An NGO in Cameroon approached Purdue with the problem of rural transport. The NGO and Purdue worked on a vehicle design solution. The solution developed was the AgRover. Purdue partnered to also build prototypes in Guinea and Uganda. A company was formed by students and alumni to scale the innovation.

From a design request... to MAPS and the AgRover
Our Solution: The MAPS AgRover

- Up to 26 km/L Fuel Economy
- 100% Readily Available Parts Found in Sub-Saharan Africa
- 5-Speed Transmission
- Up to 32 kmh Top Speed
- 1000 kg Payload
- Bench Seating for Passengers
- Suspension on all Wheels
- PTO to Attachments
- Hydraulic Brakes on all Wheels

Designed by students at Purdue University in West Lafayette, Indiana, USA in partnership with ACREST in Cameroon.
Purdue Utility Project (PUP)

- Mini-PUP: an even smaller, simpler, more cost-effective vehicle
- ePUP: electric powered PUP
Operational workshop in Lagos, Nigeria.

Two vehicles finished, 4 more in progress

The first AgRover produced is now on a palm oil farm
<table>
<thead>
<tr>
<th></th>
<th>Motor-bike</th>
<th>AgRover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel rate, unloaded (km/L)</td>
<td>35</td>
<td>26</td>
</tr>
<tr>
<td>Fuel rate, loaded (km/L)</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>Fuel price ($/L)</td>
<td>0.45</td>
<td>0.46</td>
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<tr>
<td>Payload (kg)</td>
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<td>900</td>
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<tr>
<td>Unloaded speed (km/hr)</td>
<td>45</td>
<td>28</td>
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<tr>
<td>Loaded speed (km/hr)</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Trip (km)</td>
<td>10</td>
<td>10</td>
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<tr>
<td>Rate (Naira/kg)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Rate ($/kg)</td>
<td>$0.01</td>
<td>$0.01</td>
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<tr>
<td>Working day (hr)</td>
<td>8</td>
<td>8</td>
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<tr>
<td>Trip time (hr)</td>
<td>0.56</td>
<td>0.86</td>
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<tr>
<td>Fuel per trip (L)</td>
<td>0.69</td>
<td>0.94</td>
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<tr>
<td>Cost per trip ($)</td>
<td>$0.31</td>
<td>$0.43</td>
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<tr>
<td>Trips per day</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>Fuel cost per day ($)</td>
<td>$4.32</td>
<td>$3.89</td>
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<tr>
<td>Kg/day</td>
<td>1400</td>
<td>8100</td>
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<tr>
<td>Income ($/day)</td>
<td>$7.00</td>
<td>$40.50</td>
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<tr>
<td>Rate of transport (kg-km/hr)</td>
<td>3,750</td>
<td>21,600</td>
</tr>
<tr>
<td>Profit ($/day)</td>
<td>$2.68</td>
<td>$36.61</td>
</tr>
</tbody>
</table>
Local Manufacturing

- Cost is a barrier to mechanization
- Imported equipment
  - Expensive
  - Depends on unreliable supply chain
- Local Manufacturing
  - Decrease costs
  - Suitable equipment
  - Maintainable locally
  - Employment, build local economy

Questions and challenges:

- How local is local?
- Efficiency?
- Cost?
- Quality?
  - Local materials
  - Fabrication process

References: Houmy et al., 2013; Kienzle et al., 2013; Sims et al., 2012; Jenane 2012
Thesis: Investigation of an affordable multigrain thresher for smallholder farmers in sub-Saharan Africa

Thesis available at: http://search.proquest.com/docview/1776459149
Scope of Study

- Sub-Saharan Africa
- Smallholder farmers
- Multigrain
  - Corn
  - Soybeans (cowpeas)
- Locally manufactured
Field Research in Ghana

- 2 farmers, 3 manufacturers, and an NGO

First farmer
- 9 yr. old thresher, overloading sieve, towing, estimated 380 kg/h (corn)

Second farmer
- New thresher, imported, estimated 1875 kg/h (corn), $1650 (after 70% subsidy)

