

DEVELOPMENT OF SMALL POSTHARVEST TOOLS FOR SEED PRODUCTION OF CORN AND SQUASH

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ABSTRACT

One of the priorities of BPI La Granja is to produce high quality seeds. Since lack of tools suitable for postharvest handling results to delayed seed processing and compromises the viability of seeds, then there is a need to develop postharvest processing tools to facilitate processing of cereals and vegetables. There were two kinds of small tools developed, namely; Corn Ear Cutter and Squash Fruit Slicer. This study aims to assess the efficiency of seed processing of corn and squash using the developed tools versus the manual processing and to determine labor when the developed tools are used in corn and squash seed processing.

The tools were fabricated at the Bureau of Plant Industry, La Granja National Crop Research, Development and Production Support Center, La Carlota City, Negros Occidental. Prototypes were made from recycled materials but costs of the tools using brand-new parts were also mentioned. Three workers were assigned to perform the seed processing using the tools as well as the manual processing by hand. The average outputs of three workers were used as basis to determine the performance of the tools. Results showed a satisfactory performance in terms of processing using the tools.

The use of Corn Ear Cutter saved 78.38% of time and 79.67% cost of labor compared to manual processing. The Squash slicer can reduce 30.13% of time and an average of Php10.99 per hour labor cost was saved. The use of these tools can improve the efficiency in postharvest processing of crop seeds thereby reducing postharvest losses while ensuring the quality of crop seeds produced in squash and corn.

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RATIONALE

Seed production plays a vital role in sustaining food production thereby ensuring food sufficiency and food security in the country. Without quality seeds, food production may suffer and ultimately fail. This would eventually lead to food insufficiency and at worst hunger to the country's population.

The La Granja National Crop Research, Development and Production Center (LGNCRDPSC) is one of the national crop centers of the Bureau of Plant Industry mandated to produce higher class and high quality seeds and planting materials for distribution to farmer-clientele and stakeholders; making them available to farmer-clientele whenever needed especially during planting season, thus sustaining food production.

The center's seed production program includes the postharvest handling and processing of the harvested crops which is critical in so far as achieving quality seeds is concerned. Delayed and prolonged postharvest seed processing has been a problem due to limited farmhands to do manual postharvest seed processing which at times takes about a month in the case of corn, not to mention high cost of the operation.

With the center experiencing the foregoing problem, this project was conceptualized and implemented with the goal in mind of reducing the cost of labor in postharvest processing as well as reducing the number of days for crop seed processing particularly in corn and squash. When this is achieved, high seed quality can be expected and likewise seed production efficiency is improved.

According to FAO, the important general principles for appropriate agricultural tools, some of which go beyond the general criteria for appropriate technology are: a) adapted to allow efficient and speedy work with the minimum of fatigue; b) not injurious to man or animal; c) of simple design, so that they can be made locally; d) light in weight, for easy transportation, e) ready for immediate use without loss of time for preparatory adjustments; f) made of easily available materials.

Appropriate agricultural tools and equipment should contribute to the broad objective of increasing the viability of small farms. Where small farmers are currently employing traditional technologies that are inefficient, they often cannot improve this technology because of the leap in scale and capital cost to commercially available equipment. It is therefore the goal of intermediate technology proponents to help fill this gap with good quality tools and equipment that are affordable and suited to the scale of operations of the small farmers (http://www.appropedia.org/Agricultural_tools).

In most of Asia and much of Latin America, farms are quite small. Under these conditions, most mechanized equipment will not increase the amount of food produced, but will only decrease the amount of labor required. Productivity per acre or hectare may in fact decline if these large tools require extra space to maneuver and wide lanes to drive or roll over. The appropriate tools under such circumstances, even if supported by unlimited resources, would be very different than those used in the United States, where

the amount of cultivated land per capita is relatively large (http://www.appropedia.org/Agricultural_tools).

One of the different stages in the process of enhancing labor productivity according to Rijk (1989) includes the Application of Improved Hand Tool Technology. This process started in prehistoric times when early civilizations developed stick and stone tools which were the only means to enhance labor productivity. In many parts of the world, hand tools are the only technology used in agriculture, and even in highly mechanized agricultural systems, improved hand tools are still important.

Farm tools and equipment are needed for timely completion of various agricultural operations (Balishter et al., 1991). Appropriate and selective mechanization is needed for agricultural production and post-harvest management (Mittal and Bhatia, 1988). While mechanization would augment the agricultural production by 10-15%, postharvest management could add 5-10% more by reducing losses (Singh, 2000).

