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AGRICULTURE & HORTICULTURE DEVELOPMENT BOARD

Saltburn Monitor Farm meeting report

Meeting 4: Precision

Speaker: Dr Ivan Grove (Harper Adams University)

Date: 3 May 2018

Location: Guisborough Rugby Club

For more information, visit: cereals.ahdb.org.uk/saltburn

Meeting summary – key messages

- Precision technology gives us the tools to make management decisions and can bring huge benefits like improving profitability – but it can be costly
- Before you buy, make sure everything communicates
- Do a partial budget and look at what you will gain compared with what it will cost
- Some very useful technology, such as satellite imaging, is available at relatively low cost
- Some equipment can be hired for use only when needed

Precision agriculture

Precision in agriculture has two main uses:

- Steering assistance
- Managing variation

Global navigation satellite systems (GNSS)

- Precision depends on these systems
- The two main ones are called NAVSTAR (American) and GLONASS (Russian)
- Make sure your system can use both (check before you buy) – this will improve accuracy and gets round the problem of shadowing

GNSS accuracy

- Current basic GPS: 1–3 m which is no use to precision
- Differential GPS: some can go down to less than 1 m and are fine for manure spreading and grassland work
- Enhanced systems have an extra correction from dealers and can go down to 3–20 cm
- Real Time Kinematic (RTK): 2 cm and it gives year on year repeatability, but you need your own receiver and this can be expensive

Questions before you buy

- Do you need 2 cm accuracy?
- Where would you gain the benefit?
- Does your system have terrain compensation technology to compensate for the angle on tilted ground?
- Do you need it only for a short time eg to put tramlines in? You can now buy it for just when you need it, such as for a season

Steering assistance

Light bars

- These give 15–20 cm accuracy
- They can be well worth the cost especially on grassland for spraying, and for fertiliser and slurry spreading
- But they won't talk to other things
- Try it out before you buy
- Some systems communicate by WiFi with an iphone and they can be very easy to use

Example of system for autosteer (John Deere Guidance Systems)

Semi-automated

- These systems do the steering for you

Autosteer (machine guidance)

- Work with wheel angle sensors and electro-hydraulics but these are not transferrable
- Can extend time available for field operations by allowing you to continue in the dark
- Expensive but more second hand systems are becoming available
- Essential for controlled traffic farming

Benefits of automatic steering

- Less overlapping
- Less fuel used
- Reduced driver fatigue
- The benefits tend to be small and incremental, and you would need to be farming around 500 ha minimum to see any financial benefit

Benefits of RTK autosteer

- Reduced energy use – based on reduced time in field
- Less wear and tear on machinery
- In strip-tillage non-selective herbicides can be used between rows
- Improved soils
- The whole field should become more uniform – it might all be slightly better
- This will vary between farms
- Precision is all about increments

Calculating the benefits of guidance

- Use Google Earth Tools or a tape measure to assess the accuracy of your tramlines
- Tramline overlaps when spraying are commonly in the region 4–13%
- On a 24 m boom this could be an error of 1–3 m
- In a 15 ha field this can add up to an extra 0.5 m^2 on every application
- Also common cultivator overlaps are 30–60 cm on 3–6 m equipment
- This means you would be using significantly more chemicals and seed, and increasing fuel use and machinery wear

RTK vs. dGPS

- If you introduce autosteering, a 1m overlap would become:

dGPS	0.4 m
Enhanced dGPS	0.15 m
RTK	0.025 m

- With dGPS you would not reduce all the overlap whereas with RTK you remove all of it – but at a cost

Managing variation

- Things that vary: soil, crop, topography, weather, product, equipment (wears out) and drivers
- The idea is to get rid of the variation or reduce it
- Precision can allow you to see variation in a crop that you might otherwise not be aware of, eg an aerial image of a field can show bare patches that you can't see from the ground

Precision and soils

Mapping soil variation in a field using traditional sampling methods is very time consuming

Electrical conductivity (EC) testing

- EC can be used to test part of a field and the results are extrapolated to the rest
- EC measurements allow you to infer the soil type
- It can map topsoil and subsoil
- Soils should be mapped ideally when close to field capacity (autumn) or when bone dry
- The measurements must all be done on the same day, usually when there is stubble in the field
- EC soil mapping is not expensive

Using the data

- EC results can be used to delineate soil zones and you can then sample these zones
- This helps with variable rate (VR) fertiliser spreading
- If your soils turn out not to be very variable, do you need a VR fertiliser spreader?
- Soil zones should stay the same over time but organic matter might vary

How much variability is your soil conductivity map showing?