Local manufacturer, Processors
- $1580-$1850, 1875 kg/h

Rental service
- 1 bag out of 10

A thresher manufacturer with one of his machines in Ghana. Source: Author.
Final Product
Design Overview

- Axial flow
  - Less breakage
  - Higher threshing efficiency

- Rotary separation combined with threshing cylinder

- Rasp bars
  - Common, can thresh most types of crops
Parts and Materials

- Primary
  - Belts, pulleys, bearings, shafts
  - Rebar
  - Angle Iron
  - Sheet Metal

- Other
  - Perforated sheet metal
Design: Function
Design: The Driveline

- B size V-belts and pulleys
- Twisted belt
- Over-hanging pulleys
- Shafts
  - D1 - Intermediate shaft between power source and other components
  - D2 - Fan
  - D3 - Oscillating sieve camshaft
  - D4 - Threshing cylinder

At an engine speed of 3000 rpm:
- drum: 39 ft/s (12 m/s)
- sieve oscillation: 10 Hz
- air speed: 29 ft/s (8.9 m/s).
Methods

- Weighed out plant material
- Ran all the material through the thresher
- Weighed the material from
  1. The grain bin
  2. The exit chute
  3. The ground
  4. Left in the thresher
- Separated the grain from MOG for each sample
Methods

- Ideally
  - 100% of grain is in the bin
  - 0% MOG is in the bin
Final Test Results: Corn/Maize

Grain

- 95.9%
- 4.1%
- 1.8%
- 1.7%
- 0.6%

MOG

- 6.8%
- 13.5%
- 10.2%

69.5%

Sieve after threshing. Source: Jeremy Robison.

MOG from threshing cylinder. Source: Jeremy Robison.
Final Test Results: Soybeans

- **Grain**: 94.2%
  - 5.8%
  - 4.9%
  - 0.5%
  - 0.4%

- **MOG**: 18.8%
  - 9.2%
  - 67.0%
  - 5.0%

- **Final Test Results: Soybeans**
  - Chute
  - Thresher
  - Bin
  - Ground
Summary

- **Threshing efficiency**
  - Corn: 100%
  - Soybeans: 96%

- **Grain loss**
  - Corn: 3.5%
  - Soybeans: 5.4%

- **MOG in grain bin**
  - Corn: 1.3%
  - Soybeans: 6.6%

- **Feed rate**
  - Corn: 217 kg/h
  - Soybeans: 23 kg/h
## Cost

- **Table of costs**
- **Includes 6.5 hp engine**
- **Surplus Center pricing (pulleys and bearings)**
- **University research machine shop pricing (steel)**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Qty.</th>
<th>$/unit</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paint</td>
<td>Can</td>
<td>10</td>
<td>$0.99</td>
<td>$9.90</td>
</tr>
<tr>
<td>Idler Pulley</td>
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<tr>
<td>6.5 hp Engine</td>
<td></td>
<td>1</td>
<td>$99.99</td>
<td>$99.99</td>
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<td>2.5&quot; Pulley</td>
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<td>Nuts and Bolts</td>
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<td>V-Belts</td>
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<td>Wire mesh</td>
<td>roll</td>
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<td>Angle Iron</td>
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<td>161.4</td>
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<td>3/16&quot; Plate</td>
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<td>Perforated Steel</td>
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<td>Rebar</td>
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<td>20 ga. Sheet Metal</td>
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<td>14 ga. Sheet Metal</td>
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<td>1&quot; Steel Shaft</td>
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<td>8.6</td>
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<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$756.54</strong></td>
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</tbody>
</table>
Discussion: Threshing and Cleaning

- Feed rate
  - Difficult to put stalks into input chute
  - Threshing cylinder doesn’t accept material easily
  - Never was power limited

- Test limitations (batch method)
  - Only approximations
  - More accurate if samples are taken when running at steady state
  - Not directly comparable to other methods

References: Kutzbach & Quick, 1999
Thresher training in Zaria, Nigeria
- Samaru College of Agriculture

Build → Test → "Design"
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