FINAL REPORT
Volume Two
Country Annexes

Investigation of Issues and Challenges Facing African Smallholder Farmers and Highest Potential Intervention Points in Reducing Waste and Spoilage in African Food Systems

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Alliance for a Green Revolution in Africa (AGRA)

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Preface

The Alliance for a Green Revolution in Africa (AGRA), with support from the Rockefeller Foundation, has selected partners to address a set of targeted research questions relating to reducing waste and spoilage ("PHL" for short) in food value chains.

Abt Associates Inc. was selected to carry out an in-depth investigation of waste and spoilage issues and challenges facing African Smallholder Farmers (SHF) in selected crop-based value chains and seven countries, in order to then identify high-potential intervention points.

Volume One contains the final report, complete with findings and recommendations, as well as cross country and cross commodity analysis

This second volume contains the seven detailed country annexes, which include "hotspot analyses" used to prioritize points and types of intervention.

Country Annex for Ethiopia

Dates traveled: March 11 – April 9, 2014

Main growing regions visited: Tigray Region (sesame), Amhara Region (sesame and teff), Oromoia Region (teff)

Interesting quote(s):

- Farmers independent of each other, one from the Debrehem Mahawai Primary Cooperative in Amhara and one from the Awash Bune Primary Cooperative in Oromiya, gave the same description of teff quantity losses from rats: "Rats will drink the teff."
- A member of the Yohannes Primary Cooperative in Amhara quoted a parable: "A teff grain says to a farmer: 'if you knew how much I would lose, then you would never plant me.'"
- Members of the Shewit Primary Cooperative in Tigray went against conventional wisdom, and had equal share of labor in sesame production and harvesting. Women also had equal say on when and for how much to sell the sesame. "Women are the key to the house."
- "There is no doubt that mechanization is the way of the future for sesame. However, the government will have to take care not to marginalize the SHFs in favor of large-scale farmers, which would start a revolution." – Sesame Expert, Sesame Business Network.

Figure 1: Humera Ethiopia Commodity Exchange (ECX) sesame collection

Figure 2: Teff quality check at trading

Figure 3: Traditional teff threshing with livestock

Figure 4: Polybag (aka pp bag) sampling device

Objective 1: Prioritization

Key Questions

How aware of losses are smallholder farmers involved in the selected value chains? Which types worry them the most and why?

Both crops

Teff and sesame farmers are all well aware that quantity, quality and financial losses occur all along the value chain. Yet the actual volume and value lost vary greatly by year and individual practice. Factors that change between years include weather conditions (i.e. level and timing of precipitation) and market conditions (i.e. level and timing of peak price).

Quantity loss is the type that worries farmers most, as these are the losses that are most visible to them. There are many on-farm process steps from harvest to farm-gate sale in which the opportunities for quantity loss are high for both teff and sesame.

Teff

Teff farmers worry most about quantity losses during the harvesting, stocking, threshing/winnowing, and storage stages. If harvested too late (as is often the case), teff will shatter onto the field. Stocking losses occur from rodents and household animals eating the teff, wind, losses to the ground, and rain. Threshing losses come from the traditional use of a plastered ground surface and roaming cattle, which means that teff will get lost in the cracks, be contaminated with dirt, and be eaten by the cattle. Winnowing losses occur when the wind is too strong and blows the teff with the chaff. Finding that losses do occur during storage goes against widely accepted convention in the donor and research community, which is that teff losses during storage are negligible due to the fact that teff does not have natural pest enemies such as the Large Grain Borer.

Teff quality is denoted by color (the lighter the color the better). When prices are high, practices will increase in stringency to ensure no mixing between teff types. Conventional wisdom says that teff is not affected by moisture if dried properly prior to storage yet if teff does get moldy the change in smell is immediately noticeable, and will result in both a quantity and value loss, as farmers will not be able to sell this teff. However some farmers may still be able to make use of moldy teff by either using it to feed livestock or by distilling it into a local liquor called arake.

Financial losses were not stressed in farmer interviews, yet over the past decade teff has gradually become a cash crop in the domestic due to increases in urban teff consumption. As cash sale value rises, it is likely that farmers will become more concerned about possible financial loss associated with quality and condition problems.

Sesame

Sesame farmers reported that they worried most about quantity losses during harvesting and during hilla drying (a hilla is the stacked rows of harvested sesame bundles that are left on the field to dry). Harvesting when the sesame is too early will cause it to turn red, which means a decrease in quality upon drying. Harvesting too late will cause the pods to open and shatter.

Hilla losses are also attributed by farmers to pests (particularly the sesame seed bug in wet years), rodents, wind, and rain.

Storage was a major concern for sesame farmers for two reasons. First, although farmers would like to store long enough to realize peak prices, storing too long causes the sesame to lose weight, so a balance must be achieved to maximize returns. Second, storage space is inadequate, because cooperatives and unions often do not have enough space for their own members' crop, and lack the access to the capital or financing necessary to purchase space in a timely manner. While the Ethiopian Commodity Exchange (ECX) does have ample storage capacity, it requires farmers to sell their sesame within four months regardless of the price, which is a disincentive.

What are they currently doing to prevent or mitigate those problems and what else would they like to do?

Both crops

Even the more proactive unions (which were in the process of constructing their own blended fertilizer plants, with one already running a poly bag factory) mitigate PHL only via improved storage within warehouses they control. Measures taken include storing away from walls, leaving corridors for better air circulation, using suitable stack heights, using new poly bags, and putting wooden pallets on the floor. A grading system is also employed.

Although production credit is available for pre-harvest expenses, access to credit during the postharvest period is also necessary in order to a) hiring laborers in a timely manner and b) incentivize laborers to increase the level of care and harvesting steps necessary to reduce quantity losses. Lack of access to formal credit leads to dependence on informal creditors, who charge interest rates of 200-400%.

Sesame

Gaining access to non-shattering varieties that will be less vulnerable to quantity PHL is a high priority for all farmers.

Simple on-farm mitigation measures for PHL that are commonly recommended include: (a) harvesting when the crop has senesced, (b) stacking hillas in the direction of the wind, and (c) stacking hillas close to the threshing area on a water permeable tarp.

Agriterra and the Sesame Bureau Network (SBN) have gone farther, planting in rows and then using mechanized harvesting technologies already used elsewhere, which are suitable for adoption in Tigray.

For the most part, sesame farmers not affiliated with a donor program containing a PHL component are focusing on pest management as a means to reducing losses. However, instead of taking an integrated pest management program, they rely chemical pesticides (even including DDT, which is banned in most countries) applied them around the hillas and storage areas, sometimes directly onto the sesame (which is poor agricultural practice).

Teff

The more formal PHL reduction programs of the Agricultural Transformation Agency, Sasakawa Global 2000, and the regional Ethiopian Institute for Agricultural Research centers focus on

mechanization aimed at reducing he time and manual labor required in teff production, which currently results in a demand for seasonal labor that is hard to meet. Recent efforts have concentrated on adapting multi-crop threshers used internationally and adapting them to teff and to the local terrain. Combine harvesters and hand-operated harvesters are also being researched.

What attitudinal and capacity factors inhibit greater awareness or action?

Attitudinal Factors

Farmers with unsatisfactory experiences with mechanization (either because previous technology did not perform as well as current technology, or they used technology solutions predominantly from China that had lower upfront costs but performed poorly and broke quickly and are now reticent to adopt mechanization.

Using mechanized sesame harvesters on fields planted with the traditional broadcast method (versus row planting with optimal spacing) has proven disastrous. Thin-stemmed plants are unable to withstand the beating of the harvester, which causes much shattering.

Teff farmers believe that threshers do not properly clean the teff (which leads to a lower price), and that the resulting straw is unpalatable for their oxen. ATA disagrees with this last point, as threshers cut the straw and in fact increases palatability over the traditional threshing method of having livestock walk over it.

Capacity factors

These play a greater role than attitudinal factors, as increased capacity through education and access to innovations and financing can overcome attitudinal factors.

Farmers generally do not know the exact quantity they lose through their current practices. SBN recently conducted a quantitative, sample survey of on-farm sesame PHL. The farmers who participated in the survey knew that PHL was occurring, but were surprised to learn the exact extent of the loss. This illustrates that the lack of data on exact losses attributable to different practices, and the potential solutions available, inhibiting adoption and improvement.

It was also reported that the farmer unions and cooperatives lack leadership, education, financial, and grain storage capacities with which to assist the farmer members. Leadership and education capacity limitations also extend to the farmers, which is important considering that unions and cooperatives are intended to be collective democracies led by the farmers themselves.

What are the main considerations smallholders have in deciding whether and how to act to reduce waste and spoilage along selected value chains?

For both teff and sesame, the main consideration is whether the outlays in time and money required to implement mitigations are cost-effective in relation to prior losses. Farmers have household expenses to cover, and their actions are mostly guided by what is required to make immediate payments.

What types of intervention and/or support (e.g., financial or technical) and/or incentives would stimulate further action?

More rigorous baselines need to be created for quantity, quality and financial losses at each stage of the value chain in order to provide a basis on which to measure mitigation improvements.

Quantitative loss baselines are particularly critical for the teff mechanization trials in order to better assess the benefits and costs associated with mechanization.

Even SBN noted that their quantitative survey of sesame quantity losses could use further sampling and include coverage of storage losses.

Cost-benefit analysis should be conducted to identify the innovations that are profitable and possible improvements for those that are currently not profitable (whether it is due to the enabling and regulatory environment, access to market, or access to innovative and timely finance).

Objective 2: Identification of Key Interventions

Key Questions

What are the country-specific intervention opportunities, by specific crop and geographic area?

Any mitigation efforts should be in line with Ethiopia's Climate-Resilient Green Economy Strategy under the National Growth and Transformation Plan which seeks to help the country achieve its development goals while limiting 2030 GHG emissions to around today's 150 Mt CO2e. This could be pertinent to increased mechanization run on diesel fuel.

Ethiopia not only has primary farmer cooperatives but also a second layer of farmer unions. For PHL mitigation, further effort is needed to define proper roles and responsibilities in terms of obtaining financing, construction and managing storage, marketing, access to inputs and mechanization.

Unlike other cereals, teff is highly unique to Ethiopia and Eritrea. However, greater study will need to be done in main growing regions to distinguish opportunities where teff is grown predominantly for local and household consumption versus those that are grown predominantly for commercial sale to Addis Ababa and urban consumption. This influences the quantity and type of teff grown and also the storage practices.

Sesame is considered to have originated in Ethiopia, and cultivate sesame from this country is perceived to have high quality in terms of color and oil content. With Ethiopia being the second largest sesame exporter in the world, any changes in variety, such as introduction of non-shattering cultivars, should not impair the quality.

Currently, the productive sesame growing lands in the Tigray Region are approximately 70% smallholder farmer plots. However, as the sesame industry grows, special consideration is needed to ensure that smallholders are not pushed aside by ongoing increases in mechanization and farm size.

What are the technology-specific intervention opportunities by specific crop and geographic area?

Mechanization for both teff and sesame implies changes to cultural practices. For example, mechanized harvesters require careful field preparation such as the removal of rocks, as well as planting in rows and using seeds of uniform quality and predicable germination.

For sesame, in the near-term work is needed to address the unmet need for migrant, seasonal labor for harvesting, as it is a major limitation (numbers required, availability, cost, and skills). Mechanization

through use of row planters and harvesters will help alleviate that constraint. At the same time, further research needs to be done on drying technologies because sesame must be sufficiently dry to thresh.

For teff, mechanization mostly targets harvesting and threshing. The time savings will allow farmers to harvest and thresh on time, reducing shattering loss and loss from pests and bad weather. The labor savings will reduce both human and livestock labor (as livestock are used to traditionally thresh teff).

Expert & Stakeholder Event

Dates: April 2-3, 2014

Venue: Harmony Hotel, Cameroon Street, Near Edna Mall & Bole Medhanialem, PO Box 16139, Addis Ababa, Ethiopia

Attendance: 46 people on the first day; 31 people on the second half-day. Attendees included representatives from the national and regional Ministries of Agriculture, national and regional government agricultural research institutes, farmer unions, academia, donors, local and international NGOs, and the private sector across the teff, sesame, beans/pulses and horticulture value chains.

Main Findings

Overwhelmingly workshop attendees noted that stakeholder coordination and linkages, and regulatory and enabling environment need strengthening. Specific recommendations were:

- Need for a distinct PHL department in the Ministry of Agriculture (MOA) that has stronger coordination with the regional Bureaus of Agriculture, regional research institutes, academia, donors (and in this case, particularly AGRA) and the private sector.
- Need to strengthen, coordinate and expand the collaborating platform already begun by the Jimma University/CIDA Post-Harvest Management & Value-Added Agriculture Network in Ethiopia and by the FAO/SDC's "Reducing Food Losses Through Improved Postharvest Management in Ethiopia Project."
- Line Ministries and the private sector should train farmer cooperatives on value additions based on success stories of the wheat sector in the country.
- MOA extension workers currently cease outreach activities with farmers at harvest, focusing time and resources on field preparation and crop maintenance. Harvest and postharvest management activities need to be included in extension worker programs.
- The private sector needs to be included more as an important stakeholder.
- During pre-harvest there is always credit available, but postharvest support is not covered by financial institutions, hence attention should be given towards postharvest financing.
- Value addition mechanisms need to be developed and disseminated, which will require greater coordination between regional research institutions and private efforts that are currently developing regionally-specific technologies and programs.
- "Quality" related issues should also be given due attention as they related to PHL cases.

- The recent MOA mechanization policy needs to include PHL.
- PHL programs should also include women and provide trainings and related support.

Conclusions

Ethiopian teff and sesame farmers are aware that there are postharvest losses occurring; however the extent and magnitude varies by year and individual practice, and is not quantified in any meaningful way that farmers can make decisions from. The majority of farmers are still at the awareness-raising stage and not yet the behavior change stage.

The trend is toward mechanization for both teff and sesame. Although current donor sesame programs are not focused on mechanization, given the meteoric trajectory of the sesame export business it was noted during KII's that mechanization will soon be required. Care must be taken in programming to ensure that, for both teff and sesame, the smallholder farmer is not pushed out of the business due to increased demand and economies of scale with mechanization.

Sub-Questions

What is the process from awareness to behavior change?

There are already well-established behavior change methodologies applicable to agriculture. Typically the process must be designed based on certain questions: 1) which cohorts might have to change behavior (as it relates to PHL); 2) why do they do what they do currently; 3) what are the perceived benefits from proposed innovations; 4) what are the apparent barriers to change; 5) what groups have influence over their behavior; 6) whom do they trust in terms of information and advice; 7) what other factors might contribute to or retard change; 8) how would success be measured and perceived. Once these questions have been answered, a behavior change campaign can be designed that address perceived barriers and maximize benefits through the trusted channels of information.

However, before behavior change can take place, there are fundamental gaps in awareness, which include lack of awareness of potential PHL mitigation measures at the farmer level, and an unclear cost-benefit analysis for implementing potential mitigations.

What cultural and environmental factors might be important?

Ethiopia is 43.5% Ethiopian Orthodox, 33.9% Muslim, and 18.6% Protestant (CIA World Factbook). It has 86 officially recognized ethnic groups with main ones comprising of 34.5% Oromo, 26.9% Amhara, 6.2% Somali, and 6.1% Tigrigna. Based on a KII, the religious composition of a community will influence their financial credit lending behavior; Muslim communities are less likely to engage in informal credit lending. Another example is that based on the ethnic composition of a community, agricultural gender roles will be divided differently. In Tigray, it was found that there were sesame-growing communities that had equal share between men and women on labor and decision-making, while other communities had a stark divide where only men were involved in sesame production and decision-making.

The current and historic political state of Ethiopia is an important influenced in the entire agricultural economy because of decisions taken regarding the role of the government and private sector in supplying inputs and supplies.

Between teff and sesame there is a large difference on the role that trade plays. It is currently forbidden to export teff in raw form; however, based on trends identified by IFPRI, over the past ten years, teff has shifted from a local, subsistence crop to a cash crop for urban markets, which will result in higher focus on quality and economic losses. Sesame has a high export value and the relationship between the main trade countries (China, Israel, Japan and the Netherlands) influences agricultural practices based on the different quality standards and processing levels required by the different countries.

Aflatoxin was not identified as a major quality threat to both teff and sesame. Teff, which is predominantly grown in the highlands, is not impacted by moisture during storage if stored at the correct moisture level initially. Sesame, which is predominantly grown in the lowlands, is naturally adapted to hot and dry climates where moisture impacts during storage are minimal, again, if stored at the correct moisture level initially.

When determining the returns on investments for PHL, particularly for mechanized harvesters and threshers, the length of the harvesting season is an important factor for both teff and sesame, but particularly for teff. Both crops have an optimal harvest window of just one week. For farms where there are multiple crops planted, the harvest times often coincide, in which case the teff harvest is typically left for last. This coincidence in timing not only places great pressure on harvest labor but also means that harvesters or threshers have a very short period of use and it is therefore hard to justify the investment.

In taking the SHF lens for teff, when looking at storage, there is the cultural perception that poly bags kept in the house should be used to store teff for sale, and that the gotera constructed outside the house be used for household consumption. However, farmers noted that the gotera is more protective against quantity loss and contamination from rats than the poly bags.

Are there any gender differences in the process from awareness to behavior change?

Few gender differences were noted in Ethiopia, as women and men were reported to take equal roles in labor and decision-making for teff and sesame communities. However, it was generally noted that women tend to take a more proactive attitude to innovation and to attending trainings.

What are the gender issues to consider in technology design, adoption, and up-scaling?

For both teff and sesame it was found that when there was a male head of households there was a high degree of shared labor in harvest and postharvest management activities. However, weeding is perceived as a female-specific activity.

For teff, in addition to weeding, women were responsible for construction and maintenance of the *gotera* for household-level teff storage.

However, there are sesame growing communities where there is a very distinct gender separation of roles, where women focus on production of crops grown for household consumption that are physically located near the home, such as sorghum, while the men and hired-laborers will focus on sesame production. The sesame is generally grown in fields far from the home.

For women headed households, innovations that reduced the amount of time and labor required is critical, as they require a higher number of hired laborers and therefore spend a larger percentage of their income on labor than a male headed household. If they are unable to hire labor, they are required

to wait till a male neighbor is available to help harvest, which puts them at risk of harvesting outside of peak harvest (i.e. increased quantity loss in the field) and requires them to provide a percentage of the crop to the neighbor as a form of payment (financial loss both immediately and in the future when peak price occurs, assuming they would be able to store the teff or sesame).

What are creative ways to encourage waste and spoilage reduction behavior changes?

Lead farmer demonstrations, on farm pilots, and farmer-to-farmer innovation sharing would all encourage adoption of validated innovations.

The farmer cooperative FGDs were structured to first identify areas of greatest postharvest loss and then to ask what farmers are already currently doing or aware of to mitigate those losses. There were varying degrees of innovation and interventions already being applied amongst the FGD participants. Farmers already implementing ideas and interventions were not limited to those that had recently or were currently participating in a donor program to reduce PHL. One example is a teff farmer who, for the next harvest season, had the idea to combine the use of a thresher with the traditional method as a stop-gap measure to address the issue that the thresher does not properly clean the teff or make the straw fully palatable to livestock while still reducing overall time, labor and cost required to thresh and winnow. When the Abt team asked other teff farmers about the feasibility of this idea, respondents noted that they had never thought of this possibility before.

There is heavy focus on the unions, and while it is important to build up the leadership and financial capabilities of the union, it is also important to increase the sense of ownership and empowerment of the farmer members themselves to start actively shaping cooperative and union policies and financial funds.

Behavior change campaigns can be delivered through the radio, as farmers in FGDs noted listening to the radio daily. In Ethiopia's case, the telecommunications systems and extent of cell phone ownership/use at the farmer-level are less developed than in other African countries.

To what extent do waste and spoilage levels for a particular crop influence farmers' decision to cultivate it or not?

In regards to teff and sesame, anticipation of PHL based on prior experience does not seem to influence farmers' planting decisions, because teff is a cultural and dietary staple, and sesame is a profitable and desirable specialty crop even after losses are taken into account.

Do the income/production levels of SHF influence their waste and spoilage reduction practices?

Large-scale sesame farmers generally have more PHL than SHFs in absolute terms, because the total loss is partly a function of volume produced. They may also have a greater percentage loss because of dependence on hired labor. They may also apply tighter grades and standards, which mean higher volume loss yet can also mean value gain. Data is lacking.

No large-scale teff farmers were identified, so for that crop there is no basis for comparison.

What are the primary areas for training/knowledge for helping farmers avoid pre-harvest produce losses in both quality and quantity?

PHL reduction training on quality should focus on better delineation of field plots, better planting and harvesting practices, simple on-farm processing, on-farm bagging and storage, grading and sorting along the supply chain. For both teff and sesame, quality is determined by color (the lighter the better in the instance of both), but the smell of mold can nullify color benefits and make product unsaleable for human consumption.

The issue of quality extends off-farm to traders altering the purity of both teff and sesame to increase the price for less desirable supplies. This issue is on the rise in teff as it becomes increasingly a cash commodity for urban markets. It is also a critical issue for sesame, as the ECX can add a level where transparency and quality control is obscured.

PHL reduction training for quality should focus on building first awareness of the nature, extent and sources of loss at different stages with current practices. Then participatory rural appraisals and visioning exercises should be done at the community level to determine the most appropriate technology and way forward with which to design further training.

Are farmer organizations aware of and do they appreciate the magnitude of postharvest losses' effects on their incomes? How can they best be mobilized and what new capabilities are required?

As stated earlier, farmers are aware that there are losses, but the incidence changes from year-to-year and with individual practice, so the magnitude and the resulting losses on income are not clear. In Ethiopia, although the union and cooperative structure are well-instituted, and although they may be the appropriate level in terms of instituting mitigations that require relatively high levels of financial investment, there is a relatively low level of confidence in the cooperatives and unions from the farmer members themselves. During FGDs with farmer cooperative members it was a noted trend that cooperatives and unions are not being supported and funded by their members through development and maintenance of revolving funds to finance necessary crop purchases and provision of storage facilities. This is a catch-22, where farmers are not supporting the unions/cooperatives, because they are not supporting the farmers. Leadership at the union and cooperative level needs to be enhanced while simultaneously energizing the member base.

What intervention points in the crop value chains will yield the best results (quantity and quality) in waste and spoilage reduction?

For details see the hot spot analysis in the appendix for the top three intervention points in the teff and sesame value chains.

What technologies best provide opportunities for SHFs, especially women, to engage in waste and spoilage reduction?

The main trend is toward mechanization for harvesting and threshing, which is available for both teff and sesame. This will reduce the time and hired labor requirements, which is especially beneficial towards female headed households. However, there is a risk that increasing mechanization could easily push out the SHF, particularly in the rising commercial production of sesame.

Agriterra noted that sesame harvesters and threshers are already used in Eritrea and S. Sudan.

For teff and sesame, satisfactory drying technologies still need to be identified, as currently they are both still dried on the field. Still resolved are issues of accessibility and affordability relating to the use of a semi-permeable plastic tarp to place the drying crop on.

Unseasonable rain was mentioned frequently as a problem during the harvesting, drying and threshing/winnowing stages. Farmer FGD participants noted that meteorological information, which they hear daily on the radio, is often inaccurate and unsuitable for them to use to plan their activities. The National Meteorology Agency noted that the technology they use provides accurate information, but the issue is the timely dissemination of it to the farmer level. The NMA only has 2-3 minutes per day on TV and radio to pass on information. Mid-range and long-range predictions are the responsibility of the regional and woreda-level governments, which do not necessarily have sufficient capacity to share information in a timely manner.

Hot Spot Analysis for Ethiopia

Teff Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological maturity							
Harvesting	Mixed variety with different harvest times	Improved and uniform seed within a single plot	Easily accessible based on own or neighbor's cultivation	• Own seed is free; neighbor's is not cost prohibitive • Increase in time demand for sorting and field planning	Some farmers already do this practice; need to promote uniformity of practice	N/A	Promote through extension workers and union and cooperative leadership this best management practice
	Delayed harvest	• Timely harvest: scheduling in relation to other crops, hiring of labor. • Replace hand harvesting with mechanized harvester	• Uncertain dynamics of migrant laborers; if there is an increased demand for laborers, will the supply increase? • Mechanization is not widely available.	• Access to credit to have timely hiring of sufficient labor numbers; access to credit also to provide sufficient incentive for laborers to take increased care to reduce PHL • No consensus has been reached on the best financing and supply model; but	• Cultural issues associated with informal lending schemes. • Cultural bias against machines not performing as expected. • Variability in topography make some models less suited to an area	Additional benefit to female headed households that have increased hired labor costs	• Before mechanization becomes widespread, focus on the dynamics and interrelations of farmers and the migrant laborers. • Increased access to credit through development of cooperative/union revolving funds. • Quantitative baseline survey of PHL at harvest. • Cost-benefit analysis

				likely it will be a private, mobile third-party renting the machines • Mechanization requires additional costs and labor of field preparation			of various mechanization models.
	Unexpected rainfall	Use of meteorological data	SHFs have limited access to time data through 2-3 minute radio slots per day	National, regional and *woreda*-level governments need more funding towards meteorological data dissemination and farmer use in forecasting.	Currently, farmers are of the opinion that the meteorological data is not accurate	N/A	• The national, regional and woreda-level government would need to invest in more outreach. • Once timely dissemination of accurate data can be achieved, behavior change training to farmers is needed to get them to trust using the data
Field drying	• Eaten by livestock, chickens, birds, rats • Shattering from rain and wind	• Eliminate field drying and immediately transport to stocking area/threshing area • Use of plastic tarp that is permeable to rainwater, but	• Labor shortage: not enough people to harvest within a reasonable period with the increased requirement to transport teff • Variable access to appropriate	Lack of finances to: • Increase pay to incentivize laborers to increase harvesting steps • Purchase plastic tarp	• Lack of willingness of laborers to do additional work • Environmental factor that plastic tarp will not last multiple years due wear and tear and pest	Additional benefit to female headed households that have increased hired labor costs	• Focus on the interrelations of farmers and the migrant laborers. • Increased access to credit through development of cooperative/union revolving funds. • Quantitative baseline

		this does not eliminate issue of being eaten	quality tarp		damage		survey of PHL at field drying. • Cost-benefit analysis of plastic tarps.
Transport to stocking site (mule or on top of head)							
Stocking (up to 2 months)							
Threshing/Winnowing*	• Use of plastered ground • Traditional use of livestock to thresh • Labor intensive hand-winnowing with wind • Poor quality threshers that do not fully clean teff and lose teff to wind	Mechanized threshing	• Lack of widespread access to efficient and teff-appropriate technologies such as ones that will sufficiently clean the teff without requiring an additional threshing steps • Lack of service providers	• Lack of credit to purchase machines from unions or cooperatives • Uncertain ability to make return on investment in a timely manner	• Cultural perception that threshers do not produce straw that is edible to livestock • Perception of local manufacturers that agricultural equipment is not profitable, so no reliable local supply	Additional benefit to female headed households that have increased hired labor costs	• Coordinate research institutions to ensure that best technologies are shared among regions to address issue that teff is not fully cleaned • Build up union and cooperative revolving funds • Incentivize local manufacturers to produce high-quality threshers
Grading /sorting							
Bagging							
Transport to storage							
Storage at the farm level (PP							

bag or gotera)							
Off-Farm							
Storage and handling at the trader level							
Processing							
Distribution to retailers/consumers							

* Threshing and winnowing are combined as a step, because they were often associated as one activity by stakeholders. As well, the potential solutions provided addressed both at the same time.

