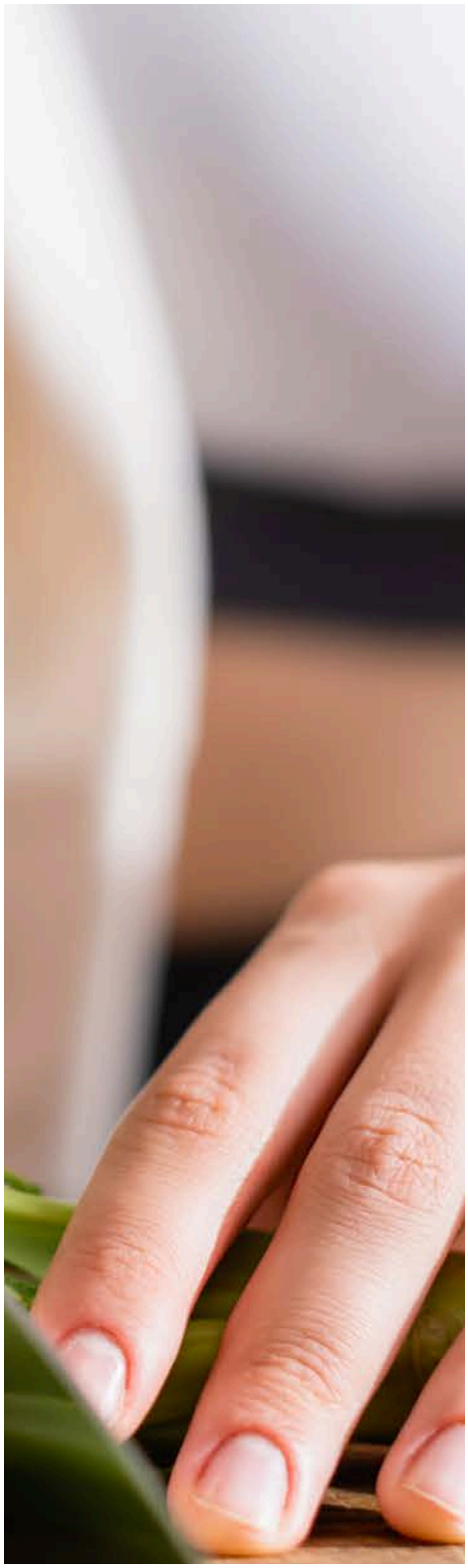

MOBILE CART REPORT

IOWA STATE UNIVERSITY™
Extension and Outreach

MOBILE CART REPORT

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COVID highlighted many constraints in the local food system and supply chain. Specifically, farms and food businesses have shared needs for tools for increasing creating value-added products for specialty crops as a means for scaling-up and connecting to new markets.

This research project involved assessing the need for processing and aggregation infrastructure for scaling-up processing of fresh fruits and vegetables in Iowa. The project built upon existing research and development of a mobile processing cart, which was tested in different non-profit and private business settings. It also created a conceptual design for an on-farm processing trailer that would be accessible and food-safe for farmers to process on their own property. The following paper describes first the findings from the mobile cart in regard to financial modeling for the utilization of the cart in non-profit and private business settings and redesign needs based on pilot partner testing. It then reviews the reasons behind the creation of a fruit and vegetable processing trailer and basic conceptual designs for further exploration.

INTRODUCTION & SCOPE

A transdisciplinary team has collaborated since 2017 focusing on local farm and food enterprises and their efforts to develop and produce value-added fruit and vegetable products. From this focused work in the food systems the team has developed a scaling-up processing toolkit in three languages and identified opportunities for value-added products for food retail businesses. Based on these previous projects to tackle the constraints of fruit and vegetable processing in Iowa, there was an identified a need to create options for small scale value-added fruit and vegetable product across businesses and organizations. Since 2019 Iowa State University Extension and Outreach has explored the needs and potential solutions to combat this gap in processing, which led to designing and building a prototype mobile fruit and vegetable processing cart in 2021. Since development of the cart, a collaborative team at Iowa State University Extension and Outreach piloted the mobile processing cart in four locations, looking to understand community and business development, food innovation, and food safety.

This pilot project involved supporting new and existing Anglo and minority farmers and food businesses in their efforts to process fresh fruits and vegetables. Iowa has specifically identified a need for processing and aggregation infrastructure for scaling-up processing of fresh fruits and vegetables. The project addressed many of the considerations a food business would need to address when considering adding value-added processing at any scale including food safety licensing and regulations, business development and feasibility, design and development of equipment, and local food procurement availability. This project will build on the existing research and work of a prototype mobile processing cart and evolve into a scale that is appropriate for on-farm processing for larger scale processing. It will also include conversations with farmers and funding partners for the potential of a fruit and vegetable processing bricks and mortar location.

