PURDUE UNIVERSITY

CAPSTONE/SENIOR DESIGN EXPERIENCE 2019

# SC-1: Cilantro & Methi Harvester

Agricultural & Biological ENGINEERING

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## 1. Introduction

**Objective**

- To design a cost-effective harvester for cilantro and methi that doesn't cut the roots while requiring minimal labor.

**Design Elements**

- Harvesting Head
- Plant transportation system

## 2. Project Background

- Currently these herbs are harvested by hand and require 12-14 hour work days to harvest one acre. They are pulled out of the soil manually.
- Farmbrero wants to keep roots intact since this increases shelf live and boosts the product's aesthetic.

**Criteria**

- Harvest 1 acre in 8-hour day
- Keep plant roots intact
- Minimize labor
- Ease of manufacturing

**Constraints**

- ~$72,000
- Simple to operate and maintain
- ~1 meter wide header

## 3. Factors

**Social Factors**

- Increases cilantro and methi production
  - Makes both plants more accessible

**Economic Factors**

- Allows Farmbrero to reduce labor costs

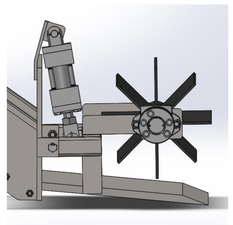
**Environmental Factors**

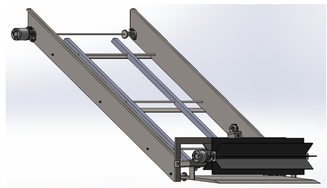
- Harvester runs of gasoline, producing $CO_2$ emissions

## 4. Harvester Design

**Harvesting Head**

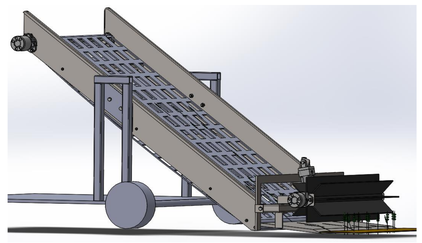
- Loosely based on sod-cutter blade
- Hydraulic cylinder adjusts cutting depth
- Paddle reel assists plant movement





**Plant Conveyance System**

- Uses chain-link wire mesh belt
- Powered by Hydraulic Motor



**Complete Assembly**

- Designed to sit on self-propelled platform
- Forward motion pushes plants from cutter blade to conveyor belt

## 5. Alternative Solutions

**Design Matrices**

- Harvesting Head

| Criteria | Removal | Roots Intact | Cost | Ease of Use | Total |
|---|---|---|---|---|---|
| Scores | 0.3 | 0.4 | 0.2 | 0.1 | |
| Sod Cutter | 9 / 2.7 | 9 / 3.6 | 7 / 1.4 | 7 / 0.7 | 8.4 |
| Indiv. Heads | 7 / 2.1 | 9 / 3.6 | 7 / 1.4 | 7 / 0.7 | 7.8 |
| Radish Type | 8 / 2.4 | 8 / 3.2 | 3 / 0.6 | 2 / 0.2 | 6 |

- Plant Transportation

| Criteria | Transport | Separation | Cost | Undamaged Product | Total |
|---|---|---|---|---|---|
| Scores | 0.4 | 0.2 | 0.2 | 0.2 | |
| Flat Belt | 8 / 3.2 | 3 / 0.6 | 8 / 1.6 | 8 / 1.6 | 7 |
| Chain Belt | 8 / 3.2 | 7 / 1.4 | 7 / 1.4 | 7 / 1.4 | 7.4 |
| Roller Conveyor | 7 / 2.8 | 7 / 1.4 | 6 / 1.2 | 7 / 1.4 | 6.8 |
| Radish Type | 7 / 2.8 | 8 / 1.6 | 3 / 0.6 | 5 / 1.0 | 6 |

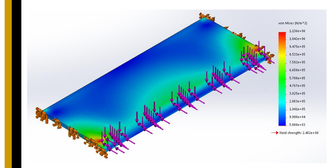
## 6. Deliverables

- Design of a harvesting head and plant conveyance system for cilantro and methi crops
  - 3-D Model: Solidworks
- Make cilantro and methi more accessible in the United States
- Cost Estimate

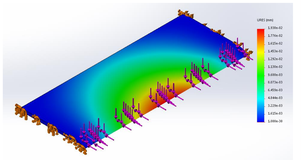
## 7. Validation Process

**Finite Element Analysis**

- Cutter blade
  - Utilizing ASAE D497.4 Standard, the draft (in Newtons) can be calculated with the following equation:
    $D = F_i [A + B(S) + C(S)^2]WT$



Von Mises Stress Analysis



Displacement

## 8. Economic Analysis

**Cost Estimate**

- "Total Parts" refers to number of pieces required prior to fabrication

The cost analysis does not include an estimate for the platform the plant transportation system will sit on as it was not within the project scope. Given the small cost in respect to the $72,000 estimate from similar harvesting machines, it can be assumed this solution is economically feasible for Farmbrero. It can also be concluded that the platform may take up a large portion of the budget.

| Material/Item | Total Parts | Cost |
|---|---|---|
| Motors + Accessories | 6 | $ 1,366.10 |
| A36 Steel | 11 | $ 667.96 |
| Carbon Steel | 1 | $ 78.26 |
| Plastics | 2 | $ 203.20 |
| Miscellaneous | 54 | $ 335.47 |
| Chain Belt | 1 | $ 1,125.00 |
| Fabrication | N/A | $ 1,135.80 |
| Total | | $ 4,911.79 |

## 9. Conclusion

The group concluded that the project scope of designing a harvesting head and plant transportation system that has the ability to harvest cilantro and methi has been successfully fulfilled. The harvesting head is properly designed to allow the plants to move from the cutter blade to the conveyance belt, and then up to workers who can bundle the plants.

For future projects, a group could work on designing a moving platform that the harvesting mechanism can rest on. In addition, the machine could be built and testing could be performed to validate the machine's design.

Sponsor:
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Standards:
ASAE D497.4
ASAE S338.5
ASABE AD11684

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