Sesame Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological maturity							
Harvesting	Too early or too late harvest driven by lack of sufficient labor overall and lack of skilled labor	• Increase access to credit to incentivize labors to increase time and effort needed to properly harvest sesame • Use of mechanized harvesters	• Uncertain dynamics of migrant laborers; if there is an increased demand for laborers, will the supply increase? High labor competition. • Mechanization is not available.	• Access to credit to have timely hiring of sufficient labor numbers; access to credit also to provide sufficient incentive for laborers to take increased care to reduce PHL • No consensus	• Cultural issues associated with informal lending schemes. • Cultural bias against machines not performing as expected. This is more so in sesame than teff. • Variability in topography make	• Additional benefit to female headed households that have increased hired labor costs	• Before mechanization becomes widespread, focus on the dynamics and interrelations of farmers and the migrant laborers. • Increased access to credit through development of cooperative/union revolving funds. • Quantitative baseline

				has been reached on the best financing and supply model; but likely it will be a private, mobile third-party renting the machines • Mechanization requires additional costs and labor of field preparation	some models less suited to an area		survey of PHL at harvest. • Cost-benefit analysis of various mechanization models.
Field drying in hillas	• Eaten by termites, birds, rats • Shattering from rain and wind	• Spray insecticide around the hillas • Form hillas in the direction of the wind with a plastic tarp that is permeable to rainwater underneath • Form hillas closer to the threshing area	• Farmers typically rely on unions to provide inputs, which are not uniform in services provided • Lack of access to appropriate chemicals; some farmers still use DDT • Variable access to appropriate quality tarp	• Affordability of insecticides depends on the household • Affordability of a plastic tarp depends on the household • Access to credit to have timely hiring of sufficient labor numbers; access to credit also to provide sufficient incentive for laborers to take increased care to reduce PHL	• Lack of education on proper chemicals to use and/or proper application • Lack of willingness of laborers to do additional work • Environmental factor that plastic tarp will not last multiple years due wear and tear and pest damage	• Additional benefit to female headed households that have increased hired labor costs	• Focus on the interrelations of farmers and the migrant laborers. • Increased access to credit through development of cooperative/union revolving funds. • Quantitative baseline survey of PHL at field drying. • Cost-benefit analysis of pesticide use; assessment of integrated pest management • Cost-benefit analysis

							of plastic tarps.
Threshing							
Winnowing							
Bagging							
Transport to storage (mule)							
Storage at the farm level (PP bag)							
Off-Farm							
Handling and transport to cooperative/union/trader/ECX							
Grading/sorting							
Storage and handling at the cooperative/union/trader/ECX	Poor bagging (loose weave, overfilling of bag)	• Supply of improved PP bags (either tighter weave or hermetically sealed) • Improve bagging practices to avoid overfilling • Eliminate sampling practice of poking the polybag that damages bag	• Variable access to either bags with tight weave suitable for small seeds or hermetic bags. However, recycled fertilizer bags have a hermetic plastic internal layer • Lack of access to education on improved bagging and sampling practices	Affordability of new and/or improved bags. Currently new bags are ETB 6-13/bag; hermetic bags are ETB 30/bag. Reuse of fertilizer bags is free.	• Perception that sampling by poking does not cause significant damage to the bag, and that multiple sampling does not cause significant loss • Overfilling bag is done, because transport is done per bag, so want to capitalize on a single trip	N/A	• Quantitative baseline survey of PHL at during storage and handling. • Cost-benefit analysis of various bag types • Cost-benefit analysis of losses due to leakage from overfilling in relation to cost per trip • Training on proper bag filling & handling
	Inadequate volume	Construction of new	N/A	Lack of access to	N/A	N/A	• Increased access to

	of appropriate storage (ventilation)	appropriate storage warehouses at the cooperative and union levels		finance at the cooperative and union level			credit through development of cooperative/union revolving funds. • Support of public-private partnerships to raise funds. • Support and expand the Ministry of Trade & Industry in their awareness building seminars on proper storage quality
	Inadequate storage practices (sanitation, stacking)	Improved storage management	Lack of access to adequate storage space forces overcrowding of warehouses	Lack of funds to construct additional storage space and/or to purchase staff and supplies to maintain space.	Lack of knowledge on appropriate storage practices	N/A	• If it is an issue of lack of sufficient space, then the same recommendations apply as above. • Support and expand the Ministry of Trade & Industry in their awareness building seminars on proper storage quality
Distribution to exporter							

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80	Zewdu Ayalew Belay	Amhara Agricultural Research Institute	Postharvest Loss Mechanization Expert

Country Annex for Ghana

- Dates traveled: March 18 – April 3, 2014
- Main growing regions visited: Tamale (pulses, cassava), Bawku (cassava, tomato), Bolgatanga (onion), Navrongo (tomato), Wa (tomato), Wenchi (cassava, tomato)
- Interesting quote(s):
  - "The post-harvest challenge in the Northern Region is lack of markets, hence produce going waste. Some farmers have even sometimes committed suicide because of lack of markets for their produce (onions). However, on-farm simple processing of most of our farm produce are possible—chip production (cassava), cut-dried tomato and others." – Ms. Janet Adama, Coordinator, Northern Region Bread Basket Committee (NRBBC), Tamale, March 20, 2014
  - "One way of making stakeholders aware of new technologies is the Innovation Platforms: all actors in the chain are involved. The Platform then looks at individual actors in the chain, finds out challenges and then the group brings innovative solutions to the challenges." Mr. John Osei Gyimah, MoFA/Municipal Development Officer for Vegetables, Wenchi, Brong-Ahafo Region, April 02, 2014
  - "If [the Larger Grain Borer] attacks a maize crib, it will destroy the maize together with the crib." – Agricultural Researcher, Northern Ghana

Figure 1: Polybag Maize Storage and Tarp Use

Objective 1: Prioritization

Key Questions

How aware of losses are smallholder farmers involved in the selected value chains? Which types worry them the most and why?

- Smallholder farmers in Ghana in general are aware of the losses they incur in their production and handling of the produce, although they may have trouble quantifying.
- Cassava farmers are especially aware of losses occurring from breakage due to poor harvest tools and their inability to store for long. Tomato farmers complain particularly about of poor transport/handling of produce after harvest
- SHFs are able to associate their quantity/quality losses with revenue foregone when they just sell as low rather than peak
- In general SHFs attribute many losses to bad weather conditions, transportation bottlenecks and spoilage from insect infestation.
- Cassava farmers are able to reduce their fresh produce loss by converting excess supply into dry cassava chips/flour (*kokonte*) which fetches a much lower price but still generates some revenue.
- Tomato farmers are aware that losses could be avoided if they could store their product or process into paste, but most do not have those options available.
- Some SHFs have complained of quality losses arising from the use/misuse of chemical fertilizer application and pesticides.
- For some products, the use of manual labor for harvesting (shattering of beans, for example) causes losses as well

What are they currently doing to prevent or mitigate those problems and what else would they like to do?

- Cassava farmers leave their mature crops in the field until markets are ready-- a situation that can lead to root rot in the soil.
- Cassava farmers would like to see more of their produce processed into other value added products such as *gari*, HQCF (chips)
- Tomato farmers sell off their produce quickly and cheaply to avoid being stuck with spoilt produce
- Tomato farmers would like to see more industry-type processing factories set up in their communities to absorb their produce

What attitudinal and capacity factors inhibit greater awareness or action?

- Cassava, as a major food crop, comes in two main types and various varieties. Cassava farmers' main attitude is to produce for food (fufu) rather than for commercial/industry-type varieties which contain more starch. Hence they are very selective of varieties they cultivate, which sometimes can be low yielding and susceptible to high postharvest losses.

- Vegetable farmers (tomato) lack of training and knowledge in the use of field chemicals, which is a big problem in terms of mitigating postharvest loss. Selection of chemicals and training in the use of these chemicals are important.

What are the main considerations smallholders have in deciding whether and how to act to reduce waste and spoilage along selected value chains?

- Generally farmers lack access to viable solutions for their PHL problems.
- They say that lack of access to credit to adopt on-farm technology or invest in capital items on farm is a major constraint.
- Smallholder farmers look mainly to the domestic fresh market to absorb their produce, but stronger out-grower schemes that open up additional distant or value-added markets would greatly help to reduce waste and spoilage

What types of intervention and/or support (e.g., financial or technical) and/or incentives would stimulate further action?

- Affordability of services e.g. on-farm processing. This should be made available to farmers
- Farmers are not so exposed to on-farm technologies, so there is the need to look at the value chain and adopt chain-wide market linkages.
- Availability of credit and entrepreneurial training for the farmers and the other actors in the chain to enable them to provide service to farmers, making technologies more accessible, reliable, and better adapted to local circumstances.
- The provision of credit and entrepreneurship training to the youth in the manufacture of simple processing and harvesting machines, creating employment to the youth.

Objective 2: Identification of Key Interventions

Key Questions

What are the country-specific intervention opportunities, by specific crop and geographic area?

Cassava

Freshly harvested, cassava keeps substantially longer under shade and on pallets/raised platforms – and longer still if it is waxed, as is the norm in parts of Central America, facilitating regional trade and global exports. The Ghanaian / neighboring country market for added-value cassava products such as gari is effectively unlimited.

Tomato

Tomato and other horticultural crops represent a means of increased productivity through product diversification and off-season production under irrigation, as a legacy of MCC compacts in Ghana. There is considerable scope for increasing smallholder diversification into tomato in the three northern regions in particular, where foliar diseases are a less serious threat than in the forest zone, but proper screening for pest and disease resistance and shipping traits is needed as well as for marketable yield.

Beans and Pulses

Pulse crops are perceived as high risk by smallholder farmers, due both to their sensitivity to insufficient and/or erratic rainfall (a significant effect of climate change across many parts of sub-Saharan Africa, even where overall precipitation is expected to increase overall. Bambara bean presents lower abiotic risk than cowpea, and enjoys strong demand in regional trade.

Beans/pulses are vulnerable to infestation by bruchid beetles (Callosobruchus maculatus) as a primary threat in storage.

Varietal selection is important for both reasons.

What are the technology-specific intervention opportunities by specific crop and geographic area?

Cassava

Waxing of freshly-harvested cassava--although not well developed in Africa and in need of testing for both market acceptance and cost effectiveness, judging from success in Central America--holds promise of making cassava more tradable while reducing waste and spoilage.

For fresh cassava produce, "Low Cost Fresh Cassava Storage" techniques may be undertaken which involve sorting/picking wholesome tubers without cutting or bruises; washing with clean water; put in plastic bags (transparent) based on quantity; after put in poly sacks and put under shade on pallets/raised platforms. This way produce can stay for 10 – 14 days and can still be used for fresh products.

Tomato

There is need for technical support to smallholder producers, particularly as regards varietal selection, harvest timing and procedures, proper agrochemical usage, and locally-appropriate means of 'no fuel' cooling at the farm and wholesale market levels.

Beans and Pulses

Whereas the Purdue PICS triple-bagging system has been well documented and successful for cowpeas, and is now being marketed for use with other beans and pulses, it remains an expensive approach, and offers limited accessibility to smallholders

Recent experience demonstrates the effectiveness of a more locally-appropriate 'double-bagging' method, using a single polythene insert.

Expert & Stakeholder Workshop

Dates: April 16-17 2014

Place: Kumasi, Ashanti Region

Address: Miklin Hotel, Danyame, Kumasi, P. O. Box KS 11730: Tel +233-51-39121 - 5

Number of Attendance: 20 participants on both days

Main Findings

Participants concluded that the main intervention points and recommended innovations to reduce PHL in Ghana for the crops of interest include:

Beans/Pulses

- Harvesting: Timely harvesting using moisture meters to determine crop moisture content in the field for beans and using mechanized harvesters to avoid bean shattering
- Storage and handling at the trader level: the adoption of the triple/double bagging (PICS) and construction of low cost storage facilities in the local communities
- Field drying: solarization to kill insects under plastic sheets.

Cassava

- Harvesting: pre-harvest land preparation of ridging to soften the land and use of harvest lifters
- Platform drying of chips: Use of community solar dryers/portable solar dryers
- Storage and handling at all levels (fresh): low cost fresh cassava storage techniques
- Transport to packing shed: intermediate means of transport (bullock carts, motorking, etc.)

Tomato/Onion

- Harvesting: pre-harvest varietal selection of early maturing; timely harvest of fruits (morning/evening)
- Storage/Grading/sorting: separation into various sizes and provision of sheds/shading
- Transport to packing points: proper packaging and package sizes
- Distribution to retailers: packaging in proper packs

Although there are different levels of accessibility and affordability, it is possible to scale-up easily in the communities by relying on FBOs, empowering them with productive assets, and linking them better with major buyers.

Conclusions

The postharvest loss landscape in Ghana is pre-disposed to problems because of many pre-harvest factors that have knock-on effects: poor variety selection, poor agronomic practices and poor farmer training. The lack of enforcement of farm produce standards results in high PHL. There is a clear need to train farmers sort harvested produce.

Experts in the postharvest loss landscape conclude that the major growing season is also the time of highest PHL, especially when farmers are not able to get produce to the market because of poor storage, transportation and other related problems.

Broadly, it was concluded that success at dealing with PHL challenges in Ghana will require: (a) behavioral change on the part of our smallholder farmers in seeing agriculture as a business and investing more in agriculture, hence need for training; (b) more effective and widespread demonstration by private providers of solutions of the cost/benefit implications of appropriate technologies available, as well as associated risks for the private sector to champion some of these technologies; and finally, (c) adjustment in the policy environment to make it more favorable to investment in this field.

Sub-Questions

What is the process from awareness to behavior change?

Create demonstration effects: demonstrating to farmers in value terms how much they lose and what that loss can purchase (in terms of bags of fertilizers, bags of maize for food, school fees, equipment purchase, etc.)

Create or support Farmer Field Schools on adoptable technologies: Farmer field schools that expose farmers to locally manufactured postharvest loss reducing technologies (using local products) that focuses on the smallholder farmer critical postharvest loss points such as hand-held harvesters, simple field storage media that are effective and efficient

Demonstrate accessibility (locally available) and affordability of simple locally manufactured tools and equipment

What cultural and environmental factors might be important?

Culturally, there are gender considerations in the postharvest loss intervention points as a result of division of labor. Tomato transport and storage, for example, is more handled by women than men; converting fresh cassava to processed *gari*, *agbelima* (fermented cassava dough) and others are all mainly the preserve of women.

When to plant and when to harvest, particularly of beans/pulses and cereals in the dry ecologies of the savanna and sahel-savanna are important, for environmental considerations arising from climate/weather changes. Simple moisture meters to determine crop moisture content in the field for cereals and beans have helped as to when to harvest.

Are there any gender differences in the process from awareness to behavior change?

Some crops are classified as women's crops (vegetables and food crops). Targeting such crops helps women in particular. Targeted effort to raising awareness of postharvest loss hotspots and related financial costs can create awareness.

Women usually work on marginal lands, which tend to result in lower productivity.

Women are the food providers in most households. They are therefore more inclined to harvest early and sell early even if cheaply, just to ensure that the family can eat.

Women need to be made aware of simple technologies available to reduce postharvest losses. If that results in more food on the table for longer, it can lead to strong behavior change.

Differentials in credit access between men and women and the high costs of capital for many small-scale farmers constrain adoption of many postharvest loss intervention technologies.

What are the gender issues to consider in technology design, adoption, and up-scaling?

Technology design must be sensitive to both cultural and local habits. Heavy equipment, for example, could deter women's use.

Women dominate in the production, harvesting, storage, handling, processing of cassava and tomato, among others in the values chain. For successful mitigation of postharvest losses, this will require technologies that are gender friendly and empower them. .

In up-scaling of technologies, women's access to credit requires considerable attention.

What are creative ways to encourage waste and spoilage reduction behavior changes?

Demonstrating to farmers what simple technologies have worked in other domains and in their own environment.

Demonstrating accessibility (locally available) and affordability of these simple locally manufactured tools (the cost-benefits of these simple technologies)

Working with "market-makers" to change incentive structures and share risks/rewards

To what extent do waste and spoilage levels for a particular crop influence farmers' decision to cultivate it or not?

Farmers are guided by past behavior. Persistent market gluts as a result of lack of access or market development that have caused huge postharvest losses and wastage also erode profits. Such experiences also constrain farmer capacity to repay loans. Low profits and credit woes also constrain farmer planting decisions for the next season. They may even reduce land area, or at least just maintain the previous year's area size cultivated.

Do the income/production levels of SHF influence their waste and spoilage reduction practices?

Despite low productivity and levels of production among SHFs, estimates of post-harvest losses are high. Waste and spoilage reduction practices are influenced through SHF linkages to actors in the

product market. It has more to do with behavioral change and access to market than of high income/production levels.

What are the primary areas for training/knowledge for helping farmers avoid pre-harvest produce losses in both quality and quantity?

- Selection of improved and adapted crop varieties/seeds for planting
- Proper land preparation that loosens the soil for easy crop harvest in terms of root crops
- Use of good cultural practices, especially pest and disease control

Are farmer organizations aware of and do they appreciate the magnitude of postharvest losses' effects on their incomes? How can they best be mobilized and what new capabilities are required?

Most farmer organizations exist to take advantage of improved farm technologies, improve the availability and cost of inputs and to better access output markets. These farmer organizations are hugely aware of the magnitudes and the costs of postharvest losses to their incomes, and are more than willing to act, taking advantage of collective action and leaderships. However, they need options. For example, the Chairman of Pena Farmers Association (tomato producers) in Wenchi in the Brong Ahafo Region indicates that "No [PHL reduction] technologies exist for tomato farmers in Awisa." This farmer group in tomato, for example, requires better varieties of tomato for cultivation and report that "due to lack of storage facilities if the market queens fail to come we do not harvest, we leave the crops on the farm to rot". They indicate that if new technologies were brought to them that would help enhance the shelf life of produce to give them better price and improved incomes they would readily adopt them and scale them up for production.

What intervention points in the crop value chains will yield the best results (quantity and quality) in waste and spoilage reduction?

Onion

- Production: due to farmer's lack of knowledge about physiological maturity for harvest, they do late irrigation putting a lot of water into the crop, which leads to bulb rot in store, due to high water content of the bulb.
- Storage: much loss occurs in storage due to types of storage designs, which are not well ventilated thus causing rots.
- Transport: since vehicles lack cooling devices, high temperatures in the truck during transport cause a lot of bulb rot.

Tomato

- Production: Varieties with better shipping characteristics would help reduce losses
- Harvesting: SHFs lack knowledge about maturity process, especially color break, and also less injurious harvesting methods
- Handling: SHF use large crates made of wood, which cause a lot of spoilage , especially deterioration of the quality of produce

- Transport/Storage: since farmers do not own crates or boxes for storage, and are leery of rapid maturation, they do not normally store tomato. The storage is done by market queens who bring in the boxes at the time of harvest, which puts farmers at disadvantage

Cassava

- Harvesting: Lots of wastage and loss occurs due to lack of proper tools, lack of information on maturity & harvesting methods; use of manual labor.
- Storage: After harvesting and drying, farmers lack facilities to store. Traditional storage structures are not well ventilated. Farmers also lack storage bags so they rely on market queens for bags which are not very hygienic. There is also lack of transport

Beans/Pulses (soybean)

- Varietal selection: Better cultivars that tend not to shatter are needed.
- Harvesting: Farmers do not use the right technology, and have to rely on hired labor for harvesting which does not care about losses.
- Threshing: Farmers thresh on the bare ground
- Transport: The lack of simple farm gate transport technologies and from farm gate to store transport are both problematic.
- The traditional methods of processing are: soy *dawadawa*, soy *khebab*, soy milk, etc. The demand of this local nutritious food is low due to lack of awareness on its food nutrient qualities.
- Lack of good or proper packaging, both method/material used for packaging. Lack of storage facilities for processed food.

What technologies best provide opportunities for SHFs, especially women, to engage in waste and spoilage reduction?

Cassava

- Waxing freshly-harvested cassava
- The "Low Cost Fresh Cassava Storage" which can allow produce to stay for 10 – 14 days and can still be used for fresh products.

Tomato

- Locally-appropriate means of 'no fuel' cooling at the farm and wholesale market levels.

Beans and Pulses

- Purdue triple-bagging system / more locally-appropriate 'double-bagging' method

Hot Spot Analysis for Ghana

Cassava Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological Maturity							
Harvesting	High breakage of roots Lack of labor to harvest	Proper land preparation that loosen the soil Varietal selection	Tractor services not accessible Varieties of cassava available	low	low	Men biased	Access to tractor services to work on the soil before planting recommended varieties
Field drying (when applicable)							
Platform drying (when applicable)							
Threshing/shelling (when applicable)							
Winnowing (when applicable)							
Transport to packing shed							
Storage at the farm level	Low shelf life of harvested produce due to infestation and rot from sun and rain exposure	• Waxing freshly-harvested cassava • The "Low Cost Fresh Cassava Storage" which can allow produce to stay for 10 – 14 days and can still be	High but access to large quantities of wax can be problematic	medium	Currently low	Women can easily adopt	The promotion of these technologies can increase the shelf-life of cassava and enhance market value of fresh produce. It can also help transport across longer space to markets

		used for fresh products.					
Grading and sorting							
Off-Farm							
Handling and transport to first receiver	Bulk transportation in open trucks accelerate rotting	Waxing?	low	low	low	Male-biased	See above
Storage and handling at the trader level							
Processing (when applicable)							
Downstream storage (when applicable)							
Distribution to retailers							
Handling and transport to first receiver							
Storage and handling at the trader level							
Processing (when applicable)							
Downstream storage (when applicable)							
Distribution to retailers							

Tomato Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological Maturity	SHF do not have knowledge about	Selection of better varietal strains	high	high	high	Women can easily access	Increasing the shelf life of tomato crop is one

	harvest maturity and harvesting methods and poor varietal selection						sure way of minimizing post harvest loss on farm
Harvesting							
Field drying (when applicable)							
Platform drying (when applicable)							
Threshing/shelling (when applicable)							
Winnowing (when applicable)							
Transport to packing shed	SHF use large boxes made of wood which cause a lot of spoilage , especially deterioration of the quality of produce	Smaller and more durable boxes to contain smaller volumes	high	low	low	High among women	Smaller volumes packed in lighter and durable containers can transport better, especially if shelf life is long
Storage at the farm level							
Grading and sorting							
Off-Farm							
Handling and transport to first receiver							
Storage and handling at the trader level	Poor bulk packaging in boxes resulting in squashed produce and rotting	Smaller and more durable boxes to contain smaller volumes	high	low	low	High among women	Smaller volumes packed in lighter and durable containers can transport better, especially if shelf life is long

Processing (when applicable)							
Downstream storage (when applicable)							
Distribution to retailers							
Handling and transport to first receiver							
Storage and handling at the trader level							
Processing (when applicable)							
Downstream storage (when applicable)							
Distribution to retailers							

Onion Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological Maturity							
Harvesting	Due to farmer's lack of knowledge about physiological maturity for harvest, they do late irrigation putting a lot of water into the crop and this lead to bulb rots in store, due to high water	Better training and practice	high	high	high	Women access high	Better agronomic education and input use timing could reduce PHL drastically

	content of the bulb.						
Field drying (when applicable)							
Platform drying (when applicable)							
Threshing/shelling (when applicable)							
Winnowing (when applicable)							
Transport to packing shed							
Storage at the farm level	Much loss occurs in storage due to types of storage designs, which are not well ventilated thus causing rots	Low cost, local material -made mud houses for families and groups	high	high	high	Women access high	Local material-made ventilated muds are easily available and adopted
Grading and sorting							
Off-Farm							
Handling and transport to first receiver	Transport vehicles lacking cooling devices, high temperatures in the truck during transport cause a lot of bulb rot	Ventilated transport	high	high	high	Women access high	Use of ventilated and less packed vehicles could prevent rotting during transportation
Storage and handling at the trader level							
Processing (when applicable)							

Downstream storage (when applicable)							
Distribution to retailers							
Handling and transport to first receiver							
Storage and handling at the trader level							
Processing (when applicable)							
Downstream storage (when applicable)							
Distribution to retailers							

Soybean Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological Maturity							
Harvesting	Shattering of beans due to poor harvesting techniques	Moisture meters to help with when best to harvest	low	low	low	Women not likely to afford	This technology can help farmers decide when to harvest, based on the moisture content
Field drying (when applicable)							
Platform drying (when applicable)							
Threshing/shelling (when applicable)							
Winnowing (when applicable)							

Transport to packing shed							
Storage at the farm level	Pest infestation and reduction in grain quality	Triple/double bagging technology	high	low	medium	Accessible to women	This technology has proven to prevent postharvest loss in grains
Grading and sorting							
Off-Farm							
Handling and transport to first receiver							
Storage and handling at the trader level	Pest infestation and reduction in grain quality	Triple/double bagging technology	high	low	medium	Accessible to women	This technology has proven to prevent postharvest loss in grains
Processing (when applicable)							
Downstream storage (when applicable)							
Distribution to retailers							
Handling and transport to first receiver							
Storage and handling at the trader level							
Processing (when applicable)							
Downstream storage (when applicable)							
Distribution to retailers							

Contact List

No.	Name	Affiliation	Position
1	Musa Salifu Taylor	Feed The Future USAID Agriculture Technology Transfer Project, Tamale	Organization Development Advisor
2	Chief Awudu Abubakari	University For Development Studies, Tamale	H.O.D. Dep't Of Mechanization & Irrigation Technology
3	Rex Asanga	TRIAS Ghana (Local NGO)	Manager
4	Ebenezer Martey	TRIAS Ghana (Local NGO)	Manager
5	Wekem Raymond Avatim	SEND Foundation (Tamale)	Director Of Livelihoods & Food Security Development
6	Samuel Agongo	SEND Foundation (Tamale).	Director Of Livelihoods & Food Security Development
7	Linda Dari	University for Development Studies, Tamale	Food & Postharvest Technologist
8	Mr. Prince Fuseini Haruna	MoFA/RTIMP, Tamale	Officer-In-Charge
9	Issah Sugri	CSIR/SARI- MANGASTATION BAWKU	Researcher
10	Mr. Akoto	TONO IRRIGATION FARMERS UNION (TICFU), KASENA NANKANI DISTRCT, NAVRONGO.	PROJECT EXTENSION OFFICER
11	Shaibu Seini	CSIR/SARI- WA	ENTOMOLOGIST
12	Osei Badu Jacob	CHAIRMAN	ESO NYAME YE FARMERS ASSOCIATION, NKONSIA, WENCHI, B.A. GHANA
13	Douglas Nsoah	Chairman	Grace Quality Farmers Association, Wenchi
14	Aaron Akyea	MANAGER	WENCHI AGRICULTURE STATION
15	Mr Ofosu Dankyira, J.	MoFA	Crop Specialist, Sunyani, B.A
16	Mr. E. D. Eledi	Private	Former Regional Director, MoFA, Ashanti Region
17	Mr. Peter Asibey-Bonsu	ACDI-VOCA/ADVANCE	Farming Systems Specialist
18	Mr. Hassan Abdelrazig	WFP/P4P	Country Coordinator
19	Mr Lawrence Krampa	MoFA	District Director, Ejura, B.A
20	Mr. Johnson Panni	MoFA Agricultural Engineering Services Directorate	Crop Postharvest Specialist
21	Mr. A.K.B Deyang	MoFA Agricultural Engineering Services Directorate	Director/Crop Postharvest Specialist
22	Mr. Naaba A Jonathan	Presbyterian Agricultural Services	Field Coordinator
23	Mr. John Lovelace Kpodoviah	MoFA Agricultural Extension	Assistant Director

		Services Directorate	
24	Mr. J.K. Addo	CSIR-CRI	
25	Dr. R.K. Maalekuu	Department of Horticulture, Kwame Nkrumah University of Science and Technology, Kumasi	Senior Lecturer
26	Mr Vesper Suglo	AGRA	AGRA Seed Node (focal point)
27	Mr. Kenneth Owusu	National Development Planning Commission (NDPC)	Special Assistant to Director General

Country Annex for Kenya

- Dates traveled: 12 March to 10 April
- Main growing regions visited: Western and Eastern Regions
- Interesting quote(s):
  - "Selling maize at a low price and then buying it back later is the biggest problem we have. The reason is poverty: farmers need the cash." – A.S. Omushieni, Bungoma County Director of Agriculture
  - "Sometimes we are forced to treat only a limited amount of maize against weevils with Actelic Super because of lack of finance. The rest we use ash or pepper, which in not as effective." Female farmer and member of KIWAKI Self Help Group, Mbooni East, Makueni County.
  - "Even if you know the price will go up, you can't take care of your kids if you hold the maize for longer. You won't have money to pay for school fees." – Female farmer, Bungoma County
  - "There is a perception that the horticulture sector is high value, so nobody is willing to put money where money already is. So there is a lot of underfunding on vegetable research." – Dr Willis Owino, Lecturer, Department of Food Science and Technology, Jomo Kenyatta University
  - "Why is there no cheap moisture test? Nobody is funding that because large farmers use expensive moisture meters." – Sophie Walker, ACDI/VOCA
  - "I see [maize over-treated with chemicals], and I feel like crying." – Joseph Munga, Manager, Dandora Millers
  - "Although Kenya has established maize standards, enforcement is wanting. If a trader's maize is rejected by miller A, he/she will just move around and will get a willing buyer miller B." – Jane Wanza Kamau, EAGC.

