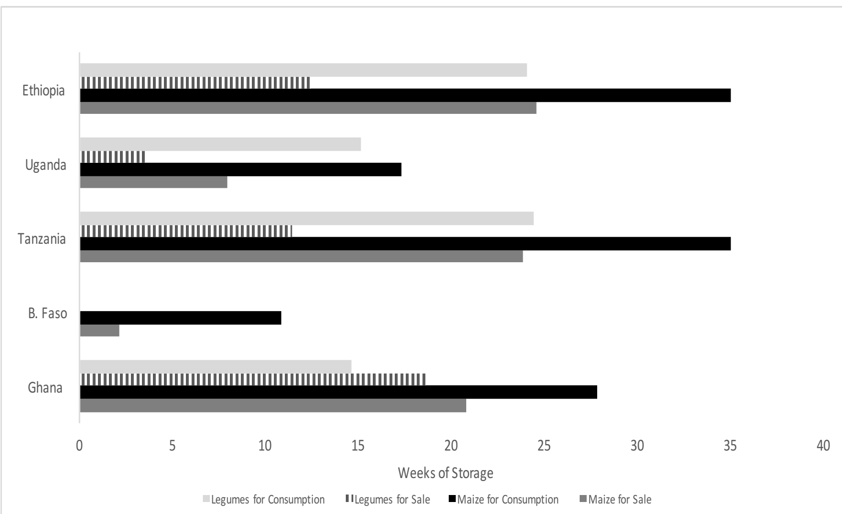

Figure 5: Actual Storage Time

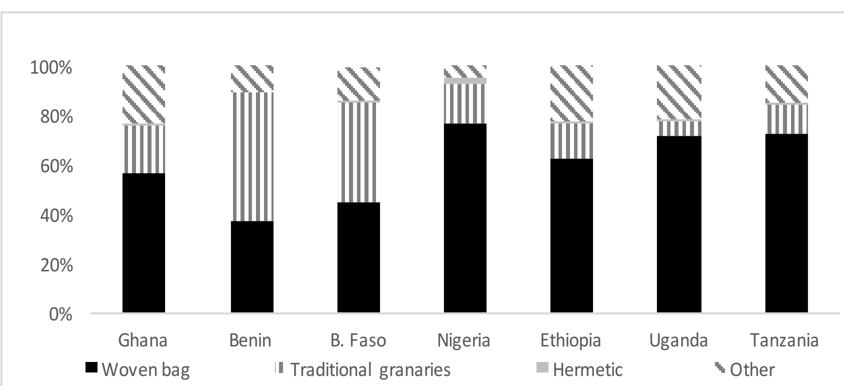

Figure 6: Storage Technologies Used for Maize

used storage technology for both maize and legumes is the woven bag, which shows that bag technologies are culturally acceptable to many smallholders in SSA. For maize, farmers also use traditional granaries and many other technologies. Hermetic storage is very low for maize and legumes in East Africa. However, 6.3% of farmers in Burkina Faso, and 5.7% of farmers in Nigeria, use hermetic technologies to store their legumes.

Discussion

In comparing average PHL, it is clear that Tanzania has the highest average PHL at 6.9% for maize and 7.3% for legumes, while Burkina Faso has the lowest at 1.9% for maize and 1.3% for legumes. Tanzania is the epicenter of the larger grain borer (*Prostephanus truncatus*) distribution, which explains the large PHL even though 51% of farmers use storage protectants. By comparison, 77% of farmers in Ethiopia applied storage protectants to their maize, which may explain their lower losses. Farmers in Uganda have the lowest use of storage protectants on maize at only 12%. The very low PHL in Uganda can perhaps in part be explained by farmers' decisions to sell their maize before insect damage accumulates and thus storing for only a very short time. Farmers in Uganda store on average about eight weeks for market sale and 17 weeks for home consumption; farmers in Ethiopia and Tanzania store on average over 23 weeks for market sale and 35 weeks for home consumption. These results highlight the point that farmers take actions to reduce PHL, either by applying protectants or selling early to avoid losses. The early sales in Uganda mean that farmers cannot take advantage of higher prices that often occur later in the marketing year. Thus their actions to reduce PHL also reduce their income. However, this is a calculated tradeoff, albeit an imperfect one, that we expect farmers to make.

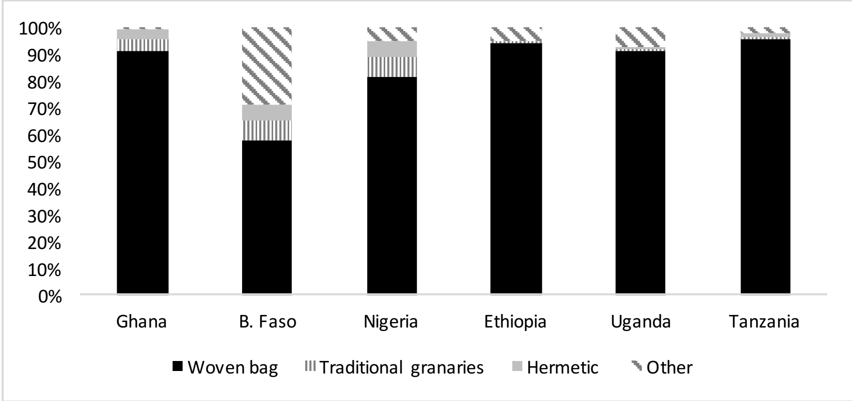

Figure 7: Storage Technologies Used for Legumes

Conclusions

The findings in this brief report highlight the need for smallholder farmers to have greater access to effective storage technologies. Awareness is one step in that process; cultural acceptance of bag technologies may provide a useful foundation for growth. At a minimum, reducing PHL will mean greater income and food security in sub-Saharan Africa.

References

Affognon, H., C. Mutungi, P. Sanginga, and C. Borgemeister (2015). "Unpacking Postharvest Losses in sub-Saharan Africa: A Meta-Analysis." *World Development* 66:49-68.

Gitonga, Z.M., H. De Groote, M. Kassie, and T. Tefera (2013). "Impact of metal silos on household's maize storage, storage losses and food security: an application of a propensity score matching." *Food Policy*, 43: 44-45.

Hoffmann, V. and K. W. Gatobu (2014). "Growing their own: Unobservable quality and the value of self-provisioning." *Journal of Development Economics* 106:168-178.

Jones, M., C. Alexander, and J. Lowenberg-DeBoer (2011). "An Initial Investigation of the Potential for Hermetic Purdue Improved Crop Storage (PICS) Bags to Improve Incomes for

Maize Producers in sub-Saharan Africa." Working paper, Department of Agricultural Economics, Purdue University. West Lafayette, IN. USA.

Kadjo, D., Ricker-Gilbert, J., Alexander, C. (2016). Estimating Price Discounts for Low-Quality Maize in sub-Saharan Africa: Evidence from Benin. World Development, 77, 115-128.

Kadjo, D., J. Ricker-Gilbert, C. Alexander, T. Abdoulaye, N. Baco (2015). "What drives smallholder farmers' storage behavior in sub-Saharan Africa? Evidence from Benin," presentation at International Conference of Agricultural Economists, Milan, Italy.

Kaminski, J., and L. Christiaensen (2014). "Post-harvest loss in sub-Saharan Africa – What do farmers say?" *Global Food Security* 3 (April) 149-158.

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