

## Designing a Food Processing Laboratory in Haiti

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### INTRODUCTION

**Partner:** Gedeon Eugene, President, Université Anténor Firmin (UNAF)

**Location:** Cap-Haïtien, Haiti

**Motivation:**

- Almost 50% of food is imported<sup>1</sup>
- 40% of households in chronic food insecurity<sup>2</sup>
- Up to 35% of basic food crop is lost in post-harvest chain<sup>3</sup>



**Food Processing in Haiti:**

"This is where value is added and where the most profit can be realized, yet there is almost no food processing industry in Haiti..."<sup>4</sup>

### GOAL AND OBJECTIVES

To design a commercial food laboratory for students at UNAF where they can learn the skills and technology needed to produce quality, shelf-stable food products that can be transferred into a sustainable microbusiness

- Preserve raw ingredients for the off-season
- Enable small-scale production for local community
- Provide hands-on learning for UNAF students
- Be a business opportunity for the students and community

### CONSTRAINTS

- Water quality
- Inputs/resources
- Technical experience of users
- Energy use
- Implementation cost

### GLOBAL AND SOCIETAL IMPACT

- Capacity building
- Supply chain development
- Encourage entrepreneurship
- Creation of jobs
- Partnership development

### FOOD SAFETY CONSIDERATIONS

**Mango:**

- Most common fruit grown in Haiti, but spoils very rapidly
- Sweet, fibrous stone fruit
- Approximately 30% waste (peel, stone, and fibrous flesh)



**Product Selection:**

- Mango Jam
- Mango Nectar

**Mango Products:**

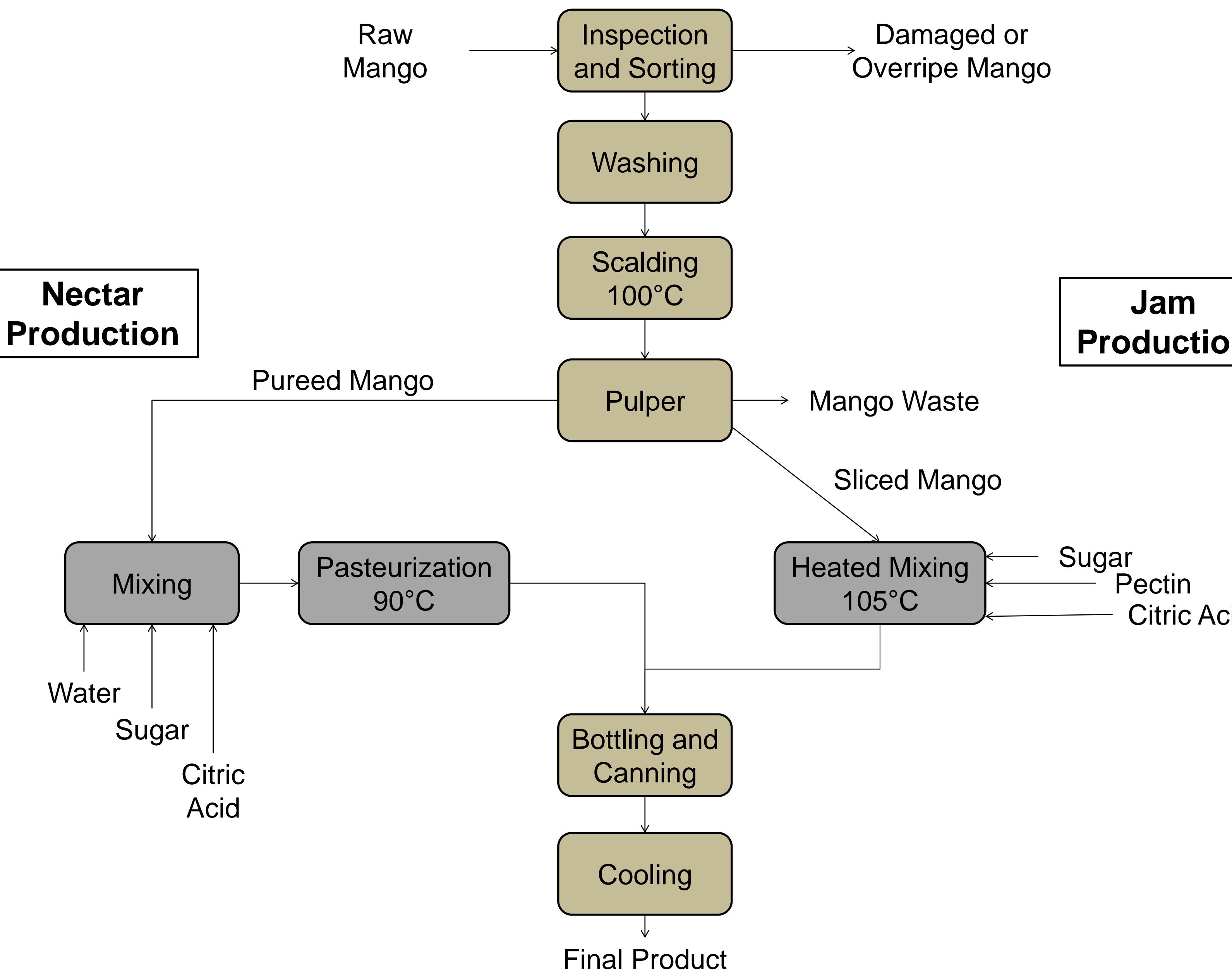
- High-acid
- Low water activity
- Risk of spoilage and disease
- Target microorganism: *Escherichia coli*

