

# SUMMARY OF RESULTS AND INSIGHTS FROM POST-HARVEST LOSS TECHNOLOGY TESTING IN GUATEMALA

FEED THE FUTURE INNOVATION LAB  
FOR THE REDUCTION OF POST-HARVEST LOSS



KANSAS STATE UNIVERSITY  
UNIVERSITY OF NEBRASKA- LINCOLN  
SHARE GUATEMALA

(Contact: [kazin@humanitasglobal.com](mailto:kazin@humanitasglobal.com) or +1-202-552-3004)

## GUATEMALA'S PATHWAY TO PROGRESS

The Republic of Guatemala, a vibrant, resilient and diverse country, has a rich history and culture, and a long-standing track record of collaboration with international institutions and developing domestic strategies and programs to improve outcomes for its people.

The UNDP's 2016 Human Development Report, which values and ranks 188 countries and UN-recognized territories by achievement in three key dimensions of human development, places Guatemala at 125. The report indicates that while there is still much to accomplish, Guatemala has experienced an increase in its Human Development Index (HDI) value from .47 to .64 between 1990 and 2015, which is a 33.8 percent increase. More concretely, the HDI shows that life expectancy at birth increased by 9.9 years, mean years of schooling increased by 3.2 years, expected years of school increased by 4.2 years and Guatemala GNI per capita increased by approximately 39.5 percent between 1990 and 2015.



Guatemala's leaders, from across sectors, remain committed to tackling both immediate and underlying challenges facing rural and vulnerable communities and are eager to transform the agricultural, food and nutrition landscape. Guatemala's leadership recognizes that the country must reduce drug and gang-related

violence, improve agricultural productivity, combat hunger and malnutrition, improve primary and secondary educational achievement, and tackle the effects of climate change, if sustained and widespread transformation is to be achieved. In addition, there are dedicated and determined efforts by civil society and the private sector that want to deliver the best outcomes possible for the next generation. They recognize that bold steps are required through the right investments, resources and support

The Government has strategies to strengthen the agricultural sector, through agricultural policies, gender, food fortification, and support for family farming, which contribute to the reduction of poverty and hunger, and contribute to food and nutrition security and the development of a better Guatemala. It is a matter of building pathways for proven interventions to flourish, while also implementing approaches and innovations that complement traditional knowledge and existing efforts to prioritize a thriving agricultural sector that can yield sustained progress and prosperity.

## TACKLING AGRICULTURAL, SOCIO-ECONOMIC & NUTRITION CHALLENGES

Guatemala is recognized as a leader in Central America for non-traditional agricultural exports such as snow peas, green beans and fruit, which has contributed to economic growth. Despite this, over half of the population lives in poverty and over half of all children under the age of five are chronically malnourished. In the Western Highlands, where the majority of the population is indigenous, the poverty rate reaches 76 percent and the chronic malnutrition rate for children under the age of five is 67 percent.

Maize is the principal crop in Guatemala, with an annual production of 1.67 million tons<sup>1</sup>. Subsistence-oriented agricultural practices, strongly connected to Mayan heritage, dominate

<sup>1</sup> USAID: Global Hunger and Food Security Research Strategy: Climate Resilience, Nutrition, and Policy 2014 - 2017

"Reduction of Postharvest Losses in the Western Highlands of Guatemala" Survey Assessment Report

“Concentrating on rural families is the greatest commitment that this nation must make and that is my commitment from the Ministry of Agriculture, because the goal is to transfer that 61 percent of agricultural households to a situation of commercial surpluses”.

- Mario Méndez Montenegro, Minister of Agriculture, Livestock and Food, Republic of Guatemala.

maize production. Maize was first domesticated in the Western Highlands and is an integral part of local identity. Smallholders continue to cultivate maize alongside export crops due to the cultural importance. As a staple food in the diet, families in the Western Highlands may need between five and 15 pounds of maize per day to feed their family.