Figure 2: Maize Storage on Tarp, Machakos County

Figure 2: Tomatoes in Lined Crates, Jubilee Market, Kisumu

Objective 1: Prioritization

Key Questions

How aware of losses are smallholder farmers involved in the selected value chains? Which types worry them the most and why?

Farmers are acutely aware of financial losses they suffer due to selling at times of low prices. With horticultural crops, this happens because of gluts and needing to sell immediately to avoid spoilage that would be incurred during storage. With maize and to some extent with beans, the cause is the need for cash. They sell to pay school fees and other expenses even though they know the commodity price will rise in the coming months and they will likely have to buy back maize at a higher price later on.

Quantity losses of maize and beans:

- Farmers note a significant level of losses due to pests (larger grain borer, maize weevil, rats) and are particularly concerned with the increasing presence of LGB.
- Mold is also a problem and one that farmers have yet to find a satisfactory solution for in many instances.
- Increasingly variable rain patterns mean that cereals and beans/pulses sometimes reach maturity and must be harvested while rains continue, leading to an inability to dry sufficiently before storing.

Quantity losses of tomatoes:

- The main tomato losses that farmers cite occur during transport from the field, household/packing area and to traders for sale. Bruising and crushing lead to heavy losses due to the bulk storage containers that farmers use for transport.
- Moisture loss and heat account for significant tomato losses as well, but farmers are less aware of these effects.

Cost concerns and intra-household decision-making play an important role. With maize and beans, men control the money but women are often in charge of preserving the crops. Women often face difficult choices between expenditures on school fees or health needs on the one hand and on proper storage on the other. Thus, households face a tension relating to whether to spend money on post-harvest management or on other pressing needs.

Aflatoxin awareness varies widely, but those farmers who have heard of it are concerned but often misinformed about how to detect it (they think it can be gauged from looking for mold) and would not know what to do if they suspected its presence. There is no training or technology currently providing them with adequate solutions for aflatoxin.

What are they currently doing to prevent or mitigate those problems and what else would they like to do?

Farmers mainly use cheap or free technologies as much as possible. For pests, that means chemical dusting (if they can afford it) or ash/chili peppers (if they cannot afford chemicals). For drying, many

use tarpaulins rather than drying on the ground, but they would like cost-effective ways to dry better, especially since they often cannot get maize and beans dry enough through sun drying.

Tomato farmers in Mbooni East use borrowed bread crates to transport tomatoes to the market. They said they were better than wooden crates, but still had to line the inside of the crates with cartons to protect the tomatoes from bruising. They claim losses are minimal when using this combination of plastic bread crates and carton.

Small farmers have significant barriers to adoption with nearly every potential improved solution to pest and moisture problems. Either costs are too high (containers, dusting, mechanical drying), rains prevent proper drying (they are very worried about climate change) or they are unable to understand or use technologies properly.

There is differentiation between different types of farmers in what solutions they are able to access. Male farmers and those who are wealthier are more likely to use improved storage containers (such as wooden crates for tomatoes instead of baskets) than poorer farmers and female-headed households, for example.

Farmers would like ways to prevent or otherwise deal with aflatoxin, but there are no practical solutions yet available.

What attitudinal and capacity factors inhibit greater awareness or action?

Many solutions require cooperation among farmers. This can work with tomatoes, but there is deep mistrust with more basic commodities, especially maize because in Kenya it is synonymous with food itself. Farmers see their own production of maize as linked to their own identity. Therefore, collective storage and marketing solutions have largely failed here. There is also mistrust of NCPB (National Cereals and Produce Board, which purchases about 10% of Kenyan maize) stretching back decades.

There is a dearth of post-harvest training available in general. Storage solutions in particular are often misused even when they are available. Overuse of chemicals is a particular problem with tomatoes, and farmers are often unaware of the dangers or do not care because the market demands cosmetically attractive tomatoes.

Farmers' limited numeracy skills also present a barrier to organization and better marketing practices. For example, if farmers combine their maize to dry it, they have a hard time understanding what weight or volume they should receive after the moisture loss.

Technologies such as metal silos have been given out for free or at very high subsidized rates and without technical information. This has contributed to poor usage and often misuse of the silos. For example some farmers do not use the rubber seal to ensure the silo is airtight. Capacity building is needed in this area.

What are the main considerations smallholders have in deciding whether and how to act to reduce waste and spoilage along selected value chains?

Farmers are often aware that potential income is being lost, but are unable to take meaningful action because they do not have funds and are unable or reluctant to take loans.

Gender is also a factor. Yet as noted above, women may want to preserve their grains and pulses better, but their husbands control the money, and women are often not given enough money to cover both crop concerns and family needs.

What types of intervention and/or support (e.g., financial or technical) and/or incentives would stimulate further action?

- Appropriate financial products (i.e. school fee loans guaranteed by grains, technology-specific loans for storage or other innovations);
- Cost-benefit analysis of new technologies supported by rigorous quantification of current losses and potential savings;
- More comprehensive hands on education on how to use innovations correctly;
- Decreased focus on overly expensive or large-scale solutions and collective grain storage, which has proven time and again to be unpopular in Kenya, in favor of increased attention to small-scale and cheaper technologies;
- Holistic approach to tomato farming, as greenhouses and irrigation are key solutions but higher-intensity agriculture like this comes with significant problems (i.e. soil defects, diseases), which farmers cannot address without help that they are not currently receiving (i.e. Ministry of Agriculture, Kenya Agricultural Research Institute, etc.).

Objective 2: Identification of Key Interventions

Key Questions

What are the country-specific intervention opportunities, by specific crop and geographic area?

Maize:

- Innovative financial products are key, as much of the “loss” farmers incur is an opportunity loss incurred because they sell at the wrong time. Policy issues are also important, such as the fact that storage solutions and materials to make them (i.e. metal for silos) are currently taxed, though as agricultural technologies they are entitled to exemption.
- Metal silos are a promising solution from a technological standpoint, but their cost (ranging from Ksh6000 to Ksh16,000) is prohibitive for smallholders.
- Plastic silos are a potential alternative to the metal type and may be lower-cost (currently in proof-of-concept phase).
- Hermetically-sealed bags from producers such as GrainPro (SuperGrainBag) and Bell Industries (PICS bag) are becoming more widely available as alternatives to regular poly bags.
- More intervention and research is needed in drying and moisture testing technologies.

Tomato:

- Invest in development of locally-appropriate varieties that are appealing to the local market and more resistant to disease.
- Promote production of hard skinned varieties that have long shelf life and can withstand bruising compared to the soft skinned varieties.
- Explore increased tomato processing and opportunities for export of processed tomato products, and if feasible select varieties with higher soluble solid content.
- Support development and dissemination of technologies that even out the temporal distribution of tomato production (i.e. irrigation and greenhouse production).
- Encourage greater awareness of postharvest physiology to improve harvesting decision based on color break
- Encourage greater use of grading, sorting and packaging to add value while reducing bruising

Beans:

- Shift to mono-cropping or switch focus to other crops, since losses are so high due to intercropping. In reality, Kenyan farmers produce less cheaply than those in neighboring countries and in the long run may be better off focusing on other crops (the trend is already in this direction).

What are the technology-specific intervention opportunities by specific crop and geographic area?

Maize:

- Many storage solutions are coming on the market. Pay increased attention to those that can be made cheaply (i.e. hermetic bags, plastic silos (cost of this not determined yet, also unsure if it will be strong enough to prevent LGB infestation).
- Drying is the most significant gap at the moment: farmers need, but do not have, inexpensive solutions for drying especially since seasons are becoming unpredictable and they often are forced to harvest when it is raining and cannot dry cereals and pulses sufficiently. There is potential to expand the use of collapsible plastic driers and adjust their size from the current 18 meters long to sizes commensurate to smallholder needs.
- Moisture meters or innovative moisture testing solutions (such as the Coke bottle and salt method) would help farmers to dry better and to negotiate better prices with traders. Finally, Aflasafe and other aflatoxin-addressing products are key. These need to be rapidly tested and disseminated with appropriate education.

Tomato:

- Greenhouses, irrigation, and processing for tomatoes especially in Eastern and Kirinyaga County/Central Kenya. A
- Appropriate storage such as shelving and appropriate refrigeration (regular or new solutions like CoolBot, if it gets past the proof of concept stage)
- Explore use of ethylene absorbers while product is stored

Beans:

- Many of the above-mentioned technology solutions are also appropriate to beans, but drying is the most crucial and the one for which no promising innovations have yet appeared locally.

Expert & Stakeholder Workshop

Dates: 9 – 10 April 2014

Place: Maanzoni Lodge,

Address: Off Nairobi – Mombasa Highway. P.O. Box 611 – 00204, Athi River: email: info@maanzonilodge.co.ke. Web: www.maanzonilodge.co.ke

Number of Attendance: 18 first day; 17 second day: attendees included Ministry of Agriculture staff, development agencies, millers, university researchers, international agriculture research institutes, National Cereals and Produce Board, and international NGOs

Main Findings

Looking at the three value chains (maize, beans and tomatoes) there was general consensus that most of the post-harvest losses start on the farm before harvest, and stem from pests and diseases that affect the crops on farm.

Most of the PHL work in Kenya has been done on maize, but little has been done on beans and tomatoes.

The technologies that exist are often not adopted widely for several key reasons:

- Low empowerment of farmers and influence of traders;
- Lack of knowledge by farmers;
- Prohibitive costs of some of the technologies;
- Consumer preferences for tomato (consumers prefer softer varieties, which spoil more easily).

Findings/recommendations for maize:

- Encourage aggregation by farmers to access mobile dryers.
- Introduce hot air driven dryers that can use maize cobs as fuel.
- Consider innovation in small mechanical dryers suitable for small scale farmers.
- Innovation in grain moisture meters that can be used by small scale farmers.
- Make tarpaulins accessible and affordable for sun drying.
- Collapsible dryers were proposed as potential solution but there is need to adjust the size, currently at 18meters long which was said to be too high. Also cost is an issue.
- Reinforced plastic silos which are cheaper and lighter and can be in smaller sizes; they are resistant to the large grain borer.

- Improved wooden cribs: to keep rodents, weevils and contaminations away.
- Invest in research and development of LGB resistant plastic bags.

Findings/recommendations for beans:

- More research is needed on post-harvest loss issues in beans, including cost-benefit analysis.
- Use longer sampling spears to avoid puncturing all corners of the bags.
- Standardize the quality of bags and use separate bags for storage and transportation.
- Use properly calibrated weighing scales (but some farmers were said to prefer use of *gorogoro* (local measure of about 2kg) especially when they know their grain is of the low weight quality).
- Breed varieties with pods that are resistant to splitting during harvesting.
- Also need to research appropriate threshing technologies for beans. Currently there is no threshing technology in the market for small scale bean producers.
- Promote mono-cropping which reduces chance of damage when harvesting during wet season.
- Storage/transportation and marketing: as in maize.

Findings/recommendations for tomatoes:

- Practical training on postharvest losses for farmers, extension officers, store attendants, county government markets (sensitization on need of storage facilities for perishables).
- Active bag packaging.
- Underground cellars in specific areas.
- Low cost cold storage facilities e.g. Coolbot.
- Value addition.
- Promote appropriate packaging technologies for transportation
  - Wooden boxes (appropriate depending on size);
  - Plastic crates (appropriate but expensive);
  - Netted sacks (appropriate for short distance);
  - Plastic buckets and basins (appropriate for short distance);
  - Wheelbarrows, bicycles, tuktuk, pickups, trucks (appropriate for short distance);
  - Refrigerated trucks (appropriate for short distance but not economical or available).
- Promote technologies that even out the production of tomatoes throughout the year (greenhouses and drip irrigation).
- Aggregation and processing at the producer level.
- Storage at the market as a potential solution.

Conclusions

Kenyan smallholders face significant post-harvest losses in each of the three value chains examined here (maize, beans and tomatoes). Losses are quantitative, qualitative, economic and financial, and farmers in general do not have adequate tools or resources to address the causes of loss. Currently, innovation and funding focuses largely on storage solutions and there are promising technological innovations coming on the market in that area, but it is in not clear whether farmers will be willing and able to pay for them. Other stages where losses occur, such as drying, transport, threshing and shelling are relatively un-touched by research and development of post-harvest loss reduction technologies. Similarly, maize has captured much of the local and international research and development capacity, leaving other crops lacking in viable post-harvest management technologies.

Sub-Questions

What is the process from awareness to behavior change?

Behavior change depends on farmers' awareness both of the problems they face and of what they could do differently to solve those problems. Awareness of post-harvest losses varies by crop and among different types of farmers, but in general farmers are quite aware of the different types of losses they experience. However, there is far less awareness of potential solutions to these losses.

Additionally, adoption rests not only on farmers' desire to change their behavior but on their capacity to do so – this includes both skills and resources. Newer technologies, such as the metal silo, have met with significant challenges to adoption due to a) farmers' lack of liquidity to purchase and b) their lack of ability or training to use the technologies properly. All technologies must be accompanied by thorough, hands-on education in proper use. Otherwise, farmers are likely to be discouraged by the lack of results and will stop using the new technologies after a season or two of bad experiences.

What cultural and environmental factors might be important?

In Kenya cultural factors are especially significant for maize. Since maize is by far the most important food staple, and because farmers have been growing their own for generations, households are very reluctant to cooperate in ways that make maize storage and processing more cost-effective (i.e. aggregation for drying, group storage and marketing, etc). Past attempts at collectivization of maize production, storage, and/or marketing have largely failed.

Climate change and weather variability also play a role in losses for cereals and grains. Farmers have more difficulty than ever figuring out when to plant and harvest, and the rains no longer cease at predictable times, which leads to issues with moisture control, hence mold and aflatoxin.

Are there any gender differences in the process from awareness to behavior change?

Resource control and decision making between spouses greatly influence awareness and behavior change. Men wield power in decision making on resource use, e.g. what technologies to adopt/ purchase.

While women may attend most of the meetings, the decision-making process is largely male dominated. Awareness creation should therefore target both men and women.

What are the gender issues to consider in technology design, adoption, and up-scaling?

The primary gender issues are those of cost and access to financing. Women lag behind men in adoption of agricultural technologies in general, and post-harvest technologies are no exception.

However, women who operate in groups (noted especially with tomatoes) seem to be having some success in accessing and financing new technology adoption. This suggests that larger-scale technologies (such as greenhouses or small processing facilities) that women can use together may be more appealing than technologies aimed at individual households.

What are creative ways to encourage waste and spoilage reduction behavior changes?

Many farmers have minimal appreciation of the wastage and spoilage incurred at different levels except when there is large-scale loss. Losses at harvest, threshing, winnowing and drying may be ignored because individually they appear insignificant. Capacity building among smallholders farmers to appreciate wastage and spoilage at all levels could lead to behavior change.

To what extent do waste and spoilage levels for a particular crop influence farmers' decision to cultivate it or not?

Although production risk (as in dry beans) is certainly a deterrent to planting, anticipated PHL levels as such seem to have minimal effects on farmers' decisions about which crops to cultivate. Farmers seem to accept PHL as part of the natural order of things, and though they might do things to reduce losses they seem relatively philosophical and resigned about them.

Do the income/production levels of SHF influence their waste and spoilage reduction practices?

Income and production levels dohave a significant influence on waste and spoilage practices. Especially with maize, farmers at higher production levels are more able and willing to invest in post-harvest loss reduction technologies. Many of the new technologies that are available are far more economically advantageous for larger farmers than for smaller ones (especially with regard to maize storage).

What are the primary areas for training/knowledge for helping farmers avoid pre-harvest produce losses in both quality and quantity?

Choice of varieties in maize, beans and tomatoes when planting. Some tomato varieties spoil faster after ripening, some bean varieties shatter when the mature and dry, while some maize varieties are prone to aflatoxin related to moisture stress if planted in the wrong agro-ecological zones.

Good agronomic practices to prevent pest and disease attack especially in beans and tomatoes which contribute to post harvest losses.

Reduction in bean losses could also be achieved through promotion of mono-cropping as opposed to intercropping.

Are farmer organizations aware of and do they appreciate the magnitude of postharvest losses' effects on their incomes? How can they best be mobilized and what new capabilities are required?

Farmer organizations are aware of losses incurred due to poor drying and storage of grains and this has let efforts to support collective drying and storage activities especially for maize. However, although some groups have had success (e.g. Ngarua Self Help Group in Nyahurur) others have been plagued by mistrust and failed to achieve their goals.

Tomatoes and other higher-value crops have seen relatively more success when it comes to collective action. The trust issues that seem inherent in maize marketing groups have not been as problematic for other crops, so mobilizing around non-maize crops will probably generate the best results.

What intervention points in the crop value chains will yield the best results (quantity and quality) in waste and spoilage reduction?

For maize, beans and tomatoes interventions should start before harvest through improved agronomic practices to avoid spoilage and quality loss at this level.

For maize harvesting, threshing, drying and storage are the other key intervention points.

For beans harvesting, threshing, drying and storage are important intervention points.

For tomatoes, timely harvesting, packaging and transportation are important intervention points to minimize losses in quality and quantity. Seed selection/breeding and changing the way and timing of how tomatoes are cultivated (i.e. moving to year-round irrigated production instead of seasonal rainfed production) is also extremely important.

What technologies best provide opportunities for SHFs, especially women, to engage in waste and spoilage reduction?

For maize, need to build capacity on best agronomic practices, provide tarpaulins for harvesting, small bags for moving harvested cobs from farm to homestead, improve shellers, collapsible dryers, and improved storage technologies (hermetic bags or silos that are resistant to LGB and rodents).

For tomatoes, improved agronomic practices to minimize pests and disease, the development of locally-appropriate, long shelf-life varieties, and supplementary irrigation to ensure quality tomatoes and to even out production and reduce the cycle of gluts. Women should also be supported with improved packaging and transport technologies. Plastic crates lined with carton boards to avoid bruising of the tomatoes are recommended. Capacity building at this level to avoid over packing and loading should also be provided.

For beans, provide capacity building in selecting varieties that do not shatter when mature and dry and especially during harvesting.

There is also need to research better threshing and winnowing technologies and to support improved drying and storage technologies.

Hot Spot Analysis for Kenya

Maize Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological Maturity							
Harvesting							
Field drying (when applicable)	Moisture (linked to mold and aflatoxin)	Mechanical driers (mobile or stationary), tarps, solar dryers	Driers are rare in Kenya, usually too far away for farmers to travel. Tarps are widely available and widely used, but they do not solve the problem of heavy rain.	Combined cost of drying and transport is prohibitive for SHF; only larger farmers are able to afford. Tarps are affordable to (and used by) many farmers already.	Driers need volume to be efficient, but SHF dislike combining their maize; many not aware of any driers near them	Drying is female responsibility but men usually control HH finances	Smaller drying solutions located closer to farmers, affordable moisture meters, education on low-cost moisture "tests" such as salt in Coke bottle
Platform drying (when applicable)							
Threshing/shelling (when applicable)							
Winnowing							

(when applicable)							
Transport to packing shed							
Storage at the farm level	Insects (larger grain borer and maize weevil), theft, mold, rodents	Metal silo, plastic silo, hermetic bags, education on better use of regular bags	Improved storage products have limited availability now, but significant donor interest is poised to increase availability significantly in the coming years	Metal silos are prohibitively expensive for SHF, plastic silos are still in proof-of-concept phase, hermetic bags are cheaper but still represent significant investment	SHF tend to be risk averse, so even relatively small investments such as hermetic bags may be difficult to promote. These products also require proper use to work, and SHF can be quickly discouraged by infestation and abandon technology if used improperly.	Female-headed households are unlikely to have any extra funds for any improved storage. In marriage, women have limited budget control and especially if husband works far away women will have limited budget to allocate between storage/ farming expenses and children (i.e. clothes, school fees).	Focus on lowest-cost options and on training farmers to use products correctly and replace them when they become worn or damaged. Make farmers aware of cost-benefit between PHL and adoption of storage to make the investment feel less risky.
Grading and sorting							
Off-Farm							
Handling and	Financial loss from	Financial tools and	There is a general	TBD – solutions not	Local leaders cite	Women lack	Invest in developing

transport to first receiver	selling quickly at low prices and buying maize back at higher prices later	education to enable farmers to store longer and sell later	lack of financial instruments designed for farmers at harvest as well as limited presence of financial institutions in rural areas	developed enough to know yet	lack of savings culture and financial literacy among SHF. Trust may also limit adoption of financial tools or local solutions such as table banking.	control of finances but are generally responsible for storage, so intra-household decision making and resource allocation represents a challenge.	financial tools and education around how and why to store maize for longer, rather than focusing on physical storage solutions alone.
Storage and handling at the trader level							
Processing (when applicable)							
Downstream storage (when applicable)							
Distribution to retailers							
Handling and transport to first receiver							
Storage and handling at the trader level							
Processing (when applicable)							

Downstream storage (when applicable)							
Distribution to retailers							

Bean Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological Maturity							
Harvesting	Since beans are usually planted as an intercrop with maize but reach maturity faster, they must often be harvested mid-rainy season leading to mold and loss	Plant as monocrop or discontinue planting in favor of other crops – beans can be purchased more cheaply than they can be grown (when taking into account PHL) in many parts of Kenya	These are behavioral solutions, so they are technically accessible but farmers lack education on options	Easily affordable, but moving away from intercropping would seem like a "loss" of potential to farmers, seeming less affordable than it really is	Farmers may prefer to plant their own beans rather than buying and may resist the urge to intercrop as it is seen as a way to "make the most out of their land"	This is a matter of planting decisions, so education may need to focus on men	Investigate viability of discouraging farmers from intercropping beans and of supporting beans for marketing and trade (even as imports) rather than growing for own consumption
Field drying (when applicable)	Trying to dry during rainy season leads to high losses and mold	Mechanical drying, different plant/harvest timing	Mechanical driers are not widely available and are not generally used for beans.	All technically viable solutions are too expensive for beans, which are grown in small quantity.	Beans are something of an afterthought for farmers, so they do not actively seek or adopt bean-centric technologies.	Women mainly responsible for drying, but any investment in technology would need	Look for opportunities to create economies of scale for bean production where mechanical drying and threshing would be economically viable – then promote these technologies in those

						to involve men because they control budgets.	places. If those economies of scale do not exist in Kenya, do not invest in beans.
Platform drying (when applicable)							
Threshing/shelling (when applicable)	Breakage from being beaten, time intensity of shelling	Dry completely before threshing, thresh more carefully, invest in threshing machines if economy of scale can be reached	Threshing machines are virtually nonexistent. Drying solutions (and harvesting at better times) would help, but there are few driers available.	Mechanical threshing is not economical because of small bean quantities, and mechanical drying is expensive and beans must be transported to it, which is costly.	Bean production is becoming economically disadvantageous and is decreasing overall. Therefore, PHL solutions for beans are of relatively low interest to farmers and to donors.	Women mainly responsible for time-consuming threshing task	Look for opportunities to create economies of scale for bean production where mechanical drying and threshing would be economically viable – then promote these technologies in those places. If those economies of scale do not exist in Kenya, do not invest in beans.
Winnowing (when applicable)							
Transport to packing shed							
Storage at the farm level							
Grading and sorting							
Off-Farm							
Handling and transport to first receiver							
Storage and handling at the							

trader level							
Processing (when applicable)							
Downstream storage (when applicable)							
Distribution to retailers							
Handling and transport to first receiver							
Storage and handling at the trader level							
Processing (when applicable)							
Downstream storage (when applicable)							
Distribution to retailers							