MOBILE CART

CONCEPT DESCRIPTION

The Mobile Cart was developed in 2021 year with partnership from Iowa State Food Safety team, graduate students, Community Economic Development and Farm, Food, and Enterprise Development Extension. The cart was intended to fulfill a need for small businesses to process raw products into value-added products in spaces that didn't have a certified kitchen nor the funding to build out a certified kitchen. The cart was designed to fulfill inspection needs for food safe inspection, and included a food processor. Over the course of 2 years, the cart was built and tested in event space, businesses, and schools.

The prototype mobile cart included key components for successful fruit and vegetable processing including a food processor, a variety of processing types of blades, cutlery equipment, apple corer, and additional kitchen items to support small scale businesses and organizations. The intended audience were groups seeking to add value to current products, like raw produce, through the creation of salsas, diced or sliced fruits and vegetables, meal kits, etc. that can then be, used in taste testing, educations, or resold. Another use identified through the pilot was processing products for taste-testing in school or event settings.

FIGURE 1: Series of Images of Value-added Products Made at Retailer 1 Pilot (right).

FIGURE 2: Series of Images of Value-added Products Made at School Pilot (above).

The mobile processing cart is a stand-alone unit that needs to be transported to food safe locations for use. Depending on the use there are different requirements for food safety restrictions. For example, if a business would like to sell products following processing, there are specific licensing and food safety considerations. Through the pilot, the processing cart was tested at two events, one school, and one business, where all users then shared feedback on potential financial viability of the cart, current design issues, and overall use of the current cart model. In addition to these four on-site pilots, additional feedback was received from businesses on financial considerations and the value they may receive from using the processing cart in their own businesses. Pilot participants were selected based on their interest to add value to raw products for taste-testing or to create new value-added products for sale. The mobile processing cart allowed them to test the viability of value-added processing for their business, or to test the potential of utilizing in school or event settings for education and engagement. Access to the mobile processing cart allowed them to process into a value-added item. An additional requirement for the testing of the cart was to have access to a three-tiered sink for cleaning and preparing products ahead of use, and a sink for cleaning the equipment.

DESIGN

During the pilot, partner organizations were asked to both provide feedback on design and financial considerations. This section will review feedback on design aspects and share edits and design strategy moving forward. The original prototype is shown below, with findings and updated concept design drawings following.

FIGURE 3: Images of Prototype Mobile Cart Developed with Iowa State Engineering Capstone Project (above).

Primary feedback from cart testers included time, water access, processor (size and cleaning), and cart development. Table 1 below details direct quotes.

TABLE 1: Critiques of Cart Components of Cart Testers.

COMPONENT	OPPORTUNITIES	POSITIVE
Time	Time consuming to use at first, but once became familiar with the tools and features, the process was fast and easy.	
Water	Due to the cart not having a sink . . . adding a sink to the cart would be [beneficial]. This is a challenge due to weight, water access, and pump; however, the trailer or additional modules for the cart may assist in this in the future.	
Processor		
Size	The current size of the processor is culinary scale and does not adequately fit all sizes of fruits and vegetables. For example, larger apples will need to be cored and then halved or quartered to go through the processor.	Have the processor and using the dicing blade made fast work of this task.
Cleaning	While the culinary processor is an effective tool, without having access to more powerful cleaning tools in kitchens, the dicing blades can be very difficult to clean.	
Cart	The cart was designed with the pop-up shelves to create more space for preparation and processing. The pop-up ability includes squeezing the sides of a metal piece to allow for the shelf to shift up and down. These are quite tight and can be difficult to fold up and down.	Trash bin cut-out was very helpful and noticeable decrease in food waste. [The] mobile food processing cart is an amazing idea for entrepreneurs.