| Bacteria            | <i>Leuconostoc mesenteroides</i> <sup>5</sup>       |
|---------------------|---|
|                     | <i>Alicyclobacillus acidocaldarius</i> <sup>6</sup> |
| Fungi               | <i>Zygosaccharomyces bailii</i> <sup>6</sup>        |
|                     | <i>Pichia membranaefaciens</i> <sup>5</sup>         |
|                     | <i>Penicillium expansum</i> <sup>7</sup>            |
| Foodborne Pathogens | <i>E. coli</i> O157:H7 <sup>5,8</sup>               |
|                     | Various <i>Salmonella</i> species <sup>8</sup>      |
|                     | <i>Listeria monocytogenes</i> <sup>5,8</sup>        |

### PRODUCT RECIPE

| Ingredient  | Functionality       | Mass Percent (%) |              |
|-------------|---------------------|------------------|--------------|
|             |                     | Mango Jam        | Mango Nectar |
| Raw Mango   | Flavor, Color, Body | 49.5             | 30.0         |
| Sugar       | Sweetener           | 49.5             | 8.7          |
| Citric Acid | Lowers pH           | 0.6              | 0.5          |
| Pectin      | Gelling Agent       | 0.5              | -            |
| Water       | Reduce Viscosity    | -                | 60.8         |

