Making the best of GPS

David Ross

Using GPS +/- variable rate applications to correct soil nutritional problems.

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VRA seed and fertiliser

VRA Lime

VRA fertiliser

What are we trying to do?

- Grow a crop in a variable environment (soil and weather) to achieve optimum yields and consistent crop quality

To do this we must

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- Make efficient use of nutrients based on good root development
- Use organic and manufactured fertilisers efficiently and profitably
- Create good soil conditions through effective soil management

So what can we do?

- Gain a better understanding of our soils
  - Looking at soil series maps
  - Taking time to think about variations within fields
  - Analyse your soils – pH, P, K, Mg

Variation within an area and within a field

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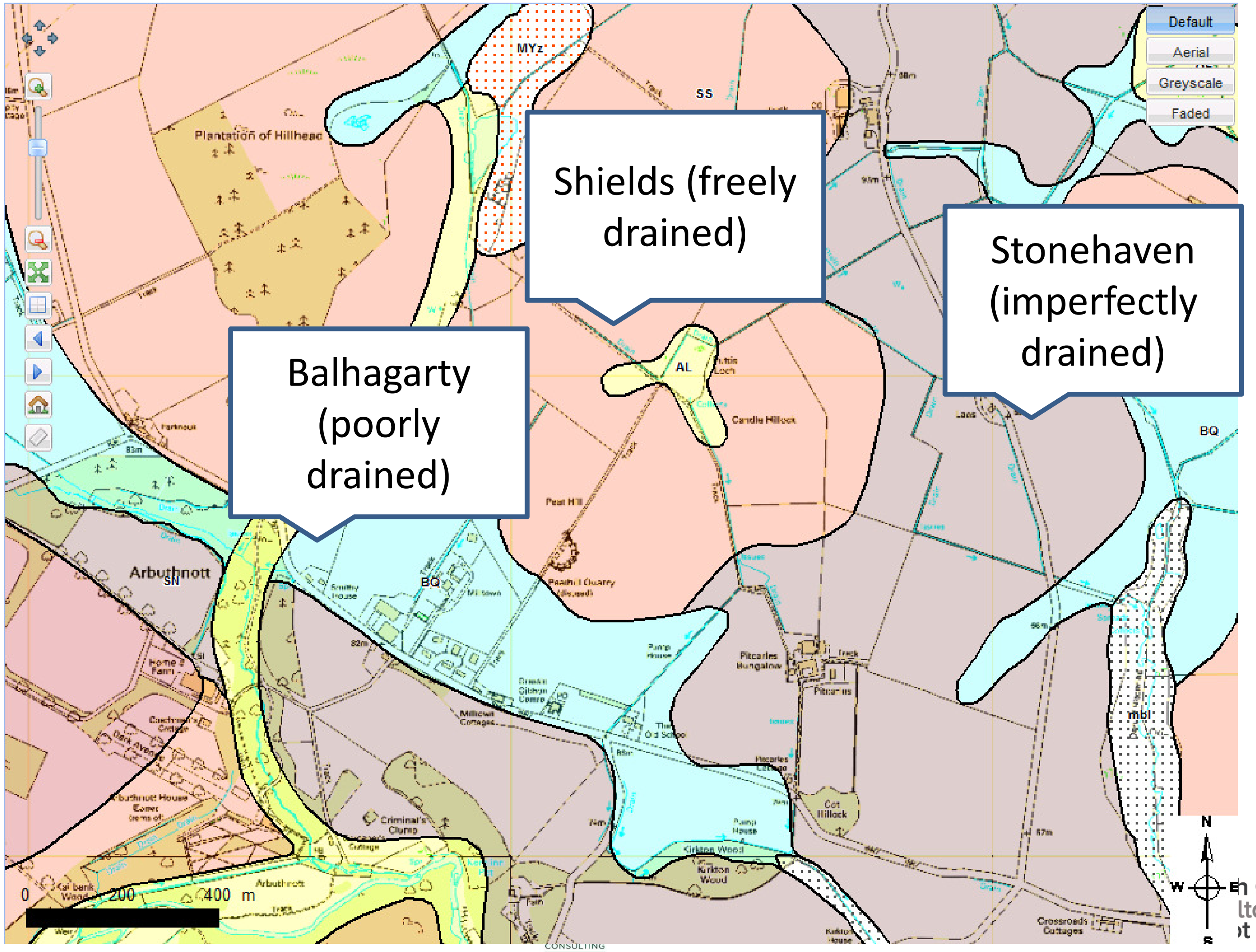

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Why is pH so important?

- At soil pH values below 5.6 in mineral soils in Scotland soluble aluminium inhibits cereal root growth and reduces yield.

- Plant produces stubby roots instead of long fibrous roots – limits nutrient uptake

- At best limits yield, at worst crop is a right off

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Notice thick, stubby roots

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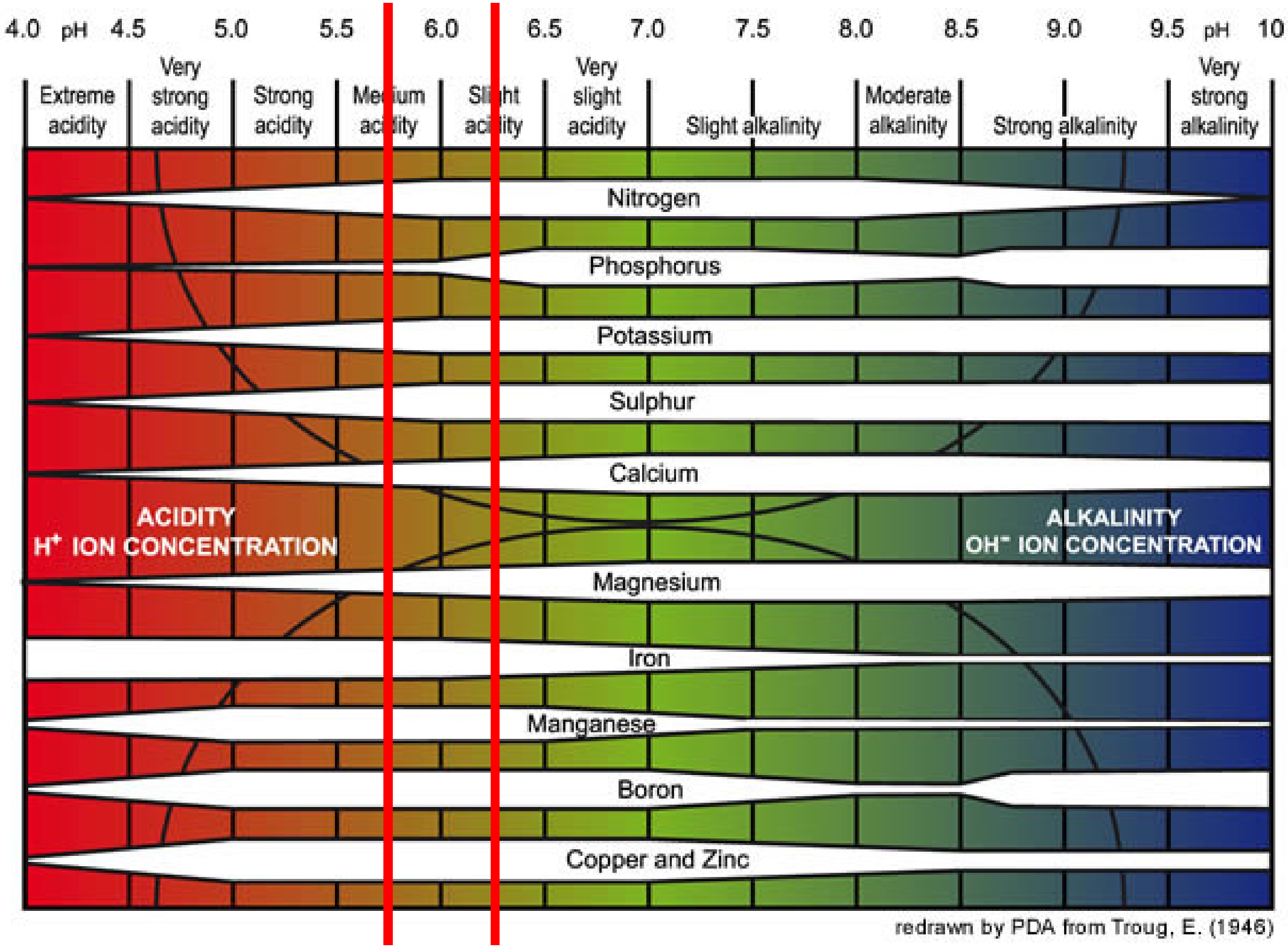
Limits the availability of other nutrients