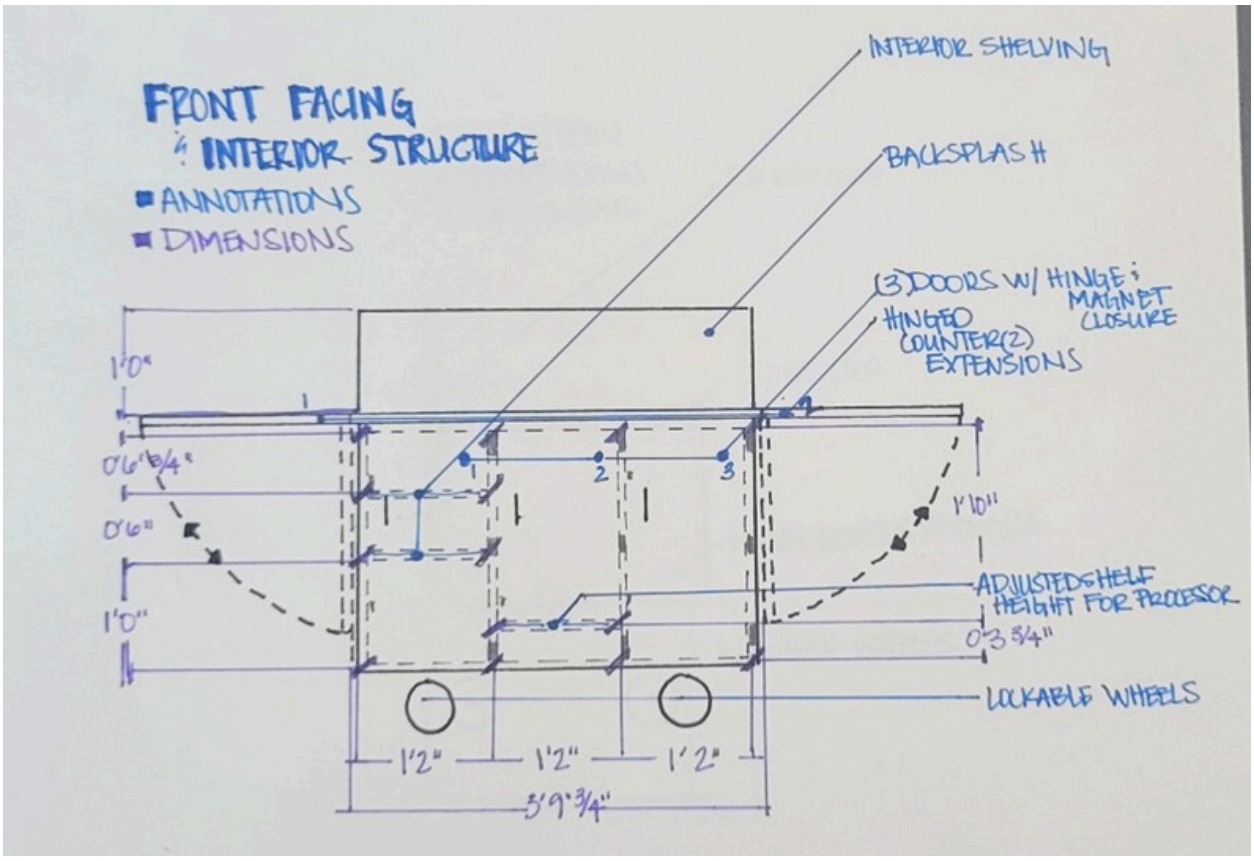


FIGURE 4: Front-facing and Interior Structure Concept Design (above).

UPDATED CONCEPT DESIGN

Feedback from the test pilot locations provided the team with specific design changes to increase the usability and experience of the processing cart. The annotated drawings below depict some of the main changes to the cart to improve performance.

The main change depicted in the "Top View" drawing include moving the trash shoot to the middle of the cart instead of to one side. This provides the person processing space on both sides of the processing machine for easier use and direct disposal of food waste.

The overall width of the cart will be kept to the specified 2'8" which will allow the updated cart to go through any standard doorway. An update both seen in the "Side and Front Views" includes a taller backsplash. This modification provides an additional safety measure along with space for additional vertical storage and business branding.
Additionally, the cart's doors and storage has been rearranged to foster easier access and the change in location for the waste disposal.

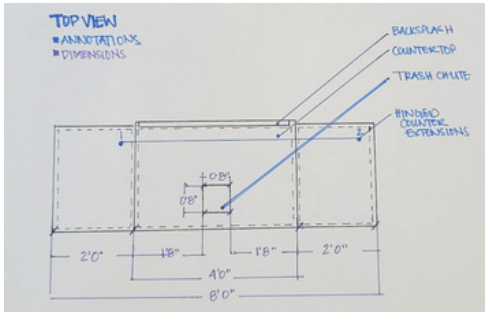


FIGURE 5: Top-view Concept Design (above).

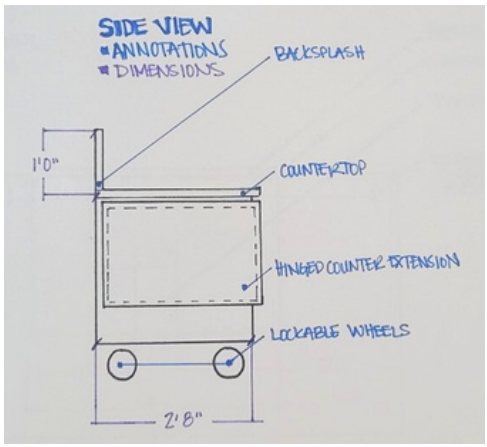


FIGURE 6: Side-view Concept Design (above).