Tomato Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological Maturity	Tomato varieties most popular to consumers are softer and spoil faster; bacterial and	Develop seed varieties for the local context, encourage storing in shaded areas	Seeds are widely available but none are ideally suited to local needs. There is not enough				Consider investing in seed breeding (not solely on post-harvest interventions,) since many issues with

	other diseases and harvesting in the sun lead to even faster spoilage.	during harvest	education about how to address diseases and sun-accelerated spoilage.				tomatoes start with the selection of varieties.
Harvesting	Rainfed tomatoes harvested at same time, leading to glut (this causes low prices and high rates of spoilage)	Irrigation, greenhouse growing and introduction of local processing	These technologies are generally available, although education on using them properly is limited	All technologies are expensive and SHF must generally form groups to be able to afford (or access loans) to purchase them. But as a higher-value crop, group arrangements are economically and socially feasible for tomatoes.	Greenhouses are gaining traction especially in Central and Eastern Kenya. Processing is limited.	As a non-staple crop, tomatoes seem to offer a particular opportunity for women. Women can also be experienced at operating in groups. Tomatoes are also a popular crop for youth.	Continue to support technologies that even out harvest time for tomatoes throughout the year (irrigation and greenhouses). Invest in education so that farmers are able to adopt to the new issues presented by higher-intensity agriculture (i.e. soil fertility, diseases, pests, etc).
Field drying (when applicable)							
Platform drying (when applicable)							
Threshing/shelling (when applicable)							
Winnowing (when applicable)							
Transport to packing shed							
Storage at the farm level							

Grading and sorting							
Off-Farm							
Handling and transport to first receiver	High rates of crushing and bruising from woven baskets and wooden crates.	Smaller plastic crates lined with carton paper	These containers are fairly widely available, but they are not often promoted as appropriate for tomatoes. Wooden crates are even more accessible (made to order), but they are expensive.	Improved containers are not expensive but farmers do not always see their value. Some farmers simply borrow containers from bread sellers, which is free (or barter).	Male and wealthier farmers often use the wooden crates, but plastic containers are more rare.	Women are far less likely to access better packing containers due to awareness and cost.	Increase distribution of better containers and look at creative solutions such as sharing the plastic containers used by bread sellers, which some farmers have successfully borrowed for tomato transport
Storage and handling at the trader level							
Processing (when applicable)							
Downstream storage (when applicable)							
Distribution to retailers							
Handling and transport to first receiver							
Storage and handling at the trader level							
Processing (when							

applicable)							
Downstream storage (when applicable)							
Distribution to retailers							

Contact List

No.	Name	Affiliation	Position
1	Saline Aoko	Jubilee Market, Kisumu	Trader and Assistant Secretary of Traders' Association
2	Charles Bett	KARI	
3	Arnold Chenge	One Acre Fund	External Relations Associate
4	Hugo De Groote	CIMMYT	
5	Jane Gitau	Ministry of Agriculture (Bungoma)	Sub-County Deputy Officer
6	Raphael Gitau	Tegemeo	Research Fellow / Agricultural Economist
7	Zachary Gitonga	CIMMYT	Quantitative
8	Stanley Guantai	ACDI/VOCA	
9	Jane Kamau	EAGC	
10	Kamechu	Ministry of Agriculture, Mbooni East Subcounty	Crop pathologist
11	Philip Kandie	National Cereals and Produce Board	
12	Erustua Kang'ethe	University of Nairobi	
13	David Karanja	KARI Katumani	
14	Charles Kariuki	KARI Katumani	Centre Director, Entomologist
15	Joseph Karugia	ILRI	ReSAKSS Coordinator
16	Josphert Kimatu	South Eastern Kenya University	Plant Molecular Epigenesist and Post Harvest Management Consultant
17	Anthony Kioko	Cereal Growers Association	Chief Executive Officer
18	Lilian Kirimi	Tegemeo	
19	Steve Kiseve	Ministry of Agriculture	Mbooni East Sub-County Agriculture Officer
20	Grace Kyalo	Horticultural Development Authority	Acting Managing Director
21	Milton Lore	Land o' Lakes	COP, Kenya Feed the Future Innovation Engine
22	George Mabuka	Cereal Growers Association	Project Officer
23	Dr. Ibrahim Macharia	Kenyatta University School of Agriculture	Lecturer, Agribusiness Management and Trade
24	Nyamwela Masese	Kisumu County MoA	County Crops Officer
25	Benson Mghanga	NCPB	Bungoma Silo Manager
25	Rebecca Mincy	Acumen Fund	

27	Pauline Mugendi	Land o' Lakes	Agricultural Innovation Specialist, Kenya Feed the Future Innovation Engine
28	Dr. Eusabius Mukhwana	SACRED - Africa	Executive Director
29	Joseph Munga	Dandora Millers	Factory Manager
30	Charity Mutegi	IITA	
31	Mary Muteti	Makueni County MOA	
32	Rose Mutuku	Mati Logistics	
33	Backson Mwangi	Cereal Growers Association	Project Officer
34	Dr. Francis Nang'ayo	AATF	Regulatory Affairs Manager
35	Tabitha Nduku		
36	Josephine Ngalula	Chwele Market, Bungoma County	
37	PM Nyaga	National Agricultural Research Laboratories (NARL)	
38	Johnston Nyongesa	Anglican Development Services	County Programs Officer
39	Henry Nzioki	KARI Katumani	Aflatoxin research
40	Obadiah Nzioki	Ministry of Agriculture, Mbooni East Subcounty	Agribusiness
41	Hannington Odame	Centre for Africa Bio-Entrepreneurship	Director
42	George Odhiambo	KENFAP	
43	Milicent Olunga	Tegemeo	
44	A.S.Omusheni	Ministry of Agriculture	Bungoma County Director
45	Willis Owino	Jomo Kenyatta University of Agriculture & Technology	Department of Food Science & Technology
46	Victor Papa	Anglican Development Services	Field Officer
47	Eric Solomonson	One Acre Fund	
48	Tadele Tefera	CIMMYT	Effective Grain Storage Project Leader
49	Sophie Walker	ACDI/VOCA	Effective Grain Storage Project Leader

Country Annex for Mozambique

- Dates traveled: March 9-April 4, 2014
- Main growing regions visited: Maputo, Beira Growth Corridor (beans/pulses), Nacala Growth Corridor (beans/pulses, cassava, groundnut, sesame)
- Interesting quote(s):
  - "All in all, there exist problems in the postharvest storage and protection of crops. Some measures say that 40% of the harvested crop is lost. These losses are a result of a simple lack of adequate technologies." – Official, Nampula Ministry of Agriculture
  - "Women have a very important role in the value chain for all crops, but are constrained by a cultural (or traditional) inability to make the financial decisions." – Participant, Breakout Group, AGRA Stakeholder and Expert Workshop
  - "One of the hardest things to change in the fields is behavior. To do this, you need a long term, sustainable extension program to be repetitive and demonstrative." – IKURU Representative
  - "Storage options do not exist for the small farmers in Mozambique." – SHF
  - "Any technology MUST be sensitive to local habits, otherwise the technologies are harder to introduce and have lower adoption rates. Thus there is no one storage solution, rather the knowledge of that fact is the solution in a certain sense." – Helvetas Representative

Figure 3: Presentation at the Stakeholder Workshop in Nampula

Objective 1: Prioritization

Key Questions

How aware of losses are smallholder farmers involved in the selected value chains? Which types worry them the most and why?

Sesame

Sesame farmers are particular cognizant of losses since this one of the most commonly grown cash crops in both of the two main agricultural regions in Mozambique (Beira and Nacala Corridors.)

The most worrisome of PHL losses in sesame experienced by farmers are associated with losing seeds in the field. For a variety of reasons, the sesame pods can open before the farmer has harvested, with the plant dumping all its seeds into the ground, effectively losing the whole crop.

Weather can also cause PHL. If the weather causes the harvest to come unexpectedly early, then the farmer won't have the labor to harvest all the seeds before they fall. Moreover, high winds or flooding can create the same types of losses.

Groundnuts

Farmers are also aware, to a certain extent, of the losses in groundnuts. At this point, aflatoxin is fairly well known by farmers, but only known in a terminological sense. Many do not know how the Aspergillus fungus infects the groundnuts and when it spreads.

Farmers generally identify aflatoxin as any visible discoloration or mold, but are not aware that aflatoxin can exist in high levels without clearly visible symptoms. As a result, storage of groundnuts is the most worrisome point for losses in the value chain since it is perceived as the point in which aflatoxin is the greatest threat.

Beans/Pulses

The most relevant beans and pulses in Mozambique are dry beans, pigeon peas, soybeans, cow peas and butter beans. The analysis regarding this group of crops will avoid any crop specific assessment, and instead focus on the general issues facing smallholders and the rest of the points on the value chain for the category as a whole.

Most bean/pulse farmers cite the lack of access to improved seed varieties as their biggest challenge. While seeds are technically a production input (and therefore not a post-harvest loss or type of waste) varietal choice can be the catalyst for many types of losses in the field.

Farmers cited the poor varieties as taking longer to mature, which leads to higher risk on spoilage in the field due to climatic events or pests.

The second most worrisome type of loss for bean and pulse farmers is storage. The majority of SHFs do not have proper knowledge or access to improved storage technologies. Most store crops in their house, exposing the beans/pulses to pests, humidity and therefore creating losses.

Cassava

Depending on whom one speaks with in Mozambique, losses in the cassava value chain are either well known to farmers or considered to be minimal. Cassava has the reputation as being a crop with low losses due to its ability to be stored for long periods of time underground. However, demand for cassava comes from two main sources: fresh users and processors. For fresh cassava consumption, the argument for low losses holds, since consumption is generally limited to the farmer's own household, and shortly after harvest. On the other hand, for the processed market, losses do occur and are recognized, since most farmers employ low tech solutions for processing on farm. These types of losses are the most worrisome for farmers who sell any form of processed cassava, be it for flour, mash, or beer.

What are they currently doing to prevent or mitigate those problems and what else would they like to do?

Generally speaking, even for leaders among the small holder farmers, there is a big gap between the mitigation that is actually happening compared to that which they would like to do. The main issue is not lack of awareness, but rather lack of access to the proper technologies, which in turn is linked with access to credit. Given that knowledgeable farmers only represent a part of the total farmer population, it is fair to say that the rest generally possess neither the awareness nor the means to actively mitigate postharvest loss problems. Many times, traditional techniques are viewed as the safest practice. Losses due to inefficient harvesting, storage or processing are countered by increasing volume (or at least attempting to) of harvest or yield.1

Sesame

There are several low technology options for farmers to reduce spillage in the field, most of which involve spreading plastic throughout the rows of the field to catch fallen seeds.

Alternatively, farmers can put plastic below drying racks to catch falling seeds, once harvested (note the latter use of plastic does not prevent the in-field spillage, which is more problematic.) Although this is an option farmers said was feasible, most are not using this technique due to the two most common barriers to adoption discussed above (cost/access constraints or lack of awareness.)

Groundnuts

For groundnut farmers the challenge seems to be more lack of awareness than the lack of access to mitigation technologies. This derives from the fact that aflatoxin is the main cause of spoilage and other losses in Mozambican grounduts. Aflatoxin mitigation starts with strong varieties that will produce a healthy plant while resisting pest and disease pressure. Good agricultural practices in the field, and then proper storage practices, also matter greatly. Although the biocontrol Aflasafe, which is the newest and perhaps most promising technology used for combating aflatoxin in Nigeria, has been introduced in concept and on a pilot basis in Mozambique, it is not yet available in the marketplace.

[1] Note that this is not always possible given farmers credit constraints. The purpose of the statement was to show that the mentality of farmers tends to think about increasing yields as opposed to improving efficiency.

Within good agricultural practices, the most important components related to preventing moisture from forming on the field and in storage. Some farmers are becoming more organized in the timing of their planting and harvesting, in order to avoid harvesting close to the rainy season (which can introduce moisture pre storage) and storing peanuts with the shells still on. These are two improved practices that a small proportion of farmers are using, but are by no means widespread. Many farmers interviewed stated they would like to plant improved, more resistant and higher yield varieties and also use improved technologies for drying. Improved drying and storage technologies are both hindered by cost constraints.

Beans/Pulses

Farmers are currently using traditional crop production and storage methods in an effort to improve volume harvested, yet are doing little to raise overall productivity. Awareness and cost are the two major limitations for SHFs.

Farmers would like to use improved varieties that mature on a shorter cycle to reduce the risk of climatic events that would induce losses. They also cite the desire to use improved threshing technologies, but in Mozambique these machines are extremely expensive and therefore completely inaccessible to farmers. Most are aware these technologies exist, but simply can't access them.

Cassava

Cassava farmers typically process cassava on farm by cutting and air drying them. To prevent losses, farmers air-dry the cassava in small amounts when it is sunny and move the cassava indoors if it rains. This creates a longer than normal drying time and can leave the cassava vulnerable to disease. Farmers also prefer to dry on farm because it greatly reduces transport cots since fresh cassava can weigh up to 30% more.

Cost of improved driers is high, but improved practices can be achieved by drying cassava in smaller pieces, and purposefully harvesting during the dry season.

What attitudinal and capacity factors inhibit greater awareness or action?

There is a general tendency in Mozambican SHF agriculture to rely most on traditional techniques that have been proven over time. Often, these can be related to local culture or customs and therefore hard habits to break. For all crops, the reluctance to move away from traditional practices, whether as a result of distrust or perceived risk of new technology, is a major reason for inaction.

What are the main considerations smallholders have in deciding whether and how to act to reduce waste and spoilage along selected value chains?

As stated above, the most important considerations for smallholders are cost and perceived risk. By cost we mean mostly the out of pocket cost of acquiring and using improved varieties or technologies, but there are other cost components as well: time needed to access them, transportation, etc. Perceived risk relates more to the way cash- constrained farmers think of behavior change. For farmers with extremely limited financial resources, investing in a new technology that is generally unfamiliar is a huge risk that many are not willing to take.

Sesame

- Cost of mitigation technology (plastics, drying frames, etc.)
- Variety selection; white varieties typically yield higher prices, but are harder to access and more expensive.

Groundnuts

- Storage type and timing; farmers are often forced to sell prematurely if they cannot properly store. Others chose to store in imperfect conditions, using Attelic to preserve.
- Variety of seed and access to improved varieties.

Beans/Pulses

- Variety selection; being able to select a short cycle variety is crucial in preventing losses in the fields. Access to these varieties is a big hindrance.
- Storage type and timing; much like groundnuts, farmers are often faced with the decisions to sell immediately at a low price or store, loss some production to spoilage and sell at a higher price

Cassava

- Timing of harvest; cassava does not have a long shelf live after harvest and therefore pulling cassava out of the ground at the time or consumption or during the dry season is crucial
- Consume vs. process; farmers typically use cassava as a staple crop during lean seasons, but the market for processed cassava (flour, chips and beer) is growing and increasingly farmers are having to decide between consumption and processing (the latter has the higher potential of spoilage and loss.)

What types of intervention and/or support (e.g., financial or technical) and/or incentives would stimulate further action?

Extension services that have broader outreach, more frequent contact with target farmers, and better grasp of challenges and feasible solutions would help stimulate improved agricultural practices. The repetitive and demonstrative aspects of well-done extension work are of most importance to encourage behavior change and transition practices from traditional to a hybrid of traditional with improved technologies. Having demonstrations and repetition of demonstrations helps reduce the perceived risk and therefore decreases the barriers to behavior change. Incentivizing the downstream actors in each value chain would help create demand for higher quality products, which could potentially translate into fewer losses for smallholders. Lastly, bringing costly processing or harvesting equipment to the farmer on a seasonal basis could improve efficiency and also serve as an opportunity to provide extension services.

Objective 2: Identification of Key Interventions

Key Questions

What are the country-specific intervention opportunities, by crop and geographic area?

Sesame:

- Investing in value addition; generating awareness and capacity to make oil.
- Investing in improved seed varieties and ensuring access to that seed (i.e. filling missing markets in seed value chain.)

Groundnut:

- Investing in improved varieties that show greater resistance to aflatoxin
- Ensuring access to storage technologies that involve reasonable cost and distance.)

Beans/Pulses:

- Facilitating trust by disincentivizing side selling, improved on-farm processing (especially threshing.)

Cassava:

- Commercializing cassava flour and developing the market for cassava for making beer
- Promoting mobile processing units in order to bring access to drying and processing technologies to smallholders.

What are the technology-specific intervention opportunities by crop and geographic area?

Sesame:

- Simple on field processing technologies and access to markets. One example is putting rows of plastic in the field so sesame seeds are not lost if pod opens before harvest.

Groundnut:

- Commercialization of aflasafe and improving access to proper storage to prevent to proliferation of aflatoxin.

Beans/Pulses:

- Improved storage technologies that are sensitive to local traditions. Expanding on the *gorongoza* (traditional storage silo made with low cost materials) and spreading use and knowledge is a key first step.
- Improved processing technologies (threshing and drying) and access to these technologies

Cassava:

- On farm processing as raw material for beer and flour.
- Improved on-farm drying practices

Expert & Stakeholder Workshop

Dates: March 27th, 2014

Place: Melenio Hotel, Nampula

Number in Attendance: 25

Main Findings

- Local government officials are often invited to participate in workshops or asked for interviews, but from their point of view, the lack of a centralized knowledgebase makes each of the studies and island unto itself, and the wheel is required to be reinvented every time. They see so many organizations re-inventing the wheel; a centralized knowledge base that is accessible to many "types" of stakeholders is a potential intervention that could empower motivated actors in the government or on the ground to create/promote projects, based on research conducted by organizations like AGRA.
- The afternoon session was dedicated to identifying the main challenges and potential solutions for each of the crops of interest in small groups. These groups were tasked to work together to identify what the top 3 challenges are for each crop, and what the top 3 potential interventions are that could address these problems. Each group then elected a representative to present their findings to the workshop as a whole. The results of the small group discussion can be found in the appendix.
- Gender issues are general under-addressed and differ by region. In the north, women are key actors in on farm management with do not yield power in making financial decisions, which are traditionally reserved for the man. Even in cases where women hold and work their own plot of land, the financial decisions regarding that plot are left to her husband. For female-headed households, women who have inherited land form family face the problem of land titling. They can legally own a title to land and therefore carry a large risk that neighbors of relative can come and take her land.

Two innovative solutions to solving many of the post-harvest loss problems in Mozambique surfaced:

1. DADTCO presented on their mobile processing units, which have been most used in Nigeria These are large vehicles that travel to smallholder farms and process cassava into cakes, then buy the cakes form the farmers. The cakes are the basic ingredient for producing cassava beer, which is a growing industry in Mozambique. The model could potentially be expanded to other crops that require expensive processing. Instead of requiring smallholder farmers to purchase expensive equipment, the equipment could be brought to them.
2. SNV presented their oilseed platform (verbally, they were unable to make a PowerPoint presentation.) This platform is an online and group oriented program that brings together experts and farmers to share best practices both in working groups and virtually. The online component is still in the development phase, but the working groups have seen success. They have groundnut, soy and sesame groups that help connect farmers to buyers, provide extension services and promote good agricultural practices

Conclusions

Mozambican stallholder farmers are generally aware that post-harvest losses are occurring, but the losses vary by year and are not tracked in any way. Most farmers respond to these losses not by improving efficiency of production and postharvest techniques used, so as to reduce losses, but rather by purchasing inputs that increase the volume produced of a given crop. Therefore, if a farmer experiences 20% losses, instead of trying to reduce the 20%, (s)he tries to increase the 80%. Understanding which is the most cost effective and sustainable approach is the fundamental issue underlying behavior change required to reduce postharvest losses for smallholders.

To that extent, behavior change is typically hindered by either some sort of cost constraint (monetary, time, distance, access etc.) or a lack of awareness. There are several innovative solutions being implemented in Mozambique, but few organizations and even less donor funding is addressing the issue of post-harvest losses directly.

Sub-Questions

What is the process from awareness to behavior change?

In the case of Mozambique, the process from awareness to behavior change has historically been a slow one. SNV has experience in providing expansion services and improved technologies to smallholder in northern Mozambique, but still see farmers reverting to traditional practices. Cultural and traditional agricultural practices have deep roots and farmers see behavior changes as an inherently risky endeavor. Lower risk (or perceived risk) is a crucial step in the process.

What cultural and environmental factors might be important?

Traditional storage technologies are used often, despite the low level of effectiveness. A factor to consider in this regard is to modify existing technologies in a way that is easy to understand and cheap to adopt for smallholders. Adapting and improving existing technologies leads to higher adoption (as opposed to introducing a brand new technology.)

Transportation infrastructure in the agricultural regions often prevents smallholders form accessing technologies and extension services. Programs like mobile processing that bring these services to the farmer's door are more likely to see higher rates of adoption.

The southern regions allow more opportunities for women to participate in farm management, trade and transport of agricultural goods.

Are there any gender differences in the process from awareness to behavior change?

Women who are aware can often translate that awareness to improved practices, but in most agricultural communities, the male household head is the decision maker. Therefore, in some regions, particularly the north, women have more limited access to transforming household practices.

Then again, in both northern and southern regions, women have a strong influence (albeit not total power) in household decision making. Therefore, awareness must be created equally across gender in order for ideas to be reinforced within a household.

What are the gender issues to consider in technology design, adoption, and up-scaling?

Storage technology design must be sensitive to tradition and culture. This requires adapting efficient solutions to existing storage practices. Different storage technologies have seen different levels of success depending on how well the technologies match the local traditions.

Adoption requires behavior change which is a slow process that requires repetitive demonstrations of how to use new technologies and implement new practices. This requires trained and experienced extension staff, which does not exist in Mozambique.

Scaling up is somewhat restricted by the first bullet; just because a technology is successful in one village does not imply it will be in the next village.

What are creative ways to encourage waste and spoilage reduction behavior changes?

Bringing goods and services to the doors of farmers with limited access. This can include improved storage (silos, hermetic bags, etc.) processing equipment or extension services.

Creating networking opportunities to connect buyers and seller.

Providing the needed oversight to ensure contract farming is not undermined by side-selling.

Incentivizing actors downstream in the value chain to demand higher quality goods (for example, aflatoxin free maize, high quality cassava flour, etc.) which creates a pull effect on farmers and also transfers price premiums to farmers.

To what extent do waste and spoilage levels for a particular crop influence farmers' decision to cultivate it or not?

Waste and spillage don't affect a farmer's decision to cultivate as much as it affects a farmers decision to sell. Most of the crops of interest are staple crops (cassava, some beans, groundnuts) or significant cash crops (sesame, some beans/pulses and groundnuts.)

Do the income/production levels of SHF influence their waste and spoilage reduction practices?

Yes. Farmers with less than 5 hectares typically do not have the capital to invest in storage, harvesting or processing technologies. These are the farmers that face the most access problems due to cost and capital constraints. This same group of farmers, as a result of their inability to purchase improved storage or processing equipment, as well as limited cash flow, is forced to sell production at a lower price when the market is flooded. Farmers with more than 5 hectares tend to have improved storage facilities and are able to wait for higher prices.

What are the primary areas for training/knowledge for helping farmers avoid pre-harvest produce losses in both quality and quantity?

Storage is an area where there is a general lack of knowledge. It also is relevant across many different crops. This can have a large effect on reducing quantity losses.

Timing of planting and harvest is another theme that was raised multiple times. Many farmers are not organized enough to time their harvests at a time that minimizes risk of loss due to weather. Providing farmers with the tools needed to be aware of the effects that organization can have on their income is key.

Are farmer organizations aware of and do they appreciate the magnitude of postharvest losses' effects on their incomes? How can they best be mobilized and what new capabilities are required?

Yes, they are generally aware the main sources of loss as well its magnitude, but they lack specific reliable data, and therefore have difficulty running the equivalent of "what if?" scenarios.

SNV's oilseed platform provides a good case study of a program that mobilizes associations to take a more proactive role in reducing postharvest losses. Extensions services are generally very poor, so SNV brings in foreign experts to provide higher quality extension services at the crop working group level. Human capital for agricultural production and postharvest loss control needs to be upgtraded in Mozambique.

AgriFUTURO also had an innovative model to mobilize farmers associations. Associations as such do not have the legal status to access formal credit. To combat this, AgriFUTURO developed a program that provided services to associations to become legal entities that could then access credit for its members.

What intervention points in the crop value chains will yield the best results (quantity and quality) in waste and spoilage reduction?

See appendix.

What technologies best provide opportunities for SHFs, especially women, to engage in waste and spoilage reduction?

Mechanization of harvesting, threshing and processing. This also includes drying technologies, which are important for groundnuts, beans and cassava. There is potential in bringing these technologies to farmgate for harvesting/processing

Improved storage technologies and awareness. This requires low cost storage solutions that are sensitive of local customs.

Improved buy-seller relationships. There is a need to reduce side selling by incentivizing farmers to hold produce longer and to respect agreements made. Improved storage could potentially be a complimentary intervention.

Hot Spot Analysis for Mozambique

Sesame Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender
On-Farm						
Harvesting	lack of knowledge of the maturity cycle/time of harvest	Interventions focused on farm organization and knowledge dissemination	Would not be an issue if services came to the farmer	Assumed to be free for the farmer	Generally low.	Could be given equally across genders
Field drying (when applicable)	Unexpected rains or wind can causes seeds to fall out prematurely	access/knowledge of simple on field technologies to collect seeds that fall prematurely	Is low at the moment for rural communities.	Even though the technology is simple, lots of plastic is required.	Would be high if the first two points are met along with adequate training.	Would tend to be male dominated due to financial implication
Grading and sorting	mixing varieties (white and brown)	better distribution of seeds. Focus on white variety which is preferred in export markets	Is very low. Access to seeds is one of the most talked about hurdles.	Potentially high	Is expected to be high, since improved varieties are well known.	Same as above.

