PURDUE UNIVERSITY

CAPSTONE/DESIGN EXPERIENCE 2016

Cotton Packaging

Agricultural & Biological ENGINEERING

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Problem Statement and Background:

Clean cotton lint is vital to creating high quality fabrics and other cotton products. It is necessary to avoid contamination of harvested cotton. Harvested seed cotton bales can become contaminated by plastics, oil, grease, and other debris during storage in the field or during transportation to a cotton gin. The most effective way to keep harvested seed cotton free of contamination is to package the cotton immediately as it is harvested. Current seed cotton packaging systems require extensive labor or provide minimal contamination protection. CNH Industrial is working with Signode Industrial Group, a leader in material packaging systems, to develop a cotton bale forming and packaging system similar to the one currently being implemented in Signode's GinFast system for packaging ginned cotton. The Cotton Packaging Team worked with CNH and Signode to develop design alternatives and model a potential solution for implementation in future cotton picker designs.

Current CNH module with manually placed tarp

Current production Case IH Module Express cotton picker

System Requirements:

- Final system must be fully automated
- Must be able to complete full work day (approx. 300 bales) without reloading packaging material
- Must be compatible with other components required to harvest and compress cotton
- Bale size 4'x4'x8'

Project Goals:

- Focus on automating packaging material input and placement
- Design components required to place packaging material
- Create a working prototype packaging system scaled to size of current GinFast bags that demonstrates a potential future solution for use on CNH cotton pickers
  - –All the parts have the correct movement, but are not automated
  - –Sufficiently demonstrate all required processes

Design Alternatives:

A decision matrix was used to determine the best of several potential design solutions by evaluating the effectiveness of each design in several factors that were determined through research and the system requirements stated by CNH. Seven total designs were considered and evaluated in nine different categories to determine the optimum solution.

Unweighted Decision Matrix (7 best - 1 worst)

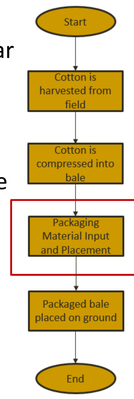
Design Description	Cost	Labor Requirement	Contamination Prevention	Packaging Material Contamination Potential	Bale Handling	Bale Transportation	Design Feasibility	Reliability	Compatibility with Other Components	Total
Large Square Module, Manual Tarp (CNH Current)	7	1	1	3	1	3	7	7	7	37
Small Square Bale, Individual Bag from Roll	3	4	5	7	7	7	2	4	5	44
Small Square Bale, Individual Bag from Stack	4	7	5	7	7	7	2	3	5	47
Small Square Bale, Continuous Material Cut	6	4	5	4	7	7	6	6	4	49
Round Bale, Continous Material Cut	5	4	5	4	3	2	5	6	3	37
Small Square Bale, Wrapped	2	5	7	5	7	7	6	5	2	46
Round Bale, Wrapped	1	5	7	5	3	2	6	5	1	35

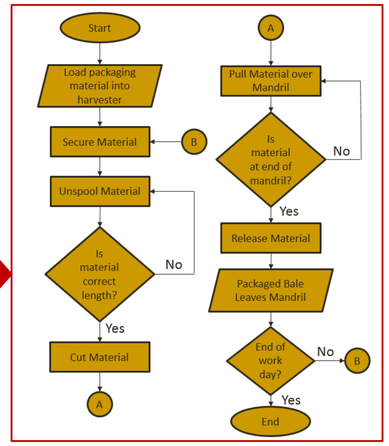
Final Design:

The chosen design uses packaging material from a roll to package a small square bale. The packaging system was broken down and divided into several processes required for automated packaging of cotton bales.

Loading Material

- Circular loomed PET material similar to GinFast bags
- Comes as a tube on a roll of 300 bales worth of material
- Loaded into top of harvester before work day





Securing Material

- Open end of material is secured to grab/pull device
- Material is secured on all sides to prevent catching and tearing of material
- Grab/pull device includes actuated gripping plates to secure material

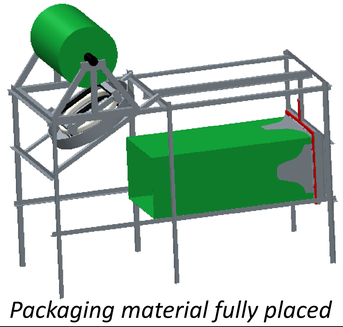
Grab/pull device used to secure material

Unspooling/Cutting Material

- After material is secured to grabbing mechanism, the pulling mechanism will rotate to unspool the bag until it reaches the correct length
- Motor on spool assists in unspooling material

Placing Material

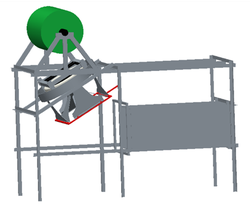
- Cut material is pulled over bale mandril
- Grabbing mechanism releases material at end of mandril



Packaging material fully placed

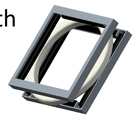
Material Removal and Reset

- Packaging material is removed as cotton bale is pushed out of mandril
- 6 inch of material overhang required
- Grabber/puller component returns to start position to grab next bale's material



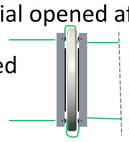
Floating Mandril:

- Material must be held open between cutting for one bale and grabbing for next bale
- Packaging material will initially be pulled through a "floating" opener mandril to keep the packaging material opened after cutting to bale length



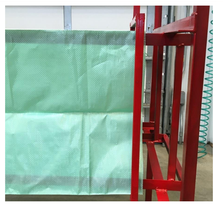
Floating mandril

Material feed from roll



Material cut and grabbed

Material flow



Economics, Impact, and Sustainability:

- Estimated budget of $1000 to develop fully automated scaled prototype
- $80 spent to prototype structural components
  - –100' – 1 ½"x 1 ½" x 1/8" angle iron x $.60/ft = $60
  - –25' – 1"x 1"x 16 ga. Steel tube x $.80/ft = $20
- Estimated production cost of $1500-$2500 per machine to implement packaging system
- Reduces labor cost to farmer
- Reduces ginning cost
- Increases value of harvested cotton
- Increases quality of life for cotton industry workers
- Reduces energy required for bale transportation and ginning

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