redrawn by PDA from Troug, E. (1946)

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Soil pH mainly varies within fields for 3 reasons

- Old field boundaries
  - Due to different cropping/liming/field histories
- Soil Texture
  - Light soils tend to drop quicker and need less lime to increase pH
  - Heavier soils tend to drop slower but need more lime to increase pH (TN656)

Soil pH mainly varies within fields for 3 reasons

- Lime application
  - Most spreaders spread to 10-12m and are notoriously variable (partly due to lime not flowing easily)
  - Under or over application tends to persist in the soil for decades
  - Application mistakes tend to be cumulative and long lasting
  - Cannot forecast where they occur.
  - Examples are
    - Lime tipped in field gateways
    - Spreaders choking/running out of lime/double application
    - Calibration errors

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Cannot forecast where soil pH is likely to change

- But we can analyse using GPS to find this out

- There are two ways this can be mapped
  - Computer generated interpolation maps
  - Grid pattern

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Computer generated interpolation maps

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- Computer generated interpolation is notoriously difficult and unreliable when you have a small number of samples per ha

  (yield maps can have 100's of samples per ha so interpolation is much more reliable).

- *It also assumes that the soil pH changes evenly and predictably across the field i.e. if point A is 6.0 and point B is 6.6 then half way between A and B must be 6.3.*
- This is not the case in reality as soil pH can change abruptly in the field in an unpredictable manner.

Spot the difference: 4 per ha & 1 per ha

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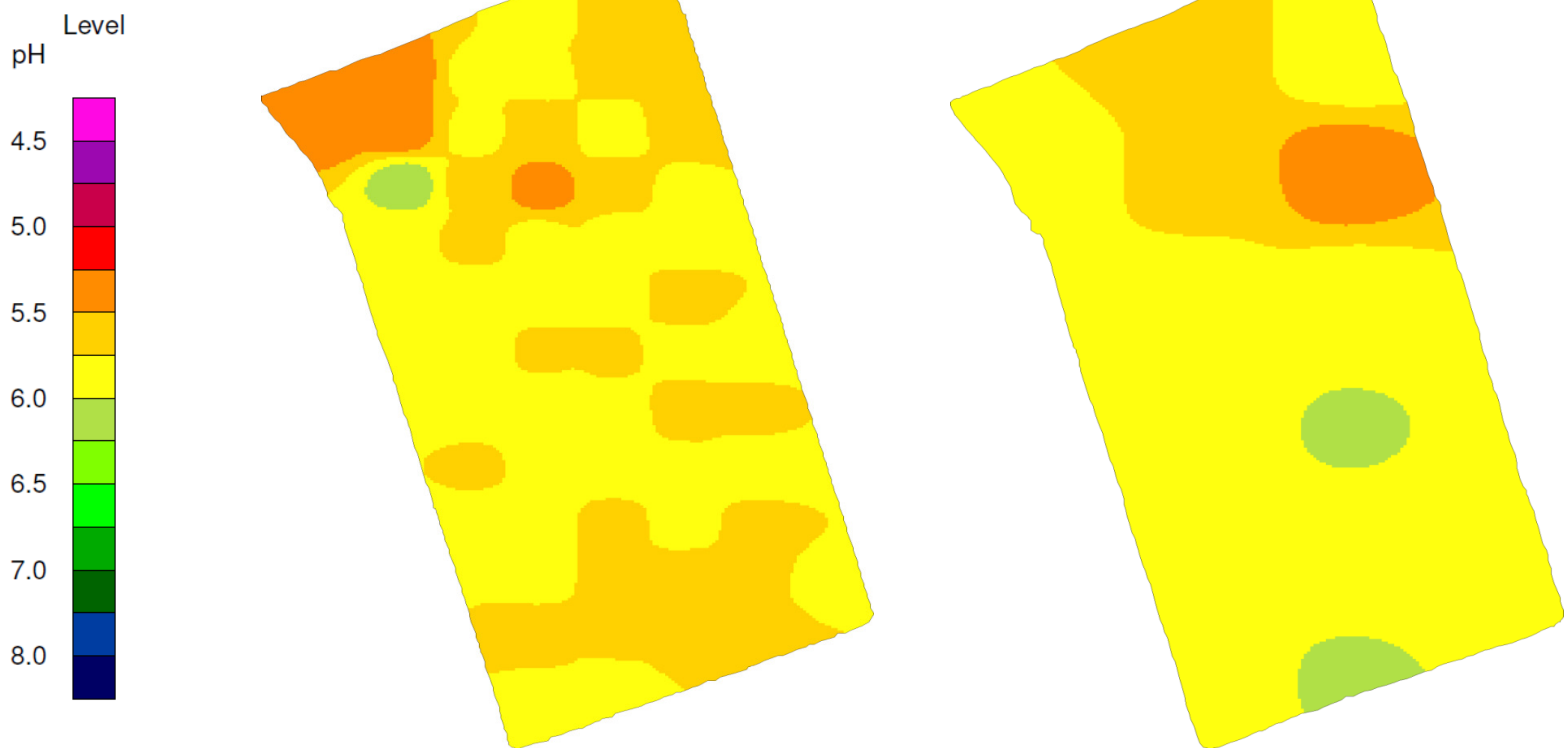

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Grid Sampling

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- Benefit of grid areas is that you are spreading lime on the ACTUAL pH result from the lab – not a computer generated, interpolated map of what soil pH might be.