FINANCIAL FINDINGS

Two businesses, an event, and a school were recruited to provide feedback on the prototype mobile fruit and vegetable processing cart. These four organizations were asked to evaluate the cart and provide either projected or actual sales data. A primary goal of the project was to determine if the cost of the cart could be recovered through profits gained by its usage. Results obtained from these four organizations show that the estimated $10,000 investment in a cart such as this could generally be recovered within a reasonable period of time.

Three of the organizations provided projected data based on their perception of resale potential, while one provided actual results after testing in their facility. Organizations were asked to provide feedback on the financial understanding and the ease of using the spreadsheets.

TABLE 2: Financial Feedback from Cart Testers.

PRICE AND QUANTITIES

"Does not think in terms of sales dollars, but rather in quantities (pounds, quantity, etc.)"

OTHER COSTS, BEYOND PRODUCT

- Would like more columns so individual costs can be entered (labor hours, labor rate, packaging and labels).
- If processing seconds costs are viewed differently, basically, "free."
- Wondering how to handle and track allocation of overhead items such as insurance, regulatory compliance, administration.
- There is a learning curve for each product to be processed, such as food safety, how best to process each product (cube, slice, etc.), shelf life. Can these costs be identified and tracked?

FOOD WASTE

- Food waste must be considered somewhere.
- Some processed product will go unsold and should be accounted for. Will be more of this "waste" in a retail setting, less when filling orders.

INCOME STATEMENT

On the income statement would like to be able to adjust sales year to year, rather than the present scenario where every year growth is the same.

The financial data reported by each company follows, along with additional analysis and financial projections.

EVENT

For this event the cart was used to prepare a product called Egg Skillet. This required processing of four inputs which were shredded cheese, shredded leafy greens, diced onions, and diced potatoes. At this event the food was given away, so the figures supplied were projections. The hypothetical sales revenue that would have been generated from sales of Egg Skillets was $1,163, and it was estimated that this was $388 more than the products could have sold for if not processed. Deducting costs of $88 the net gain was $300.

TABLE 3: Event, Hypothetical Sales Revenue of Egg Skillets.

HYPOTHETICAL SALES REVENUE OF EGG SKILLETS	
Typical Revenue (Unprocessed)	$755
Extra Revenue from Processing	$388
Total Projected Revenue	**$1,163**
Extra Revenue from Processing	$388
Additional Costs of Processing	$88
Net Gain from Processing	**$300**

Since the cart was only used for one day and results were estimates, assumptions were made about long-term usage. First, since the sale date reported was a weekend day (Sunday), it was assumed the Egg Skillet will only be offered for sale on weekends and only for events to assess this as a business practice to pay off the cart. With weekend sales at events, it was estimated that the average net gain from use of the mobile processing cart will be $300 each day (Saturday and Sunday), or $600 for the weekend. In this instance the total annual gain would then be $31,200, and the cart would pay for itself in about four months.

A second scenario could be that the Egg Skillet is offered for sale every day, but also assumed that sales on weekdays is one-half of the sales made on weekends. Additionally, it is assumed that processing costs are proportionate to those reported by the company, meaning an additional net profit of $150 each weekday. Annualizing these results then we have a total gain of $70,200 and the cart is paid for in less than two months.

RETAILER #1

Retailer #1 reported actual sales data and used the mobile processing cart to prepare and make several different Hispanic food items. There were sales of $1,702.70 of products that generally could be classified as ready to eat snacks and drinks. The products, such as Dorilocos and Duros, combine fresh processed items, such as limes, cubed cucumber, and grated carrots, with chips like Doritos, Tostitos, or a puffed wheat snack. Of these, Dorilocos created the most sales revenue, while Duros produced the greatest profit margin (mark-up percentage). The retailer reported they did not use the cart throughout the month, but instead it was used only on days when greater sales were anticipated. They learned that sales improved when products were processed fresh at lunchtime, rather than prepared in advance. Additional products made were then put in the refrigerator for retail purchase.

Data supplied by the retailer showed that sales of these value-added products resulted in $846 of added revenue. No data was supplied for additional costs associated with creation of these products, primarily labor. Therefore, it was assumed that costs were equivalent to one-third of the additional revenue, or $282. This leaves a net gain of $564 for the month.

TABLE 4: Retailer #1, Actual Sales Data for Hispanic Food Items.

ACTUAL SALES DATA FOR HISPANIC FOOD ITEMS	
Typical Revenue (Unprocessed)	$856.70
Extra Revenue from Processing	$846.00
Total Projected Revenue	**$1,702.70**
Extra Revenue from Processing	$846.00
Additional Costs of Processing	$282.00
Net Gain from Processing	**$564.00**

Given the results above, annual revenue from these products would be $20,432.40 ($1,702.70 x 12 months). For the year, the added value of the processing would be $10,152. Adjusting for estimated costs associated with the processing, the net annual gain would be reduced to $6,768. Given these results, the cart would pay for itself in roughly 18 months.