- A soil conductivity map consists of a range of (often very different) colours
- Don't assume this big range means your soils are very variable
- This depends on how sensitive the index is e.g. all the readings might be in a narrow range
- Look carefully at the information and consider what it is actually telling you

Soil brightness

- This is based on reflection from the soil
- It can't do depth so it only tells you zone variability
- It works to 5 m resolution
- Not expensive
- Can be used for targeted mapping P, K and Mg
- Correlates with pH
- These yield maps are a guide to nutrient offtake
- To make use of them you need a variable rate spreader and good quality fertiliser

Using yield maps

- Sometimes variation in fields is seen in some seasons but not others
- This temporal variability is due to yield maps detecting when a crop is stressed
- It is important that you look over time, in several seasons
- Get your spade out and you will probably find compaction in stressed areas
- In addition soil compaction maps can be done using a penetrometer to tell you which parts need subsoiling so that you don't need to do the whole field

Remote sensing

Vegetation mapping

- Based on electromagnetic (EM) radiant energy
- Some parts of the EM spectrum (infra red) can be measured with special cameras
- The level of absorption indicates the thickness of the canopy
- This produces an index called Normalised Diffference Vegetative Index (NDVI)
- NDVI is influenced by factors such as ground cover, leaf area index (LAI, indicates how many layers there are in the crop), and soil brightness
- The disadvantage is it saturates at leaf area index 3
- But it still provides a good indication of crop health

Red Edge Normalised Difference Vegetative Index (RENDVI)

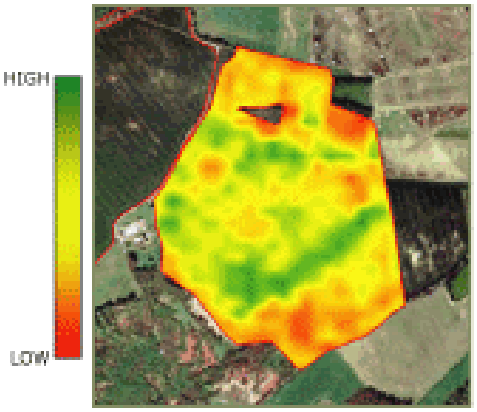
- Gives a better indication of leaf area index
- There is little saturation when LAI is greater than 3
- Corresponds well with chlorophyll content and N
- These methods can identify N and Mg deficiencies which cause pale leaves

Variable rate nitrogen

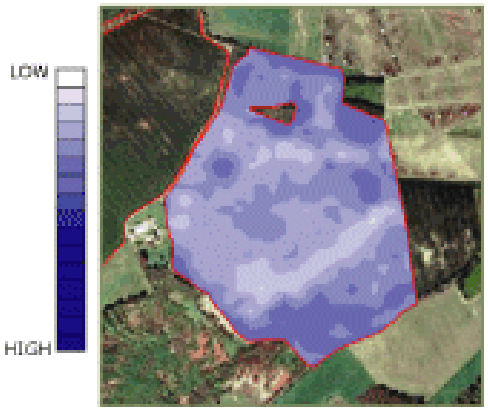
- Two methods can be used, both giving you a better way of managing the crop, with N applied only where needed:
    - Crop sensors – expensive but can be hired affordably
    - Satellite images – low cost (can be < £8/ha) and can bring considerable cost savings in N use
- Both systems lead to a more even, better quality crop and a better harvest

Crop sensor

Satellite images: Soylsense variable N for winter wheat



Leaf area map



N application map

Variable seed rates

Only works well if you also use variable rate N

Variable depth cultivations

- Alters cultivation depth based on soil type
- Advantages are it can optimise fuel consumption, increase average work rate and improve soil structure
- However it doesn't alter the width of the cutting edge (important for critical depth)

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Economics of precision

How do you decide if it is worth it?

- Do a partial budget and look at the key things that will change
- Compare what it will cost with what you will gain
- There is no point if it will cost more than you will gain
- Net effect = total benefits – total costs

Revenue lost	**Revenue gained**
Interest on capital in bank	Additional yield per ha
Opportunity cost	Surplus machinery sold

Extra costs (not capital):

- RTK subscription
- Equipment depreciation
- Additional insurance

Costs saved:

- Less fuel, chemicals, fertiliser
- Reduced labour
- Less soil damage

Using drones

Basic unmanned aerial vehicle (UAV) with camera (basic RGB)

- Can be used to map the farm (photographs)
- Cost around £1500
- Quickly become out of date
- You need a licence and commercial insurance if you are using the equipment to manage a crop
- Cost of training + licence is £1200–£1500
- An NDVI camera upgrade costs £2000–£6000 depending on level of complexity
- If you use drone technology properly you can get a huge benefit but you must keep to the regulations
- Drone operation in the UK could be lost because there are too many and too many used badly

Examples of drone used for crop monitoring (Grove, 2018)

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Find out more – Links to AHDB information sheets or research

Automating nitrogen fertiliser management for cereals (Auto-N)
Hands Free Hectare 2: Autonomous farming machinery for cereals production
Hands Free Hectare
Exploiting yield maps and soil management zones
An up-to-date cost:benefit analysis of precision farming techniques to guide growers of cereals and oilseeds

For more information on soils, visit ahdb.org.uk/greatsoils

Next meeting

Date: 24 May 2018
Topic: Summer meeting
Time: 11.30
Location: Barns Farm, Skelton TS12 2QS

For more information or to find out more about Farmbench, AHDB's benchmarking tool, contact: Judith Stafford

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