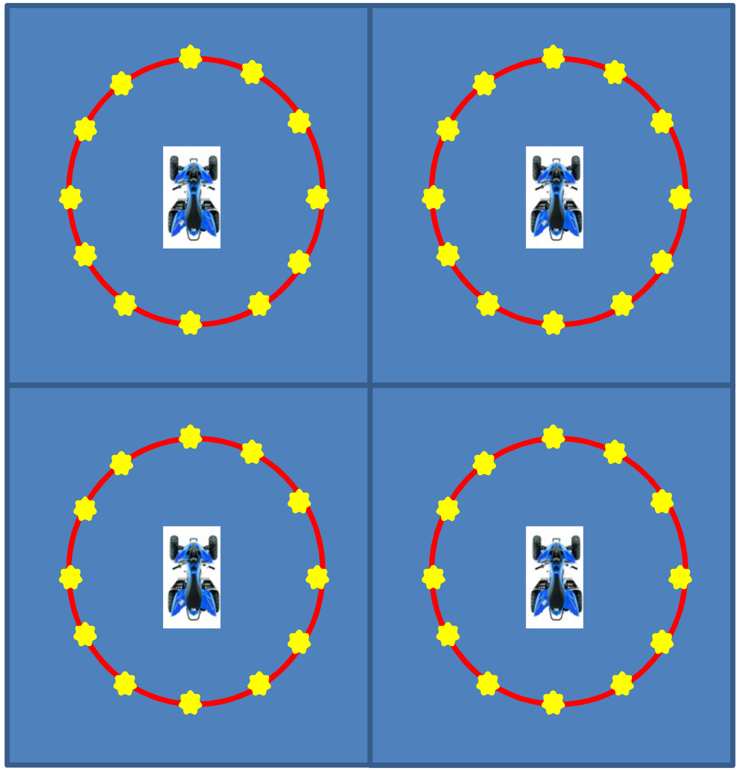
- Large amount of samples - 12 sub samples from a grid in a circle about 15m from the grid centre so that getting at least 1 sub-sample from every pass of the lime spreader when it spread lime last time the field was limed – no matter which way the spreader passed through the grid.

Grid Sampling

- Effectively interpolating based on physical samples, not a computer algorithm. Sampling is based on AREAS.

Grid Based Sampling

- 4 samples per ha
- 12 sub samples
  (48 per ha)



Grid Based Sampling

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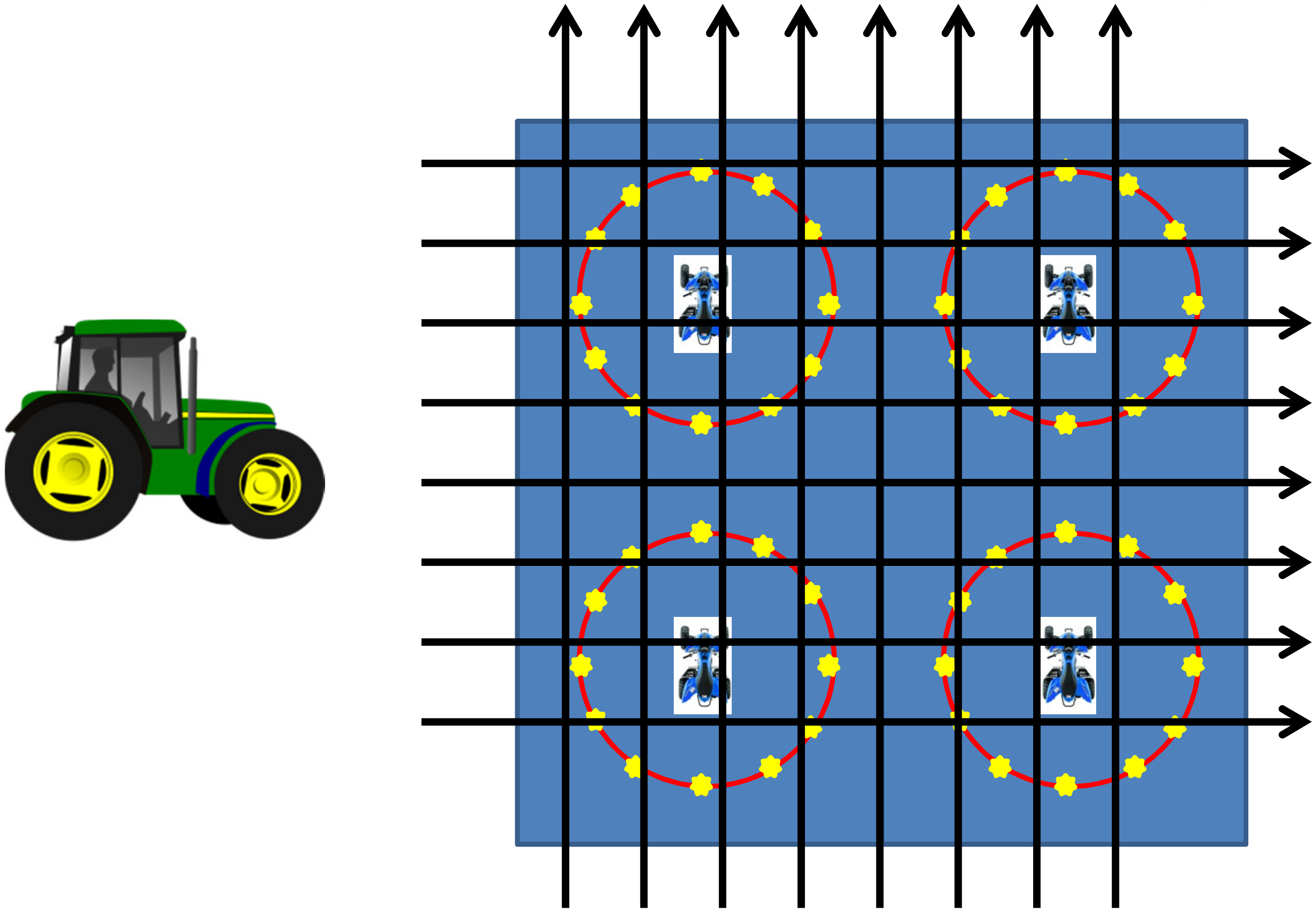