Maize storage losses at the farmer level due to pests, relative humidity, and heat and microbial growth reduce surpluses and quality of maize that could be sold at market, or consumed safely later, and nutritional profiles of harvested maize, which further diminishes nutrition and food security and farmer profits. Fumonisin and aflatoxin, both types of mycotoxins, levels in local Guatemalan maize are 10 to 50 times above world average levels. Mycotoxin contamination may not be noticeable in stored grain, or the severity of the fungus may not be known. Consumption of mycotoxin-contaminated grain has a range of health implications including immunity suppression, impaired growth, nutritional interference, liver cancer and death.<sup>2</sup>

Wasting maize is culturally unacceptable and it is said that “People who waste or throw the maize kernels may develop rash on their skin”, which would be a “punishment from God” for the sin of wasting maize.<sup>3</sup> Damaged maize, due to high moisture levels, fungi, rodents, insects and other things, is rarely discarded and typically still used for human or animal consumption.

Women play a key role in the drying, storage and distribution of maize in the home, though they have limited access to agricultural inputs such as land, financing and credit, and in decision making. Men typically manage the material, social and political resources and make the decisions. The decision to discard or consume damaged maize often falls to women as they are responsible for this stage of agriculture.

### THE POST-HARVEST LOSS INNOVATION LAB TACKLES THREE POST-HARVEST LOSS CHALLENGES FOR MAIZE

Through the USAID-funded Feed the Future Innovation Lab for the Reduction of Post-Harvest (PHLIL), Kansas State University (KSU), the University of Nebraska-Lincoln (UNL) and the Guatemalan NGO SHARE are working together on three key areas with significant post-harvest challenges: drying, storage and mycotoxin contamination of maize through the testing and evaluation of traditional drying and storage technologies against improved technologies.

Through a phased approach, SHARE, KSU and UNL are building capacity, conducting research to develop and identify post-harvest innovations to benefit maize farmers, and identifying pathways that can create access to these technologies and impact at scale in Guatemala.

The increased availability of food and provision of safe food associated with PHLIL’s work provides pathways to increased nutritional status, greater recognition of health, a transition out of poverty, and the tools necessary for children to adequately learn, develop and prosper.

<sup>2</sup> Ochieng, P. J., Okun, D., Runo, S., Njagi, N. J., & Murage, J. (2013). Public Health Strategies for Preventing Aflatoxin Exposure. *BJC*, 45, 1-22.

<sup>3</sup> Mendoza, J. R., Sabillón, L., Martínez, W., Campabadal, C., Hallen-Adams, H. E., & Bianchini, A.

(2017). Traditional maize post-harvest management practices amongst smallholder farmers in Guatemala. *Journal of Stored Products Research*, 71, 14-21.

## PHLIL FINDINGS AND FARMER PREFERENCES GUIDE DECISION ON POST-HARVEST TECHNOLOGIES

**Drying:** A Hybrid Biomass Furnace and Solar Dryer, an STR Dryer (from Vietnam), and an earlier version of the AflaSTOP furnace-type dryer were tested. The tests and corresponding farmer feedback indicated that none of the options were affordable for the study participants, and would not perform in an optimal manner due to the complex environmental conditions, such as the relative humidity and the low temperatures that characterize the Western Highlands of Guatemala. In the absence of new workable drying solutions, the team has focused instead on providing educational knowledge on improving traditional drying methods and best post-harvest management practices. These have been incorporated into the post-harvest manual.

**Storage:** Hermetic bags (GrainPro) were tested, in addition to plastic drums and metal silos. Silos/drums are preferred over bags due to rodent damage and the plastic drums are preferred by the study participants, due to their ease of use and affordability. Storage technology was performed with maize for consumption only. Storage technologies were disseminated among study participants.



**Mycotoxin:** An assessment of the quality of maize harvested (Nov. 2015-Jan. 2016) by smallholder farmers in Chiantla and Todos Santos after 30, 60 and 90 days of storage. While toxin levels were found to be below internationally accepted limits, there are extremely high consumption levels of maize in the Western Highlands. As a result, mycotoxin levels in the amount of maize consumed exceed safe limits.

These results help to inform household behavior related to mycotoxins, and have helped create appropriate content for the post-harvest manual.