TABLE 5: Retailer #1, Annualized Sales Revenue Hispanic Food Items.

ANNUALIZED SALES REVENUE FOR HISPANIC FOOD ITEMS	
Annualized Revenue (Unprocessed)	$10,280.40
Extra Revenue from Processing	$10,152.00
Total Projected Revenue	**$20,432.40**
Extra Revenue from Processing	$10,152.00
Additional Costs of Processing	$3,384.00
Net Gain from Processing	**$6,768.00**

RETAILER #1, CONTINUED

As stated above, the mobile cart was only used on days when stronger sales were anticipated. In fact, on one two-day "weekend" (Friday and Sunday) sales of processed products were $488.72. If we add Saturday sales and project the same daily sales of $244.36 over the course of 52 weekends, revenue would total $38,120.16 and the added revenue would be $18,940.30 (proportionate to added revenue from actual results). With costs assumed to remain at one-third of added revenue, net gain from the processed products would be $12,626.87 and the cart would pay for itself in less than ten months.

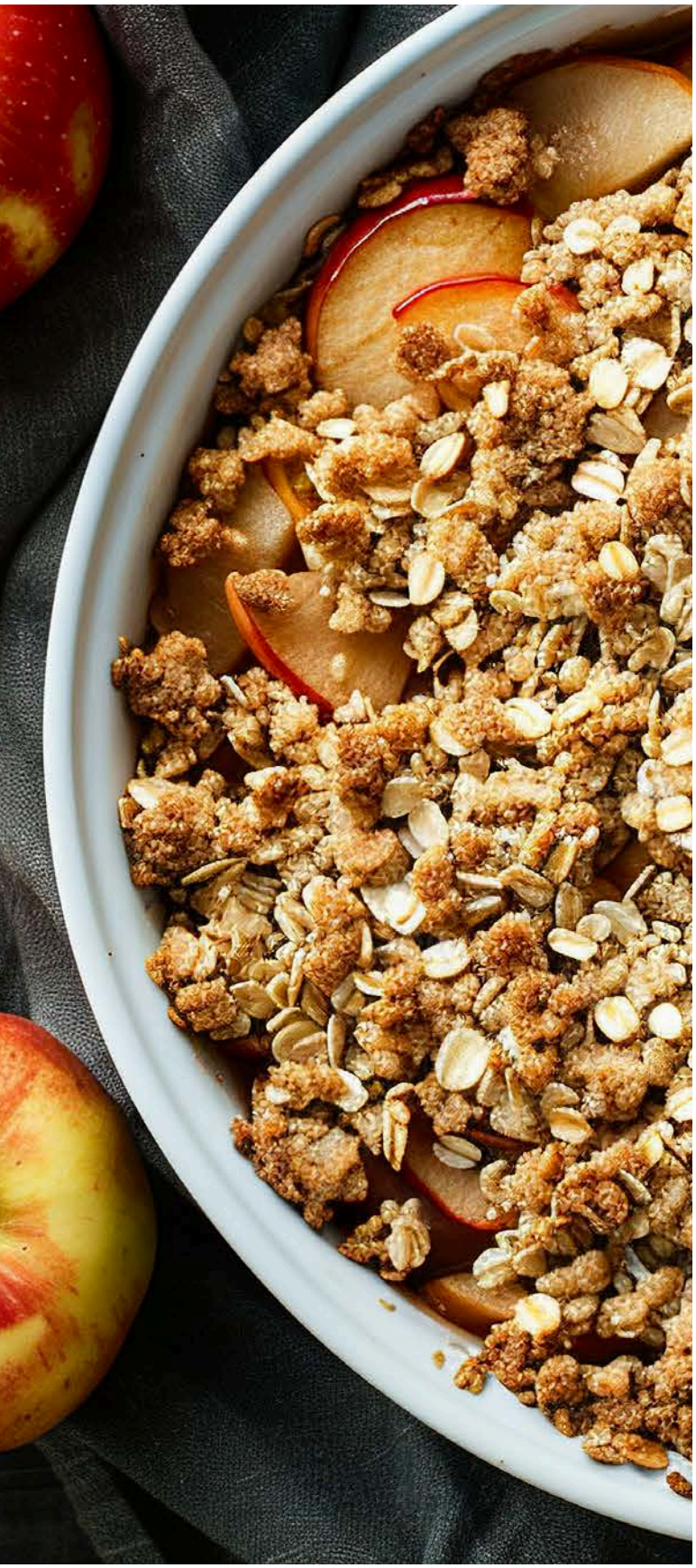
TABLE 6: Retailer #1, Annualized Projected Sales Revenue for Weekends Only.

