**i-ACES Vol.2 No. 1 (2016)**
*Inquiry in ACES: An Undergraduate Research Journal*
College of Agricultural, Consumer and Environmental Sciences
University of Illinois at Urbana-Champaign

i-ACES
{inquiry-ACES: Highlights of Undergraduate Research in ACES}

# Reducing Postharvest Loss in All Areas of the Production Chain

Alyssa Volland[1*]

[1]Department of Animal Sciences, University of Illinois at Urbana-Champaign

[*]volland2@illinois.edu

ARTICLE INFO

*Article history*:
Received 16 January 2016
Accepted 2 April 2016

*Keywords*: Postharvest loss, production chain, food scarcity, international agriculture, food waste

ABSTRACT

In today's world, 30% of the food produced is wasted. That food could be used to nourish millions facing food scarcity and hunger. Food lost during the production chain is referred to as postharvest loss. Reducing postharvest loss can effectively feed starving mouths while conserving resources and decreasing the pressure to produce more. There are five main areas where postharvest loss can be reduced – harvest, storage, transportation, processing, and retail. New approaches and technologies in each of these areas will increase the amount of food available for human consumption. However, implementing these solutions will require cooperation among nations and substantial financial support from public and private sectors.

## INTRODUCTION

Today's world faces the threat of not being able to feed its growing population. There are just over seven billion people in the world now, and over 800 million are undernourished (WHES 2015). By 2050, there will be over nine billion people in the world that will need to be feed. How can society feed these additional people while also facing resource scarcity, political differences, and an increasing amount of greenhouse gasses? One suggested method includes abandoning old production habits of focusing on increasing yields. Instead, society should focus on saving what it already has. One-third of all food produced globally is lost or wasted after it has been harvested. These losses are called postharvest loss. However, most of the loss is preventable and can be reduced through technology, education, innovation, and collaboration among stake-holders.

In October 2015, the First International Congress on Postharvest Loss Prevention met in Rome, Italy and discussed postharvest loss on a global level. Representatives from sixty-two countries presented their research, discussed solutions, and learned from one another. Here, participants developed a roadmap towards postharvest loss. The roadmap identified that food is lost in five major parts of production-- harvest, storage, transportation, processing, and retail. This paper describes specific reasons why food is lost in these areas of the production chain. It also offers solutions on how to reduce losses in all five areas. The end of this paper offers a personal reflection developed after attending the First International Congress on Postharvest Loss Prevention in Rome, Italy.

## HARVEST

The way crops are harvested affects whether they are suitable for the marketplace and human consumption. Bruised and damaged fruits and

crops are less likely to be purchased and often go to waste. Being able to decrease bruising and produce higher yields at harvest will positively impact the amount of food available by the end of the production chain. If more food is produced, then more food will be available as human sustenance.

Fruits that grow on trees such as oranges and apricots are especially susceptible to loss simply due to gravity; the fruit may fall without any notice and bruise once it hits the ground. This may also be the result of harvesting techniques such as individually picking fruit off the tree, which is the method used in many countries. A slip of the hand can cause the fruit to be dropped, potentially making that fruit unsuitable for the market. Twenty percent of apricot losses in Tajikistan are due to harvesting techniques (Umeda 2015). Harvesting in Tajikistan is the part of the production chain with the highest percent of apricot loss when compared to the other areas of the production chain (Umeda 2015). There is a very similar situation for orange production in Nigeria. Since 3% of the world's oranges come from Nigeria, reducing bruising is essential to provide for the world marketplace (Ugoh 2015).

New technology, such as mechanical fruit harvesting, is available to replace old-fashioned harvesting by hand. However, mechanical fruit harvesting is a system that is too expensive and impractical for developing countries. In addition, mechanical harvesting often damages the fruit anyway and would not dramatically decrease postharvest loss. The best way to reduce waste of these two fruits would be to prevent the fruit from forcefully hitting the ground. Putting nets in between trees to catch the falling fruit and lessen the impact is one possible solution to reduce bruising. One other simple solution would be to harvest more carefully by hand and to be mindful of fruits being dropped.

Crops being harvested at an improper time will affect whether that crop is wasted or is consumed. Harvesting the crops at the recommended moisture level will increase the crops' longevity and likeliness of being consumed. Soybeans are especially sensitive to moisture. If the moisture content is at or below 13%, then the kernel will shatter and fall to the ground (Paulsen 2015). Remaining attentive to each crop's proper moisture content will increase yields and give the crop a greater longevity when moving through the production chain.