Map of grid areas

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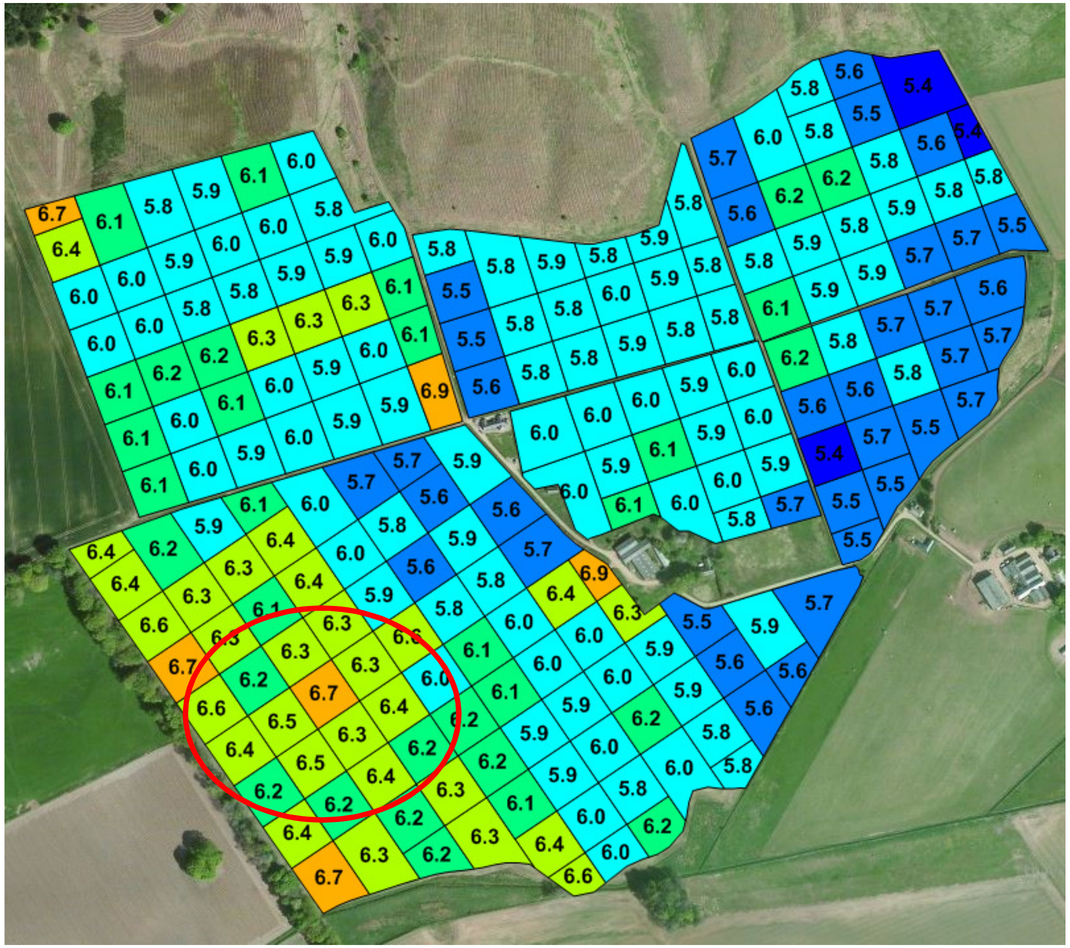
- Notice pH 6.7 bounded by pH 6.2, 6.3, 6.4, 6.5. Computer-generated map would not predict 6.7.



So what are we trying to achieve?

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- Decrease variability
  - After the precision application of lime a field should have a more consistent pH

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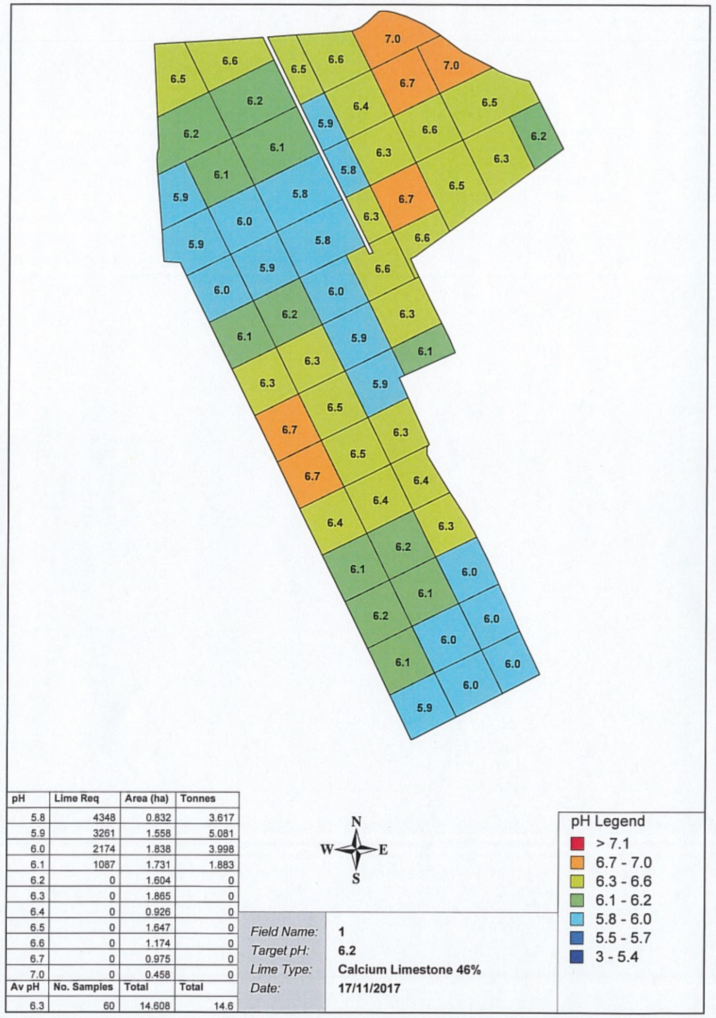
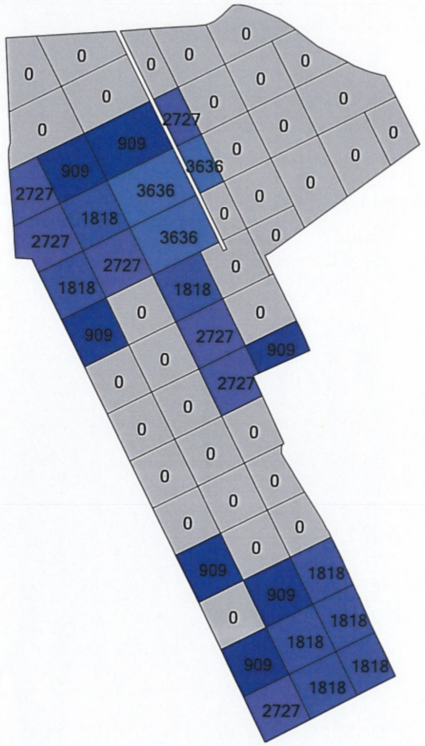
pH Map



pH	Lime Req	Area (ha)	Tonnes
5.8	4348	0.832	3.617
5.9	3261	1.558	5.081
6.0	2174	1.838	3.998
6.1	1087	1.731	1.883
6.2	0	1.604	0
6.3	0	1.865	0
6.4	0	0.926	0
6.5	0	1.647	0
6.6	0	1.174	0
6.7	0	0.975	0
7.0	0	0.458	0
Av pH	**No. Samples**	**Total**	**Total**
6.3	60	14.608	14.6