ANNUALIZED SALES REVENUE FOR WEEKENDS ONLY	
Annualized Revenue (Unprocessed)	$19,179.86
Extra Revenue from Processing	$18,940.30
Total Projected Revenue	**$38,120.16**
Extra Revenue from Processing	$18,940.30
Additional Costs of Processing	$6,313.43
Net Gain from Processing	**$12,626.87**

Finally, it was assumed that if the cart was used seven days a week, and sales on weekdays added 50% to weekday sales, or $122.18 per day, total annual revenue would rise to $63,533.60 and added revenue is $31,567.17. Deducting one-third for added costs and the net revenue gain for the year would be $21,044.78 and the cost recovery period would be less than six months.

TABLE 7: Retailer #1, Annualized Projected Sales Revenue, Including Weekdays.

ANNUALIZED SALES REVENUE INCLUDING WEEKDAYS	
Annualized Revenue (Unprocessed)	$31,966.43
Extra Revenue from Processing	$31,567.17
Total Projected Revenue	**$63,533.60**
Extra Revenue from Processing	$31,567.17
Additional Costs of Processing	$10,522.39
Net Gain from Processing	**$21,044.78**



SCHOOL

The third participant provided hypothetical data for three products and primarily focused on using the cart for taste-testing education. Each created product used one or more processed inputs. These were quesadillas, apple crisp, and minestrone soup. Projected sales of these items for a one-month period were $1,800 for minestrone soup, $1,575 for quesadillas, and $750 for Apple Crisp. Total sales were estimated to be $4,125 and mark-up was estimated to be 50% for each product. It is assumed that the projections included products that are made available for sale only periodically on certain days of the month. The school estimated that additional revenue created through use of the processing cart during this time was $1,375. Costs of processing was estimated at $176 leaving net value-added of $1,199.

TABLE 8: School, Hypothetical Sales Data for Taste-Testing Education.

HYPOTHETICAL SALES DATA FOR TASTE-TESTING EDUCATION	
Typical Revenue (Unprocessed)	$2,750.00
Extra Revenue from Processing	$1,375.00
Total Projected Revenue	**$4,125.00**
Extra Revenue from Processing	$1,375.00
Estimated Costs of Processing	176.00
Net Gain from Processing	**$1,199.00**

This data shows that the $1,575 in quesadilla sales created added value of $463. With periodic monthly usage as assumed in the data above, this annualizes to added value of $5,556. For minestrone soup the $1,800 in projected sales produces added value of $513, or $6,156 annually. Apple crisp sales of $750 will yield $225 in additional margin, or $2,700 when annualized.

Using the cart only periodically, the school projects they will recoup the cost of the cart in roughly eight months. If the school were to use the cart more regularly it is very likely the time for cost recovery would be shortened, perhaps considerably. For example, if the cart were used regularly and these projected sales were doubled, added net value would be roughly $2,400 per month and cost of the processing unit would be recovered in a little more than four months.

RETAILER #2

This retailer provided a great deal of feedback on the data to be reported but also estimated their revenue and expense if they used the cart for processing. The projected annual figures showed total additional revenue of $8,850 and net value added of $5,167. Given the projections, the cart would pay for itself in about two years.

The processing contemplated included diced bell peppers, cubed sweet potatoes, shredded cabbage, quartered watermelon, cubed squash, and cubed roots. The greatest mark-up was expected to be 80% for the cabbage, resulting in $1,600 additional revenue. The complete list of products and projections is shown below.

TABLE 9: Retailer #2, Projected Annual Figures by Product.

PROJECTED ANNUAL FIGURES BY PRODUCT			
Product	Mark-up (%)	Added Revenue	Net Value Added
Bell Peppers	50%	$1,000	$750
Sweet Potatoes	50%	$1,500	$1,250
Cabbage	80%	$1,600	$850
Watermelon	30%	$1,500	$667
Winter Squash	50%	$1,250	$650
Roots for Roasting	50%	$2,000	$1,000
Total:		**$8,850**	**$5,167**

FINANCIAL FEASIBILITY SUMMARY

Three of the companies reporting projected or actual results expected to use the mobile cart to process ingredients for a ready-to-eat product. While the data supplied indicates the processing would lead to increased profitability of products sold, it is more difficult to precisely gauge the impact of the cart in these scenarios, due to the efforts being projections vs. actuals. It was also noticed that many of the products created included processed produce that was then combined with other products. Retailer #2 was the only project collaborator that planned to sell processed produce as stand-alone items.

For the four organizations participating in these trials there seems to be consensus that the mobile processing cart can be an advantage for users. However, we realize that not all expenses were fully understood, such as labor, materials for packaging, etc. Additionally, none of the participating companies planned to use the cart on a daily basis, so as described above, a certain amount of estimating was necessary.

