CASE STUDY

Designing new products to increase food safety of harvested vegetables in Cambodia

A cost effective, replicable vegetable washing product can help agro businesses in Cambodia achieve Good Agriculture Practices.

The Plant and Food Research Institute, New Zealand (PFR) commissioned the iDE Cambodia Innovation Lab to design a solution that enabled Cambodian agriculture businesses to guarantee food-safe, pathogen-free vegetables for their customers. This was identified as a key step in PFR's broader mission in Cambodia: to enable businesses to reach compliance with proper agricultural standards which would allow them to be certified as GAP (good agricultural practices).

Due to a lack of knowledge, equipment, and technical support, many farmers in Cambodia follow unsafe washing practices at their farms, usually involving contaminated water that exposes fresh produce to harmful pathogens and posing health risks to customers. Therefore, the goal of improving food safety focused on designing solutions that allowed for harvested vegetables (from rural farms) to be processed, washed, and stored (at collection points) in an efficient and user friendly manner.

"I always wash my vegetables here in this pond, I think it's not good to drink this water but it is clean enough for washing vegetables."
—Som Tha, Farmer, Project Alba

Understanding the needs of farmers and collection point actors

Unsafe handling and washing of freshly harvested vegetables was identified to be a key issue. Farmers like Som Tha take harvested greens to fresh water irrigation ponds in plastic crates to be washed. There, they dip each individual vegetable in the water and rub the soil off. Unfortunately, most fresh water ponds are contaminated with animal feces from domestic animals.

Overall, we learnt that farmers lacked the necessary knowledge, support, or tools to ensure proper washing at farms. This meant washing was being done in unsanitary conditions leading to a high build-up of pathogens at the source. For farmers, washing vegetables

meant removal of soil foremost in order to improve the appearance. Further, washing vegetables was seen as a burden for farmers who expected the washing to be done by someone further downstream in the supply chain.

The collection point—a central location where harvested produce from smallholder farmers is aggregated and dispatched to customers/markets—was identified as the key touchpoint for vegetables to be processed and washed. This ensured minimal handling and stopping unsanitary washing of harvested vegetables at farms.

Listening to the needs of the agricultural business owners and managers, we discovered that a lack of knowledge of the right food-safe process, no available equipment in the market, and lack of knowledge on standard operating practices were the key challenges to be addressed through our designs.

These needs were translated into key design principles that provided guidance to the design and prototyping process. Design principles were framed around usability, comfort, ease of maintenance, hygiene, safety, and ergonomic use for men and women.

Learning by doing through multiple prototype fidelities

Following research, we introduced insights and design principles to a selection of engineers, designers, WASH experts, and specialists in post harvest practices and developed a number of ideas, eventually narrowing them down to a final idea for a vegetable washing station.

Designing new products requires adopting an iterative prototyping process combined with constant feedback loops at each step of the process. This not only ensures that we learn from the prototypes that fail early on and design better products, but also ensure that we bring the voice and needs of the people we design for into the design process.

In this project, the final idea was prototyped through multiple fidelities of prototypes (low, medium, and high), iterating upon the design at each stage based on feedback from real users. This included:

1. **Constructing and user testing a low fidelity scale washing station model:** Through this we solicited early feedback from collection point staff and managers on aspects of functionality, aesthetics, workflow, and usability.

Bringing the concept alive in 3D, we enabled end users to understand the underlying concepts better. Feedback around usability and practical constraints was gathered from a quick testing at the collection point.

2. **Conducting flow experiments to understand core concepts of the prototype realistically**: We conducted fluid dynamics experiments by connecting buckets in series. Buckets were used as a proxy material to evaluate the key principle of our washing station design: ensuring a constant flow of water from one sink to another. This was necessary to achieve water dilution which prevented build up of soil during the washing of vegetables.

Using plastic buckets as proxies to steel sinks and conducting simple experiments, our team was able to test prototype flow dynamics of the washing station design.

3. **A fully functional medium fidelity prototype:** Once the basic design, functionality, dimensions, workflow, and fluid dynamics were understood, we then designed a full scale wooden washing station prototype to understand whether: our technical assumptions on water flow and angle of inclination were accurate; the table was usable and desirable to collection points; and if additional enhancements could improve performance and user experience.

We produced a full sized prototype and explored the design of the counter surface in more detail. The prototype was also tested for usability and ergonomics with two collection point staff.

4. **A ready-to-use final prototype:** A final prototype of the vegetable washing station was installed at a collection point of Natural Garden (a local agricultural business). This prototype was introduced to the staff through training and guidance on operating procedures, and, over a one-week period, we assessed its adoption, capturing feedback on a set of usability criteria (e.g., usability, memorability, learnability, error prevention, ergonomics, time savings, resource savings). This prototype was further iterated upon three times and each evolution was installed at collection points of three other agro businesses.

The final prototype installed at Natural Garden was tested over a one-week period. Improvements based on observations and feedback were retroactively made.

Impact

Time savings: Staff operating the washing station were able to thoroughly wash a crate of leafy greens (6 kgs) in 15 minutes, about 6-8 minutes faster than traditional washing methods.

Water savings: With a slow constant flow achieving sink dilution, the design eliminates the need to refill the sinks offering further time savings. The water savings were of greater note, offering savings of approximately 500 liters per 30 minute wash cycle. The water savings are compared to traditional washing methods in a large basin of water.

Cost savings: With no available market ready alternatives, the washing station costing $1,400 requires low capital investment considering the capacity of vegetables being processed (12-15 kgs washed in a 30 minute cycle). In the case of Natural Garden, guaranteeing safe vegetables at a markup price of 100KHR/KG has yielded exponential returns on investment with the capital expenses long been recovered. Further, this has enhanced brand value and appeal to a growing Cambodian customer base that is demanding assurance on high quality, safely processed vegetables.

Opening New Market Opportunities: Following standard operating procedures on the washing station allows businesses to achieve greater compliance with agricultural standards for export markets. The washing station takes agricultural businesses a big step closer to reaching new international markets, offering even greater returns on investments.

Creating a push for local businesses to adopt GAP (good agricultural practices): Five major agricultural businesses currently have washing stations installed in their collection points. The need to stay competitive in the market has nudged businesses towards adopting washing stations and its demand in the agricultural business sector has steadily increased.

"I like that this washing station is designed for me, I found it simple and easy to use, and it works so much better than the traditional washing which would make my back hurt."
—Collection Point Staff

Lessons Learned

- **Designs don't always translate well between 2D and 3D:** The prototyping process can be messy and will not always necessarily flow smoothly from the sketching phase to the prototyping phase. Many times, the team had to switch between sketching, making mini prototypes, and making full scale prototypes in order to better understand the complexities in the design/construction.

- **Ensuring continuity in the real environment is key:** From our testing we learned that collection point managers are a critical link in ensuring proper long-term adoption of washing practices and usage. Frequent supervision and support to the staff early on will aid adoption over time.

- **Taking a broader systems view of food safety is necessary to uncover other opportunities to promote food safe practices:** This project constituted an important starting point in the innovation of products and strategies for promoting safe post-harvest practices. In order to create lasting impact in the community, there is a critical need to spread awareness of the initiative beyond the confines of farmers and collection point staff over to the general public.

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