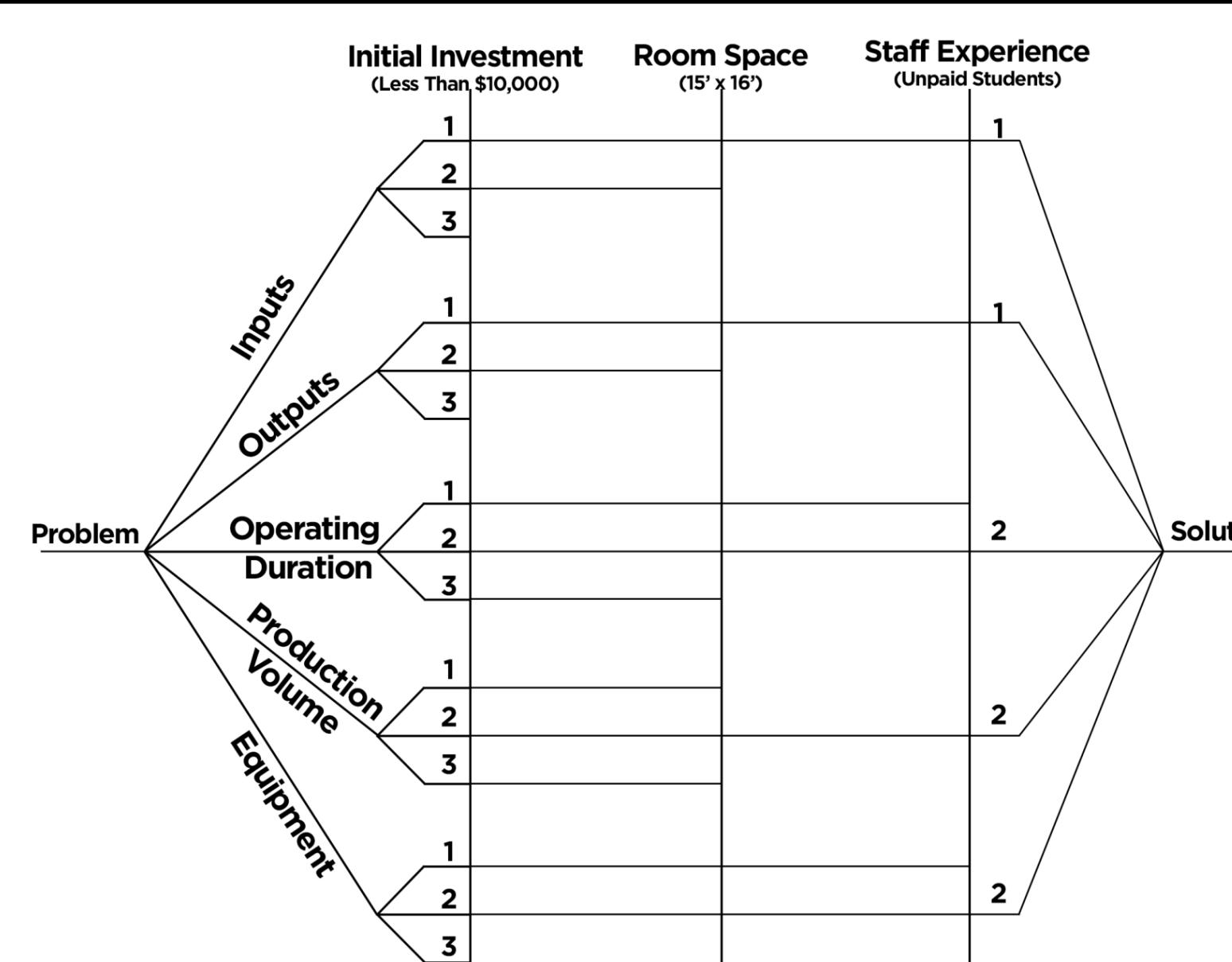
### PROCESS FLOW



### PROCESSING REQUIREMENTS

|                           | Juice | Jam   | Units |
|---------------------------|-------|-------|-------|
| Batch Size                | 150   | 200   | L     |
| Cycle Time                | 125   | 140   | min   |
| Mango Input               | 170   | 90    | kg    |
| Mango Waste               | 51    | 27    | kg    |
| Water Req. for Product    | 128   | -     | L     |
| Water Req. for Processing | 737   | 712   | L     |
| Thermal Load              | 153.1 | 137.5 | MJ    |

### ALTERNATIVE SOLUTIONS



**References**

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- Duarte, I.F, Delgadillo, I, Gil, AM. 2006. Study of Natural Mango Juice Spoilage and Microbial Contamination with *Penicillium expansum* by High Resolution <sup>1</sup>H NMR spectroscopy. *Food Chemistry*, 96, p. 313-324.
- United States Food and Drug Administration. Guidance for Industry: Juice HACCP Hazards and Controls Guidance First Edition; Final Guidance. Available from <http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/ucm072557.htm>.