Company #1, holding the event, only submitted results for one day, but those projected results were promising. With regular usage it seems the $10,000 cart cost could be recouped within six months, and quite possibly less. Company #2, a retailer, used the cart only on weekends, but estimates showed that with more regular usage costs could be recovered in six to ten months. While projecting only periodic usage of the cart, Company #3, a school, was able to project additional net profit of almost $1,200, which if projected forward would allow for recovery of the $10,000 cart in about eight months. Additional analysis showed that with more regular usage, cart costs could be recouped in two to four months. Estimates from Company #4, a retailer, were less optimistic, showing it would take roughly two years to recover the cost of the cart. Time to pay off cart from examples follows.

TABLE 10: Estimated Time to Pay Off Cart.

	COMPANY 1 (EVENT)	COMPANY 2 (RETAILER)	COMPANY 3 (SCHOOL)	COMPANY 4 (RETAILER)
Type of product	Egg skillet	Numerous value-added products	Quesadillas, apple crisp, and minestrone soup	Single product processing
Time of usage	Regular events	Weekend retail	Two options; irregular and more frequent	Weekly
Time to pay off cart	6 months	6-10 months	8 months with existing use; or with increased use 2-4 months	2 years

Although results described in this document are generally positive, potential cart users will want to use caution when weighing the benefits versus costs of using a mobile unit such as this. As users consider investing in this $10,000 mobile processing cart, there are several key factors to consider:

1. Items selected for processing: As described above, some products are marked up a considerable amount after processing, others are marked up a lesser amount. Potential users should spend some time researching the products intended for processing and estimate the mark-up percentage that can be achieved.
2. Amount of processing needed with the cart: If the cart is used regularly and for a variety of products, there is a good chance that this cart will pay for itself within a reasonable period of time. On the other hand, if the cart will be used only sparingly, it may not make sense to make this investment.
3. Availability of alternative processing facilities: If the user currently has the ability to process produce at their own facility or some other convenient location, it may still be worthwhile to have mobile processing capability, but additional analysis may be needed. Would the mobile cart provide flexibility that would allow for additional processing on demand? If so, would the estimated increase in net profits make this a good investment?
4. Costs of processing: Price and additional costs should be carefully considered in advance. If the end product requires a great deal of processing labor, an unusual amount of waste, or there are other costs to consider, these must be accounted for in any profitability analysis.

NEXT STEPS

Following the implementation, the team received additional funding support from Iowa State to re-build the cart based on feedback from the developers and initial pilot users. The cart will be fabricated in the summer of 2024 and offered through County Extension Services as a rentable model. Additionally, the food safety team continues to work with inspections to create up to date materials for utilizing the cart. Standard operating procedures will be available soon.

PROCESSING TRAILER

CONCEPT DESCRIPTION

While the Mobile Cart was an initial offering for businesses to process fruits and vegetables for value-added products, the team learned quickly that the cart was not appropriate for on-farm processing. This was primarily due to the lack of food safe buildings and interior coverings. Therefore, the team began to investigate the potential for a fruit and vegetable processing trailer that could be driven on to farm properties, allow for processing of products, and then store products on farm post-processing.

The design concept was tested via a scaled model at several different events across the state of Iowa. Processing equipment was included based on interviews and surveys with farmers and food businesses across the state.

It should be noted that the current rendition of the concept includes a powered trailer with both pre-and post- refrigerated storage, however, it is anticipated that farmers or value-added product creators will need to store product on site post- creation. A second option would be partnering with a food hub or alternative producer for the storage and re-distribution of the product. The team is applying for further grant and funding support to investigate the best logistics and business model for the trailer to ensure sustainability.

CONCEPTUAL DESIGN & DESCRIPTION

EXTERIOR

FIGURE 10: Exterior Image of Trailer Concept Design (above).

The trailer exterior (Figure 10) shows the right side of the trailer – as described in Figure 2, with a pedestrian entrance ramp to the back of the raw product storage.

The front of the trailer (shown in Figure 11, above) will feature two different coolers, one for initial raw product and the second for processed product. Both the right and left of the coolers will feature ramps for loading and unloading products.

Figure 11 also highlights the potential for a pop out expansion on the left of the trailer to create additional workspace. The back of trailer features both a three-tiered and single sink utilities. Finally, a double door is built in to offer loading and unloading capabilities for processing equipment.

The standard interior was created in this fashion as a flexible option for different user types to then switch out equipment based on needs. In this concept, equipment would be stored at a convenient location for accessible transition of equipment depending on season and need. In addition to the equipment showcased in the standard interior, it is then anticipated that the following three scenarios would be highly plausible for Iowa farmers, based on common products identified from the interviews for innovative value-added products.

STANDARD INTERIOR

FIGURE 11: Standard Interior with Expansion Shown (above).