Lime Map

1 Lime Application Map

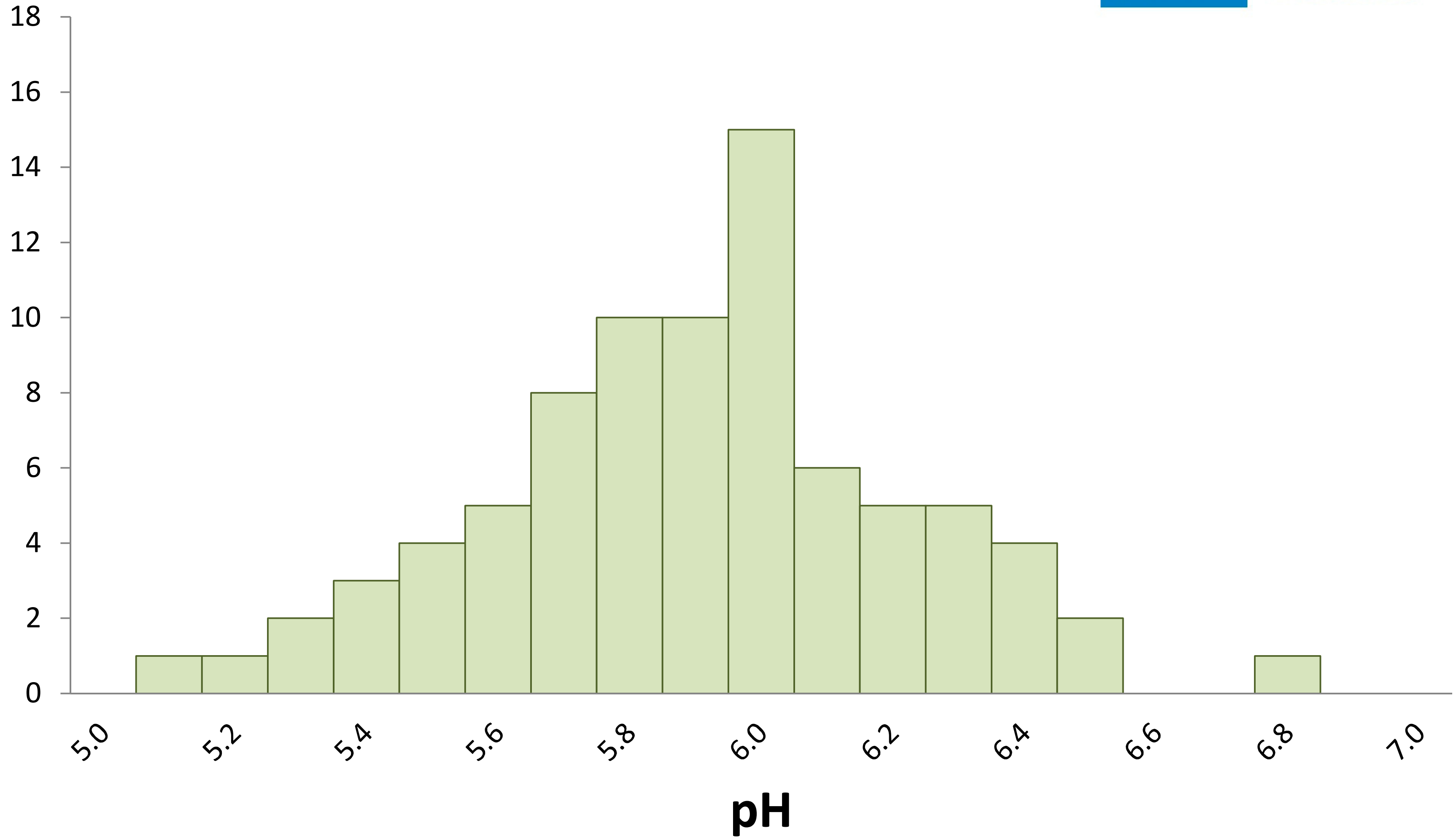


pH	Lime Req	Area (ha)	Tonnes
5.8	3636	0.832	3.025
5.9	2727	1.558	4.249
6.0	1818	1.839	3.345
6.1	909	1.731	1.573
6.2	0	1.604	0.000
6.3	0	1.865	0.000
6.4	0	0.926	0.000
6.5	0	1.647	0.000
6.6	0	1.174	0.000
6.7	0	0.975	0.000
7.0	0	0.458	0.000
Av pH	No. Samples	Total	Total
6.3	60	14.609	12.192

Target pH:	6.2
Years since sampled:	0
Lime Type:	Mag Lime 55%
Date:	20/02/2018

Lime Rates Kg/Ha
- 10000 +
- 9000 to 10000
- 8000 to 9000
- 7000 to 8000
- 6000 to 7000
- 5000 to 6000
- 4000 to 5000
- 3000 to 4000
- 2000 to 3000
- 1000 to 2000
- 1 to 1000
- No Lime