Finding solutions to postharvest processing problems in agriculture requires (improved) agricultural tools and machinery. Machines are required to assist with postharvest loss reduction and on-farm processing. Thus it is now (again) recognized that agricultural mechanization is crucial in the fight against hunger and poverty, and at the same time to address environmental and health concerns (<http://www.unapcaem.org>).

In many developing countries, agricultural production and food security are adversely affected by insufficient use of farm power, low labor productivity and labor scarcity. The existing postharvest environment requires appropriate technologies to maintain quality of commodities. Poor handling of agricultural commodities can result in quality deterioration and losses (<http://www.bar.gov.ph>).

One of the solutions to alleviate postharvest losses is the use of appropriate mechanization. This refers to mechanization and how it is used for a specific situation (<http://www.unapcaem.org>). The use of agricultural mechanization embraces the use of tools, implements and machines for agricultural land development, crop production, harvesting, preparation for storage, storage, and on-farm processing. The simplest and most basic level of agricultural mechanization is the hand tool technology which is the use of tools and simple implements using human muscle as the main power source (<http://www.unapcaem.org>).

PhilMech in 2009 conducted qualitative and quantitative loss assessment of corn postharvest in three corn producing provinces namely: Isabela, Bukidnon and South Cotabato. Analyses of the postharvest losses were measured at the on-farm and off-farm levels of operation. An average of 7.8 percent was lost in the corn postharvest system, of which 4.54 percent was due to drying loss. In Isabela, the losses amounted to around 7.15 percent where 4.01 percent was measured in drying. In Bukidnon, postharvest losses obtained was 7.35 percent, 4.99 percent was also due to drying loss. While in South Cotabato, 5.98 percent was the total postharvest losses from which 4.63 percent was incurred during the drying operation. <http://www.philmech.gov.ph/?page=phlossinfo>.

The Department of Agriculture reported that the result of more investments in drying and processing facilities, corn postharvest losses were reduced to 12.9 per cent in 2012, from 15 per cent in 2011. <http://www.thecropsite.com/news/14998/philippines-expects-record-corn-harvest/#sthash.iq4dLBsG.dpuf>.

Greater use of machine labor at the farm level, in processing, and transportation has the potential to increase yields and decrease post-harvest loss. <http://www.fao.org>.

Appropriate use of mechanization increases productivity along the entire value chain, improving yields and reducing on-farm and post-harvest loss, all critical elements in the sustainable intensification of agriculture. <http://www.globalharvestinitiative.org/index.php/2013/06/mechanization-to-increase-yields-decrease-post-harvest-loss-and-improve-quality-of-life/>.

In the Philippines, postharvest losses remain as one of the most serious problems in the corn industry. A profit of as high as P1.6 billion is lost from our local corn farmers annually. <http://www.bar.gov.ph/chronicle-home/archives-list/418-june-2002-issue/4786-june2002-proper-tending-of-corn-after-harvest>.

In monetary terms postharvest losses in the Philippines represented more than \$600 million per annum for rice and more than \$100 million for corn. But using existing knowledge and best practice it is possible to reduce these losses by up to 30%. <http://aci.gov.au/>.

The Department of Agriculture (DA) and Philippine Center for Post Harvest Development and Mechanization (Philmech) on its corn and cassava mechanization roadmap revealed that the impact of the corn mechanization program would result in additional corn supply of 228,780 MT for four years and could mean an additional income to farmers. Mechanization increases crop yield, crop intensity, production area and reduces postharvest losses. It also enhances labor productivity. With machinery provision, it is estimated that corn grain yield may increase from the present national average of 2.88 MT per hectare to 3.85 MT per hectare in program areas by 2017. <http://www.mb.com.ph/corn-cassava-mechanization-pushed/#by54uKSzqWxptDXY.99>.

BAR (2008) reported that postharvest losses of commodities represent a very significant loss of 10-50% of production output in developing countries. This means that one-tenth to one-half of all the land, inputs, and labor used to produce the commodities goes to waste. Losses from postproduction can be related to occurrence of poverty.

OBJECTIVES

The general objective of this project is to develop appropriate tools that could improve the efficiency in the postharvest processing of crop seeds.

Specifically, it aimed to:

1. assess the efficiency of seed processing of corn and squash using the developed tools versus the manual processing;
2. determine how much is saved in terms of labor cost when the developed tools are used in corn and squash seed processing.

METHODOLOGY

Place and Duration of the Project

This project was conducted at the Bureau of Plant Industry-La Granja National Crop Research, Development and Production Support Center, La Carlota City, Negros Occidental from July 2014 to June 2015.

