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Robotic Potential for Food Production

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FutureFarm

Farming in 2050

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- Identify trends in the past that are true today and carry through to the future
- Identify weaknesses in current system
  - Is big always good? Highest yield gives highest profit? ....
  - Can tractors be twice the size in the next ten years? ....
- Assumptions
  - Sustainable food supply in changing conditions
  - Improve farm economic viability
  - Desire to have less environmental impact
  - Tighter legislation from EU and UK
  - Energy prices increase
  - More volatile weather due to climate change
  - More competition from world food prices
- UK agriculture must become more flexible and efficient

Current farming system

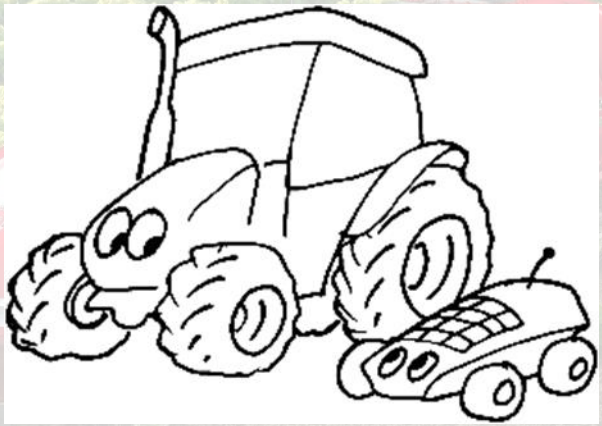
- Industrial production line
  - Maximum crop production after the war
  - Large tractors doing the same work everywhere
  - Cheap energy
- Flexible manufacturing
  - React to changes in real-time based on current conditions
    - Weather, growth, prices, legislation, incentives
    - Information intensive

Current size

- Mechanisation getting bigger all the time
  - Due to driver costs
    - Doubling work rates keeps costs down
  - Reaching maximum size
    - Combines are now at maximum size that can fit inside a railway tunnel for transport
    - Good for large fields
  - Small working window needs a bigger machine but the bigger the machine the smaller the working window.
    - Self fulfilling prophecy
    - Horsepower does not help when weight is the problem
  - We cannot change the weather but we can change the tractor

Farming with robots

- Keeping seeds, sprays, fertiliser etc. the same
- Remove machine constraints
- Focus on plant needs
- Farm Management Information System
- Large manned tractors for large harvesting logistics
- Four stages
  - Crop establishment
  - Crop scouting
  - Crop care
  - Selective harvesting



Robotic seeder

- Ultra light, very low draught force
  - No agronomic compaction
  - Put seed into the ground in any weather
- Micro tillage
  - Cultivate for each individual seed position
- Permanent planting positions
  - Same place each year
- Use vertical or rotary seeding methods
  - Punch planting
- Seeding depth to moisture
  - Improve germination rates

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Ultra light seeding robot

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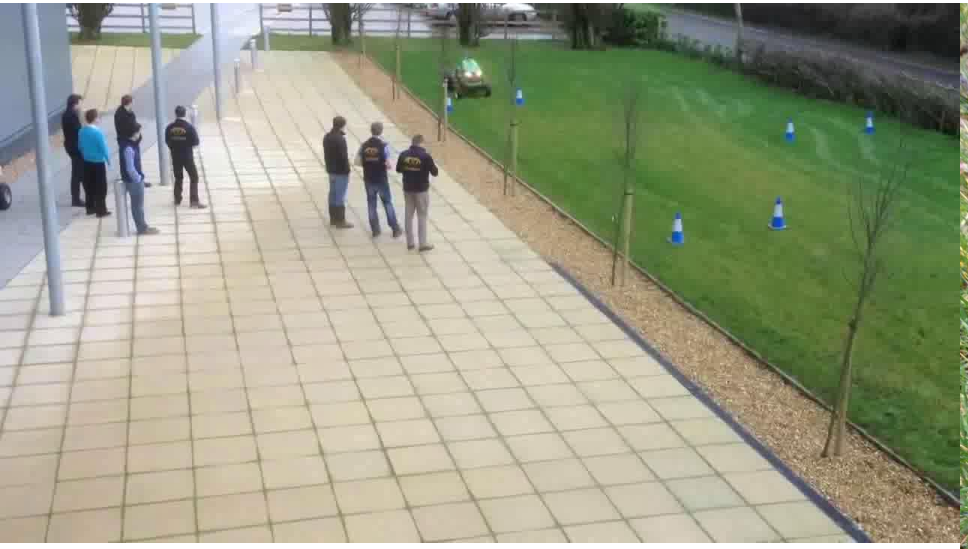
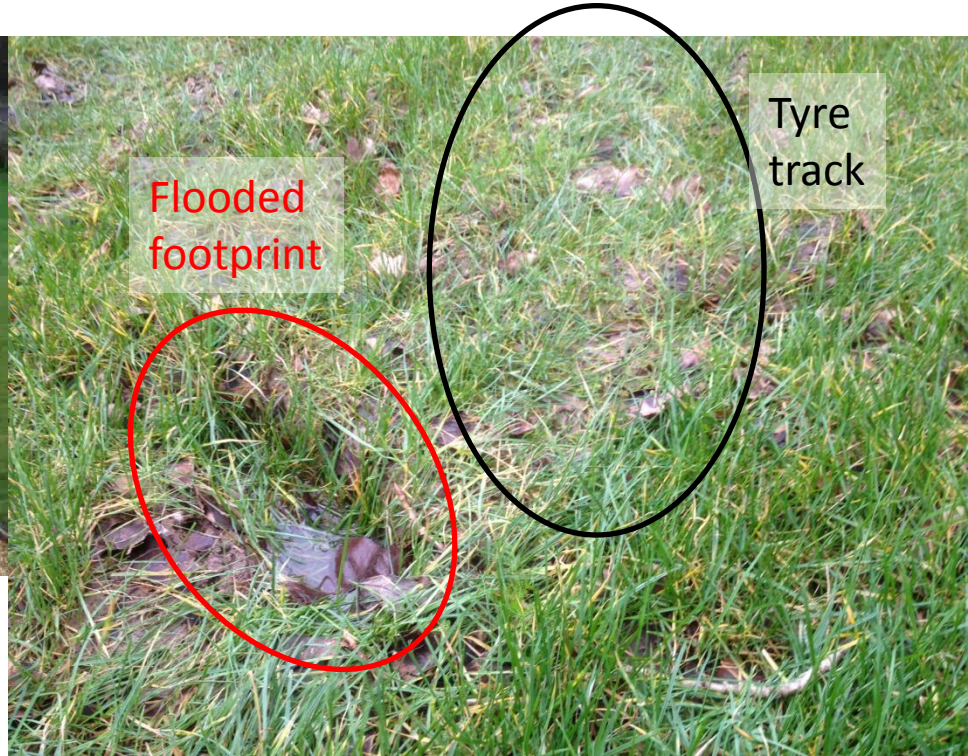
- Less than 40kPa (6PSI) under the contact patch does no agronomic damage even at field capacity
- Can seed the ground in any weather conditions