### FUTURE WORK

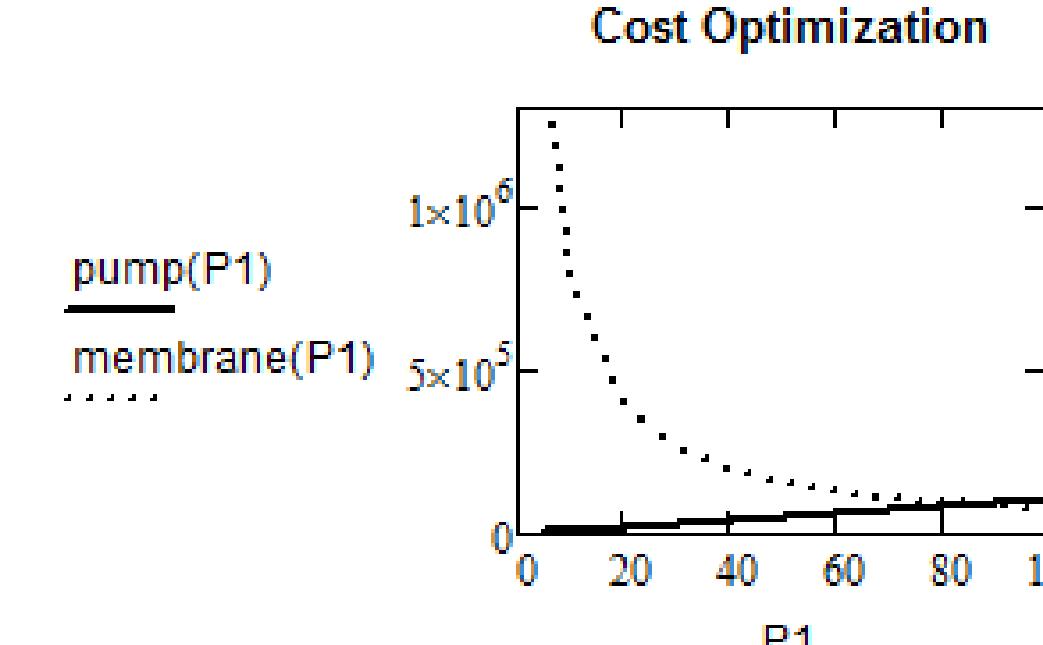
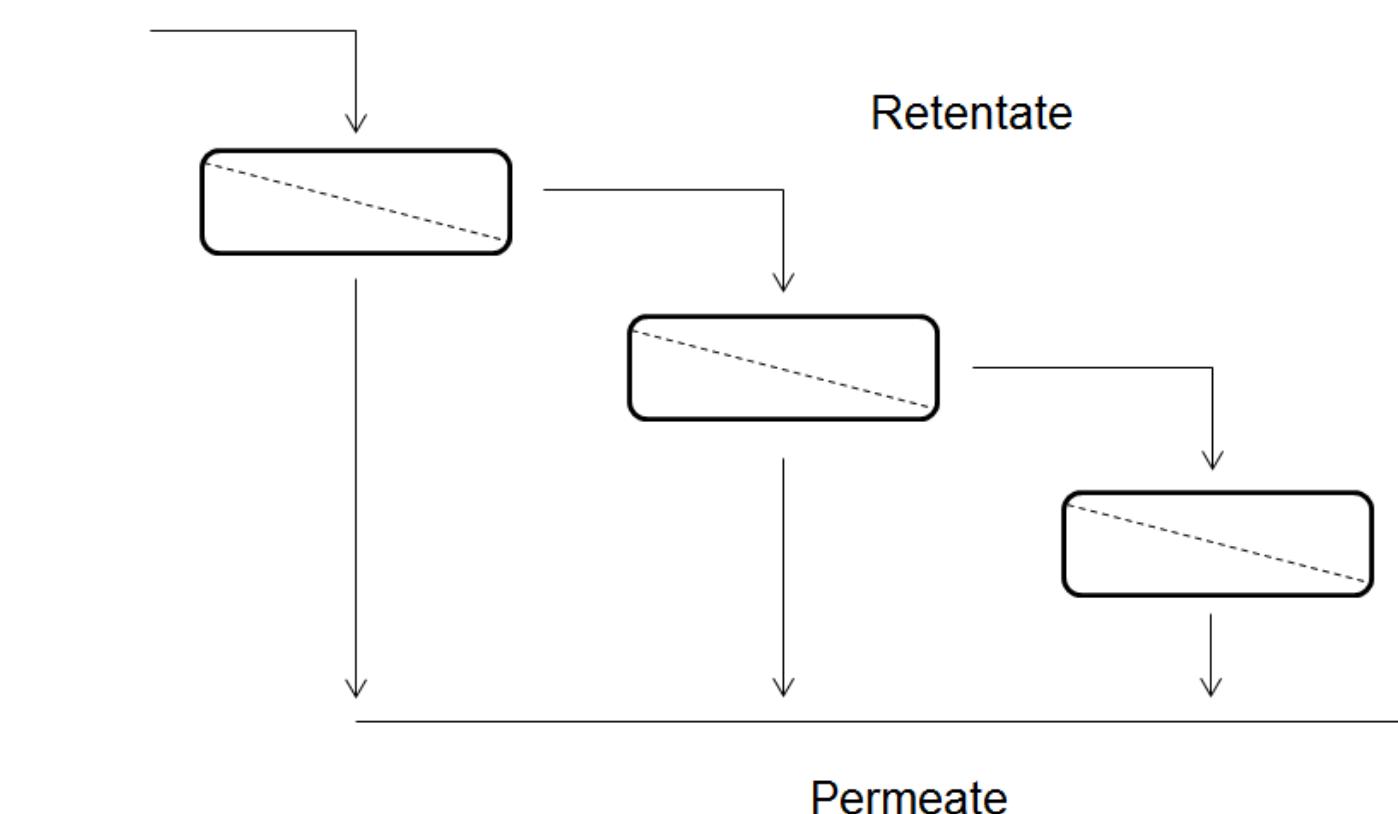
- Design course curriculum to introduce students to food processing
- Find and train project manager
- Address sustainability hurdles
- Identify local market opportunities