First time sampled



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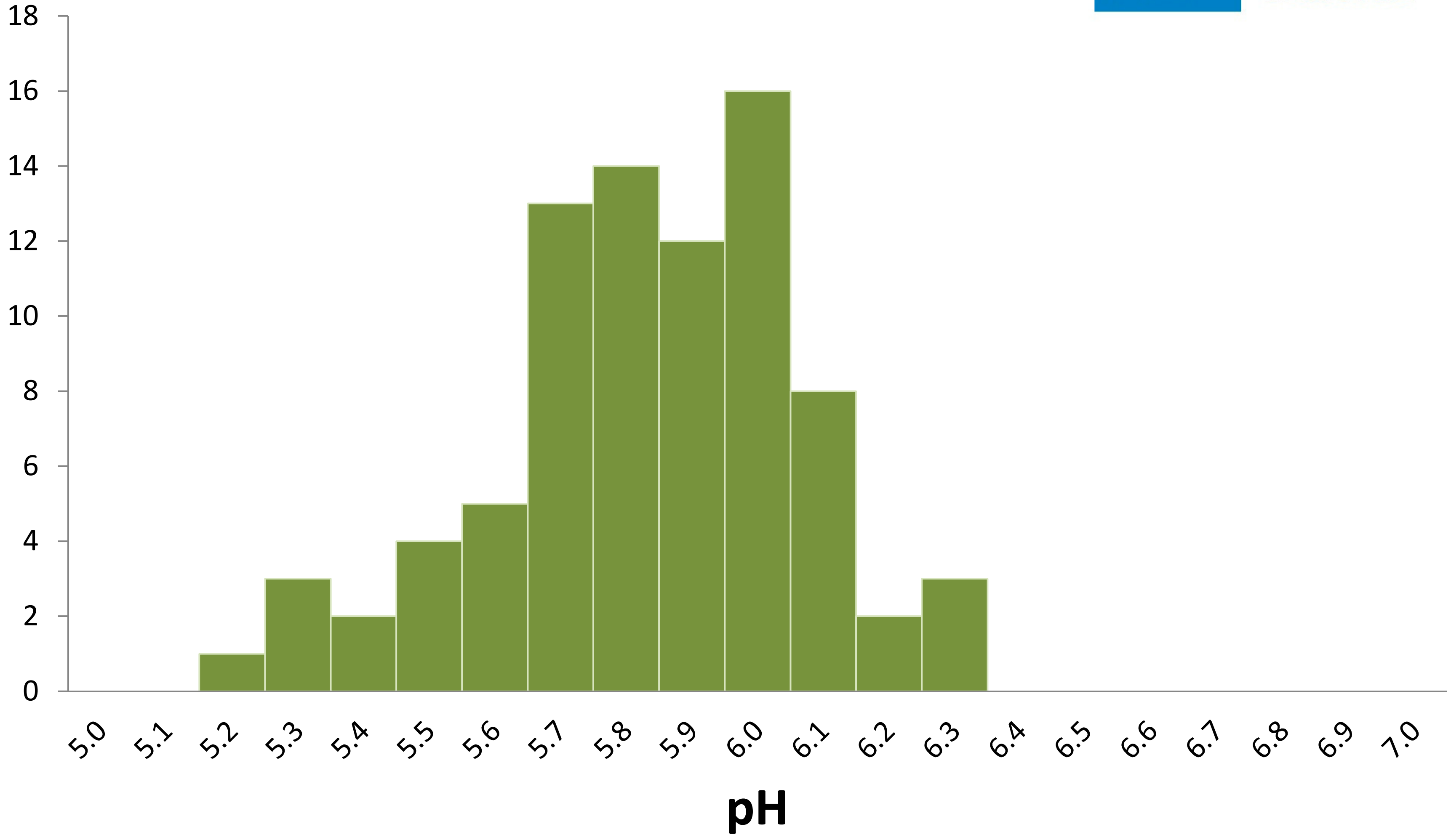
Second time sampled



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Sampling rate & lime requirement

- Sampling rates vary: generally 1/ha to 4/ha
- A higher sampling rate
  - Is more accurate
  - Reduces variability within fields
  - Is more expensive

Remember the golden rules

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- 2 t/acre (5t/ha) maximum applied in one application
- If more required split the application
- Lime can take 18 months to fully neutralise

Zoning Fields for P & K: Principles.

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- Aim is to forecast where soil fertility levels are likely to change.
- pH is very variable, lower cost and crops response is high - so grid sample.
- P, K, Mg tends to be less variable, higher cost of analysis and more intensive sampling only improves crop response when soil levels are low or high.
- With experience can forecast where soil fertility levels change using old field boundaries, yield levels, soil textures and farmer/advisor experience.

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Zoning Fields:
Then use Yield Zones

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- Divide old field boundaries up into different yield zones

- If the yield changes within each old field split into low, medium and high yield zones (or just low / high)

- Also inconsistent yield zones

- High yielding areas tend to be lower in P and K due to greater removal, lower yielding areas tend to be higher in P and K due to application being greater than removal.

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Zoning Fields:
Finally split using other factors.

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- Different soil textures – light soil will hold less nutrients.
- Slopes and hollows – subject to erosion and deposition.
- Drainage problems
- Tree shade
- Farmer and agronomist knowledge is key.

Moss and Clay

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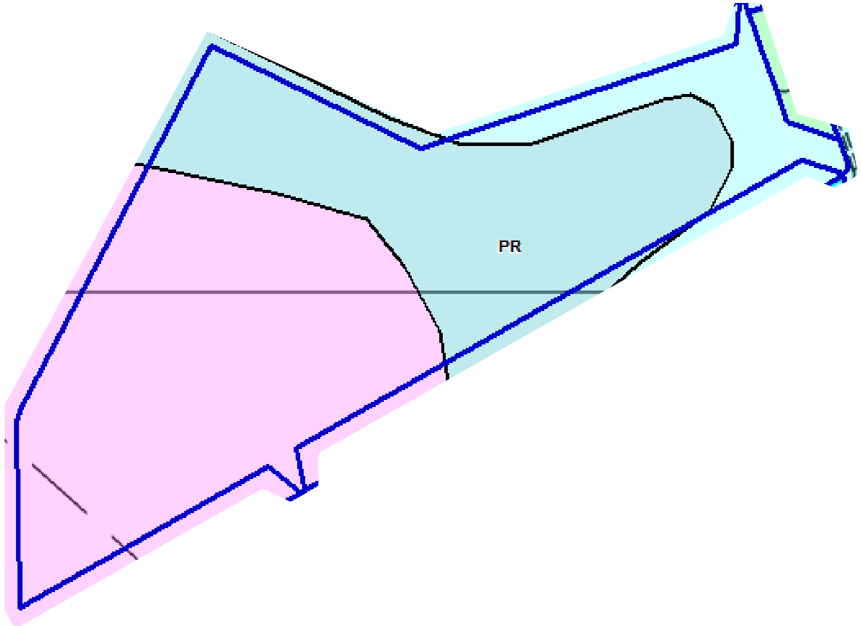

