The Present and Future of Agricultural Mechanization in Latin America

Current Situation of Mechanization in Latin America and a Global Perspective

S.A. Shearer
Food, Agricultural and Biological Engineering
Columbus, OH
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• Mechanization of grain is easy -- specialty crops present challenges.
• Should aggregate small holder farms or, utilized shared equipment business models (winners and losers).
• Provide management and operator education (e.g. selection, maintenance and operation).
• Must develop supply chain – equipment consumables and repair parts access.
• New government policies (e.g. suppression of import tariffs, cost share and tax incentives).
• Must create markets to absorb increased production – infrastructure may be limiting.
• Alternative access to capital – small holders may be limited by ability to secure debt.

Strategies for Mechanization of Indian Agriculture
First fixed-frame tractor over 500 hp!

Fendt 1050 Vario (396 to 517 hp) - MAN 12.7 L

http://www.used-fendt-tractors.com

http://farmindustrynews.com
Trends in Ballasted Tractor Weight

Spark Ignition Engines

Compression Ignition Engines

Note: Maximum tractor weight is increasing at a rate of 900 lb/yr.
2015 North American Combines

John Deere S690
- Engine - 13.5 L, 543 hp
- Grain Tank - 400 bu
- Unload Rate - 3.8 bu/s
- Fuel Tank - 330 gal
- Base Mass - 45,856 lbs
- Head - 616C (9,900 lb)
- Loaded Mass - 79,587 lbs

Case IH 9240
- Engine - 15.9 L, 550 hp
- Grain Tank - 410 bu
- Unload Rate - 4.5 bu/s
- Fuel Tank - 317 gal
- Base Mass - 46,297 lbs
- Head - 4416 (11,800 lbs)
- Loaded Mass - 83,114 lbs

Claas Lexion 780TT
- Engine - 15.6 L, 543 hp
- Grain Tank - 385 bu
- Unload Rate - 3.8 bu/s
- Fuel Capacity - 304 gal
- Base Mass - 39,683 lbs
- Head - 16 row (11,070 lbs)
- Loaded Mass - 73,855 lbs
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Combine Classes

- **Class X** – 565 hp
- **Class XI** – 629 hp
- **Class XII** – 693 hp
- **Class XIII** – 757 hp

Nominal Engine Power (hp) vs. Combine Class

The Ohio State University
How big is too big?

http://www.bauerbuiltmfg.com/db-series-planters.html
How fast is too fast?

Seeding rate of 63 ac/h!
Grain cart technology?
Grain Cart Compaction Study

Equalizer - 104,800 lbs
Wheeled - 96,000 lbs
Yield Map Resolution Enhancement

Visible V12  Yield Map  Adjusted Map

Yield (bu/ac)
- 10 to 90
- 90 to 125
- 125 to 150
- 150 to 175
- 175 to 200
- 200 to 226
# U.S. EPA Off-Highway Emissions (CI)

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<tr>
<td>0-7 (0-10)</td>
<td>(7.5) / 8.0 / 0.40</td>
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<td>8-18 (11-24)</td>
<td>(7.5) / 6.6 / 0.40</td>
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<td>19-36 (25-48)</td>
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<td>(4.7) / 5.5 / 0.03</td>
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<td>37-55 (49-74)</td>
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<td>Optional Tier 4 Interim 0.30 PM 1</td>
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<td>(4.7) / 5.5 / 0.03</td>
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<td>56-129 (75-173)</td>
<td>Tier 3</td>
<td>3.4 / 0.19 / 5.0 / 0.02</td>
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<td></td>
<td>0.40 / 0.19 / 5.0 / 0.02</td>
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<tr>
<td>130-560 (174-751)</td>
<td>Tier 3</td>
<td>2.0 / 0.19 / 3.5 / 0.02</td>
<td></td>
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<td>0.40 / 0.19 / 3.5 / 0.02</td>
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<tr>
<td>&gt;560 (&gt;751)</td>
<td>Tier 2</td>
<td>3.5 / 0.40 / 3.5 / 0.10</td>
<td>0.67 / 0.40 / 3.5 / 0.10 (a)</td>
<td>3.5 / 0.19 / 3.5 / 0.04</td>
<td>0.67 / 0.19 / 3.5 / 0.03 (b)</td>
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**NOx/HC2/CO/PM (g/kW-hr)**

(NOx+NMC)/CO/PM (g/kW-hr)