Figure 12, below, includes a layout that incorporates equipment for sorting, blanching, and packaging greens. In this scenario, raw products would be brought into the front right side of the trailer and then go through the process of cleaning, blanching, and packaging. Following the packaging the product would flow back to the left side of the trailer for cold storage before transportation to final market destination.

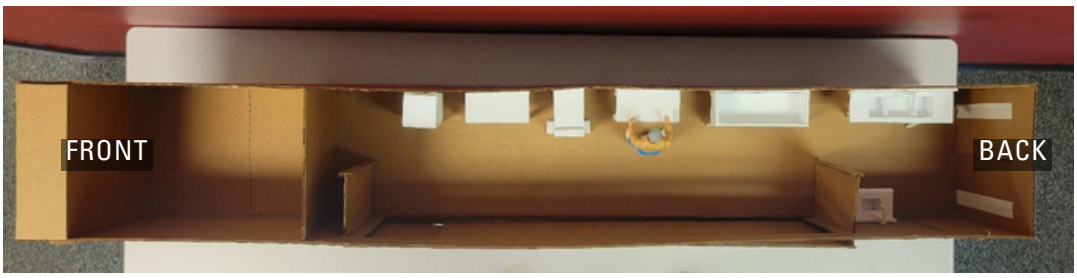


FIGURE 12: Example Layout for Blanching and Packaging Greens (left).

Figure 13, below, includes a layout that incorporates equipment for creating a packaged fresh cut medley. In this scenario, raw products would be brought into the front right side of the trailer and then go through cleaning, processing, and packaging. Following the packaging the product would flow back to the left side of the trailer for cold storage before transportation to final market destination.

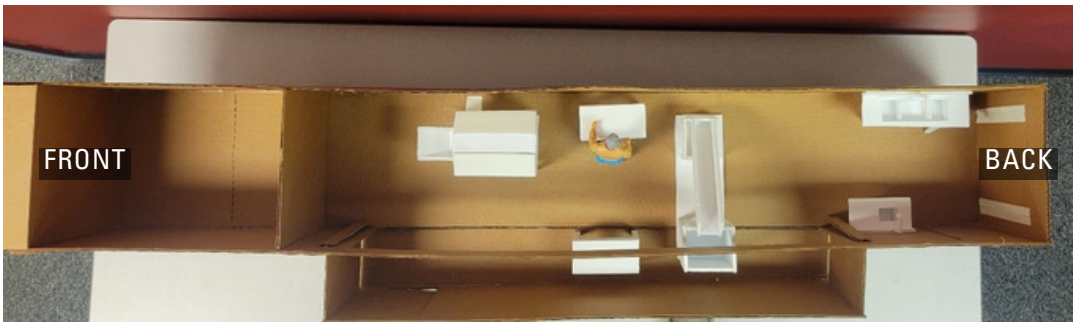


FIGURE 13: Example Layout for Processing and Packaging Mixed Vegetables (left).

Figure 14, below, includes a layout that incorporates equipment for creating sliced, vacuum sealed products. In this scenario, raw products would be brought into the front right side of the trailer and then go through cleaning, slicing, and packaging. Following the packaging the product would flow back to the left side of the trailer for cold storage before transportation to final market destination.

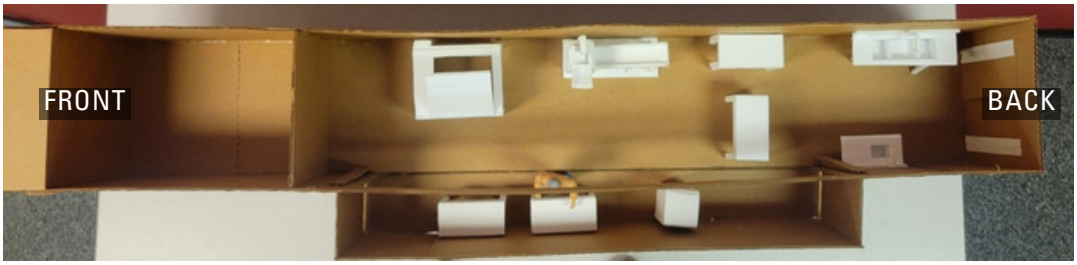


FIGURE 14: Example Layout for Slicing Produce and Vacuum Sealing (left).

NEXT STEPS FOR PROCESSING TRAILER

Possible next steps will include further understanding hurdles identified for farmers to have access to food-safe locations that could be utilized to process, store, and sell value-added products, specifically fruit and vegetables. Research would involve investigation into efforts to process fresh fruits and vegetables through on-farm processing techniques, such as additional precedent and case studies and outreach to successful mobile processing businesses nationwide.

The research may include site visits to understand design, logistics, business model, and product development. Which will then lead to an updated processing trailer design and precedent study report.