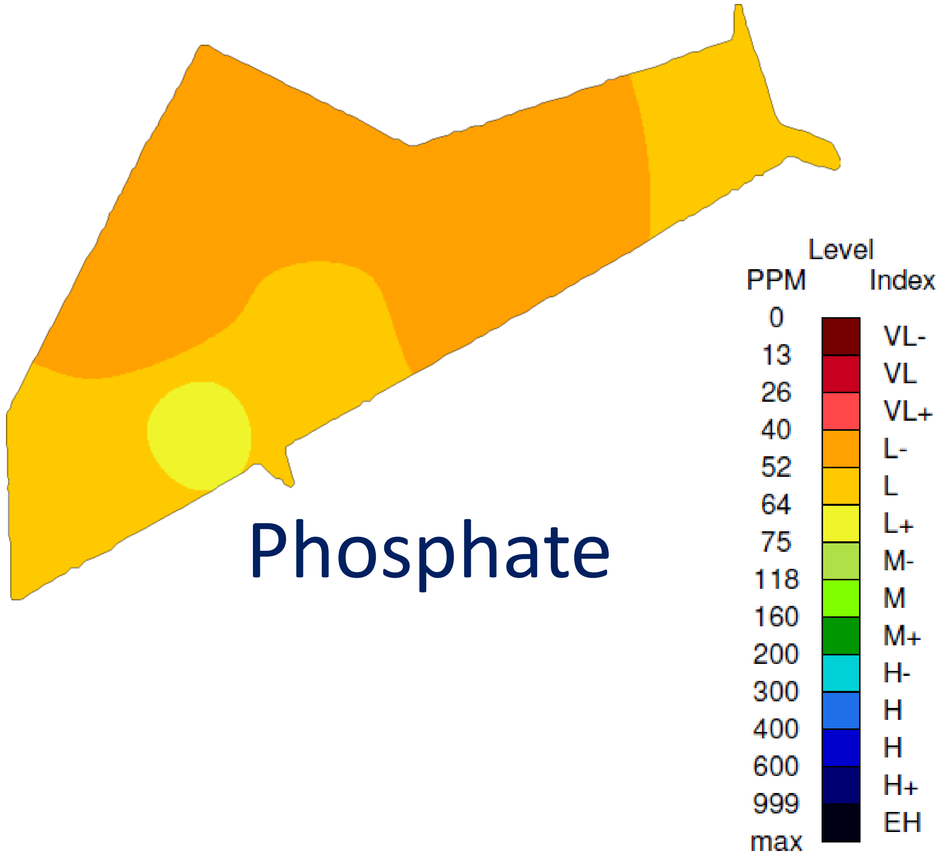

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Alluvial Bank

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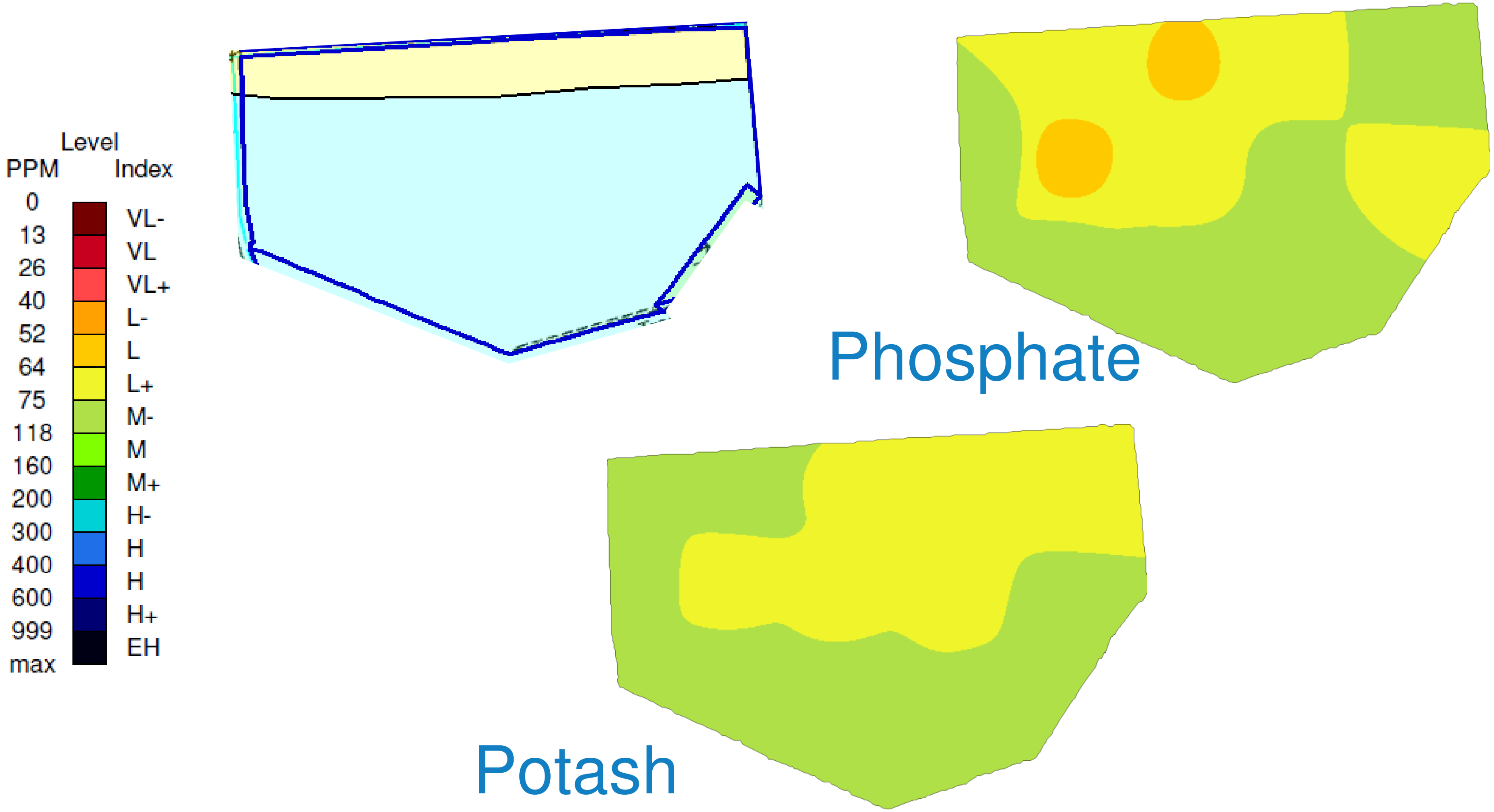