Two small postharvest tools for seed processing were developed, namely: Corn ear cutter and Squash fruit slicer.

Development of Prototype

A. Corn ear cutter

The corn ear cutter prototype was fabricated using recycled materials found in BPI La Granja. The blade was made of used brasscutter blade. A handle/lever was obtained from a non-functional knapsack sprayer. Scrap flat bar was used as the cutter guide and the main body with built-in stool was made of miscut wood.

This tool was designed for use on the removal of both ends of the corn ear that contain poor quality seeds instead of the traditional manual removal by hand of the corn kernels on both ends of the corn cob. This activity is done prior to corn shelling to reduce labor cost on seed selection in order to produce high quality seeds.

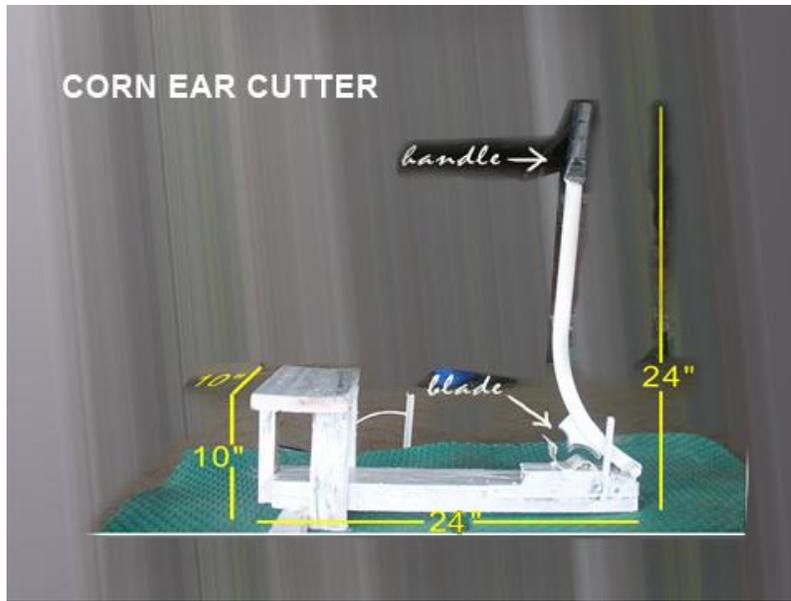


Figure 1. Basic dimensions of the fabricated corn ear cutter.

Functions of the Parts of the Corn Ear Cutter

1. **Handle**- used as lever in extraction of poor quality seeds on both ends of the corn ear. This part has fixed cutting blade found at the lower end near the pivot point. Its only movement is by pushing manually in place the tip and bottom of corn ear to be cut and by pulling to extract the poor quality seeds from corn ear.
2. **Blade**- a flat sharp part of the tool that is used for cutting. This part is fixed in the lower part of the handle.
3. **Cutter guide**- a part wherein the tip and bottom of corn ear is placed for extraction or cutting. This is made of steel formed into half circle installed to the main body and set to align with the blade.
4. **Stool**- this is a small seat made of wood built for the worker operating the postharvest tool. The weight of the person sitting on the stool serves to stabilize the tool during the processing of corn ear.
5. **Main Body** - this is made of wood and it holds every part of the tool.

B. Squash Fruit Slicer

The squash fruit slicer was developed to facilitate easy and efficient processing of squash fruits during seed extraction.