Additionally, the team validated and piloted low-cost moisture meter evaluations of the John Deere moisture meter and PHL moisture meter. Study participants accepted the use of a measurement tool, and showed interest in purchasing it for use. Personnel from the local Guatemalan NGO, SHARE Guatemala, and the Universidad del Valle de Guatemala (UVG) received technical training by PHLIL researchers on proper field sampling for grain evaluation and microbiological and mycotoxin analysis. Also, a fully operational mycotoxin laboratory was established at UVG, which now has the capacity to provide in-country testing for mycotoxins.

## PHLIL'S WORK SUPPORTS NATIONAL PRIORITIES OF GUATEMALA

While Guatemala does not have a single national development plan, the country does have a series of development plans for specific geographic areas. PHLIL's efforts in Guatemala support one of the country's primary development foci, achieving food security in the Western Highlands, through agricultural development and a focus on improved performance in the post-harvest stage of the value chain.

While the country has taken efforts to prioritize food and nutrition security and agricultural development, the actual implementation of these policies is weak to non-existent due to weak governmental institutions. Civil society has been a strong and active sector alongside the Government in pursuing development goals, and will continue playing a critical role in realizing national goals.

### **Improving agriculture productivity in the Western Highlands supports poverty alleviation and socio-economic equality.**

Agriculture is the primary source of employment in Guatemala, especially in the Western Highlands. Populations there have few options for income-generation and 74 percent of those working in agriculture are poor. Food insecurity and chronic malnutrition disproportionately impacts

communities in this area and economic growth remains low. The Government has recognized the health, education and economic consequences of malnutrition and prioritized agricultural development and rural employment opportunities to improve outcomes. Improving agricultural productivity through a shift from subsistence-based farming to commercial-oriented farming will support a transition out of poverty and improved food security.

The strengthening of agriculture and smallholder production is a national priority through the transfer of knowledge and new technologies. There is a defined and well-articulated focus on building up smallholder farmer capacity and productivity through training, infrastructure development, technology transfer and knowledge sharing. Improving agricultural productivity is seen as essential for food security and overall prosperity.

Women are active in agriculture but gender-based barriers limit access to land, credit, financing, information, markets and inputs. The Gender Policy in Agriculture aims to reduce the gap in women's access to agricultural activities and support, and promote the participation and empowerment of women in rural development.

**Education, behavior change and focused, integrated actions are central to improved food, nutrition and resilience.** Agricultural inputs, nutrition products and food donations by the Government will not be a hallmark of the current administration. Instead, there is a push to strengthen community coping and resilience mechanisms to improve nutrition, agriculture and health outcomes. Education and behavior change are seen as fundamental to improved agriculture, nutrition and health practices, and reinforces the desire to empower families at community and household levels with the tools and assets they have at their disposal. Behavior change and knowledge transfer that is focused on strengthening current practices at specific points in the value chain versus complete changes to agricultural practice are preferred practice.



**Climate-smart solutions and approaches are viewed as essential given Guatemala's ongoing vulnerability to climate events and shocks.** For the Government of Guatemala and development actors in country, attention to disasters due to climate change has become an elevated priority given the devastation that rains, drought, pests and disease have had on agricultural livelihoods. Because there is a poor track record of climate-smart agriculture and poor systems in place to build sustained, climate-resilient responses, having tools and specific techniques from across sectors that can support farmer and rural communities, so that they are prepared for resilience in the face of shocks is being sought out by political leadership and civil society.

**Reducing and preventing PHL supports improved health and nutrition outcomes through women's empowerment.** Gender equality is cited as the single most important determinant of food and nutrition security and consequently, plays a major role in PHL and the related impacts.<sup>4</sup> Maize drying, storage and sorting are primarily women's responsibility, but women have little to no economic empowerment or leadership within the home, and lack access to agriculture extension training and information. "Wasting", or throwing out damaged maize is rarely practiced, and instead is consumed by humans or animals. These gender inequities constrain the avoidance and reduction of PHLs.

---

<sup>4</sup> De Schutter, O. (2013). Gender equality and food security: Women's empowerment as a tool against hunger.