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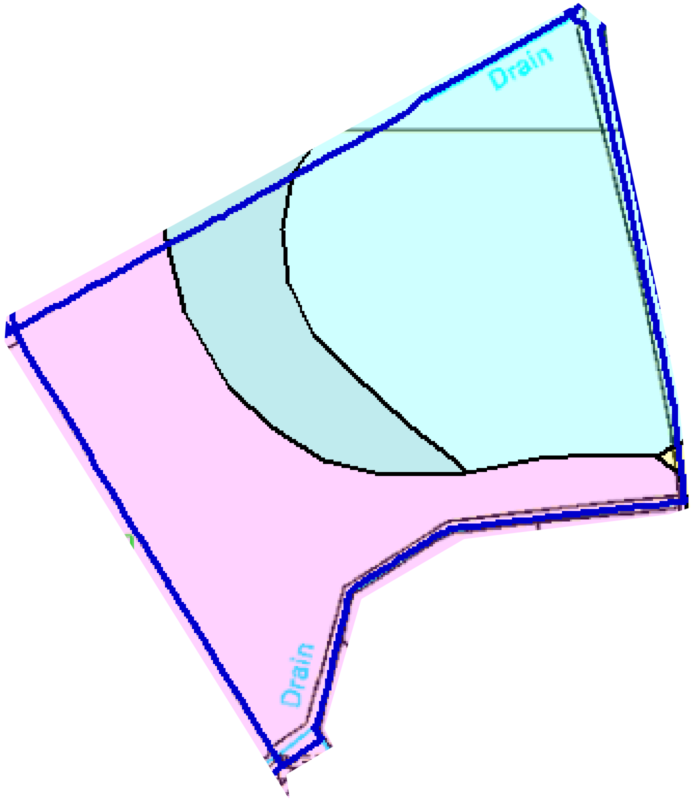
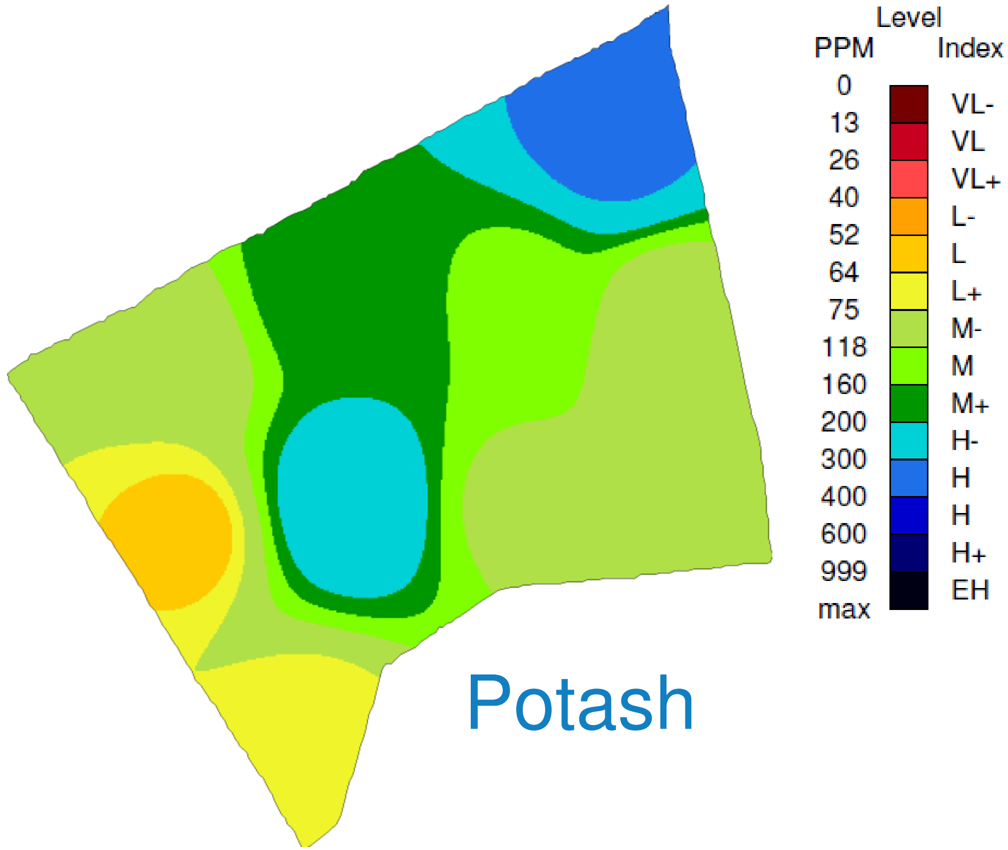
Old Midden Sites





Potash

Zoning

- The use of zones can significantly reduce the soil analysis bill compared with grid sampling.
- Many fields may only have 2 or 3 zones, so less costly soil analysis needs to be carried out.

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So pH, P and K are at an optimum so what next?

- pH will require retesting and spreading again within 5 years
- Once P and K, are in the recommended status for your rotation it's a case of maintaining the status
  - Rotation without potatoes P = M, K = M-
  - Rotation with potatoes P = M, K = M+

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Replace what is being taken off by the crop (TN633)

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Crop	Yield (t/ha)	P Removal (kg/ha)	K Removal (kg/ha)
Winter Barley	8.4	67	83
Winter Wheat	8.4	67	83
Spring Barley	6.0	52	71
Spring Oats	6.0	53	104
Winter Oats	6.0	53	104

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Replace what is being taken off: Yield Maps

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- Utilise yield mapping data to replace what the previous crop take off thus maintaining soil P and K status

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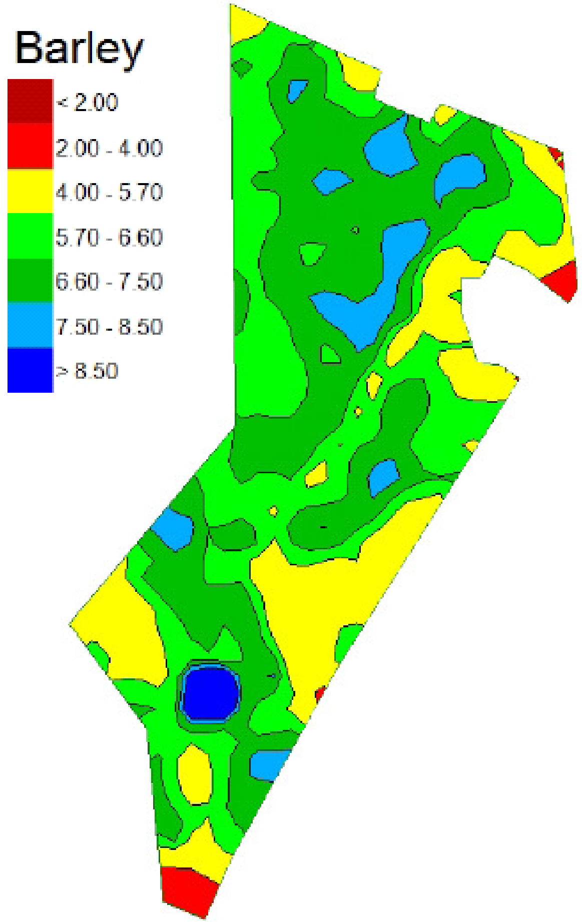
Replacing off take: Spring Barley

Yield (t/ha)	P (kg/ha)	K (kg/ha)
2.00	17	24
2.00 – 4.00 (3.00)	26	35
4.00 – 5.70 (4.90)	42	58
5.70 – 6.60 (6.2)	53	73
6.60 – 7.50 (7.00)	60	83
7.50 – 8.50 (8.00)	69	94
>8.50	73	100



Conclusion

- Tackle pH first – it's the key to soil health
- Use your own knowledge and information to hone how you sample for P and K
- Once you have got to the required status then use a nutrient balance to maintain the status
- Use yield information if available

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Thank You

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