Groundnut Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender
On-Farm						
Harvesting	harvesting at the right time to maximize yield	forming associations to plan out staggered harvests so there is no labor shortage (which leads to crop rotting in the field because the	Would not be an issue if services came to the farmer	Assumed to be free for the farmer	Generally low.	Could be given equally across genders

		farmer doesn't have the capacity to harvest it all at once)				
Field drying (when applicable)	Climate change/ unexpected rains	Extension services focused on field and harvest planning in order to avoid harvesting at the wrong time. Also associations like explained above can be a part of the solution	Would not be an issue if services came to the farmer	Assumed to be free for the farmer	Generally low.	Could be given equally across genders
Storage at the farm level	lack of appropriate storage technologies to reduce the spread of aflatoxin	Access and knowledge of improved storage technologies that are sensitive to local customs	Very low. No storage solutions available at reasonable price.	Same as Accessibility.	Potentially high, but faces cultural and traditional hurdles. Lower cost improves adoption.	Would tend to be male dominated due to financial implication

Beans/Pulse Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender
On-Farm						
Field drying (when applicable)	existence of "short-cycle" varieties; these varieties exist but are not well distributed/well known	More research into the development of these varieties at the government level. Then adequate distribution of the seeds.	Is very low. Access to seeds is one of the most talked about hurdles.	Potentially high	Is expected to be high, since improved varieties are well known.	Would tend to be male dominated due to financial implication
Threshing/shelling (when applicable)	lack of knowledge regarding how to best de-shell some	Extension with focus on A frame drying technologies. Also use	Relatively accessible. Can be made with materials found on	A frame is relatively affordable, uses less plastic than sesame	The A frame drier is relatively popular and could be improved with	Incorporating women into A frame drier construction could

	varieties. This also is linked with the crops' ability to store.	of plastic sheet under dryer can reduce waste.	farm.	solution	small changes,. So adoption could be high.	improve adoption.
Storage at the farm level	lack of appropriate technologies to prevent pests and fungus	Access and knowledge of improved storage technologies that are sensitive to local customs	Very low. No storage solutions available at reasonable price.	Same as Accessibility.	Potentially high, but faces cultural and traditional hurdles. Lower cost improves adoption.	Would tend to be male dominated due to financial implication

Cassava Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender
On-Farm						
Platform drying (when applicable)	lack of processing and drying technologies forces farmers to air-dry, which is vulnerable to climate takes longer	mobile processing/drying units	Assumed to be high since it comes to farm gate.	Also assumed to be provided for free, subsidized, or contingent of sale to processor.	DADTCO has seen high adoption rates. If the demand for processed cassava keeps increasing, adoption will improve.	Can be a cross-gender intervention.
Storage at the farm level	Access to markets	facilitate improved contract relations with buyers to guarantee markets and transportation	High potential. Buyers know exactly where to find sellers and go to them.	Has potential to be very cost-effective.	Need to ensure no incentive to side sell, otherwise adoption will be low.	Involving the female household member could help enforce contracts
Off-Farm						
Handling and transport to first receiver	Lack of transportation	Same as above.	High potential. Buyers know exactly where to find sellers and go to them.	Has potential to be very cost-effective.	Need to ensure no incentive to side sell, otherwise adoption will be low.	Involving the female household member could help enforce contracts

Contact List

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9	Rui Fereira	Alnutri Mozambique	
10	Emerson Zhou	BACG	Executive Director
11	Abu	BAGC, Chimoio	
12	Honorata Sulila	CEPAGRI	
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22	Guillermo Machado	ETG	Director
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85	Orlando Tixi	IIAM-Nampula	
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91	Julio Simao	IFDC	
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93	Joao Augusto	farmer-Mongola	
94	Julio Viador	farmer-Malema	
95	Justino Jorge Murigri	farmer-Moma	
96	Joaquim Tomas	DPA/SPA	
97	Leonardo Buchili	SNV	
98	Farmer group	Beira	
99	Farmer group	Nampula	

Country Annex for Nigeria

- Dates traveled: March 28-12 April, 2014
- Main growing regions visited: Ondo State (cassava), Kwara State (cassava, tomato, onion), Ogun State (cassava), Abuja (tomato, onion), Kaduna (tomato, onion)
- Interesting quotes:
  - "The cost of using crates combined with increased transportation costs as a result of the transportation vessel having to make three to four trips compared with one in the present practice of stacking cassava tubers, it is doubtful if the technology can be really considered as affordable." – Dr. Abiodun Aderibigbe Amao, National Stored Product Research Institute
  - "Benefits of using the crating system must be shown, but agreement among the critical stakeholders; government, farmers, transporters and marketers is needed if there will ever be adoption of tomato crating system in Nigeria." – Mr. Sha'ibu Muhammed, Secretary, Bello Brothers Transporters' Association, Kaduna

Figure 4: Women Peeling Cassava

Figure 2: Women Extracting Starch for Fufu

Figure 3: Tomatoes in Unventilated Vehicle

Figure 4: Rotting Onions

Objective 1: Prioritization

Key Questions

How aware of losses are smallholder farmers involved in the selected value chains? Which types worry them the most and why?

Small holder farmers (SHF) are aware of quantitative (volume), qualitative (deterioration in sensory traits and nutritional loss), and financial losses throughout the cassava, tomato and onion value chains, right from pre-harvest, harvest, storage, transport, processing, distribution up to consumption.

However, the magnitude, types and sources of PHL differ for the three priority crops identified for Nigeria, and they all depends on season, variety, technologies and product.

Cassava

Pre-harvesting:

- The Fulani (Bororos) nomads rear livestock (sheep and cattle) which are left to feed on cassava farms during forage scarcity. Huge loss in cassava stems have discouraged cassava farmers from cultivating cassava in some part of the country, since they can't stop herders from encroaching on their farms.

Harvesting:

- Farmers delay the time of harvesting until they get a better price, which sometimes results in fibrous tubers and rot, and tubers in that condition are thrown away during processing.
- Careless/rough handling of tubers at harvest results in the breakage of tubers; and some are left in the ground leading to losses that were evaluated at up to 20%.
- Use of manual tools (cutlass and hoe) to uproot tubers result in higher losses in the dry season (20-40% loss) due to hardened soil than in wet season (10-20% loss). Significant losses (up to 80%) are also experienced in swampy soils, when these soils flood during the rainy season.
- Harvesting by all farmers 12 months after planting (i.e. physiological maturity) sometimes leads to a glut in the market, because they all plant at the about the same time, since cultivation is rain-fed and seasonal. This causes some SHF to postpone harvest of their tubers in order to wait for periods of scarcity and higher prices. This practice may result in huge losses, since tubers become woody as they senesce, or are inundated in swampy soils if there is unexpected rainfall.

Storage:

- There are no other methods for preserving cassava roots once physiological maturity is reached other than in-situ storage, which keep tubers fresh for an average of 12-14 weeks after maturity, but the quality of tubers is affected due to senescence and rotting.

Transportation:

- Breakdown of vehicles during transportation of tubers can lead to huge losses of up to 100% when repairs may take days, and if another vehicle can't be arranged to evacuate the tubers, the situation worsens since fresh tubers need to be processed within 72 hours.
- Stacking of cassava tubers produces bruises that eventually lead to rot, due to heat buildup. Losses have been evaluated at 2-5%.
- During vehicle loading workers step on tubers while arranging them in the vehicle, leading to breakage, rotting and unhygienic conditions.
- Delay in transporting tubers due to bad or flooded roads prevents fast evacuation of already harvested cassava, leading to spoilage and waste.
- Some tubers may be lost during transport if trucks have rails that let tubers pass, though wastage may be minimal.
- Bad roads lead to tuber damage, and compression leading to rot.

Processing:

- Semi-processed products (wet mash) can only be stored for a limited number of days (5 at most)
- Processing of cassava into wet mash is essentially a women's activity.
- The product quality and level of waste is influenced by crude processing methods by locally fabricated machines that do not use food-grade materials.
- Most often processors source water from streams and rivers, which are polluted and result in unhygienic products.
- The side of the road is used for drying tubers, which is unhygienic since animals tend to eat part of the product, and sometime defecate on the dried product, and road traffic also leads to contamination of product.
- Peeling of small sized tubers during processing result in cutting off fleshy parts in an attempt to achieve clean peeling and some tubers are even discarded (about 50% loss).
- Grated cassava (wet mash) often spills, due to the breaking of sacks in which it is put for pressing. This is a direct result of the tearing of sacks during pressing

Distribution:

- No standard packaging of local cassava products e.g gari, lafun etc. Therefore farmers heavily rely on using polythene bags and even fertilizer bags that may be potentially harmful to bag the processed product

Tomato

Harvesting:

- Harvesting is usually carried out at full ripe stage, which leads to rapid deterioration, especially if there is prolonged waiting for evacuation from the farm; during long distance transportation, or other form of handlings. (Up to 20-30% loss after harvesting are common)
- Farmer's losses are greatest during the peak season (Jan-April), sometime in May and prices are too low so that they often choose not to sell

Processing:

- Sun-drying at the roadside or spreading inside the farms is common; this is not hygienic because the environment may be dusty and if not controlled, animals contaminate tomato reducing quality of the product

Transportation:

- Tomatoes are usually transported from the north which is the biggest production area to the south of the country. During market glut, having taken tomato long distances for sale, if farmers are not able to sell, they may just dispose of their produce by off-loading and throwing it all along the road paths or in bushes.
- Longer travel times affect the shelf life of tomato fruits such that more than 50% of transported tomato is often wasted before arriving at sales point.
- Price fluctuations also result in farmers' losses, so that some of them give up tomato growing.
- Tomato are usually packaged in jute sacks or woven baskets, and are stacked on top of one another during transportation resulting in loss due to mechanical injury, internal heat buildup, and acceleration of respiration due to ethylene rise.
- Use of inappropriate transportation means, even fuel tankers! Tomatoes are typically placed in woven baskets and then strapped on the top and on the side of the tanker to avoid multiple fees (taxes) that farmers pay when transporting from the north to the south.

Onion

Harvesting:

- Losses occur during harvesting because farmers harvest onions manually (About 30% of harvested onions go to waste)
- Losses increase especially in the rainy season because farmers harvest immature onions which are not properly cured for the market
- Losses are also recorded when market price is very poor, large quantities of onions rot away

Transportation:

- Sizeable losses are also recorded during transportation due to the breakdown of vehicles, and bad weather (heavy rainfall)
- During transportation, onions are usually bagged and stacked one on top of the other

What are they currently doing to prevent or mitigate those problems and what else would they like to do?

Cassava

Harvesting:

- Long diggers (a heavy metallic tool) are use during the dry season to loosen up compacted soil, which is very tedious, and the diggers are very heavy.
- A portion of the stem is left (4-6 inches) attached to the cut-off root of tubers, leaving only a small portion. This prevents openings on the tubers which would allow for pathogens to enter and lead to rotting undergound. While the tubers are left un-harvested in the ground (tubers stores for up to 3 months before spoilage, especially during the rainy season.
- Harvesters were developed for large-scale processors, not for SHFs, and are not available to the latter.

Storage techniques/technologies:

- Harvested tubers are kept under shade trees and covered with fresh shrubs (stores 3-4days before rotting) commonly used by SHFs

Storage:

- Cultivation of improved cassava varieties (TMS 419, TMS 0505) which store better in situ until they are needed.

Tomato and Onion

Storage:

- During raining season, farmers first expose the onions to the sun, then later spread them in the open for fresh air
- Storing of bagged onions, under shades. This reduces the water content, hence make it storable for up to 3 months
- Farmers pack tomato in baskets and cover with a layer of dry grass and wood and allow good ventilation between each layer of tomato basket and the next. This keeps tomato fresh for about 48hours

Transportation:

- Tomatoes are sorted before transportation
- During transportation, onion bags are perforated to allow for fresh air, especially during long distant travels

Processing:

- Sun drying of tomato when there is no market or market price is very poor, then they bag and kept dried during transportation for market

What attitudinal and capacity factors inhibit greater awareness or action?

Attitudinal factors:

- Mechanized farming is believed to be only for large scale farmers
- Some smallholder farmers see losses in crops (cassava, onion and tomato) to be part of the process of farming, i.e. a natural phenomenon
- SHFs are generally not interested in storing their cassava tubers because they harvest whenever they want to sell or process them into other products
- Cassava processors into local food such as fufu want freshly harvested tubers for processing and are not interested in storage of cassava tubers

Capacity factors:

- SHF are largely farmers with low level of education and can be difficult to convince at times due to beliefs, also lack of resources impedes them in becoming aware of solutions to postharvest losses.
- Farmer associations sometimes do not have the financial strength to assists their members.

What are the main considerations smallholders have in deciding whether and how to act to reduce waste and spoilage along selected value chains?

- Financial cost implication is a major factor because if the technology or technique requires the use of credit, existing interest rates in the country or farmers access to collateral will affect their decision of whether and how to act on PHL in the value chains.

What types of intervention and/or support (e.g., financial or technical) and/or incentives would stimulate further action?

- Information dissemination through Agricultural Extension Officers should be strengthened as there is a huge gap between technology that is available for tomato onion and cassava value chain and the technology adopted by these farmers simply by extending existing well-proven technical information
- Cost versus benefit studies should be carried out to determine the profitability of technology being considered to be able to convince small holder farmers in adoption
- Demonstrations should inform SHF about the existing technologies and the impact on reducing postharvest losses.
- Production is not linked with marketing in the value chain. Therefore market research can be carried out to assist in identifying market demands.

Objective 2: Identification of Key Interventions

Key Questions

What are the country-specific intervention opportunities, by specific crop and geographic area?

Farmers are encouraged to form/join cooperatives to enable them to assess loans, buy equipment, machines etc.

The Federal Ministry of Agriculture and Rural Development (FMARD) integrated an approach to agriculture through the Agricultural Transformation Agenda (ATA) and Horticulture Transformation Tomato Value Chain Implementation Action Plan 2012 – 2015 by Federal Government of Nigeria. These programs supports the production and postharvest handling of target crops (cassava included) through a favorable policy environment, access to finance and land, improved infrastructure and tax benefits.

What are the technology-specific intervention opportunities by specific crop and geographic area?

Cassava

Harvesting:

- Use of harvester.

Storage techniques/technologies:

- Trenching: This is a 3m deep trench covered with palm fronts overlay. Cassava tubers harvested at recommended 4-6 inches of stem attached are then arranged in layers, then covered with palm fronts in such alternate arrangement. The final layer at the top is then covered with palm fronts before the trench is finally covered with soil which has to be moistened (daily). This method can store tubers for 13-15 weeks keeping all the proximate composition of the fresh tubers in the pristine state.
- Sawdust storage technique: Storage in sawdust in wooden trays with the sawdust being moistened slightly everyday (this can stores for about 10-12 days before decay sets in).
- Cassava warehousing: A moderate-sized room is partitioned into two. The floor is concreted and slanted to allow easy outflow of water away from the cassava tubers. Sawdust is used as overlay as cassava tubers are arranged in layers alternately with moistened sawdust. Moderate space is left between the topmost layer of cassava tubers and the roof of the warehouse for adequate ventilation.

Processing techniques/technologies:

- Hybrid dryer: This technology combines solar (sun) and thermal energies (kerosene stove). Solar energy is used in the day and kerosene stove is used at night, respectively, to dry materials during processing
- Multipurpose crop dryer- This processing technology uses only thermal energy to dry materials during processing

- Solar tent: Sun rays are trapped inside an enclosed environment (two sides) to dry cassava products. A side of the tent is covered with white polythene sheet (to encourage maximum absorption of sun rays while the other side is covered with a black polythene material to conserve the trapped energy.
- Platform drier: This processing technique requires use of black nylon to be used as overlay to conserve heat energy during Sun drying. This method is commonly used to dry cassava tubers into cassava flour
- Use of Manual peelers, cassava graters, mechanical fryer, manually operated chipping machines and mechanical chipping machines.
- Sieving machine developed to reduce cost of sieving and it increases production efficiency
- Pulverization: after frying of wet mash, the dried product called gari is sieved. The waste (locally called koko) is re grinded to produce gari filter commonly referred to as 'lebu' in the local language.
- Chimney frying pan: This frying technique reduces wastages during frying and increases processing efficiency. It's a smoke-controlled processing technology, reducing the potential exposure of operators to health risks including cancer-causing substances.
- Electric frying machines: It reduces time spent on frying and larger volumes of mash are fried at a time.
- Sun drying: This method is commonly used for the conversion of cassava into chips, which can be ground and reconstituted.
- Platform dryer: This processing technique requires use of black nylon to be used as overlay to conserve heat

Transportation:

- Cassava crates have been developed to transport tubers to prevent stacking tubers one on top of the other and even the more common stepping on tubers during compact arrangement for transportation.

Onion and Tomato

Harvesting:

- For onions, farmers have been advised to harvest at the breaker point.

Storage

- Use of evaporative coolant structure (block-in-block design) in storing tomato at farm level

Transportation:

- Use of crates in packaging tomato during transportation
- Transportation of tomato through cooling van system right from the farm gate to the market or processing site. Converting trucks into cooling vans.

Packaging:

- Use of multipurpose dryers has been developed to dry farm produce including tomato fruits. This simple technology assist in packaging to elongate the shelf life of tomato fruits, thus preventing post-harvest losses
- Tomato packaging: Polythene packaging sheet has been developed. After drying, tomato is packaged with polythene which is later sealed. Women have been trained on simple sealing technology using candle wax rather than machines which may be too expensive.

Processing:

- Conversion into tomato and onion into puree/juice
- Solar trays have been developed to dry fresh tomato for preservations (small capacity)
- Artisanal drying of onions for off-season consumption

Expert & Stakeholder Workshop

Dates: 24th and 25th April, 2014

Place: Abuja, Nigeria

Address: Lapour Hotel, Plot 974, Okonjo Iweala Way, Wuye, Utako District, Abuja.

Number of Attendance: 15 participants on both days

Main Findings

Cassava

- Identify appropriate varieties for each agro-ecological zone and specific product
- Need for improved mechanized harvesting methods – present methods are not appropriate for SHF; but good systems for large farms
- Establishment of small scale processing centers in the midst of SHF (within the same locality) (clustering of farmers to use/supply common processing center)
- On-farm peeling/grating of tubers to have concentrated semi-finished product to solve the issue of bulk to value in cassava transportation
- Organization of Farmers groups into clusters to access loan/credit to procure processing and farm machinery

Tomato

- Timely harvesting of tomato (early morning or late in the evening when the weather is cool)
- All qualities of tomatoes have a market; roadside food businesses and poor households look for broken and squashed tomatoes because of lower price point
- Storage of tomato in a cool shed or with evaporative cooling system such as Zero Energy Cooling Chamber needs to be explored.

- Use of reusable plastic crates both at the farm, during transportation and at retailer level. Pilot study can be carried out to assess how to implement a reusable plastic crate system
- Need for an organized market and a consistent market structure along the tomato value chain

Onion

- Selection of disease resistant varieties and sourcing for seed from reliable source
- Use of ventilated crates to retard heat build-up
- Drying into a more stable product such as powders
- Structuring of operations in onion handling such that hired labor can be trained

Cross-cutting issues

- Hygiene from production to consumption is problematic, especially in processing sites and markets
- Accessibility to novel products, methods and technologies is limited
- General lack of trust between stakeholders in the value chains, specifically regarding weight and measures & quality
- Lack of appropriate packaging contributes to PHL, yet consumers are also not willing to pay for it
- So far the Government now has not put priority on the reduction of post-harvest losses and wastage
- There is consequent lack of organizational structure/prioritization
- Need for more support to acquire technologies through direct support and loan funds.
- Extension services are concentrating on staple food production, paying less attention to other sectors such as horticulture, livestock and fisheries
- There are very few extension agents who are knowledgeable about and can support post-harvest management improvement

Conclusions

In Nigeria there is a huge gap between the PHL reducing technologies and techniques that are available, and those that are actually adopted by smallholder farmers. Therefore there is a need for holistic intervention.

The importance of pre-harvest factors such as choice of variety at planting, cultural/agronomic practices is an important determinant of PHL among SHFs. The problem does not begin at harvest.

Major PHL challenges identified included: poor handling of produce in the value chain; lack of or inadequate storage facilities; farmers not able to get produce to the market because of transportation problems; issues of funding for relevant government institutions to implement improved technologies/techniques, which leads to a wider gap for their adoption in SHFs.

There is need for pilot-testing of technologies and demonstration trials to showcase technologies prior to wide-scale introduction.

The private sector should be the driving force in technology dissemination.

Consumer preferences, often tied to culture and religion, also play an important role in PHL in Nigeria.

Interventions proffered include training farmers, hired labor and where possible other stakeholders along the value chain; behavioral change such as attaching quality to produce that will attract value addition to selected crops; creation of awareness through information dissemination for the identified appropriate small scale technologies backed up with demonstrations; organizing farmers group into clusters; cost/ benefit implication analysis that should be made available to SHFs; creating synergy among relevant government agencies/projects; and encouraging technologies to be driven by the private sector.

Farming needs to be viewed and treated as a business.

Finally, the government should provide favourable policies to help reduce PHL such in the area of tax reduction and other relevant issues.

Sub-Questions

What is the process from awareness to behavior change?

Smallholder farmers (SHF) are aware of postharvest losses along the value chain. But there is a need to make them see the benefits, i.e. how much will be gained monetarily for other household activities by reducing wastes and spoilage along the value chain. Also, for SHF to make a behavioral change especially in technology/techniques also depend on its cost effectiveness. Such behavioral change may include harvesting tomato early in the morning rather than mid-morning after completing household chores and having to wait for transportation. Reducing PHL along value chain will result in more income especially for women resulting in better nutrition for the household.

What cultural and environmental factors might be important?

Cultural factors involve beliefs, preferences, traditions, or cultural norms.

In the case of cassava, women are the engine behind the value chain yet the benefits are unequally distributed, so they usually receive lower remuneration for more work. They are responsible for some harvesting, transportation and most the processing of cassava tubers into food products such as *gari*, *fufu*, *lafun* etc. are seen as a women's job. This is very labor intensive because only semi mechanized (mostly using fabricated equipment). Men are responsible for the on-farm activities in the cassava value chain, i.e. they generally govern pre harvest factors in the cassava value chain. But recent awareness borne from the creation of commercial processing factories (especially High Quality Cassava Flour production) has increased the involvement of men, yet it still cannot be compared to that of the women. Also there is no standard measurement for packaging and trading for local cassava products e.g. *gari*, *lafun* etc.

Most products are traded in volumetric measures that are not standardized, leading to losses along the chain. Farmers, processors and traders heavily rely on using polythene bags and even fertilizer bags that may be potentially harmful. Environmental factors that are important to consider is climate change as its affects SHF, which are highly dependent on rainfed agriculture that is seasonal.

A more general belief of some SHFs that straddles crops is that waste and spoilage along the value chain is seen as nature taking its own share from the harvest.

Are there any gender differences in the process from awareness to behavior change?

The cassava and tomato value chains exhibit different gender roles for men and women in production and processing activities. Women are responsible for the majority of the cassava and tomato processing and trading while men are often associated with cultivation to harvesting tasks and transportation. Yet male involvement is on the rise as processing becomes more mechanized and commercialized.

In the onion value chain, men are more involved in both cultivation and some aspect of handling and wholesale trading, while women are involved in processing and small-scale distribution and retailing.

What are the gender issues to consider in technology design, adoption, and up-scaling?

Women's role in cassava and tomato processing is highly labor-intensive and largely non-mechanized. Therefore technology considered should be gender sensitive and easy to operate. Culture should also be considered. Encouraging women to form groups/associations helps in accessing loans necessary to adopt new technologies.

What are creative ways to encourage waste and spoilage reduction behavior changes?

The use of simple appropriate small scale technology are usually accepted by SHFs especially those that have a low cost, make use of local materials that are within the reach of small scale processor, can be afforded by a farmer or as a small group, can be controlled and maintained by the farmers and processors with their skills and non-scientific technological education. This will be backed up with demonstration for farmers and processors for them to experience the grains they can make by reducing waste and spoilage in their crop production.

To what extent do waste and spoilage levels for a particular crop influence farmers' decision to cultivate it or not?

Pilfering of cassava tubers by Fulani nomads in some part of the country has discouraged some farmers in going into cassava production in some part of Nigeria. Glut is another issue that has really discouraged farmers in going into production to the extent that farmers left their farms un-harvested rather than harvesting and incurring debt on hired labor. Due to the unpredictable climate/weather conditions and gluts that increase production risk and PHL in crops some farmer were unable to pay back loans collected at the farmer's group level and have decided to engage in other activities to pay back their loans.

Do the income/production levels of SHF influence their waste and spoilage reduction practices?

Yes the income and production levels of SHF influences PHL as well as their beliefs, preferences, traditions, or cultural norms. Small scale producers usually have higher percentage of losses than large scale producers; they are also unfavorably exploited by traders that offer very low prices for their products.

What are the primary areas for training/knowledge for helping farmers avoid pre-harvest produce losses in both quality and quantity?

- Planning planting and harvesting dates,
- Determination of maturity indexes for harvesting

- The use of improved varieties (improved planting materials) with better storability
- Proper field sanitation pest and disease control
- Improved cultural practices (agronomic practices), planting density; fertilization and pesticide use
- Improved harvesting practices for cassava

Are farmer organizations aware of and do they appreciate the magnitude of postharvest losses' effects on their incomes? How can they best be mobilized and what new capabilities are required?

Farmer organizations are aware of the magnitude of postharvest losses and its effect on their income. In the past they have been disappointed by the government bringing white elephant project/technology into the village, such as bringing technologies that are powered by electricity as a means of reducing waste and spoilage and most rural dwellers have access to little or no electricity. But in recent times there has been a new approach such as giving them improved varieties with better storability (traditional). To mobilize them, there is a need to encourage and demonstrate at farmer organization level because many farmers have not seen any technology that exist especially for tomato, onion and cassava storage and pre-cooling. There is also need to work with the transporter unions to improve the way agricultural produce are being handled during transport, since a high amount of product deterioration and spoilage is being caused.

What intervention points in the crop value chains will yield the best results (quantity and quality) in waste and spoilage reduction?

Cassava

- Careless/rough handling, manual harvesting with hoes and cutlass especially during the dry season results in breakage of tubers, many of which are left in the ground, constituting a major loss during harvesting
- There is no storage technology for cassava known to farmers (note: *most SHF are unwilling to store but rather sell directly to HQCF processors or traditional food processors*)
- Cassava has extremely low value to bulk ration. Drying on farm will reduce the cost of having to transport huge amount of tubers and have a product with a longer shelf life, that can be sold when market process are higher.
- Most processors fabricate the same type of cassava based products leading to market glut and low prices, need for diversification strategies and investing into processing of a wider range of products.

Tomato

- SHFs usually harvest tomato on the field at full ripe stage even though at this stage the product has very short shelf life (producers lack the knowledge of tomato harvest maturity and the best point for harvesting to guarantee transport)
- Careless/rough handling of tomato then occurs during harvesting, transportation and distribution
- Use of woven basket with rough inside (not lined and washed) causes bruising and spoilage, and encourages growth of deteriorating agents (fungal and bacterial growth). These baskets

are also placed on one another resulting in tomato loss due to compression. These tomatoes are usually no totally wasted, but sold at a discount price to mostly food preparation businesses leading to potential health risks.

- Farmers' sun-dry left-over tomato after sales or when there is glut at road side, paths or spread on the farm. This is not hygienic because the environment may be dusty and if not controlled animals contaminate tomato reducing quality of the product.