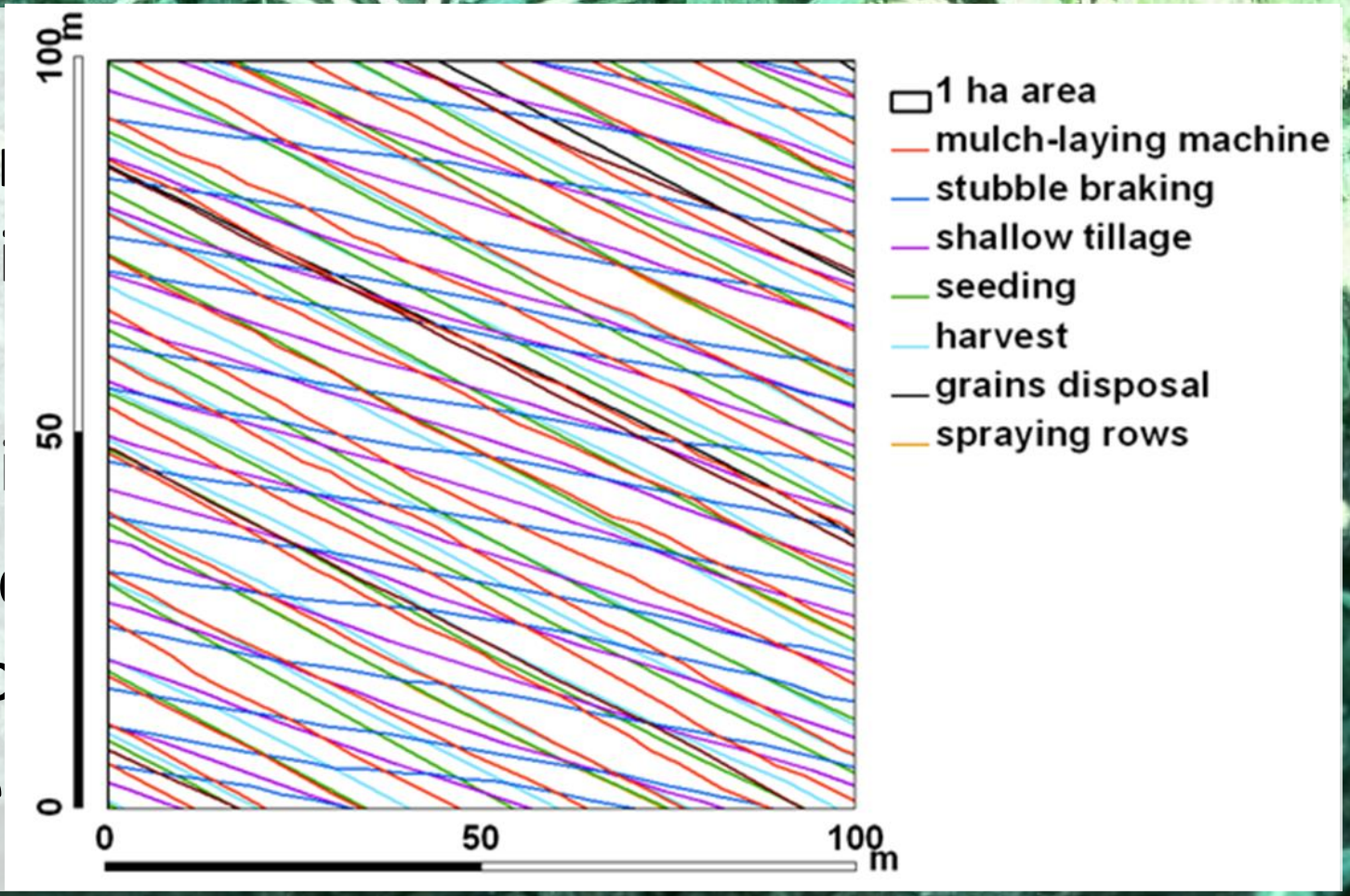


February 2014



Current system: Compaction

- Up to
  is ther
  machi
- Up to
  tyres
- If we
  we do
- Move



Optimised route planning

Crop scouting

- Working with agronomists by giving near-real-time data over the whole farm
- UGVs (Unmanned Ground Vehicle)
  - Phenotyping robots
    - Crop trials to evaluate new genotypes
  - Scouting robots
    - Targeted agronomic measurements
- UAVs (Unmanned Aerial Vehicle NCPF seminar 30th Jan)
  - Rapid assessment technique
  - High resolution imagery
    - Visible: Crop cover, growth rates, flooding extent, late emergence, weed patches, rabbit damage, nutrient imbalance
    - Non-visible: NDVI, Thermal, multispectral
    - Sensor limited by weight and power

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Dionysus robot

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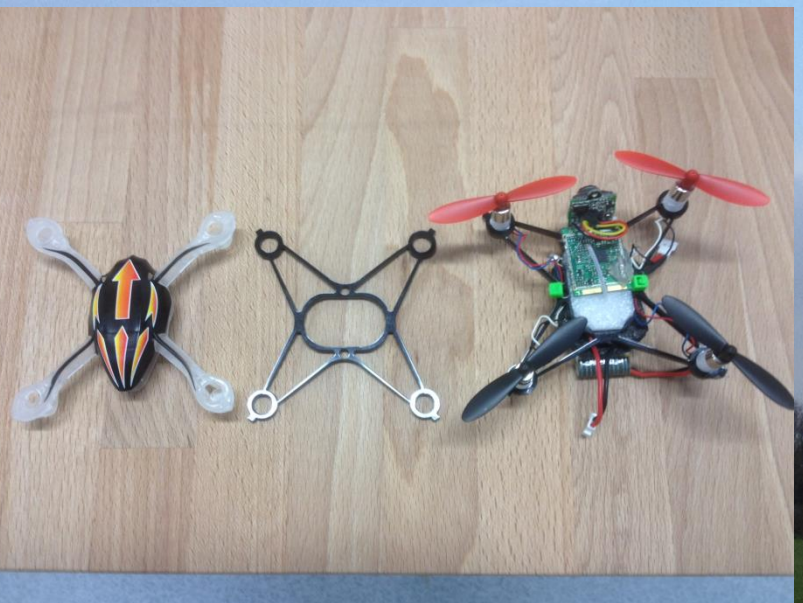
- Crop scouting robot for vineyards
- Build by Harper Adams MEng (2013) students for the University of Athens
- Software Architecture for Agricultural Robots
- Thermal camera for irrigation status
- Multispectral camera for nutrient status
- LIDAR for canopy extent and density

Unmanned aerial vehicle

- Bespoke hexacopter
- Live video feed
- 3 axis gimbals
- 20 minute flight time
- Developing a quad microcopter



Robotic Weeding

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- Mechanical weeding
- Micro droplet spraying
- Laser weeding

Source: Esben Pedersen / Landsbladet 44/2002

The Royal Veterinary and Agricultural University

Intra-row Weeding with a Cycloid Hoe

Denmark, May 2006

Robotti

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MicroDot spraying

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- Machine vision recognises the leaves of the plant in real time and records the position and speed
- MicroDot sprayer puts chemical only on the leaf of the plant saving 99.99% by volume

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Laser weeding

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- Machine vision recognises the growing point of the weed
- Laser kills the weed by heating the growing point
- Saving 100% herbicide

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- Harper Adams University is now building a real-time robot to laser and microdot weeds
- Funded by a major agrochemical company 2014-2017

Selective harvesting

- Up to 60% of harvested crop is not of saleable quality
- Only harvest that part of the crop which has 100% saleable characteristics
  - Phased harvesting
- Pre harvest quality and quantity assessment
  - Grading / packing / sorting at the point of harvest
    - Add value to products on-farm
  - Grade for quality
    - Size, sweetness, ripeness, shelf life, protein etc
  - Minimise off farm grading and sorting
  - Add value to on-farm products


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Conclusions

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- Is this the future?
- We can use these technologies now
- All of these concepts have been developed and initially researched
- Not many of them are commercially available through “lack of demand”
- How long will it be before UK farmers take advantage of these new opportunities?

Autonomous tractors in China

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