Problem:
- Vegetables and other fresh produce are difficult to transport from field to the market
- Customers expect only the best looking and non-damaged produce to buy
- They pick over any damaged or bruised product, resulting in lost profit for the farmer
- Current mode of transport is with rigid frame wagons that do no offer any protection from road hazards, such as potholes and rough roads

Background:
- Farmer near Battleground, IN specializing in vegetables and other fresh produce.
- Wagons are pulled into town from Battleground during the morning hours, where the wagons will sit through the day, letting customers pick out the produce they want
- Wagon must be able to handle a max of 4,000 lbs

Alternative Solutions
Solution #1- A-Arm Design
- Complicated design
- Requires constant maintenance and upkeep
- Expensive to implement
- Large amounts of custom modifications

Solution #2- Coil Springs
- Increases bouncing to the load
- Does not allow for variability with the load
- Can sway and cause shifting of the load
- Adds too much height to the wagon bed

Solution #3- Leaf Springs
- Does not allow variability of load
- Requires a large area to mount
- Durable and low maintenance
- Decreases the shocks to the load, but does not dampen

Solution #4- Air Bags
- Allow variability of suspension for load sizes
- Easy Installation
- Can be mounted in smaller areas
- Require lateral support

Final Design
Criteria: Maintenance, Cost, Durability, Ease of Installation, Variability in Load

The team decided that Solution #4 best suited the criteria that we had set out to meet.
- Solution #1 was too expensive and was not feasible
- Solution #2 did not meet the ease of installation due to limits in mounting space
- Solution #3 was not feasible due to the height that it put the wagon bed

Final Solution: Solution #4- Air Bags
- Air Bags mounted low, to allow minimum height to the wagon, only adding 3-1/2” to the height
- Custom mounting brackets
- Shock Absorbers to allow lateral support of the Air Bags
- Shock Absorbers dampen the vertical motion
- Can be made in on-farm shops by farmers

Impact/Sustainability
- Simple design, that allows farmers easy implementation with on-farm resources
- Parts for initial build or any repair work are easily found at automotive or farm stores
- Sturdy design that can be adapted for any other use that the farmer would have to haul fragile cargo
  - This can be done through changing the shocks and air bags to others that are readily available on the market
- Helps to reduce damage and increase the profit that a farmer can make

Economic Analysis

<table>
<thead>
<tr>
<th>Items</th>
<th># of Units</th>
<th>Cost per Unit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firestone 9001 Air Bag</td>
<td>4</td>
<td>$94.00</td>
<td>$376.00</td>
</tr>
<tr>
<td>Air Hoses</td>
<td>1</td>
<td>$35.00</td>
<td>$35.00</td>
</tr>
<tr>
<td>Magnum 65177 Shock Absorbers</td>
<td>4</td>
<td>$48.40</td>
<td>$193.60</td>
</tr>
<tr>
<td>Misc. Nuts &amp; Air Fittings</td>
<td>1</td>
<td>$75.00</td>
<td>$75.00</td>
</tr>
<tr>
<td>3/16&quot; Steel Plates</td>
<td>4</td>
<td>$50.00</td>
<td>$200.00</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td></td>
<td><strong>$879.60</strong></td>
<td><strong>$879.60</strong></td>
</tr>
</tbody>
</table>

Estimated Economic Impact
- Damage per day: $20.00
- 3 Days / Week: $60.00
- 12 Weeks / Year: $720.00

Budget
- Equipment Lifetime - 7 years: $5,040.00
- 30% reduction in damage: $1,512.00

Acknowledgements:
Mr. Scott Brand

Sponsor:
Dr. Martin Okos

Technical Advisor:
Dr. Daniel Ess

Instructors:
Dr. Robert Stwalley
Dr. Bernie Engel

Title: Wagon Suspension II