Onion

- Use of late fertilizer application to boost plant growth actually leads to onions with high water content that are highly perishable, but results in large onions that are appreciated by the market.
- Harvesting of onion at immature stage, sometimes because SHF are not aware of physiological maturity and other times to take advantage of early high market prices at the early season
- Lack /improper curing of onion after harvesting
- Use of inappropriate transport system and bagging of onion in sacks and overloading to reduce transport cost on this result in poor ventilation and heat buildup leading to rot.

What technologies best provide opportunities for SHFs, especially women, to engage in waste and spoilage reduction?

Cassava

- Since women are more involved in processing of tubers, machines that will assist in drying, grinding/grating, pressing frying/roasting of cassava tubers
- Diversification of cassava based products that have a higher market price.

Tomato

- Use of appropriate small scale technology that will ensure cooling of the tomato on the farm without the use of electricity such as an Evaporative Coolant Structure or the Zero Energy Cool Chamber ZECC (http://ucce.ucdavis.edu/files/datastore/234-2143.pdf) and if possible at traders level.

Hot Spot Analysis for Nigeria

Cassava Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological Maturity	• There is inadequate knowledge of optimum age for prime maturity time • There are too many varieties thereby causing confusions, hence farmers cultivate with no specific target	• Create farmers awareness that cassava roots should be harvested exactly at the 12th month • Identify and promote key varieties mainly for starch, gari, and direct human consumption in each state	• Prime maturity time to harvest is easy to communicate • Cassava stems (planting materials) should be in large quantities • Improved cassava stems are readily available • There should be a sensitization of farmers to cultivate cassava for commercial stem production for 2-4year period	• Means of communications are not expensive • Improved varieties are moderately available	• No constraint to adoption • Improved varieties are currently in very high demands	No gender limitation to adoption	• Communication of 12-month prime maturity harvesting time is recommended for up-scale • Promotion of 3 key varieties that are specific for starch, gari, and direct human consumption are recommended for up-scaling in each agro-ecological zone
Harvesting	Breaking of tubers during harvesting through the use of hoe and cutlass especially during	The use of cassava harvester/training on proper handling at harvest					Farmers' groups/cooperatives can receive government assistance to purchase harvester and make

	dry season when the soil is compacted						payment over a period of time
Field drying (when applicable)	High deterioration (low shelf life) of tubers and delay in harvesting time due to glut	Diversifying into other product such as conversion into dry chips on the farm					Cassava has extremely low value to bulk ration. Drying on farm will reduce the cost of having to transport huge amount of tubers and have a product with longer shelf life.
Platform drying (when applicable)	Drying into cassava chips on the roadside with quality deterioration and unhygienic conditions	Use of solar dyers; hybrid dryers; platform dryers or solar tunnel					Demonstration trials in collaboration with research institutions and agricultural extension services
Threshing/shelling (when applicable)							
Winnowing (when applicable)							
Transport to packing shed							
Storage at the farm level							
Grading and sorting							
Off-Farm							
Handling and transport to first	Over stacking of cassava tubers	Training of farmer and hired labour					Training of farmers through Government

receiver	results in bruises leading to rot Rough/handling during loading and offloading Dropping off of tubers in transit	on proper handling of tubers Use of guarded truck					Agricultural outlets.
Storage and handling at the trader/processor level	Storage prior to processing in big piles, in the heat	Storage in shade, under open ventilated canopy					Demonstration trials with traders/ processors
Processing (when applicable) **Processing:** ***Peeling and Washing***	• Cassava is processed into a few products eg. gari, lafun, fufu with regional preferences; most products have low price and experience glut • Lots of tubers waste away (left unpeeled) because cassava roots are too small • Edible flesh of cassava tubers are lost in the attempt to achieve clean	Diversification of processing products to capture higher market value ***Starch production:*** Cottage entrepreneur within cassava production cluster should wash cassava tubers without peeling, mill finely and de-water (to produce	***Starch production:*** Tuber conversion into wet cakes is accessible at clusters' level ***Gari production:*** • Peeling machines can be sited at specific	***For Starch:*** Wet cakes at clusters' level reduces cost of transportation, and highly affordable ***For Gari:*** Peeling machines may be affordable at farmers' clusters	• No constraint to adoption of the technologies • Adoption should be within clusters of cassava farmers	***Starch:*** It is gender friendly ***Gari:*** Peeling machines have positive and negative gender	Exposing processors to new processing options; effective tax rebates on importation of processing equipment ***Starch:*** Wet cake is highly recommended ***Gari:*** • Peeling machine is highly recommended • There must be Pilot

	peeling	into wet cakes), and supply to the processing companies such as MATNA Foods Ltd, and Nigeria Starch Mills) ***Gari production:*** Use of cassava peeling machines that also wash at same time. IITA has promoted some prototypes with local fabricators	processing centres/clusters • There is need for grants for processors to take off • There is need for a clean portable water source	level		implications *- (It ensures women' safety and saves time; but takes away women means of livelihood)*	testing to ascertain cost effectiveness by an entrepreneur within clusters
Downstream storage (when applicable)	Processed products are transported in inappropriate packaging; in trucks that transport divers products that can lead to leakage	Protection of processed products in good quality plastic packaging; training of transporters					Research should evaluate more appropriate local options; large scale importation of packaging material facilitated by government sale to SHF; tax rebates for importers
Distribution to retailers	Sanitary conditions during transport need to be improved; spilling of product	Protection of processed products in good quality plastic packaging; training of transporters					See above; Training of transporters
Handling and transport to first	Sanitary conditions during transport	Training of transporters					Training of transporters

receiver	need to be improved; spilling of product						
Storage and handling at the trader level	Storage of product in plastic and cement bags not appropriate	Facilitate access to high quality food grade packaging material					Research should evaluate more appropriate local options; large scale importation of packaging material facilitated by government sale to SHF; tax rebates for importers
Processing (when applicable)							
Downstream storage (when applicable)							
Distribution to retailers							

Tomato Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological Maturity	Tomatoes are harvested at physiological maturity or later instead of breaker stage	Training of SHF on correct harvesting technique for tomato eg. cutting with the peduncle and leaving some of the stalk on the tomato					Farmers training on correct harvesting point, method and tools to use for controlling postharvest rot and preserving quality
Harvesting	• Harvesting at full	• Training of	Crates are	Crates are	low	**Male and**	• Introduction of reusable plastic

	ripe stage • Rough handling at harvest • Harvesting into woven baskets • Wrong time of harvesting as at mid-day	farmers on cultivation and harvesting techniques (importance of maturity stage, proper handling at harvest etc.) • Use of reusable plastic crates • Shading under trees or canopy or umbrella	available but limited in number	expensive		**female** (This depends on: region to region, education, religion and culture)	crates (subsidized) and training to farmers through Government Agricultural outlets. This can also create jobs (washing of crates by women and youths) • Training of farmers by Extension officers • Forming Farmers group to access
Platform drying (when applicable)	There is a lot of waste during the production season. Since there is no place to store, Farmers carried out drying is on road side so as to save some, exposure to agent of contamination do have effect on health.	• Use of multi-purpose dryer/solar dryer • Training of end-users	This is not available to the farmers Low	Farmers cannot afford both dryers	low	Mostly women in the southern part of the country, men and women in the north	• Training of all stakeholder (farmers, extension officers, technicians, etc) • Forming Farmers group to access
Transport to packing shed	In baskets, loaded onto carts drawn by animals – some damage of not well packaged tomatoes;	Simple methods like lining the baskets with paper or carton can reduce damage; reducing loading in individual baskets					Demonstration trials;

		to maximal 20kg					
Storage at the farm level	Tomato are sometimes kept under shade, no proper storage of tomato known, no pre-cooling or cooling of product	Use of block-in-block design of ZECC (Zero Energy Cooling Chamber)					It is built from local materials around the farmer and requires no external supply of energy.
Grading and sorting	No grading and sorting	Grading and sorting on basis of size and maturity level					No extra technology, just training
Off-Farm							
Handling and transport to first receiver	Rough handling and use of improper containers for transport	Storage crates					Introduction of reusable plastic crates
Storage and handling at the trader level	• Overloading of trucks/vehicle. Fruits are exposed to the sun and heat, no temperature control • Breakdown of Vehicle • Rough handling Fruits are exposed to the sun and heat, no temperature	• Use of crates • Use of ventilated vehicle • Use of shading or umbrella to protect fruits against heat; enclosed points of sales no open markets	Available in limited number	Farmers overload trucks to limit the number of runs to reduce cost. They may not be able to afford all costs	Low (As good as not in use)	• Men and Women (Region, religion influences this too)	• Awareness raising and demonstration trials • Training of all stakeholders (Farmers, Traders, Truck owners etc.) • Formation of Cooperative Societies of all stakeholders.

	control, also rats and mice can damage products in the market						
Processing	Processing into puree and juice, but packaging materials are mostly recycled jars with old covers	Use of new, appropriate packaging for processed products					large scale importation of packaging material facilitated by government sale to SHF; tax rebates for importers
Downstream storage	Storage of processed products in inappropriate conditions	Need for proper storage conditions protected from heat and sun for processed products					Information leaflets on proper storage conditions for fresh and processed products
Distribution to retailers	Breakage of already processed products during distribution	Packaging of products in padded cartons and loads in trucks needs to be well stabilized to avoid shifting of load					The government needs to improve the state of roads to reduce losses during transport
Handling and transport to first receiver							
Storage and handling at the trader level							
Processing (when applicable)							

Downstream storage (when applicable)							
Distribution to retailers							

Onion Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Production	Varieties with good storage characteristics that are appreciated by the market	• Disease Resistant variety with good storability • Local red					Breeding is a on-going challenge Local Variety are already Identified and pre planting field treatment is an important GAP
Physiological Maturity	Harvesting of immature onions	Curing to prepare onions for storage; immature onions are smaller sized but practice is used to harvest early and achieve a higher price					Promotion of Curing to enable storage of Onion in Conventional Crib and Shelf life extended in Improved Crib with Breather Pipes for Onion Cribs
Harvesting of matured onions	Curing requiring nature of Fresh harvested Onions	Curing					Continued Promotion of Curing of freshly harvested Onions prior to Storage
Delaying of harvest of Onions	Damage and infection	Harvest at maturity latest					Continued promotion of harvesting of Onion at maturity
Field drying	• Lack /improper curing of onion before taking them to the	• Training of farmers on proper curing of onion • Small scale forced					Training on different methods for curing of onion with its cost implication and benefits

	market • Drying to accelerate curing and improve storability	air dryers • curing guarantees the storability of onions and lets SHF potentially access more remunerative markets later on in the season					
Platform drying (when applicable)	Drying of onions into dried onions for household consumption; sometimes unhygienic conditions during drying	Training of farmers on proper drying of onion					Training of farmers on proper drying of onion and hygienic packaging, contact with multinationals that use onion flakes, powder
Transport to packing shed (FIELD TO MARKET)	Delay in transportation small trucks in , only if money is not available;	Money to pay for transport					Delayed transportation to the market should continue to be discouraged
Storage of Onion in Conventional Crib (Single platform covered with grass at the farm level, but with limited shelf life)	• Lack of proper storage shed leads to postharvest losses and having to sell at low price • Inadequate Ventilation for cooling off of Storage in crib; covered with	• Low-cost onion storage sheds can be built from local materials and prolong storage so that SHF can get higher price; • storage condition (temp.25-30ºC & humidity 65%-	low	Some funds needed	low	Mostly men and some women – since onion is produced in north and agriculture in that	Demonstration trials and training of farmers in proper construction of onion storage sheds Promotion of adoption of incorporation of breather pipe to increase storage capacity and extend shelf life

	grasses	70%). • Crib can be improved by include breather pipes				zone is male dominated	
Grading and sorting for the market	Field damage and infection are reduced	Grading and Sorting	Local technology, curing on sun-energy use tarpaulin, rotten are thrown away	Very low cost	Already adopted, non-adoption due to carelessness+	Mostly men since onion production and wholesale trading is male dominated ; some small scale women retailers -	The Grading and Sorting to improve quality and increase value should continue
Off-Farm							
Handling and transport to first receiver	• High heap of bagged (Jute and Woven Polypropylene) Onions (300-450 Bags) transported in Metal built Trailer Container, exposure to direct sun, humidity and potentially rain • Overloading of transport and	Ventilated Stackable/Collapsible Plastic Crates; covered with tarpaulin in case of rain Training and tax reduction by the government; importation of improved packaging material					Promotion of Packaging of Onions in Ventilated Stackable/Collapsible Plastic Crates to limit damage, infection and spoilage during Transportation in Trailers Multiple tax paid by farmers and transporters on trips especially for transporting onion and other food commodity from the northern part of the country to south should be reviewed by the government. Use of ventilated trucks

	Loss to bad weather (heavy rainfall) and bagging onions in sacks						
Storage and handling at the trader (Wholesale or Retail) level	• High heap of bagged (Jute and Woven Polypropylene) Onions on Platform under thatch roof market shed • Stored in piles on the floor, sometimes with polythene bags under; sorted into sizes; sold by quantity not weight; price dependant on size • Sale by weight so that production of large watery onions is encouraged; proper curing of rarely done so that onions are highly perishable	• mproved storage structures – onion storage sheds; evaporative cooling structures; temperature control stores • Slated shelving of Jute Bagged Onions on Platform under thatch roof market shed • Stacking of Ventilated Stackable/Collapsible Plastic Crates with Onion on Plastic Pallets under thatch roof market shed	• Slated shelves can be produced locally • Stackable crates can be found in Nigeria; institute recyclable crate system;	• First cost of stackable crates recycling system is high, state or outside institution will need to support this technology – through grants	Slated shelves have been adopted since low-cost and local/improved technology	Mostly men since onion production and wholesale trading is male dominated; some small scale women retailers	• Jute bag packaging (but not Polypropylene bags that heat up the produce and aggravate spoilage) of Onion placed on Slated shelves or platforms • Promote adoption of Stack Storage of Onions in Ventilated Stackable/Collapsible Plastic Crates under thatch roof market shed • Temperature controlled warehouses should be constructed in markets with individual cubicles that can be rented out to individual traders; management through market authority
Processing (when applicable)	Abundance of harvest, glut, value	Processing into dried (using NSPRI	+	+	-	-	Promotion of Production of NSPRI MPD dried Onion for Milling into

	addition opportunity	Multipurpose Dryer) Onion Rings Milled into Powder for hermetic packaging					Powder
Downstream storage (when applicable)							
Distribution to retailers							

Contact List

No.	Name	Affiliation	Position
1	Mr Adeniyan	Ondo State Agricultural Development Project	Director of Agricultural Technical Services
2	Mr Olajide	Aramson Cassava Processing Industry, Ondo State	Chairman of Aramson, Casava Processing Industry
3	Mr Femi Falaye	Akure Owode Farmers and Processing Association, Ondo State	Chairman of the Akure-Owode farmers and Processing Association
4	Mrs Comfort John	Ilu Abo-Mekun Cassava Processing Association, Ondo State	Member of the Cassava Processing Association of Mekun Community
5	Mr Ogunlade Albert	MATNA Foods Company Limited, Ondo State	Managing Director MATNA Foods Company Limited
6	Mr Ogunbodede Samuel	Farm to Feed the Nation Cassava Producers Association, Ondo State	Chairman of Farm to Feed the Nation Cassava Association
7	Dr Abiodun Aderibigbe	National Stored Product Research Institute (NSPRI), Kwara State	Director of Research Outreach Department
8	Mr Olanrewaju Umar	Kwara State Agricultural Development Programme (ADP), Kwara State	Deputy Director, Department of Technical Services
9	Mr Tijani Jimoh	Aanu-Oluwa Cassava Processing Society, Kwara State	Cassava Processor, Head of Farmer Based Organization (FBO)
10	Mrs Sidikat Sheu	Pampo Cassava Grower and Marketer Association, Kwara State	Member, Cassava Grower and Marketer Association
11	Mr Muritala Aremu	Private Transporter, Kwara State	Private Transporter
12	Female Focus Group	Pampo Cassava Growers and Marketers Association, Kwara State	Cassava Grower and Marketers Organization
13	Exco, Eyenkorin Produce Transporters Union	Anta Aje Igboro Eyenkorin Transporter Association, Kwara Statae	Transporters Association
14	Mr Kehinde Ebenezer	Ogun State Cassava Revolution Programme (OGCRP), Ogun State	Head of Post harvest handling Unit
15	Professor, J.G. Bodunde	Federal University of Agriculture, Ogun State	Crop Physiologist/Horticulturist
16	Mrs Arakanga	Women Cassava Processors, Ogun State	Head of Processing Unit
17	Mr Obasi Sunday	Federal Ministry of Agriculture and Rural Development (FMARD). Abuja	Chief Agricultural Officer
18	Mr. Hussaini Illyasu	Federal Capital Territory Fadama III Coordination Project, Abuja	Community Development Officer
19	Mrs Helen Amos	Wako-Gada Women Farmers, Abuja Cooperative	Member, Women Farmers

		Society	Cooperative Society
20	Mallam Ali Farri	Wako-Asshara Fadama Community Association, Abuja	Chairman Wako-Asshara Fadama Community Association
21	Mallam Shehu Sanni	Wako-Asshara Fadama Community Association, Abuja	Secretary Wako-Asshara Fadama Community Association
22	Mallam Adamu Sumaila	Wako-Asshara Produce Transporters Association, Abuja	Member, Wako-Asshara Produce Transporters Association
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24	Mr Efuntoye Ademola	Federal Ministry of Agriculture and Rural Development, Abuja	Deputy Director, Roots and Tuber Section, Desk Officer for Cassava Value Chain
25	Mr Hashem Ahmed	Dansa Foods Company Limited, Abuja	Administrative Manager
26	Mr Amadu David	Ikara Food Processing Company Limited, Kaduna State	Manager, Head of Quality Control
27	Mr Audu Abilah	Ikara Community, Kaduna State	Farmer/Supplier of tomatoes
28	Mr Bala Ibrahim	Ikara Community, Kaduna State	Farmer/Onion Supplier
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30	Mr Yau Kassin	Kaduna State Agricultural Development Programme	Assistant Director, Department of Agricultural Extension
31	Mr Yakubu Umar	Kaduna State Agricultural Development Programme Kaduna State	Deputy Director, Department of Agricultural Extension
32	Mr Sha'ibu Muhammed	Bello Brothers Transporter Association. Kaduna State	Secretary, Bello Transporters Association
33	Mr Rabiu Mustapha	Dogara Ga'Allah Tomato Growers Association, Kaduna State	Member, Dogara Ga'Allah Tomato Growers Association

Country Annex for Senegal

- Dates traveled: March 10 to April 28, 2014
- Main growing regions visited: Dakar, Thiès (manioc, tomate), Kaolack, (arachide) Fatick (arachide) Diourbel (arachide), Saint louis (tomate)
- Interesting quote(s):
  - Le manioc est l'enfant orphelin de la recherche et de l'étude au Sénégal
  - Le manioc à dit « Repique moi et va t'assoir jet te fournirai de la nourriture suffisante »
  - L'arachide est l'or du Saloum

Figure 5: Transport Arachide Entre Points de Collecte et Usine

Figure 2: Machine Pour Transformation Arachide en Huile

Figure 3: Sachets Granulés à Base de Manioc Séchage

Figure 4: Tomate Séchée Artisanalement

Figure 5: Séchage Industriel dans le Site de la Socas

Objective 1: Prioritization

Key Questions

How aware of losses are smallholder farmers involved in the selected value chains? Which types worry them the most and why?

Une bonne parties des producteurs rencontrés sont conscient des pertes post-récolte toutefois il ne sont pas en mesure de donnée les quantités exactes de ces pertes. Les causes principales de ces pertes viennent des attaques en cours de stockage. Certaine pluies en fin de saison entrainent également des pertes dans les parcelles d'arachide en cours de récolte

- Pour l'arachide les producteurs soutiennent que les pertes les plus importante interviennent principalement pendant le stockage de gousses ou des graines (avec les attaques fréquentes) et secondairement pendant les récoltes le séchage et le battage. Les pertes au cours du stockage sont dues aux attaques alors pendant la récolte, le battage et le vannages on note en plus des attaques des pertes pouvant venir du climat (pluies parasite) et aux animaux divagants. Les quelques magasins de stockage qui existent sont soit en mauvais état ou entre les mains de quelques individus ainsi les producteurs ne disposent pas de magasins adéquats pour stocker les récoltes.
- Pour la tomate les pertes les plus importantes interviennent entre la maturité et la récolte surtout la tomate industrielle où la collecte est assurée par les industrielle et non par les productteurs. Les producteurs soutiennent aussi que des pertes sont notées pendant la commercialisation des tomate surtout pendant les période de forte production. Ces pertes sont dues à l'absence de possibilités de stocker la tomate mature. Pendant les période favorables on a une surproduction et le marché est saturé ce qui entraine des méventes. Pour la tomate industrielle, la collecte est assurée par les industrielle et toute production non planifiée entraine des problèmes de vente
- Selon les producteurs, le manioc enregistre plus de perte pendant la récolte, le transport et la commercialisation. La transformation du manioc est timide au Sénégal et les tubercules de manioc sont consommées comme légumes ce qui limite la consommation. Durant la transformation selon les producteurs, les pertes des pertes de qualité sont notées pendant le séchage, de déplissage car le matériel utilisé est surtout manuel.

What are they currently doing to prevent or mitigate those problems and what else would they like to do?

Face à ces pertes, les producteurs ont développé des stratégies pour lutter contre elles:

Arachide:

- Deux méthode de traitement sont appliquées pour la conservation de l'arachide : la fumigation, l'application de malathion qui est un insecticide. L'application du malathion commence au champs avec les meules pour lutter contre les attaque en période de séchage. certains producteurs ont développer une technique de stockage des graines de semences qui consiste a utiliser des fûts métalliques de 200 l avec le fond rempli de sable stérilisé de même que la partie supérieure.

- Les problèmes de commercialisation qui ont été notés ces dernières années ont poussé certains producteurs ou groupes de producteurs à mettre en place de petites unités de transformation qui produisent de l'huile triturés, des pattes et de la poudre d'arachide destinées au marché local ;
- L'Institut Sénégalaise de Recherche Agricole (ISRA) a mis au point des sacs doubles en polyéthylène qui permettent une bonne conservation des arachides pendant plus de 9 mois sans détérioration des produits. Ces sacs sont en phase de tests dans les zones de Tivaoune, région de Thiès car, ils peuvent être utilisés aussi pour le stockage du niébé et du manioc.

La seule technique utilisée en milieu paysan pour le stockage du manioc le stockage sous terre qui consiste à laisser les tubercule arrivées à maturité sous terre avec les tige (ne pas récolter). Selon les producteurs, cette technique permet de conserver les tubercule pendant 9 mois à 1 ans sans dégâts majeurs.

La tomate est très difficile à stocker en milieu rural :

- Pour lutter contre les pertes certains producteurs surtout de la zone de Saint Louis ont noué des contrats avec les industries de transformation qui viennent collecter le produits au champ;
- D'autre producteurs ont mis en place en collaboration avec des groupements de promotion féminin des unités de transformation en produisant plusieurs gammes : tomate séchées, tomate concentrée, confitures de tomate
- Les producteurs partenaires de l'ONG Agrecol Afrique ont expérimenté la durée entre la récolte et la dégradation de deux types de tomate : tomate produit biologiquement (sans intrants chimiques) et tomate produit conventionnellement (avec des intrants chimiques) à l'issus de cette tests ils ont conclut que la tomate produit biologique est plus facile à conserver dans les conditions naturelles que la tomate issue de l'agriculture conventionnelle.
- Des groupements de producteurs ayant des moyens plus important utilisent des container frigorifiques pour les stockage de la tomate mais les coût de production augmentent considérablement avec cette technologie.

What attitudinal and capacity factors inhibit greater awareness or action?

Pour l'arachide on peut noter

- Comme contrainte l'absence de magasins adéquats. En effet, plus de 70 % des producteurs avec qui nous avons échangé soutiennent que dans leur zone ils n'y'a pas de bon magasin pour stocker les récolte sans pertes.
- Certains producteurs reconnaissent qu'ils existent des pertes post –récolte mais sont peut conscient de l'ampleur de ces pertes à cause souvent des fortes productions.
- La transhumance qui entraine le déplacement des animaux en fin de saison est aussi une contrainte de sensibilisation des pertes post récoltes
- Les producteurs disposent peut de connaissance sur les techniques de stockage

Pour la tomate

- La contrainte principale est le climat, la chaleur accélère la maturation des tomate et augmente les pertes par pourriture
- Les producteurs n'ont pas vraiment reçu de formation sur des techniques de luttes contre ces pertes et leur niveau de connaissance ne permet de pas de faire face à ces pertes
- Les producteurs de tomates industrielles dépendent des industrielles qui sont les principales si non les seuls acheteurs de cette tomate

Pour le manioc on peut dire la manioc est une culture marginale au Sénégal peut de technologies ont été développées pour cette culture

What are the main considerations smallholders have in deciding whether and how to act to reduce waste and spoilage along selected value chains?

Pour réduire les pertes post récoltes il faudra:

- Arachide: réduire le temps de séchage avec la vulgarisation de machine pour égousser ou des batteuses d'arachide, améliorer les conditions de stockage et développer des unités semi-industrielles de transformation en milieu rural, toute en renforçant la gestion de ces unités .
- Manioc : valoriser la transformation du manioc au Sénégal, introduire des technologies relatives à la récolte et au stockage qui ont été développées dans des pays d'Afrique de l'ouest où la production de manioc est très développée;
- Un politique de consommation des produits locaux par des plaidoyers est aussi nécessaire. En effet malgré la forte production d'arachide, le sénégalais ne consomme pas l'huile d'arachide car une bonne partie de cette huile produites par les industrielles est exportée
- Un plaidoyer pour la prise en compte des aspect post récoltes dans la politique de l'Etat , en effet depuis longtemps les gouvernements mais aussi les projets et programmes mettent l'accent surtout sur la production (augmentation des rendements) sans prendre à bras le corps le post production qui est aussi un segment important dans la production.
- Promotion des énergies renouvelables dans la transformation des produits agricoles : séchage de tomate, vaporisation du manioc
- Pour la tomate : développer la transformation en milieu rural avec des équipement adéquats. Même pour la tomate industrielle, une transformation primaire peut être expérimentés par les OP et le produit semi transformé pourra être vendu au industrielles
- En collaboration avec les industrielles, transfert la transformation primaire dans le OP ceci va permettre de réduire considérablement les pertes au champs et créer des emplois en milieu rural surtout pour les femmes.

What types of intervention and/or support (e.g., financial or technical) and/or incentives would stimulate further action?