### IMPLEMENTATION

The partner is invested in this project (will be constructing a new building on the university property) and is eager to implement as a microbusiness for UNA.

### SUSTAINABILITY: REVERSE OSMOSIS

**Optimization Goal:** To minimize the cost of producing sterile water by changing the pressure required by the pump to produce  $6.0 \times 10^{-5} \text{ m}^3/\text{s}$ .



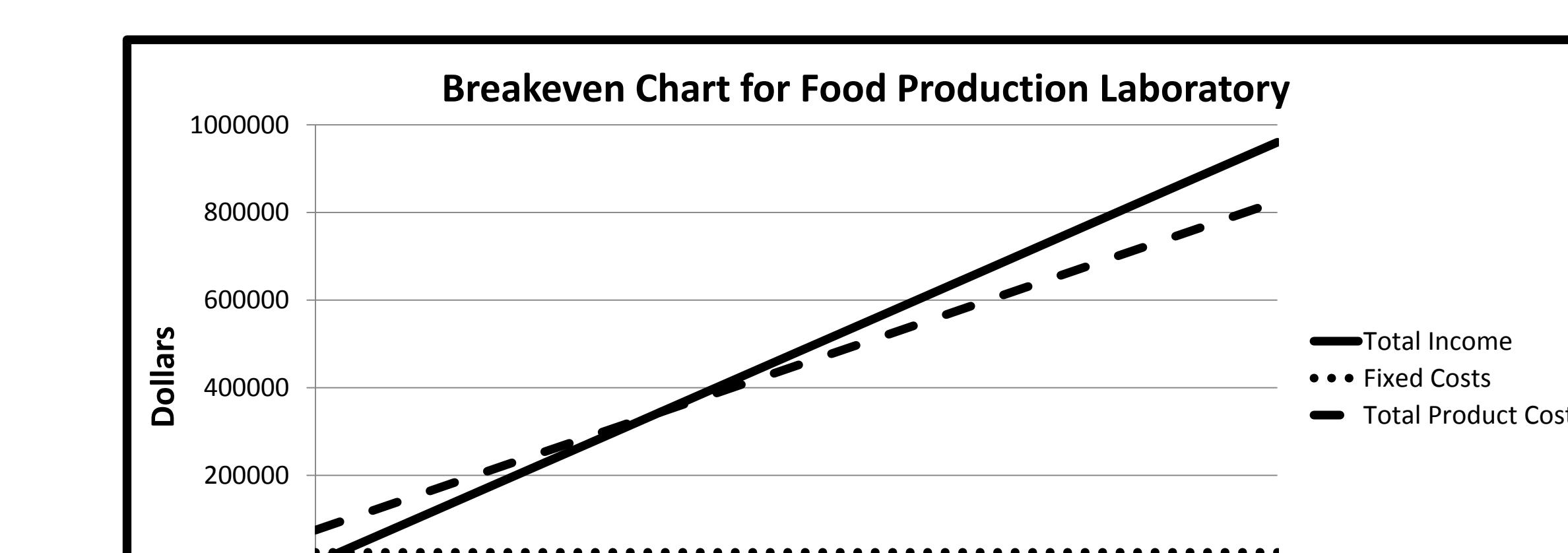
### ECONOMICS

| Equipment                    | Size (unit)                       | Estimate (\$)     |
|------------------------------|-----------------------------------|-------------------|
| Wash Basin                   | 0.51 (m <sup>3</sup> )            | 250.00            |
| Scalding Tank (Tank)         | 1.17 (m <sup>3</sup> )            | 250.00            |
| Scalding Tank (Heating)      | 800 (W)                           | 200.00            |
| Fruit Pulper                 | 350 (kg/hr)                       | 3,000.00          |
| Heating and Mixing Tank      | 1.17 (m <sup>3</sup> )            | 1,500.00          |
| Heat Exchanger               | 0.125 (m <sup>2</sup> surf. area) | 700.00            |
| Water Bath                   | 0.15 (m <sup>3</sup> )            | 350.00            |
| <b>Total Equipment Cost:</b> |                                   | <b>\$6,250.00</b> |

| Total Product Cost        | Estimate (\$/yr)   |
|---------------------------|--------------------|
| Manufacturing Cost        | 72,000.00          |
| Direct Production Costs   | 48,000.00          |
| Fixed Charges             | 18,000.00          |
| Plant Overhead Costs      | 6,000.00           |
| General Expenses          | 3,000.00           |
| <b>Total Yearly Cost:</b> | <b>\$72,000.00</b> |

| Capital Investment               | Estimate (\$)      |
|----------------------------------|--------------------|
| Direct Plant Cost                | 12,875.00          |
| Indirect Plant Cost              | 7,875.00           |
| Fixed-Capital Investment         | 20,750.00          |
| Working Capital                  | 3,500.00           |
| <b>Total Capital Investment:</b> | <b>\$24,250.00</b> |

| Product      | Unit       | Production Rate    | Price   | Income (\$/yr)                          |
|--------------|------------|--------------------|---------|---|
| Mango Jam    | 500 mL Jar | 7,200 jars/year    | \$10.00 | \$72,000.00                             |
| Mango Nectar | 1 L bottle | 4,800 bottles/year | \$5.00  | \$24,000.00                             |
|              |            |                    |         | <b>Total Yearly Income: \$96,000.00</b> |



### FUTURE WORK

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