## STORAGE

Improper drying and storage techniques contribute to the abundance of postharvest losses. Insects and pests drawn to the crops may contaminate all or part of the harvest. The *Aspergillus* fungus thrives in a moist environment supplemented with oxygen. *Aspergillus* produces aflatoxins, a poisonous, carcinogenic mycotoxin that grows predominantly during the drying and storage stage of production. It causes liver cancer and immunosuppression in adults and growth stunting and mental impairment in children. According to a report from the United States Agency for International Development, 10% of adult deaths in Southeast Asia and Sub-Saharan Africa are due to liver cancer that may be caused by aflatoxins. Additionally, about 35% percent of child growth stunting is caused by aflatoxins. This report states that 25% of the world's crops are susceptible, including maize, rice, and cassava (USAID 2012).

Hermetic storage is a technology that has been implemented to prevent aflatoxin growth as well as reduce the amount of pests present in crops. Hermetic simply means sealed and airtight. Purdue University has been developing the PICS3 (Purdue Improved Crop Storage- 3rd phase) product and has implemented this technology across Africa. They are working on creating manufacturing facilities in Africa to produce and distribute these bags. The hermetic bags are inexpensive and can last for about one year's time. They also decrease the use of pesticides and insecticides that may contaminate precious drinking water sources. Since 2007, at least 2.5 million farmers from 40,000 different villages have been trained about using the PICS bags (Commercialization 2015).

Distribution of hermetic storage bags remains a problem. Although the PICS3 bags are being implemented across Africa, not every area has access to them at this time. In the coming years, it will be difficult to achieve 100% accessibility because of the vastness of Africa. Another problem with PICS3 bags is their poor defense against rodents who can chew through the bags. However, oil containers and steel drums already exist and are common in most of Africa. These containers can be reused as a way to prevent aflatoxin growth and prevent pests from contaminating the crops. They are made of a tough material such as plastic or steel that rodents cannot damage. The hermetically sealed containers resulted in 100% weevil and bruchid mortality after four weeks (Brumm 2015). These containers do not need to be altered before they can be used as hermetic storage options. The only requirement is that they are properly cleaned and completely sealed to provide an airtight environment. A hermetic environment is needed in order to prevent the growth of fungus, stop the infestation of pests, and provide an abundant safe food supply.

## TRANSPORTATION

The transportation of food from the field to markets or processing centers contributes to food waste. Sometimes, the product has to travel very long distances in order to make it to its next step of production. Poor and insufficient trans-portation can cause food damage, spoilage, and loss.

Apeel Sciences, a California company, has developed a product called Edipeel® that is useful in preventing food spoilage during long- distance transport from one place to another. The product is a shield made from the non-edible parts of crops such as stems and leaves. These components are blended together and certain molecules are extracted for application to the crop. This product essentially keeps water inside the crop while preventing oxygen from entering and causing spoilage. It is a natural preservative and can be made organic, too. This product is an easy way to extend the life of food products and ensure that they can make it to market while still remaining fresh, despite long transportation chains (Rogers 2015).

Another solution to improved transportation is the use of refrigerated trucks when bringing food products from one place to another. According to Toby Peters who studies “cold technology” the University of Birmingham, the world needs to “do cold smarter,” and “put cold in motion,” in order to reduce postharvest loss. India needs about 180,000 refrigerated trucks in order to move around their food and prevent spoilage. Unfortunately, India only has about 10,000 refrigerated trucks right now. In Tanzania, 97% of meat is sold without ever being refrigerated. Not only does this increase meat spoilage, but it is also unsafe, potentially contributing to illness within the country. One of the cons of refrigeration is the emission of dangerous greenhouse gases that current trucks are producing. Using liquid nitrogen as a clean energy source to produce cold for the transportation of food products will reduce emissions and produce clean cold (Peters 2015).