Technique

- Appuyer la vulgarisation de la batteuse d'arachide que l'ISRA a introduit : en formant les artisans locaux dans la fabrication de la batteuses et faire sa vulgarisation dans les zones de production .
- Améliorer les unités de transformation existantes en modernisant les machines utilisées et installer des unités de transformation dans les zones à forte production ceci va permettre d'augmenter leur capacité de production et leur approvisionnement en matière première limitant ainsi les stockage en milieu paysan et les risques de pertes.
- Appuyer l'amélioration et la vulgarisation des techniques de détoxification (table de détoxification avec attapulgite) des huiles et autres produits venant des arachides pour réduire les pertes de qualité liées à l'infestation par aflatoxine.
- Introduire des unités de transformation en fonction des spéculations dominantes dans chaque zone
- Renforcer les capacités des producteurs sur les questions liées aux pertes post récoltes en les formant sur les causes des pertes post-récoltes, les techniques de stockage, la lutte contre les attaques en cours de stockage
- Construire des magasins de stockage répondant au normes techniques ou rénover les magasins existants ;
- Pour le manioc, identifier des technologies efficaces et efficience dans les pays où la spéculation est bien cultivée et les introduire au Sénégal en vue de leurs vulgarisation ;
- Mettre en place des actions de plaidoyer pour conscientiser mieux les producteurs mais aussi les politiques sur l'importance des pertes post récoltes et leurs impacts négatifs sur le revenus et le pouvoir d'achat des ménages ruraux.

Financière

- Développer un mécanisme de financement adéquat c'est-à-dire accessible aux petites unités de transformation pour le financement de leurs activités ;
- Mettre en place un programme de subvention en équipement pour les petites entreprises de transformation ;
- Appuyer la construction de points de vente (kiosques) des produits transformés par les producteurs ceci va permettre de rapprocher les consommateurs de ces produits. Ces points de ventes peut être installer dans les grandes villes comme Dakar, Thiès, Kaolack, Saint Louis … et gérer par des GIE de femmes habitant dans ces villes.
- Financer la reproduction et la diffusion de certaines technologies : batteuse d'arachide, presse à huile motorisé, table de détoxification, séchoir solaire

Objective 2: Identification of Key Interventions

Key Questions

What are the country-specific intervention opportunities, by specific crop and geographic area?

Pour l'arachide

- Kaolack
  - Un volet diffusion de technologies: reproduction et diffusion de batteuses d'arachide, presses motorisées, machine à torréfaction, table de détoxification et construction de magasins de stockage ;
  - Volet renforcement de capacité: formation des producteurs sur les causes pertes, les techniques de stockage, les techniques de transformation, hygiène et qualité dans les unités de transformation, démarche qualité, formation des artisans sur la fabrication et la réparation des machines introduites
  - Volet transformation: appui à l'installation d'unités de transformation semi industrielles dans des villages centres pour augmenter l'absorption des produits au niveau local et créer des emplois.
  - Volet intermédiation financièr: pour permettre aux acteurs d'accéder à des crédits pour financer les activités de stockage, de transformation et de commercialisation.
  - Volet intermédiation commerciale: mise en relation des unités de transformation avec les gros acheteurs pour l'écoulement des produits, développer l'export des arachides et des produits arachidiers par les petites unités villageoises.
- Kaffrine
  - Un volet diffusion de technologies: reproduction et diffusion de batteuses d'arachide, presses motorisées, machine à torréfaction, table de détoxification et construction de magasins de stockage ;
  - Volet renforcement de capacité: formation des producteurs sur les causes pertes, les techniques de stockage, les techniques de transformation, hygiène et qualité dans les unités de transformation, démarche qualité, formation des artisans sur la fabrication et la réparation des machines introduites
  - Volet transformation: appui à l'installation d'unités de transformation semi industrielles dans des villages centres pour augmenter l'absorption des produits au niveau local et créer des emplois.
  - Volet intermédiation financière: pour permettre aux acteurs d'accéder à des crédits pour financer les activités de stockage, de transformation et de commercialisation.
  - Volet intermédiation commerciale: mise en relation des unités de transformation avec les gros acheteurs pour l'écoulement des produits, développer l'export des arachides et des produits arachidiers par les petites unités villageoises.

- Fatick
  - Un volet diffusion de technologies: reproduction et diffusion de batteuses d'arachide, presses motorisées, machine à torréfaction, table de détoxification et construction de magasins de stockage ;
  - Volet renforcement de capacité : formation des producteurs sur les causes pertes, les techniques de stockage, les techniques de transformation, hygiène et qualité dans les unités de transformation, démarche qualité, formation des artisans sur la fabrication et la réparation des machines introduites
  - Volet transformation: appui à l'installation d'unités de transformation semi industrielles dans des villages centres pour augmenter l'absorption des produits au niveau local et créer des emplois.
  - Volet intermédiation financière: pour permettre aux acteurs d'accéder à des crédits pour financer les activités de stockage, de transformation et de commercialisation.
  - Volet intermédiation commercial : mise en relation des unités de transformation avec les gros acheteurs pour l'écoulement des produits, développer l'export des arachides et des produits arachidiers par les petites unités villageoises
- Dioubel
  - Un volet diffusion de technologies: reproduction et diffusion de batteuses d'arachide, presses motorisées, machine à torréfaction, table de détoxification et construction de magasins de stockage ;
  - Volet renforcement de capacité : formation des producteurs sur les causes pertes, les techniques de stockage, les techniques de transformation, hygiène et qualité dans les unités de transformation, démarche qualité, formation des artisans sur la fabrication et la réparation des machines introduites
  - Volet transformation: appui à l'installation d'unités de transformation semi industrielles dans des villages centres pour augmenter l'absorption des produits au niveau local et créer des emplois.
  - Volet intermédiation financière: pour permettre aux acteurs d'accéder à des crédits pour financer les activités de stockage, de transformation et de commercialisation.
  - Volet intermédiation commerciale: mise en relation des unités de transformation avec les gros acheteurs pour l'écoulement des produits, développer l'export des arachides et des produits arachidiers par les petites unités villageoises
- Thiès
  - Un volet diffusion de technologies: reproduction et diffusion de batteuses d'arachide, presses motorisées, machine à torréfaction, table de détoxification et construction de magasins de stockage ;
  - Volet renforcement de capacité: formation des producteurs sur les causes pertes, les techniques de stockage, les techniques de transformation, hygiène et qualité dans les

unités de transformation, démarche qualité, formation des artisans sur la fabrication et la réparation des machines introduites

- Volet transformation: appui à l'installation d'unités de transformation semi industrielles dans des villages centres pour augmenter l'absorption des produits au niveau local et créer des emplois.
- Volet intermédiation financière: pour permettre aux acteurs d'accéder à des crédits pour financer les activités de stockage, de transformation et de commercialisation.
- Volet intermédiation commerciale: mise en relation des unités de transformation avec les gros acheteurs pour l'écoulement des produits, développer l'export des arachides et des produits arachidiers par les petites unités villageoises.

Pour la tomate:

- Région de Thiès appui à l'installation d'unité de transformation semi industrielle (séchage) dans des villages centres pour augmenter l'absorption des produits au niveau local et créer des emplois et de chambres froides dans les zones à forte production (Thiès, Saint Louis et louga).
- Région de Saint Louis : Développer la transformation primaire par les unions de producteurs de tomates industrielle.

Pour le manioc région de Thiès : valoriser la culture du manioc en améliorant les techniques de production, en installant dans les zones de production des entreprises de transformation qui n'existent pas au Sénégal. Ces entreprise peuvent appartenir aux producteurs qui seront des actionnaires et seront les principaux fournisseurs en matières premières dans la région de Thiès surtout dans le département de tivaoune.

What are the technology-specific intervention opportunities by specific crop and geographic area?

- Technologie arachide: batteuse arachide, décortiqueuses motorisées, unité de transformation semis industrielle, construction de magasins de stockage, table de détoxification avec attapulgite, machine à torréfaction et moulin arachide, emballage adéquats.
- Manioc amélioration des techniques de production, installation d'usine de transformation avec des séchoirs solaires, introduction de technologie qui a marché dans un pays voisin, diversification des produits transformés.
- Tomate : séchoirs solaires, chambres froides dans le zones à forte production, unité de transformation semis industrielle dans les zones à forte production, amélioration des emballages de produits transformés.

Expert & Stakeholder Workshop

Dates: 22 et 23 avril 2014

Place: Dakar

Address:

Number of Attendance:

Main Findings

- Négocier et fixer les prix avant le démarrage de chaque campagne notamment pour l'arachide ;
- Faire en sorte que le système de calcul sur l'abattement soit plus fiable ;
- Evaluer les pertes en valeur monétaire plutôt qu'en pourcentage pour utiliser un système adéquat pour évaluer les pertes post récolte ;
- Faire d'avantage de recherches portées sur les denrées négligées et très périssables comme les racines et tubercules ;
- Préparer les post-récoltes avant les récoltes ;
- Renforcer les équipements
- Augmenter les efforts sur la distribution de bouture de manioc ;
- Mécanisation des processus de transformation du manioc ;
- La communication des produit dérivés du manioc et les plats que l'on peut faire avec le manioc (incité la population à consommer locale) ;
- La recherche des caractéristiques agronomiques des variétés de manioc ;
- Etude de la rentabilité de ce type de farine à base de manioc ;
- Le respect des conditions d'hygiène lors du séchage ;
- L'utilisation des moyens de lutte contre les attaques ;
- Appui financier et techniques des petits producteurs.
- Transférer les industries de tomate vers la zone de production ou à défaut y transférer les opérations de transformation primaire pour réduire les pertes en poids.
- Lutter contre l'importation de matière première préalable aux concentrés de tomate par les usines basées à Dakar réduit les prix aux producteurs et les besoins en matière premières.
- Mettre en place des entrepôts de stockage à température contrôlée (10-15°C) pour une conservation plus long de la tomate.
- La plupart des consommateurs méconnaissent les dangers toxiques liés à l'aflatoxine il est importer de communiquer sur les causes des infestation et les moyens de luttre contre l'aflatoxine.

- Développer des souches d'Aspergillus qui ne sécrètent pas d'aflatoxine pour occuper les sites d'infection de l'arachide.
- Développer le produit Aflasafe pour réduire les contaminations d'Aflatoxine avant récolte.
- Inciter l'ITA à mettre un produit à l'image de Aflasafe pour réduire la contamination post-récolte.
- Démultiplier les tables de trituration des l'huiles avec détoxification « seggal » à travers les zones de production du bassin arachidier (région de Thiès, Diourbel, Fatick , Kaolack et Kaffrine).
- Beaucoup de produits dérivés peuvent être tirés des graines d'arachides (huile, pâte d'arachide, savon, gâteaux, poudre, tourteaux…). Les coques, feuilles et tiges servent au fourrage et d'énergie pour la cuisson, il est important de valoriser ses utilisations.
- Respecter les normes pour l'abattage après récolte (48h) et éviter le séchage au soleil de longue durée des tomates récoltées.
- Pousser les producteurs à vendre les produits semi-finis de l'arachide plutôt que la matière première.
- Le séchage de l'huile au soleil peut réduire le taux d'aflatoxine mais entraine une réaction de peroxydation qui peut avoir des effets cancérigènes éviter de mettre les bouteilles d'huile d'arachide sous le soleil.
- L'état doit promouvoir des unités de transformation de l'arachide dans les communautés rurales pour faciliter la commercialisation et militer pour les activités de commercialisation.

Conclusions

Sub-Questions

What is the process from awareness to behavior change

Dans ce processus on peut noter la mise en place d'équipements de démonstration sur les technologies de lutte contre les pertes post récoltes, la sensibilisation sur l'impacts de ces portes, le plaidoyer pour meilleure intégration du post récolte dans les politiques mais aussi dans les actions des projet et programmes. Ce processus de sensibilisation doit se faire non seulement au niveau des ménages mais aussi au niveau des organisations des producteurs.

What cultural and environmental factors might be important?

Il faut tenir compte de l'existences des industrielles qui sont se installées depuis plusieurs années et qui interviennent sur certaines filières comme l'arachide, la tomate industrielle. sensibiliser les consommateurs sur la consommation des produits locaux. Tenir compte de niveau technique en milieu rural et de la répartition culturelle des travaux par sexe. Il est aussi important de bien analyser les circuits de commercialisation mis en place dans certains filières comme le riz et s'y référer.

Are there any gender differences in the process from awareness to behavior change?

Oui dans des pays comme le Sénégal les travaux et les responsabilités dépendent des sexes, le genre doit être intégré dans le processus de sensibilisation : les femmes gèrent le plus souvent les unités de

transformation ainsi la sensibilisions à travers la valorisation des produits locaux par leur transformation doit surtout cibler les femmes. Par contre les magasins de stockage sont souvent gérés par les hommes, ainsi les sensibilisation sur les pertes lors du stockage des récoltes et la diffusion de technologies pour lutter contre ces pertes doit êtres orientée vers les hommes

What are the gender issues to consider in technology design, adoption, and up-scaling?

La répartition des travaux par sexes, la répartition des responsabilité par sexe dans les ménages mais aussi dans les OP, le niveau des revenus par sexes, les niveau d'étude par sexe, la répartition des moyens de production par sexe.

What are creative ways to encourage waste and spoilage reduction behavior changes?

L arachide

- Vulgarisation des batteuses d'arachide ;
- Vulgarisation des luttes contre l'aflatoxine ;
- construction de magasins de stockage répondant aux normes
- Promotion (plaidoyer) de la production d'huile d'arachide avec des unités semis industrielles
- Amélioration de la présentation des produits transformés (emballages),
- Appui à l'installation d'unités de production d'emballage dans des zones à forte production
- Promotion de la détoxification avec la table à attapulgite

Pour la tomate

- Introduire la transformation primaire au niveau des organisations des producteurs ;
- Diversifier les recettes des produits transformés ;
- Améliorer la planification de la production en la callant avec les capacités des industrielles
- Amélioration des emballages utilisés
- Aménagement de zones de stockage des produits transformés adéquats

Pour le manioc

- Installer des unités de transformation dans les zones à forte production ;
- Financer la recherche action sur la mécanisation de la récolte ;
- Appui la mise en place de zones de commercialisation des produits transformés ;
- Amélioration de la présentation des produits transformés (emballage).

To what extent do waste and spoilage levels for a particular crop influence farmers' decision to cultivate it or not?

Les pertes notées au niveau de la tomate poussent certains producteurs à modifier leur programme cultural en remplaçant cette spéculation par d'autres.

Do the income/production levels of SHF influence their waste and spoilage reduction practices?

Les producteur de tomate industrielle subissent de pertes élevés au niveau des parcelles entre la maturité et la collecte par les industrielle. C'est perte selon eux peut dépasser 30 % de la production attendus.

Pour les producteurs de manioc, les pertes sont assez importantes mais ne constituent pas de menaces pour eux.

Le volume important d'arachides produit empêche aux producteurs de voir l'ampleur des pertes post récoltes et ils disent souvent que ces pertes sont supportables.

What are the primary areas for training/knowledge for helping farmers avoid pre-harvest produce losses in both quality and quantity?

Formation sur les techniques de stockage et d'inspection : lutte contre les ravageurs, technique de désinfection, aération, pratique du contrôle.

Formation sur la transformation des produits agricoles : nouveaux recettes, démarche qualité, labellisation, stockage après transformation.

Formation sur les techniques commerciales : recherche de marché, négociation commercial, contractualisation.

Formation sur l'utilisation de certaines technologies relatives à la transformation.

Formation en gestion et en gouvernance des responsables des OP

Formation sur la conservation des produits transformés.

Are farmer organizations aware of and do they appreciate the magnitude of postharvest losses' effects on their incomes? How can they best be mobilized and what new capabilities are required

Il sera important de passer par les organisation des producteurs pour mener les activités de sensibilisation et de démonstration de certaines technologies. Les unités de transformation pour réduire la détérioration des produits peuvent être gérés par les organisation des producteurs aussi. Ainsi dans les OP ou les faitière des personnes seront choisies comme animateurs et seront formées en conséquence.

What intervention points in the crop value chains will yield the best results (quantity and quality) in waste and spoilage reduction?

L'intervention doit commencer depuis la récolte pour certaines cultures comme l'arachide en appuyant la diffusion de batteuse d'arachide, en introduisant des machines utilisées dans d'autres pays pour récolter le manioc ;

La construction de magasins de stockage doit aussi faire partir des priorités

Dans les zones de production en fonction des cultures dominantes des unités de transformation doivent être installées avec des équipements de qualité ;

La labellisation pour l'amélioration de la qualité des produits ;

Appuyer à la disposition d'unités de fabrication d'emballages qui augmentent souvent les coûts de production des unités de transformation ;

Construction de points de ventes dans les grandes villes ;

Il sera important d'appuyer les unité dans la mise en relation avec les marchés potentiels par une intermédiation commerciale.

What technologies best provide opportunities for SHFs, especially women, to engage in waste and spoilage reduction?

Les technologies relatives à la transformation touchent plus les femmes: séchage de tomate, et autres produits à base de tomate, transformation du manioc (granulé, athiéké, panification, poudre de manioc), production d'huile d'arachide avec des presses motorisée, détoxification des huiles avec la table à attapulgite, torréfaction d'arachide, production de poudre d'arachide.

Hot Spot Analysis for Senegal

Arachide Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological Maturity	Infestation des gousses avec l'aflatoxine attaques des termites	Respecter l'itinéraire technique vulgarisé réduction du temps de séchage	les conseils sur l'itinéraire techniques sont fournis par les agents des structures de vulgarisation	Souvent le respect des conseils fournis par les agents de vulgarisation ne sont pas respectés	l'itinéraire technique recommandé par la recherche est peut respecter	NA	sensibilisation sur les pertes entre la maturité et la récolte
Harvesting	Perte des gousses avec la machines : gousses restent sous terre	récolte dès la maturité des cultures ne pas attendre que la terre soit trop sèche	les conseils sur l'itinéraire techniques sont fournis par les agents des structures de vulgarisation	technologies abordable ne nécessitant pas de coûts mais non respectée	technologie peut utilisée les producteurs récolte d'abord les céréale avant l'arachide	NA	appuyer les structure de vulgarisation dans des manuel de formation sur les techniques de récolte
Field drying (when applicable)	les termite cause des pertes la qualité est détériorée avec l'infestation de l'aflatoxine	limité le temps de séchage utilisation de batteuse d'arachide	la réduction du temps de séchage est une technologie accessible la batteuse n'est pas encore vulgarisée	la réduction du temps de séchage est confrontée aux activités menées pendant cette période (récolte des céréales) le coût de la batteuse peut être élevé pour	technologie connue par les producteur Technologie(batteuse) non encore vulgarisée	NA	sensibilisation des production sur les risques d'infestation pendant le séchage appuyer la reproduction et la diffusion de la batteuse d'arachide

				les producteurs			
Platform drying (when applicable)	NA						
Threshing/shelling (when applicable)	les battons utilisés entrainent la cassure des gousses	Battre la fane avec précaution utiliser la batteuse d'arachide	le battage manuel est connu et pratiqué dans toutes les zones de production la batteuse n'est pas encore diffusée en milieu rural	le battage manuel est partout utilisé la machine à battage n'est accessible pas aux producteurs	le battage manuel est bien adopté par les producteur la batteuse d'arachide n'est pas vulgarisée en milieu paysan	NA	appuyer la reproduction et la diffusion de la batteuse d'arachide
Winnowing (when applicable)	le vannage manuel sous l'effet du vent entraine la perte des gousses légères	Utiliser la batteuse d'arachide qui fait en même temps le vannage et le calibrage	Technologie pas du tout accessible	cette technologie peu ne pas être abordable pour les producteurs à cause du prix de la machine	Non encore adoptée	Elle va faciliter le travail des femmes qui assurent souvent le vannage	appuyer la reproduction et la diffusion de la batteuse d'arachide
Transport to packing shed	Pas de pertes Durant le transport ou pertes très faibles	les charrettes sont utilisée pour le transport et ne causent pas de problèmes	pratiquée par tous les producteurs	les charrettes sont disponibles dans tous les village les producteurs qui n'en disposent pas peut emprunter à leurs voisins	cette pratiqué est utilisée par tous les producteurs	NA	appuyer le renouvellement de certains matériels agricoles comme les charrettes
Storage at the farm	Pertes dues aux	construction de	les quelques	Le coût d'un	le stockage dans des	NA	Construction de

level	attaques et aux rongeurs	magasins de stockage adéquats formation sur les techniques de stockage	magasins existants ne sont toujours pas disponibles	bon magasin est élevé pour un petit producteur	magasins adéquat est connu mais non pratiqué les bonnes pratiques de stockage sont méconnues		magasins de stockage, réfection des magasins en mauvais état formation des producteurs sur les techniques de stockage
Grading and sorting	NA					NA	
Off-Farm							
Handling and transport to first receiver	pertes faibles	utilisation de camions pour le transport	cette pratiques est accessible car les industrielles contractualisent avec les transporteurs	le coût est supporté par les industrielles et les collecteurs	utilisée dans toutes les zones de production	NA	
Storage and handling at the trader level	attaque des gousses pendant le stockage	traiter les gousses avant l'arrivée dans l'unité de stockage	produits pour faire les traitement disponible	les produits utilisés sont peut coûteux et la technologie est simple	Le traitement pendant la collecte n'est pas pratiqué		ne pas stocker les gousses pendant longtemps dans les points de collecte former les producteurs sur la protection des denrées
Processing (when applicable)	faible rendement des machine manuel l'absence de détoxification limite la qualité des produits	utiliser des machines motorisées utiliser la tables de détoxification	les machines à presse d'arachide motorisé existent au Sénégal ; la tables est aussi disponibles	la faible accès au crédit limite l'accès à ces machines	la technologie commence à être utilisée dans certaines zones du bassins arachidier	elle permet aux femmes de mener des activité génératrices de revenus	appuyer la diffusion des machines motorisé et de la tables de détoxification
Downstream storage (when applicable)	les mauvaise condition de stockage entraine une détérioration des	installer des unités de stockage des	Technologies techniquement accessibles	Cette technologie demande des	Très peut d'unités de transformation dispose de magasins	cette technologie va	appuyer la construction de zone de stockage dans les unités de

	produits	produits transformés		moyens financiers et techniques	de stockage répondant aux normes	permettre aux femmes d'augmenter leur revenus	transformation formation sur la démarche qualité
Distribution to retailers	le produits est peu connu ou non apprécié par les consommateurs	Construction de points de ventes des produits transformé	Accessible mais demande un coût	le coût des points de vente ne sera pas très élevé	technologie faiblement pratiquée	permet l'augmentation des revenus des vendeuses	appuyer la construction de points de ventes dans les grandes villes gérées par des OP locale femmes

Tomate Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological Maturity	maladies avec la chaleur collecte tardive des tomates par les industrielles	Bon calage de la production avec la période favorable respect du planning de production définis avec les industrielles Transformation primaire	les producteurs connaissent souvent les techniques de production la planification est fait en collaboration avec les représentants des producteurs	ces pratiques sont très abordables et ne nécessitent pas souvent de coûts les unités de transformation primaires sont couteux	malgré les efforts le planning n'es pas respecter par les producteurs la transformation primaire n'est pas pratique	la transformation primaire peut créer des emplois pour les femmes	utiliser des variétés résistantes appuyer les producteurs à bien planifier la production en tenant compte du climat
Harvesting	dégradation physique pendant la manipulation des cageots dégradation des tomate avec la chaleur	récolter pendant les périodes fraiches de la journée	technologies très accessibles	technologies abordable ne nécessitant de pas de coût mais non	certains producteurs respectent ces pratiquent	NA	formation et sensibilisation sur l'hygiène et la qualité pendant la récolte

				respectée			
Field drying (when applicable)	NA					NA	
Platform drying (when applicable)	NA						
Threshing/shelling (when applicable)	NA					NA	
Winnowing (when applicable)	NA						
Transport to packing shed	déshydratation entrainant une perte des poids	pour la tomate industrielle faire la transformation primaire sur place dans les villages	Cette technologies n'est pas encore accessible la transformation primaire se fait des les industries	l'installation d'unité de transformatio n primaire demande des moyens financiers et techniques importants	Technologie non pratiquée	Cette technologie va permettre la création d'emplois pour les femmes	appuyer l'installation d'unité de transformation à coté des zones de production pour limiter le temps du transport
Storage at the farm level	NA	NA				NA	
Grading and sorting	NA						
Off-Farm							
Handling and transport to first receiver	Perte de poids par déshydratation les tris entraine la baisses des poids	pour la tomate industrielle le transport est assuré par les industrielles récolter pendant le moment idéale	les transport par camion est disponible car il existent des transporteurs avec qui les industrielles contractualisent	le coût du transport est supporté par les industrielles	utilisée partout	NA	appuyer l'installation d'unité de transformation à coté des zones de production pour limiter le temps du transport
Storage and handling at the trader level	NA	NA					

Processing (when applicable)	Sous l'effet du vent on note des pertes pendant le séchage des tomate	utilisation de séchoir solaires	technologies peut accessible présentement pour les petites unités de transformation	Cette technologie demande des moyens financiers et techniques	non adopté pour le moment	cette technologie va permettre aux femmes d'augmente r leur revenus	appuyer l'équipement des unités de transformation semi industrielles renforcement de capacité du personnel des unités de transformation
Downstream storage (when applicable)	les mauvaise condition de stockage entraine une détérioration des produits	installer des unités de stockage des produits transformés	Technologies techniquement accessibles	Cette technologie demande des moyens financiers et techniques important	Très peut d'unités de transformation disposent de zones de stockage répondant aux normes	cette technologie va permettre aux femmes d'augmente r leur revenus	appuyer la construction de zone de stockage dans les unités de transformation formation sur la démarche qualité
Distribution to retailers	NA	NA					

Manioc Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
On-Farm							
Physiological Maturity	NA						
Harvesting	arrachage manuel entraine la cassure des tubercules	Introduire des machines de récolte	pour le manioc ils n'existent pas pour le moment des machines de récolte	technologie non connue	technologie non utilisé	NA	importer dans la zone des technologies utilisées pour la récolte du manioc
Field drying (when	NA					NA	

applicable)							
Platform drying (when applicable)	NA						
Threshing/shelling (when applicable)	NA					NA	
Winnowing (when applicable)	NA						
Transport to packing shed	déshydratation entrainant une perte des poids	limiter la durée du transport	le moyens de transport sont souvent disponibles au niveau des villages	les charrette utlisées sont disponible dans les village. Si le producteurs n'en disposent , son voisin peut lui en prêter ou louer	d'habitude les producteurs transportent directement dans le marché	NA	installer des unités de transformation dans les zones de production pour limiter le transport des récoltes
Storage at the farm level	NA					NA	
Grading and sorting	NA						
Off-Farm							
Handling and transport to first receiver	NA						
Storage and handling at the trader level	NA	NA					
Processing (when applicable)	Sous l'effet du vent on note des pertes pendant le séchage du manioc	utilisation de séchoir solaires	technologies peut accessible présentement pour les petites	Cette technologie demande des moyens	technologies non adoptée pour le moment	cette technologie va permettre	appuyer l'équipement des unités de transformation semi industrielles

			unités de transformation	financiers et techniques importants		aux femmes d'augmente r leur revenus	renforcement de capacité du personnel des unités de transformation
Downstream storage (when applicable)	les mauvaise condition de stockage entraine une détérioration des produits	installer des unités de stockage des produits transformés	Technologies techniquement accessibles	Cette technologie demande des moyens financiers et techniques importants	Très peut d'unités de transformation disposent de zones de stockage répondant aux normes	cette technologie va permettre aux femmes d'augmente r leur revenus	appuyer la construction de zone de stockage dans les unités de transformation formation sur la démarche qualité
Distribution to retailers	le produits est peu connu ou non apprécié par les consommateurs	Construction de points de ventes des produits transformé	Accessible mais demande un coût	le coût des points de vente ne sera pas très élevé	technologie faiblement pratiquée	permet l'augmentat ion des revenus des vendeuses	appuyer la construction de points de ventes dans les grandes villes gérées par des OP locale femmes

