Autonomous Vehicles in Agriculture

Rabbit Tractors
Overview

- Why Swarm-Farming
- Path to Autonomous Farms
- Key Design Considerations
Swarm-Farming
Swarm-Farming
Size
The Tractor of the Future

• 7mph; 3.5hp (15hp burst) All-Electric Drive
• 500-1000lb Payload Capacity (250lb Vehicle Weight)
• Omni-Directional Steering
• 28” - 40” Ground Clearance; Inner Row Capable
• Changeable Li-ion Batteries w/ 3-5 Hour Life
• Cost: ~$20,000 per unit
Why Swarm-Farming?

• Remedies Problems of Large Tractors
• Benefits in Itself
Modern Farm Equipment

BIG

- Annual Capacity Utilization Ratio: 5.6%
- Deployed Capacity Utilization Ratio: 58%

COMPLEX

- Annual Maintenance Cost: $18,200

HEAVY

- Crop (Revenue) Loss Due to Soil Compaction: 15%
Increased Utilization: Numerous

Average Acres/Min:
- 120’ Sprayer: 1.55 ac
- Swarm: 2.02 ac

30.8% Increase
(excl. in-field increases)
Increased Utilization: Numerous

**Average Acres/Min:**
- 120’ Sprayer: 1.98 ac
- Swarm: 2.05 ac

**3.35% Increase**
(excl. in-field increases)
Increased Utilization: Small

Cost to Ship a Container of Rabbits to South America:
$234 per unit

Cost to Ship a Sprayer 100 miles:
$4,500
Lower Maintenance Costs: Simple

- Electric Transmission vs Internal Combustion
- Simpler Design = Lower Parts Count
Increased Yield: Small

- Wider Operating Windows
- Minimal Rundown
- Less Compaction

- Penn State Ext: up to 34% in Alfalfa
- IA State Ext: up to 20% in Corn
- Wisc. Ext: see graph (corn)
Benefits of Swarms

- Operation Scalability
- More Agile
- New Management Practices
Agile: Higher Productivity

In-Field Efficiency of 120’ Sprayer: 58% (IA State Ext.)
New Management Practices
The Tractor of the Future

• Manually Moved Between Fields
• No Tillage
• More Units = More Headaches
Autonomous Tractor Adoption Hurdles

- Short, Stressful Work Windows
- Fitting into Current Management Practices
- Regulatory Environment
Adoption Path

1. Single-Vehicle; Non-Time-Critical Use-Cases
   - Introduce tech

2. Single-Vehicle; Supplemental Use-Cases
   - Compare to baseline

3. Complete Autonomous Swarm Farming
   - Convert as old equipment needs to be replaced

Rabbit Tractors
Single-Vehicle; Non-Time-Critical Use Cases

- Soil Sampling
- Cover Cropping
- Scouting
- Transport

- Enabling Labor; not replacing it
- “Premium” Value Propositions
Single-Vehicle; Supplemental Use-Cases

- Planting
- Spraying
- Harvesting

- Autonomous Operation with Nearby Oversight
Important IP Areas

- Hardware
- Low Power/Cost Compute
- Localization
- Path Planning
Low Cost Compute

- LIDAR
- GPU Processing
- Edge and Cloud Computing
Localization

RTK-GPS

SLAM
Path Planning

- State of the Art Utilizes High Compute
- Ag is Very Unique
- Swarms are Very Unique