Employees throughout the production chain are careless and contribute to an unnecessary postharvest loss. Education of employees, especially within the transportation chain, would help to decrease postharvest loss by promoting awareness. During transportation, poor loading techniques, and reckless driving increases bruising and decreases the food available in markets. These are just a few examples of how employees contribute to postharvest loss. The employees do not do it because they are bad people, but because they do not realize how many mouths could be fed with the food they are handling. However, their poor working habits can be easily changed. Videos and educational programs are being developed in order to educate, increase employee awareness, and create positive change to prevent waste. Scientific Animations Without Borders (SAWBO) creates animations that deliver lessons about postharvest loss and aim to educate employees and producers. They are free videos that can be

translated into multiple languages and are easily accessed (Bello-Bravo & Pittendrigh 2015).

## PROCESSING

Processing is generally a negative term to some consumers because it means the food is not fresh and it contains unwanted unnatural ingredients. However, increasing food processing and reducing the amount of fresh food that may potentially spoil is a useful way to reducing food waste. If all of the fresh food cannot be consumed before it spoils, then the next best option is processing it for later consumption.

Ghana is one example of a country facing processing dilemmas. Currently, the processing sector is underdeveloped and lacks quality control. The only processing center right now is in the capital of Ghana, an urban area that is away from agriculture fields. This causes long transportation routes in order to get to the processing center. There is potential for small to medium sized processing centers throughout Ghana, especially because Ghana has high electricity coverage; 60% of the rural areas have electricity coverage (Hutchful 2015). At Ghana's only processing center, roots and tubers can be made into flour and chips with added vitamins in order to enhance the nutritional value of these items. They can be stored then consumed during times of food shortage. It would be beneficial to have multiple processing centers so that food can be processed and made useful instead of wasted.

Postharvest losses are not occurring in just crops. Fisheries and meat producers are also experiencing the effects of food waste and are actively combatting it. Even if fish and meat products do not appear spoiled, invisible bacteria are constantly growing and may cause sickness among consumers. Processing fish and meat products eliminates the risk of illness and decreases the amount of food waste. Previously, fishermen in Africa relied on sun drying and smoking to process their fish. However, cloudy, rainy, and humid periods were not sufficient for drying the fish and caused the fish to spoil. The FAO-Thiaroye fish processing technique (FTT) is used as a way to increase processing. It is an adapted kiln with an ember furnace, fat collection tray, and a smoke generator. This technique works regardless of weather conditions. Postharvest losses of fish have been reduced from 10-50% during processing to nearly 0% in areas using the FTT (Randrianantoandro 2015).

## RETAIL

Postharvest loss can be effectively reduced in all aspects leading up the market, but that effort will become futile if the consumers are unwise about their purchase decisions. Or, if the food is not sold to the right market, it will spoil and become inedible. Looking for new markets is a way to decrease postharvest loss.

Consumers with substantial income are prone to buying too much food, causing food to go to waste because it is not eaten before expiration. In the United States, the average family of four throws away two months of groceries every year (Scuse 2015). Being more careful and not purchasing more than can be consumed can fix some of these habits. Attention to 'best by' dates can also decrease the amount of food that is thrown away. They should not purchase food if they won't be able to consume it shortly after the best by date and before expiration. Consumers should typically not throw away food on the best by date if it appears fine otherwise.

Another possible solution is to find a nearby market for the damaged fruits to be sold at a discounted rate. The damaged fruit is typically just as nutritious as other fruits; the bruise is just a cosmetic defect. Discounted rates may be needed for some families to eat every day, which gives the damaged fruit importance in our society. This mentality challenges the definition of waste by saying that a waste in one market may provide an opportunity for another market that consists of the most vulnerable people. Therefore, a waste to some may not necessarily be a waste to all. Studying pineapple losses in Uganda supported this. The losses were actually lower than presumed because the pineapples

that are not being processed were still sold and consumed by the poor (Troeger 2015).

## CONCLUSIONS

I was not familiar with the concept of postharvest loss when I was selected to attend the First International Congress on Postharvest Loss Prevention. I was very curious to know more, but my first thought on postharvest loss was that it would be something I wouldn't fully understand. I knew that a large part of the engineering community was involved in postharvest loss prevention. Therefore, I figured that the solutions would be too technical, intricate, and confusing for someone like myself who does not have an engineering mindset. However, I found the solutions to be surprisingly simple and easy to comprehend. I was even able to explain the solutions to an eleven-year old who clearly understood what I was saying. If this is the case, then why aren't we implementing the solutions and dramatically decreasing losses?