Contact List

No.	Name	Affiliation	Position
1	Momar Talla GUEYE	ITA	Conseiller scientifique et Technique du Directeur Général
2	Ibrahima SARR	ISRA	Chercheur en Entomologie
3	Malick Mboji	ISRA	Machiniste
4	Diomaye DIOUF	DRDR Fatick	Responsable Génie Rural
5	Mbaye MBOW	ANCAR	Directeur Technique
6	Arthyr DASSYLVA	ASPRODEB	Responsable semences
7	Youga NIANG	CDH	Chargé de Recherche
8	Falilou Faye	DRDR Kaolack	Directeur
9	Laïty DIOP	DRDR Kaolack	Responsable semences
10	Elhadji NDIAYE	GIE unité de décorticage Kaolack	Responsable Technique
11	Doudou Lo	utilité de décorticage Kaolack	Membre
12	Elhadji BITEYE	utilité de décorticage Kaolack	responsable machine à presse
13	Fatou oumar NIASS	GIPA	Gérante
14	Ramatoulaye NIASS	GIPA	Présidente
15	Mame Fatou SOW	GIPA	Commissaire au compte
16	Fatou Penda NIASS	GIPA	trésorière
17	Ibrahima NDIAYE	Transformateur	Responsable de l'unité
18	Assane NDIAYE	Interprofessionnel du manioc	Président
19	Abdou Aziz GUEYE	COPROMAT Taïba Mbaye	Trésorier
20	Ablaye LO	COPROMAT Taïba Mbaye	Président
21	Abibou FALL	COPROMAT darou Khoudoss	Président
22	Ibrahima DIOUF	COPROMAT Méouane	Président
23	Modou FALL	Fédération des producteurs	Tivaoune
24	Assane GUEYE	Agrecol Afrique	Coordinateur
25	Maguette DIOP	transformatrice manioc Tivaoune	Gérante
26	Doudou NGOM	Zénith Fatick	Gérant unité de transformation
27	Amadou DEM	Unité de transformation Fatick	Propriétaire de l'unité de transformation
28	Ndeye Fatim FALL	REFABEC Thiès	Présidente
29	Ndeye Sira DIOP	REFABEC Thiès	Gérante
30	Fatou BOCOUM	REFABEC Thiès	Présidente club foire
31	Awa Ndiaye	REFABEC Thiès	Secrétaire
32	Amy DIALLO	REFABEC Thiès	Trésorière générale
33	Awa THIANDOUM	REFABEC Thiès	Gérante

34	Mame Seynabou KANDJI	REFABEC Thiès	Vice présidente
35	Kiné BA	REFABEC Thiès	Membre
36	Aïssatou NDIAYE	REFABEC Thiès	Membre
37	Secour SARR	ENDA Energie-Environnement-Développement	Directeur
38	Ibrahima NIASS	CCPA	Président
39	Gora DIALLO	URCAD (Diourbel)	Directeur Adjoint
40	Fatou SOW	Unité de transformation Sope Sérigne Saliou de Diourbel	Présidente
41	Diaga CISSE	Centre de formation ITA	Président
42	Mr DIALLO	Chambre de métier de Fatick	Sécréaire Général
43	Mamandou SONKHO	NOVASEN (COPEOL) Kaolack	technicien
44	Abdoulaye SY	ANCAR Kaolack	Directeur zonal
45	Maguette DIOP	Transformatrice manioc Tivaoune	Gérante unité de transformation
46	Modou FALL	Fédération des producteurs de Tivaoune	Président
47	Abdou Aziz Gueye	coopérative des producteurs de Manioc de Taîba Ndiaye (région de Thiès	Trésorier
48	Abdoulaye Dieng	Comité tomate	Président
49	Mamadou DIOP	SAED Saint Louis	Chargé de programme tomate
50	Ivan Barry	SOCAS	
51	Awa NIAKH CHEIKH THIAW	SAED	ingénieur agronome à la SAED
52	PAPA M DIEDIOU	Université de Saint Louis	Enseignant chercheur
53	MAMBAYE DIOP		Vice président
54	IBRAHIMA DEME	URDA Diourbel	Coordonateur URCAD
55	EMMANUEL SENGOR	CERESS Locustox	Responsable essais
56	YERO POULO BA	CCPA	Coordonateur CCPA
57	MAGUETE NIASSE	Direction de l'Agriculture	Technicien horticole
58	FATOU S BAKHOUM	AGROSEN	Assistante de direction
59	ALIOUNE DIALLO	ANCAR Vallée du Fleuve	Directeur
60	NGOLO DIARRA	DAPSA	Ingénieur Agronome
61	YOUNOUSSE DIALLO	ITA	Assistant recherche
62	BABACAR BEYE	ITA	Chef du laboratoire
63	TAMSIR DIAW	DRDR Thiès	Chargé des études et contrôles
64	Seynabou TOURE LAYE	Ministère de l'Agriculture et de	Conseiller Technique

		l'Equipement Rural	
65	Souleymane DIENG	ENSA de Thiès	Technicien Labo
66	Papa Samba DIAO	Sarah Consulting	Directeur
67	Matar SYLLA	PNB-SN	Coordinateur
68	Ousmane SY	CNRA Bambey	Chercheur/mil
69	Abi CAMARA	ENSA Thiès	Enseignant chercheur
70	Tacko Diawara	DRDR de Saint Louis	Directrice
71	Françi Bouba	Consultant	Consultant
72	Saïd COLY	Fonds National de Developpement Agro-Sylvo-Pastoral	Responsable Suivi évaluation

Country Annex for Tanzania

- Dates traveled: March 18 to April 7, 2014
- Main growing regions visited: Mbeya/Mbalizi (onions, maize, beans), Morogoro (maize, beans), Arusha/Mang'ula (onions, green beans)
- Interesting quote(s):
  - Garlic farmers from Ntangano Village, Ijombe Ward, Mbeya expect losses of one to five bags per acre resulting in a potential harvest of sixteen 100-kg bags. They must harvest prematurely when the market prices are higher in order to pay for school fees, medical bills and other necessities. "We know we lose produce, but what other options do we have?"
  - A female onion farmer in Mang'ula quoted, "We have one market – traders. Traders put downward pressure on prices. We have to accept their prices. What else can we do?"
  - Bean farmers from Iwindi Village, Mbalizi hire day laborers to add to the insufficient community labor available; however, the quality of laborers' work is low, as they do not have an incentive to work carefully and reduce loss. In regards to threshing, one farmer provided their solution to reduce loss: "When we thresh the beans fly away. That is why we start slowly."

Figure 8: Bean Threshing, Mbeya

Figure 6: Maize Drying

Figure 7: Onion and Maize Storage, Mang'ula

Objective 1: Prioritization

Key Questions

How aware of losses are smallholder farmers involved in the selected value chains? Which types worry them the most and why?

Overall, farmers are aware of losses that occur during post-harvest activities and are operating as optimally as they can with what little they have and with what they can control.

Maize

In all regions, farmers are concerned with losses at harvest which are due to rotting as well as pest and rodent infestation in the fields. Drying, threshing and winnowing are also primary concerns for maize farmers as these three stages can account for 10 to 15 per cent in volume losses alone. This does not account for the quality losses that occur as kernels becomes damaged when farmers thresh maize by hand or by beating maize cobs in bags with sticks. Home storage also creates problems for the smallholder famer as losses in this stage can sometimes reach up to 50 per cent due to pests, rodents and rotting if pesticides and rodenticides are not properly administered and if maize is not properly dried before storage.

Beans

Losses start at harvest as some beans have already rotted on the stalk. Rotting occurs when there is too much rainfall and pods have been compromised due to insects eating through the pods creating holes for rainwater to seep in. Collection in the field poses losses for farmers as bean stalks are fully uprooted and then tossed on the ground. When pods are dry, they can fall off the stalk and are not collected. Harvest and collection can account for up to 10 per cent in losses. Threshing by sticks can cause losses as well as beans can “jump” out of the pod and “fly away”. Additionally, not all pods open during threshing and farmers do not hand-thresh pods which remain intact during threshing.

Onions

Like maize and bean farmers, losses for onions begin at harvesting as onions are sometimes harvested prematurely or if there is too much rain onions can rot while in the ground. Onions are harvested by pulling the onion leaves from the ground by hand. In the process, the leaves often break off leaving the bulb in the ground. The hoes that farmers have are not adequate for extracting these bulbs unscathed. Storage is another problem as onions that are not dried properly can rot with losses averaging usually around 30 per cent but can be as high as 100 per cent. For onion famers in Mang’ula – a remote village in northern Tanzania – their only market is traders so the prices they receive for their onion is very low as the traders put downward pressure on prices knowing that they are the only market for Mang’ul farmers.

What are they currently doing to prevent or mitigate those problems and what else would they like to do?

Currently

For maize growers in Morogoro near Sokoine University, they are able to use the University's threshing/winnowing machine that rotates to the surrounding villages in accordance with harvest times. Maize farmers in Mbeya do not have this opportunity.

For beans, to minimize threshing losses farmers will beat piles of dried beans with sticks slowly at first so the beans don't "jump' too far away. Other than that, no interventions/procedures employed to mitigate PHL. At harvest, farmers will uproot beans in early morning when there is still dew around so there is greater chance that the pods will not fall off the stalks when stalk is fully uprooted as the beans as still "moist".

For onions in Mbeya, try to plant onions at different times throughout year to hedge risk of environmental threats. These farmers also try to save money when they can for times when yields are lean. Mang'ula farmers do not have interventions or training in PH management.

What farmers would like to do

For maize, famers would like to have machines for threshing/winnowing located in field. Not only does the machine thresh and winnow faster than the traditional methods of threshing – done by placing cobs in bag and then beating bag with sticks until kernels pop out or by hand using a knife to pry the kernels off the cob – but it ensures that the quality is higher. Traditional threshing methods can damage kernels and thus reduce the quality and price at marketplace. Maize farmers in Mbeya would like to have secured drying and storage facilities but both these structures are cost prohibitive for the small holder farmer. A brick drying structure – without roof – would cost roughly 1.2 million TZS to build. A proper storage facility would be 1.7 million TZS.

For beans, farmers would like to have a plastic bin/tub that can be used to place beans in after being uprooted from ground. Currently beans are uprooted and then placed directly on the ground causing some pods to roll away. It is not in the interest of the farmer to pick up these beans. Main losses occur during traditional threshing as beans are beaten with sticks to open pods. Beans "jump" and escape farmers and some are damaged in process. Also, some pods don't open so beans are stuck inside. Farmers would like better technology for threshing. There are bean threshing machines but the farmers that I spoke to were not aware of this technology. Washington State University has converted a chipper-mulcher into a bean thresher.2

For onions, farmers in Mang'ula would like to have post-harvest education from extension officers. To deal with traders, the farmers would like to have some training in how to better negotiate with traders so they can receive more for their produce. Ultimately, Mang'ula farmers want direct access to a market but this will require better roads.

[2] http://agsyst.wsu.edu/NicheMarket/SmallScaleHarvesting.html.

What attitudinal and capacity factors inhibit greater awareness or action?

Farmers act as efficiently as they can with what they have and the training they have received/best practices they know. They may not always be cognizant of post-harvest losses but their behavior is not to create more losses.

Farmers frequently mentioned that extension officers are only concerned and trained in agronomy/production/inputs. Very little is done to combat post-harvest losses and thus farmers do not receive this training. There are known technological innovations that could benefit smallholder farmers – such as machine threshers and small-scale metal silos for home storage – but these are too expensive for the smallholder farmer. In addition, better infrastructure and roads could help remote farmers such as the ones in Mang'ula access new markets which could potentially raise their incomes.

What are the main considerations smallholders have in deciding whether and how to act to reduce waste and spoilage along selected value chains?

Farmers act with what they have and with what they can do. They are already acting at close to optimal levels. Farmers are not intentionally trying to create more losses. The losses that occur for the smallholder farmer are generally beyond their control.

What types of intervention and/or support (e.g., financial or technical) and/or incentives would stimulate further action?

As noted above, a lot of investment has been put into production/inputs/agronomy but PHL has been under-addressed in Tanzania. It is politically "sexy" for politicians to talk about increasing production but discussion on reducing post-harvest losses is not. This is where attitudinal change should occur.

RAVInvest[3] is currently working in Tanzania to provide lockable metal silos for storage at the home for the smallholder farmer. Depending on size, the silo would cost between $150 and $200 and would be built in the village. The problem is funding. Mr. Ueli Scheuermeier, Director of RAVI, states that approximately a $1 million grant would be needed to kick-start the activity. The silos would provide the smallholder farmer with a secure and loss-free storage facility for maize, beans, onions, etc. This would allow the smallholder farmer to wait for market prices to increase for the stored commodity and to capitalize on the higher price. The metal silos could be commercially viable if structured so that the farmer must pay a little each season to pay off the silo. With higher prices fetched at the market place, the farmer would have more money to do so. Metal silos have already been introduced in Latin America and have been extremely successful in bettering the lives of the smallholder farmer and strengthening the food security of the region.

[3] http://ravinvest.biz.

Objective 2: Identification of Key Interventions

Key Questions

What are the country-specific intervention opportunities, by specific crop and geographic area?

For maize farmers in Tanzania, interventions would be most helpful during drying, threshing, winnowing and storage. For drying in Mbeya, farmers lamented that rodents, pests, termites and even children who like to play with the maize cob are a threat during the home drying stage. A drying structure could be built to reduce these threats but is cost prohibitive to the smallholder farmer as it would be too expensive at roughly 1.2 million TZS. Mbeya maize farmers also desired a communal storage facility but again such structure would be too costly – 1.7 million TZS. Maize farmers in both Mbeya and Morogoro desired machines that could both thresh and winnow maize as this would significantly reduce quantity losses (i.e. fewer broken kernels versus traditional maize threshing methods) and increase quality.

For bean farmers, harvesting and collection are areas that experience losses. Although some harvesting is outside the control of the smallholder farmer – such as too much rain, which can cause rotting – the proper application of pesticides during cultivation could reduce the susceptibility of the crop to pests. For collection purposes, farmers wanted collection bins to put the uprooted bean stalks in after harvest in order to prevent bean pods from falling off and thus not being collected. Bean farmers in Morogoro would like to see a threshing structure built in order to prevent beans from "flying away" as well as training on better threshing practices in order to reduce damage to beans. Bean farmers in both Mbeya and Morogoro were unaware of bean threshing machines.

For onion farmers, harvesting was a crucial point of loss for farmers in Mbeya as onions are often harvested prematurely in order for farmers to pay bills such as school fees, input loans, medical bills, etc. In addition, harvesting techniques are not as optimal as they could be in Mang'ula as farmers are using hoes which are not ideal for retrieving bulbs that remain in the ground. Storage is a problem throughout the country as onions require proper ventilation and cool temperatures to ward off rotting. At the time of this report, Tanzania only has three cold-storage packhouses. To put this in perspective, Kenya has over 600 cold-storage packhouses.

For all crops, farmers are hurt by the lack of formal property rights and access to credit. Farmers often have to sell the majority of their crop at harvest time in order to pay household expenses. . Farmers' homes and stored commodities at the household are accepted as collateral for bridge loans. In theory, a farmer could hold onto his/her crop longer in order to wait for market prices to go up as prices at harvest plummet due to excess supply at the market. For maize, beans and onions, off-season prices are 100 to 200 per cent higher than the prices at harvest.

Market access can also be a problem for farmers as discovered in the visit to the Mang'ula onion farmers. Traders, who serve as the only market for farmers in remote areas, can put downward pressure on prices and the farmer is left with little to no recourse.

What are the technology-specific intervention opportunities by specific crop and geographic area?

For maize, the greatest technological intervention would be to have motorized threshing and winnowing machines which could rotate from village to village during harvest as done in parts of Morogoro by Sokoine University. This would improve quality and reduce losses of maize.

For beans, although not mentioned by specifically by the smallholder farmers interviewed, perhaps a bean threshing and winnowing machine such as the one created by Washington State would be advantageous for the smallholder farmer. Use of bins could help reduce losses during harvesting/collection phase.

For onions, passive and charcoal cooler rooms are needed which could store onions for 6 months as proper ventilation is needed for onion storage. Without proper storage, famers have to sell onions in a matter of days to avoid spoilage. Very few farmers have access to proper storage facilities. Better roads that could link the Mang'ula farmers to the marketplace would increase their incomes and marketing prowess.

Expert & Stakeholder Workshop

Dates: April 3 and 4, 2014

Place: Coral Beach Hotel

Address: Coral Lane, Masaki, Msasani Peninsula, Dar Es Salaam, 2585, Tanzania

Number of Attendance: 13 both days. Participants were from Agricultural Research Institutes, Universities, Donor Projects, Ministry of Agriculture and Food Security, Other Government Offices

Main Findings

There are considerable and significant post-harvest losses for Tanzania farmers in maize, beans and onions. However, much focus – especially from the government of Tanzania – has been focused on boosting production and yields while activities to reduce PHL are overlooked. Smallholder farmers are negatively affected by PHL attributed to diseases, insects, pests, poor post-harvest handling, improper storage, lack of market access as well as other farm and off-farm activities. Therefore, trainings on good agricultural practices and proper post-harvest handling of the produce through improved technologies to farmers could be an appropriate way of increasing farmers' income through PHLs reduction.

Several issues were put suggested by participants with regards to better PHL management:

- The coordination of post-harvest intervention should be done by the Government of Tanzania under its Food Security Division, which has a section for post-harvest management.
- The private sector should be involved in providing post-harvest management technology and applications and for development support services for the innovations generated on post-harvest area.

- Data collection systems and infrastructure for agro-produce in Tanzania leaves a lot to be desired. Data is either outdated or not reliable. This adversely affects policy making and planning which in return affects the level of interventions and resources required and/or allocated.
- Development partners should arrange financial support especially to curb cash needs/demand for farmers just after harvest.
- Academia and research community should also be involved in PHL research in order to obtain reliable data and testing of innovations.
- A network of post-harvest experts should be created.
- A National Strategy for PHL mitigation and harmonization should be formulated, complete with plans for/with major stakeholders.

Conclusions

Tanzanian maize, bean and onion farmers are operating at levels that are optimal considering the sizeable number of challenges faced on a day-to-day basis. Strategic interventions along the post-harvest value chain have the potential to result in significantly increased incomes and livelihoods for smallholder farmers. Most notably, effective storage facilities at the home level would allow farmers to preserve their crop for longer and access higher market prices during the offseason. However, post-harvest loss mitigation needs a visible champion to make the Government of Tanzania more aware of the severity of post-harvest losses.

Sub-Questions

What is the process from awareness to behavior change?

Tanzanian farmers are aware of the post-harvest losses but these losses have unfortunately become status quo and essentially a cost of doing business. Behavior change is certainly possible in Tanzania as the farmers were very vocal and specific about what interventions they would like to see implemented to reduce their losses.

The Government of Tanzania needs to become more aware of the significance of post-harvest losses as it has a very limited focus which is to increase yields.

What cultural and environmental factors might be important?

Mainland Tanzania is 99 per cent African of which 95 per cent are Bantu consisting of more than 130 tribes. Tanzania has been remarkably stable over the last two decades as no one tribe possesses too much power.

Environmentally, food loss and waste inflict a host of impacts, including unnecessary greenhouse gas emissions and inefficiently used water and land, which in turn can lead to diminished natural ecosystems and the services they provide.

Are there any gender differences in the process from awareness to behavior change?

Male and female farmers are both aware of the losses and appear open to behavior change. There does not appear to be any difference between male and female farmers.

What are the gender issues to consider in technology design, adoption, and up-scaling?

There does not appear to be any difference between male and female farmers.

What are creative ways to encourage waste and spoilage reduction behavior changes?

Tanzanian farmers seem open to change if it will improve their livelihood. Any intervention activity must clearly incentivize and display the desired behavior change.

To what extent do waste and spoilage levels for a particular crop influence farmers' decision to cultivate it or not?

Waste and spoilage is viewed as an unfortunate cost of doing business.

Do the income/production levels of SHF influence their waste and spoilage reduction practices?

Farmers operate as effectively and efficiently as they can with what limited resources they have at their disposal. Income and production levels do not appear to significantly influence their waste and spoilage reduction practices.

What are the primary areas for training/knowledge for helping farmers avoid pre-harvest produce losses in both quality and quantity?

The primary area to reduce pre-harvest losses would be to correctly train farmers in the application of fertilizers and pesticides. Not all farmers have the correct understanding of when and how much fertilizer and pesticide needs to be administered. In addition, there needs to be some type of quality control in place so that farmers do not purchase expired fertilizers and pesticides which are not as effective.

Are farmer organizations aware of and do they appreciate the magnitude of postharvest losses' effects on their incomes? How can they best be mobilized and what new capabilities are required?

Farmers are aware of the losses but lack the appropriate resources to mitigate them. Losses are perceived just as a part of doing business and depending on the farmer, financial losses resulting from PHL may or may not be of great concern.

What intervention points in the crop value chains will yield the best results (quantity and quality) in waste and spoilage reduction?

Please see Hot Spot Matrices for top 3 intervention points.

What technologies best provide opportunities for SHFs, especially women, to engage in waste and spoilage reduction?

Please see section 3.1.2 as well as hotspot matrix.

Hot Spot Analysis for Tanzania

Maize Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
Drying	• Rats, hens, termites, large grain borer, maize weevil and children are problems	• Use of non-expired pesticides • Improperly used pesticides • Construction of a brick or concrete pen that encloses drying area	• Supply of good pesticides can very season to season • Building a structure is too expensive	• Pesticides are affordable • Building a structure is too expensive. Not the best ROI	• For the SHF, it is more likely to have pesticides	n/a	Ensure that good pesticides are available to farmers and that they farmers know how & when to properly use them
Threshing & Winnowing	• Traditional threshing methods break and damage kernels • Hand threshing takes too long and is only done at the household level	Have mobile threshing/ winnowing machines that can roam from village to village depending on harvest time	Threshing machines are expensive – 1,000,000 TZS	• Too expensive for the small holder farmer or group of SMF without the help of credit	• Ideally want to have threshing/ winnowing machine	n/a	Need access to credit where a group a farmers can repay threshing purchase over time with a reasonable amount of interest
Storage at the farm level	• Rats, pests, maize weevil, birds • Too much moisture leads	• Steel silo • Grain Pro bag • Purdue triple bag • Recycled food	• Steel silos are not readily available in Tanzania at the home level • GP bag and Purdue	• Steel silo would require financing • Farmers choose not to buy GP and Purdue bags as they are more expensive	• Silos last 25 to 40 years • Bags last 2 to 5 years but pests can transfer from	n/a	A lockable steel silo would be the best option but financing is needed to support the up-front costs and allow the SMF to repay over time. RAVInvest is

	to aflatoxin	containers	bag are available • Recycled food containers are available	than traditional bags and are not impervious to rats • Recycled food containers are affordable and can keep out rodents	year to year • Recycled food container can last 3 years		looking to do this

Beans Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
Harvesting & Collection	Uprooting beans and throwing them onto the ground	Have plastic bin where farmers can place uprooted stalks into	Could be purchased at any market	1000 TZS each	Seems to be very easy and plausible	n/a	Could not get a good answer as to why this practice was not already being employed
Threshing & Winnowing	• Beans "fly" from pod and are not retrieved • Pods don't open releasing beans	• Bean threshing machine? • Build room where threshing can occur so beans don't fly away	• Did not come across nor was a bean threshing and winnowing machine mentioned – found it online • Would building a room just for threshing and winnowing really be the best ROI?	• Do not know cost of bean threshing machine • Building a room just for threshing and winnowing may not be practical	Farmers would be open to any intervention that would make their lives easier so the bean threshing/ winnowing machine would be a	n/a	• Determine how much bean threshing/ winnowing machine would be • Would need financing to purchase bean threshing/ winnowing machine
Storage at the farm level	• Too little moisture reduces volume of crop • Too much moisture can	• Ensure that beans are properly dried before storage • Have bags that allow for greater moisture release	Farmers interviewed did not have moisture issues as the bags there were using allowed for moisture to be released	Moisture releasing bags are more expensive than traditional bags	Moisture is a delicate issue. On one hand you don't want to lose too much moisture as you sacrifice volume but on the	n/a	Focus on improving drying techniques so that when beans reach storage stage they are completely dry and farmers do not have to worry about moisture

	cause rotting				other hand too much moisture can rot crop		

Onions Matrix

Intervention Point	Cause(s) of PHL	Solution	Accessibility	Affordability	Adoption	Gender	Recommendations
Harvesting	• Leaves break off • Hoes damage bulbs that remain in ground. thus quality is reduced • Harvesting prematurely in order to cover bills	• Flood field • Have improved tools	• Sometimes water is not always available • Tools and knowledge of how to properly operate may not be available	Proper tools are not much more expensive but in a remote area like Mang'ula, how would they find the tools?	Farmers would accept new tools	n/a	• Provide adequate hoes and training • Irrigated fields are usually reserved for medium to large scale farmers • Need access to bridge loans
Storage	• Too much moisture can cause large amounts of rotting • Storage is not cool nor is there proper ventilation	• Construct proper storage facilities • Have farmers sell onions immediately after harvest	Farmers do not have immediate access to markets in Mang'ula as they must wait for traders to come to them	Who would pay for storage?	Farmers would use improved storage	n/a	• Would need financing to set-up storage facility as well as technical assistance on how to operate it • Donor?
Market access	Mang'ula farmers only	• Have direct access to market	No accessibility to market	• Too expensive to travel to market	Farmers would love to have any type of	n/a	Need a paved road to market which would allow

	have traders to sell to who put downward pressure on prices	• Training to teach farmers how to better negotiate with traders		• Must sell to traders to get anything	secondary market		more than one group of traders to come to Mang'ula

Contact List

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