Although women are involved in agriculture and are primarily responsible for household activities, their efforts are not recognized as true work. When these activities are combined, women are often time poor. Adoption and use of time-saving technologies by women reduces the amount of time she spends on drying and storage activities. This time can now be spent on homestead gardening, income-generating activities, pursuit of healthcare, or education. Reducing women's time poverty further allows them to improve resiliency to climate change through participation in community decision-making, learning about adaptation strategies or investing in new livelihoods.<sup>5</sup>

Women are not only tantamount to sustainable reductions in PHL but also beneficiaries of the improved productivity that may translate into personal health, nutrition, and education opportunities. Furthermore, women have frequently been shown to have greater impact on the health, education and nutrition of children when they benefit from the increased opportunities and incomes that increased productivity allows.<sup>6</sup>

**“Women play an important role in communication, the empowerment of women is important in the processes; it raises the awareness of other women and expands knowledge. A mother guide can bring awareness to other mothers in her sector, and give her experience. ”**

*- Dr. Julio César Lone. Strategy and Innovation Manager, World Vision, Guatemala.*

## THE PATH FORWARD REQUIRES MULTI-SECTORAL COLLABORATION AND ACTION

PHLIL has and continues to support the Government of Guatemala in its' efforts to increase agricultural productivity, livelihoods and well-being. Raising the capacity of smallholder farmers to reduce and prevent PHL in addition to

increasing productivity paves the way for a sustainable and vibrant food system.

To truly make progress, the path forward must support scale up and adoption of PHLIL innovations. A sustainable and safe food system, free of maize losses and high mycotoxin levels requires full participation, holistic approaches and partnerships from all sectors. The following specific calls to action to each stakeholder group will help reduce PHLs and create the food system envisioned for Guatemala.

### UN/Multi-laterals:

- **Share and promote PHLIL PHL-reducing technologies, and practices.** While PHLIL has disseminated storage technologies among farmers involved in their studies, further storage technology and knowledge diffusion is needed. Educational training is needed to build awareness as most inhabitants in the Western highlands are unaware of potential issues as a result of their current grain handling practices. UN agencies, international and regional institutions provide unparalleled technical support, leadership, capacity development, shape the research agenda and facilitate partnerships that support sustainable food systems. Sharing and promoting the PHLIL PHL-reducing technologies and educational material will create a more enabling environment for dissemination, adoption and scale of the innovations.
- **Help strengthen national efforts to improve PHL outcomes.** Successful delivery and adoption of PHL technology requires a multi-sectoral approach with multi-level support and engagement in place. UN agencies and multi-lateral institutions can engage with state and local-level actors and facilitate efforts across a range of sectors for the greatest impact.

### Government:

- **Integrate PHL into agricultural and rural development policies.** Agricultural, food security and rural development policies are still under development and expected to be

<sup>5</sup> UNDP. UNDP Climate Change Adaptation: Impact Gender - Time Poverty.

<sup>6</sup> De Schutter. (2013).

implemented during the course of the current administration. Reducing and preventing PHL provides pathways to increased nutritional status, greater recognition of health, a transition out of poverty, and the tools necessary for children to adequately learn, develop and prosper.

- **Engage with private sector to create an effective public-private partnership.** As part of the country's transition away from reliance on assistance and aid, the Government should make efforts to engage the private sector in agriculture.

#### Donors:

- **Fund testing of STR dryer in other Departments.** The dryer could have considerable impact in areas with the highest production of maize, such as the departments of Chimaltenango, Sololá, Altiplano, and Quiché, where the production is not only for consumption but also to supply to the northern area of the country and for export. Testing in these areas can provide further data for dissemination among middle-size farm operations.
- **Frame PHL reduction within national priorities for increased action.** Reducing PHL links to economic growth, food systems strengthening, farmer resiliency, improved markets, gender equity, and nutrition security. Making the link between PHLIL practices and technologies to national priorities will allow for increased PHL efforts and impact.