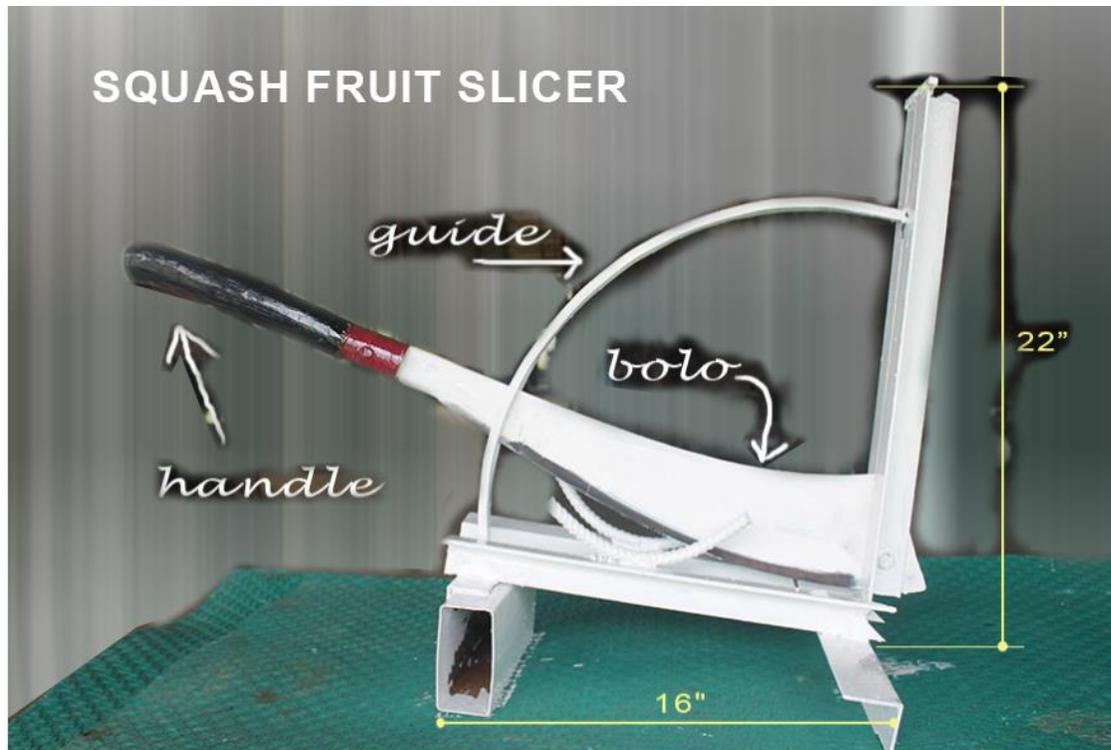


Figure 2. Basic dimensions of the fabricated Squash Fruit Slicer.

Functions of the Parts of the Squash Fruit Slicer

1. **Bolo**- a sharpened part of the tool used to slice squash fruit.
2. **Steel guide**- this is made of square bar and used as a guide of the bolo for straight slicing of the squash fruit.
3. **Main body**- this is made of angular bar welded to hold parts of the tool. The prototype squash fruit slicer main body, and the guide were made out of recycled materials found at BPI La Granja, while the bolo was procured from the market.

RESULTS AND DISCUSSION

To test the usage and efficiency of the small postharvest tools developed, these were tested in the postharvest processing of specific crop such as corn and squash versus the traditional manual processing by hand.

A. Corn ear cutter

Three male workers performed the cutting of both ends of the corn ear to discard the inferior and poorly-shaped corn seeds using the corn ear cutter. Each worker was given a sack of corn ears, all having the same weight. The length of time (in minutes) was recorded as soon as the task is finished. For the manual processing by hand, the same workers performed the task using the same weight of corn ears per sack.

As shown in Table 1, each worker was given a sack of corn ears weighing 14 kg each to remove the seeds on both ends of the corn ear. Using the developed Corn Ear Cutter, Worker A spent 12.83 minutes to remove both ends of the corn ears but the same worker spent 57.38 minutes in doing the same task by hand. In like manner, Worker B spent only 10.17 minutes when using the Corn Ear Cutter but spent 37.31 minutes by hand. Moreover, Worker C used 12.30 minutes doing the task using the Corn Ear Cutter but it took him 76 minutes to do the job by hand. On the average, it took only 12.30 minutes to do the task using the developed toll versus the 56.90 minutes required to do the task by hand. It means that using the developed Corn Ear Cutting, a farmer can save 44.6 minutes in doing the task which is equivalent to 78.38%.



Table 1. Time (minute) used in processing of corn ear using the developed small tool (Corn Ear Cutter) versus by hand processing.

WORKER	WEIGHT OF CORN EAR PER SACK (kg)	TIME USED (MIN)	
		Using Corn Ear Cutter	By Hand
A	14	12.83	57.38
B	14	10.17	37.31
C	14	13.92	76.00
Mean	14	12.30	56.90



Table 2 shows the labor cost to process 1 ton of corn ear using the tool (corn ear cutter) and by manual processing. Labor cost in processing by hand of 1 ton of corn ear based on the minimum wage rate in Region VI reached Php 2, 398.50 which is noticeably higher than the labor cost needed in processing of corn ears with use of the tool.