Technologies such as refrigeration, processing centers, and harvesting machinery are readily available in the United States and Western Europe. These nations are developed and are financially stable for the most part. They are able to afford these solutions and often take them for granted. From this experience, I realized that I personally take our technology and readily available food supply for granted. From what I learned, it seems as if funding and distribution are the largest barriers between the postharvest loss problem and quick results. Multiple times at the conference I heard that companies need to join forces with the public and private sectors to work on projects in rural communities. The Rockefeller Foundation and The Bill and Melinda Gates Foundation, both sponsors of the conference, are two organizations that have already taken action and changed many lives. Government policies to support food waste reduction are also needed in order to push this problem to the forefront of the communities' priorities and secure government funding.

There is definitely momentum on the postharvest loss issue after the International Congress on Postharvest Loss Prevention. Attending a conference with attendees from sixty-two other countries assures me the world is willing to unite and combat hunger. Keeping the momentum and the enlightened feeling will positively benefit change. With that, maintaining the network of producers and intellectuals at the conference to form communities is a great way to keep this issue in the forefront and exchange ideas. Postharvest loss prevention is not an issue where we need to start from zero. We know the solutions and we have the solutions. Now is the time to implement them.

## ACKNOWLEDMENTS

I would like to thank Dr. Prasanta Kalita, the ADM staff, Dr. Kim Graber of the Campus Honors Program, and Dean Soo Lee of the ACES James Scholar Program for supporting me and six other students as we traveled to Rome. This has been a once in a lifetime opportunity, and I am very grateful. I am excited to share the knowledge I gained with others.

## REFERENCES

Bello-Bravo J, Pittendrigh B (2015) Scientific animations without borders: High throughput global development and deployment of PHL reduction educational content. 4-7 October 2015. International Congress for Postharvest Loss Prevention, Rome, Italy

Brumm T (2015) Alternative hermetic storage containers for use by smallholder farmers. 4-7 October 2015. International Congress for Postharvest Loss Prevention, Rome, Italy

Commercialization of Purdue Improved Crop Storage (2015) Purdue Entomological Research Collection.
http://www.entm.purdue.edu/PICS3/.
(accessed 15 October 2015)

Hutchful M (2015) Expanding food processing capacity as a tool for ensuring food security and safety. 4-7 October 2015. International Congress for Postharvest Loss Prevention, Rome, Italy

Nabieva U (2015) Food losses and waste in Tajikistan. 4-7 October 2015. International Congress for Postharvest Loss Prevention, Rome, Italy

Randrianantoandro A (2015) The FTT-Thiaroye processing technique. An innovation for post-harvest loss reduction in fisheries & aquaculture. 4-7 October 2015. International Congress for Postharvest Loss Prevention, Rome, Italy

Rogers J (2015) Molecular camouflage: Natural barrier coatings to increase the marketable shelf life of fresh produce without refrigeration. 4-7 October 2015. International Congress for Postharvest Loss Prevention, Rome, Italy

Paulsen, M (2015) Harvesting: Effects of crop maturity and moisture on losses. 4-7 October 2015. International Congress for Postharvest Loss Prevention, Rome, Italy

Peters, T (2015) Sustainable cold chains for food security in the developing world. 4-7 October 2015. International Congress for Postharvest Loss Prevention, Rome, Italy

Scuse, M (2015) Special remarks. 4-7 October 2015. International Congress for Postharvest Loss Prevention, Rome, Italy

Troeger, K (2015) Re-thinking post-harvest losses in perishables: Contextualizing losses with the example of pineapple in Uganda. 4-7 October 2015. International Congress for Postharvest Loss Prevention, Rome, Italy

Ugoh S (2015) Postharvest losses along the citrus value chain: A case study of Benue State, Nigeria. 4-7 October 2015. International Congress for Postharvest Loss Prevention, Rome, Italy

United States Agency for International Development (USAID) (2012) Aflatoxin: A synthesis of the research in health, agriculture, and trade. http://www.aflatoxinpartnership.org/uploads/Aflatoxin%20Desk%20Study%20Final%20Report%202012.pdf. (accessed 29 October 2015)

World Hunger Education Service (WHES) (2015) 2015 World Hunger and Poverty Facts and Statistics by WHES. http://www.worldhunger.org/articles/Learn/world hunger facts 2002.htm. (accessed 25 November 2015)