**“What PHLIL is testing in Huehuetenango should be implemented in the maize producing regions of Guatemala and at scale. We have to couple the use these technologies with strengthening pre-harvest practices and improving agricultural practices overall.”**

*- Olga Torres, Mycotoxin Expert and Senior Scientist,  
Centro de Investigaciones en Nutrición y Salud*

#### Research Institutions:

- **Focus research into specific impact points along the value chain.** PHL can occur at different impact points along the value chain. While losses of any dimension challenge a



farmer's productivity, health, and well-being it is important to take into account the cost of investment and consequent benefit with specific attention to the impact points of loss. Research into PHL reduction must focus on specific points of the PH pathway to support reduced PHLs and agricultural development.

- **Tailor research findings for specific audience groups.** Research drives investment, needed interventions, and helps build awareness. It is critical that research findings be tailored to resonate with specific stakeholder groups that may not be familiar with or close to the research.

#### Private Sector:

- **Manufacture, distribute and market PHLIL technologies.** A local manufacturer can help make technologies available at an affordable price while building domestic capacity to respond to and improve agricultural outcomes.
- **Engage with other in-country stakeholders to create a strong multi-sectoral approach.** To bring greater attention and the ability to truly expand access and use of any PHL technology, a multi-sectoral approach with multi-level support and engagement should be in place. From the commercialization/adoption of the tested technology, and developing distribution systems, to creating a favorable policy environment where technologies can be accessed and building broad awareness of and demand for PHL reduction actions, a range of sectors is necessary.

### Civil Society:

- **Promote PHLIL PHL-reducing technologies in programming.** Reducing PHLs impacts agricultural productivity, income, gender, nutrition and health of farmers. Alignment with other priority sectors allows for a wider audience to be exposed to and trained on PHL-reducing technologies from trusted entities, while addressing key impact areas of training entities.
- **Provide education and advocacy on PHL and PHLIL technologies.** Civil society is a key and trusted sector in Guatemala. As such, they can provide advocate for and provide education on the impacts of PHLIL technologies and PHL. NGOs and other institutions are needed to increase farmer awareness about post-harvest issues and identified solutions.

### THE U.S. GOVERNMENT'S COMMITMENT TOWARD A PROSPEROUS AND RESILIENT GUATEMALA

Guatemala remains committed to achieving progress and prosperity for all. In that goal, the country has always opened the door and fostered positive and productive collaborations with institutions around the world, including the United States. The United States and Guatemala have collaborated for many years to combat hunger and malnutrition and promote agricultural development, and continues making progress towards realizing development goals for Guatemala.

The U.S. Government's Feed the Future initiative is tackling root causes of poverty, hunger and malnutrition. Through the Innovation Labs, it has propelled innovative research and academic institutions forward, and fostered mechanisms to develop, test and scale technologies and approaches that can have a transformative impact on the lives of the poor around the world. Due to its commitment to food security investment, potential for agricultural growth, and to sustain the successful partnership and development gains

made, Guatemala was selected as one of the target Feed the Future countries.

Moving forward, the Feed the Future Post-Harvest Loss Innovation Lab will continue working with Guatemala to address PHL technology adoption challenges, build upon strengths and achievements to date, foster awareness and engagement to improve post-harvest practices, and support the country's leadership in building a vibrant food system through tools and technologies that hold the promise of great impact at scale.

**“Feed the Future harnesses the power of American development leadership and innovation to partner with host governments, and community leaders and the private sector to build resilient communities with the goal of helping people stand on their own two feet, no matter what challenge may come their way.”**

*- USAID Administrator Mark Green*

### References:

- De Schutter, O. (2013). Gender equality and food security: Women's empowerment as a tool against hunger.
- Mendoza, J. R., Sabillón, L., Martínez, W., Campabadal, C., Hallen-Adams, H. E., & Bianchini, A. (2017). Traditional maize post-harvest management practices amongst smallholder farmers in Guatemala. *Journal of Stored Products Research*, 71, 14-21.
- Ochieng, P. J., Okun, D., Runo, S., Njagi, N. J., & Murage, J. (2013). Public Health Strategies for Preventing Aflatoxin Exposure. *BJC*, 45, 1-22.
- “Reduction of Postharvest Losses in the Western Highlands of Guatemala” Survey Assessment Report
- USAID: Global Hunger and Food Security Research Strategy: Climate Resilience, Nutrition, and Policy 2014 - 2017