Session 2 . Sensing of soil & crop

1. **Ever higher resolution temporal & spatial data. How high do we need? – from satellite, near-ground & in-situ sensors**

- Sensor resolution must be related to application equipment resolution
- Must be related to SV scale
- Depends! (mentioned that N varies even at the leaf scale)
- Increasing resolution is costly – must be related to equipment capability
- Larger machines (so increasing width) – losing resolution for variable application?)

2. What should we sense?

-Understanding of the soil-crop-environment system is lacking in the spatial realm.
-So what do we measure?
-What factors affect – and limit – yield? We should measure these. Again, our understanding of the system is limited.

3. We have many 'data layers'. These must be integrated to provide usable information

-How to integrate remote-sensed and ground collected data?
-If we are missing one data layer, we are missing everything!
-The weakest link is the coarsest layer of data
-On-the-go sensing must be complemented by historical data layers (both recent and older historical data)

4. What does the farmer need?

-Simplest system possible!
-Data/info is the tool to enable the farmer to make intelligent management decisions
-Yield limiting factors must be known
-A good field agronomist to interpret the data or could 'intelligent advisor' app on the farmer's smart phone do?
-Confidence in the data – uncertainty in data leads to uncertain decision making!
-Accurate yield sensing (yield affects every other decision)

Session 1 . Automation & robotics

1. Small robotic machine to intelligently manage crops, plant by plant (assume high value crops?)

-'free-range' robotics modelled on living organisms such as invertebrates
-Control of robots – safety concerns. Human intervention must be part of the system
-Robotics for pre-plant operations such as tillage and side-dress fertiliser
-Can robotics be used in soil remediation

2. Automatic control of field machines

-Auto-guidance
-Smart sprayer incorporating image analysis for weed/crop discrimination
-More efficient harvesting mechanisms – reduce grain loss
-Robotic scanning to map grain loss

3. Farmer response to automation

-Younger, more highly-qualified farmers
-Agricultural production is about risk minimisation. Will farmers spend on hi-tech?
-Social acceptability of robots?

4. Likely uptake of robotics

-Robotic weeding, selective harvesting in 5-10 yr

Session 3 . Fertiliser & other agro-inputs

1. Chemical control of weeds/pests

-Here for at least 10 yr
-Product registrations being lost at high rate
-PA to enable dose minimisation and selective application
-Regulators guided environmental restraints – not by crop requirement
-Timeliness critical

2. Fertiliser application

-SV management of N can meet both profit & environmental targets
-Largest uncertainty is weather so temporal (season to season) variability more important than SV
-Precise prediction of precipitation required
-On site (- or field) weather stations improve prediction
-More accurate (and local) weather stations for radiation & precipitation
-Management zones too restrictive ('Mother Nature doesn't work in MZs'!)

3. Questions / comments on N

-Is N the limiting factor
-Where does N go?
-Determining N rate for VRT is difficult
-Do N rates have to be precise? (flat-topped response curve)

Session 4 . Irrigation, drainage, soil management

1. Irrigation

-Precision irrigation and fertigation in high value fruit crops (price of raspberries: £6k / t)
-Irrigation management zones can be based on elevation and soil EC data
-Sensors required to increase water use efficiency, manage soil salinity, conserve water
-Wireless network soil sensors can be used for irrigation control

2. Soil management

-Compaction is main area of concern
-Compaction reduces yield, increases draft force, affects infiltration rate, destroys soil structure
-Compaction to cost £1 bn / yr
-Controlled traffic farming benefits: 8-35% yield increase, greatly reduced tillage forces, improved soil structure (but wheelways can cause problems)

3. Sensing needs

-Biotic/abiotic crop stress
-Fruit quality non-destructively
-Compaction
-Soil bulk density
-Plant water stress
-Salt stress
-Soil moisture tension, wetting front.