Table 2. Labor cost to process 1 ton of corn ear using the tool and by hand

METHOD OF PROCESSING USED	AVERAGE TIME TO PROCESSED 1TON OF CORN EARS (HR)	NUMBER OF DAYS TO PROCESSED 1TON CORN EARS (includes coffee break time)	LABOR COST Based in Php 266.50/ day Minimum wage rate (Php)
BY TOOL	13.91	1.83	487.70
BY HAND	67.74	9.00	2,398.50

B. Squash Fruit Slicer



Three male workers were assigned to perform slicing of squash fruit using the tool and a kitchen knife. Each worker was given 10 pieces of squash fruits, weighing two kilograms each. The average time (in minutes) in slicing the fruit using the tool and manual processing was determined. The average number of squash fruit processed per day was also recorded.



Table 3 shows the comparison in terms of time (in minutes) in processing squash fruits using the squash fruit slicer and kitchen knife. Using the tool, Worker A spent 2.07 minutes whereas it took him 3.30 minutes using a kitchen knife. It took Worker B only 1.00 minute to do the processing with the use of the tool while he spent 1.38 minutes when using kitchen knife. Worker C consumed 1.72 minutes in finishing the task using the tool while with the aid of a kitchen knife, he spent 2.18 minutes. An average of 1.60 minutes is used in processing of squash fruit using the slicer which is lower compared to processing by the use of a kitchen knife(2.29). Consequently, 0.69 minute can be saved in using the tool, which is equivalent to 30.13%.

Table 3. Time (minute) used in processing of squash fruit using the tool and kitchen knife.

WORKER	NO.OF SQUASH FRUITS (pcs)	TIME USED (MIN)	
		BY TOOL	BY KNIFE
A	10	2.07	3.30
B	10	1.00	1.38
C	10	1.72	2.18
Mean	10	1.60	2.29

Table 4 presents the cost of labor per hour needed to process 1 ton of squash fruits with the use of fruit slicer and by kitchen knife. With the use of fruit slicer, an average labor cost of Php10.99 was saved per hour.

Table 4. Labor cost to process 1ton of squash fruit using the tool and kitchen knife.

METHOD OF PROCESSING USED	AVERAGE WEIGHT/ FRUIT (KG)	AVERAGE NUMBER OF FRUITS IN 1TON	AVERAGE TIME TO PROCESS (HR)	LABOR COST* TO PROCESS / HR	TOTAL COST OF PROCESSING /hour (Php)
BY TOOL	3.5	286	0.76	33.31	25.31
BY KNIFE	3.5	286	1.09	33.31	36.30

* Based in Php 266.50/ day minimum wage rate (<http://ro6.dole.gov.ph/>)

C. Estimates of Material and Labor Cost

The cost of materials was based on prevailing market price in the locality. For labor cost, the current regional daily minimum wage rate of Php266.50/day was used as basis. In addition, a 30-minute coffee break time per day was also considered.

Table5. Estimated cost of brand new materials used in the fabrication of corn ear cutter.

TOOL NAME	PARTS NAME	MATERIALS W/SPECIFICATIONS	ESTIMATED COST (Php)
CORN EAR CUTTER	HANDLE	3/16"X1"X24" FLAT BAR	65
	BLADE	RESHAPE BRUSHCUTTER BLADE	540
	CUTTER GUIDE	3/16"X2"X8" FLAT BAR	40
	STOOL	8"WX10"LX10"H WOOD	50
	MAIN BODY	2"X4"X24" LUMBER	50
		3/8"X1" U.S BOLT W/ NUT	15
		WELDING ROD	40
		PAINT	200
	LABOR COST	500	
TOTAL COST			1,500

Table 6. Estimated cost of brand new materials used in the fabrication of squash fruit slicer.

TOOL NAME	PARTS NAME	MATERIALS W/SPECIFICATIONS	ESTIMATED COST (Php)
SQUASH FRUIT SLICER	BOLO	34" LONG BOLO	900
	STEEL GUIDE	10mm.X30" SQUARE BAR	45
	MAIN BODY	3/16"X2"X2"X4' ANGLE BAR	200
		3/8"X1" U.S BOLT W/ NUT	15
		WELDING ROD	40
		PAINT	200
		LABOR COST	500
TOTAL COST			1,900

CONCLUSION AND RECOMMENDATION

Based on the actual use of the tools, the results showed a satisfactory performance in terms of processing of seeds. These tools were able to save time and labor cost in processing seeds. For the Corn ear cutter, 78.38% of time can be saved compared to manual processing. In terms of the cost of labor, 79.67% can be saved. The use of Squash slicer was able to save 30.13% of time and an average of Php10.99 labor cost was saved per hour.

Generally, lack of tools suitable for postharvest handling contributes to the delayed processing of seeds thus affects the viability of seeds. Therefore, the use of the developed small tools could improve efficiency in the postharvest seed processing of crops which result to lower postharvest losses.

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