[Conversion: (g/kW-hr) x 0.7457 = g/bhp-hr]

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Global Emission Regulations

[Map showing global emission regulations with leading and lagging emissions marked.]
Evolution of IoT in Agricultural Machinery

- Chrysler Collision Detection protocol used on Deere 7000 series tractors facilitated communications between five ECUs (1992).
- Caterpillar utilized the SAE J1587 data link on the Challenger 75 and 85 tractors (1993).
- LBS standard (DIN 9684) was initiated in 1988.
- SAE J1939 standard was adopted for use in agriculture in 1992.
- JDLink Machine Messenger introduced in 2002.
- Machine Messenger replaced with JDLink Select and JDLink Ultimate in 2011.
Planter Sensor Densification
Agronomic and Machine Data Generation

- As-Applied Files (.shp)
  - Spraying [0.3 MB/ac]
  - NH$_3$ application [4.3 MB/ac]
  - Planting [5.5 MB/ac]
- Yield Data [4.3 MB/ac]
- Prescription Files [0.01 MB/ac]
- Soil/Fertility Data [0.6 MB/ac]
- Total [0.5 KB/plant (corn)]
- If 35,000 plants/acre (corn)
  - 17.5 MB/acre
  - 42.7 GB for 2,500 acres
Remote Sensing Data Generation

- 24 bits per pixel
- 2.5 cm/pixel
- 17.2 MB/acre of image data
- **4.9 kB/plant (corn)/yr**
- If 35,000 plants/acre (corn)
- 429 GB for 2,500 acres
- **10 x data rate**
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Verizon 4G Wireless Availability

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<table>
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<tr>
<th>Technology / Features</th>
<th>1G</th>
<th>2/2.5G</th>
<th>3G</th>
<th>4G</th>
<th>5G</th>
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<tr>
<td>Data Bandwidth</td>
<td>2 kbps</td>
<td>14.4-64 kbps</td>
<td>2 Mbps</td>
<td>200 Mbps to 1 Gbps for low mobility</td>
<td>1 Gbps and higher</td>
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<td>Standards</td>
<td>AMPS</td>
<td>2G: TDMA, CDMA, GSM 2.5G: GPRS, EDGE, 1xRTT</td>
<td>WCDMA, CDMA-2000</td>
<td>Single unified standard</td>
<td>Single unified standard</td>
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<tr>
<td>Technology</td>
<td>Analog cellular technology</td>
<td>Digital cellular technology</td>
<td>Broadbandwidth CDMA, IP technology</td>
<td>Unified IP and seamless combination of broadband, LAN/WAN/</td>
<td>Unified IP and seamless combination of broadband,</td>
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CNH Industrial and ASI Team Up

https://www.asirobots.com/farming/
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ASI Mobius Solution

https://www.asirobots.com(platforms/mobius/)
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Level of Autonomy

![Diagram showing the relationship between Total Cost, Total Cost of Ownership, System Development Cost, Lifecycle O&S Cost, and Optimal LOA.](image)
“How Smart, Connected Products Are Transforming Competition”
by M.E. Porter and J.E. Heppelmann
Blue River Technology

https://www.wired.com
Modern Agricultural Tractor
• A Deere 8R coming out of Waterloo should have a mechanical life of 20,000 h.
• In the Midwest U.S. this tractor will likely be used 500 h/yr.
• Mechanical life of the tractor might exceed 40 yrs.

Smart Phone
• Which model do most people carry today?
• What is “expected life” of an iPhone?
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Break-Even Investment Cost for Autonomous Tractors (Shockley, et al.)

The graph illustrates the break-even investment price for intelligent controls in US$1,000 as a function of hectares. The different lines represent various scenarios:

- Base Comparison
- 10% Selected Input Reduction
- 7% Yield Increase
- All Anticipated Benefits

The x-axis represents the number of hectares, while the y-axis shows the break-even investment price.
• First autonomous tractors will be used in permanent crops.
• Low-power vehicles will minimize liability (< 50 kW).
• Alleviation of soil compaction likely to drive the adoption of autonomous vehicles (< 3,500 kg).
• Expect a resurgence in spark ignition engines -- emissions and mechanical life will drive adoption.
• Obsolescence and mechanical life should coincide (5,000 h life or, 5 to 7 cropping seasons).
• Parts inventory and service will be provided via service trucks, minimizing the need for dealerships.
• New business models will challenge traditional agriculture – lease, contract farming and logistics services!
Questions?