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Maximising the use of GPS Soil sampling on a mixed farm

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Topics for today

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- The importance of pH
- The importance of P, K and S
- The differences in sampling systems
- Results from the fields tested at Limekilns
- What factors do you need to think about?
- Recommendations for lime/fert/FYM?slurry
- What's the benefit?

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Why are our soils important?

…and the sun sometimes shines!

Liebiggs Barrel

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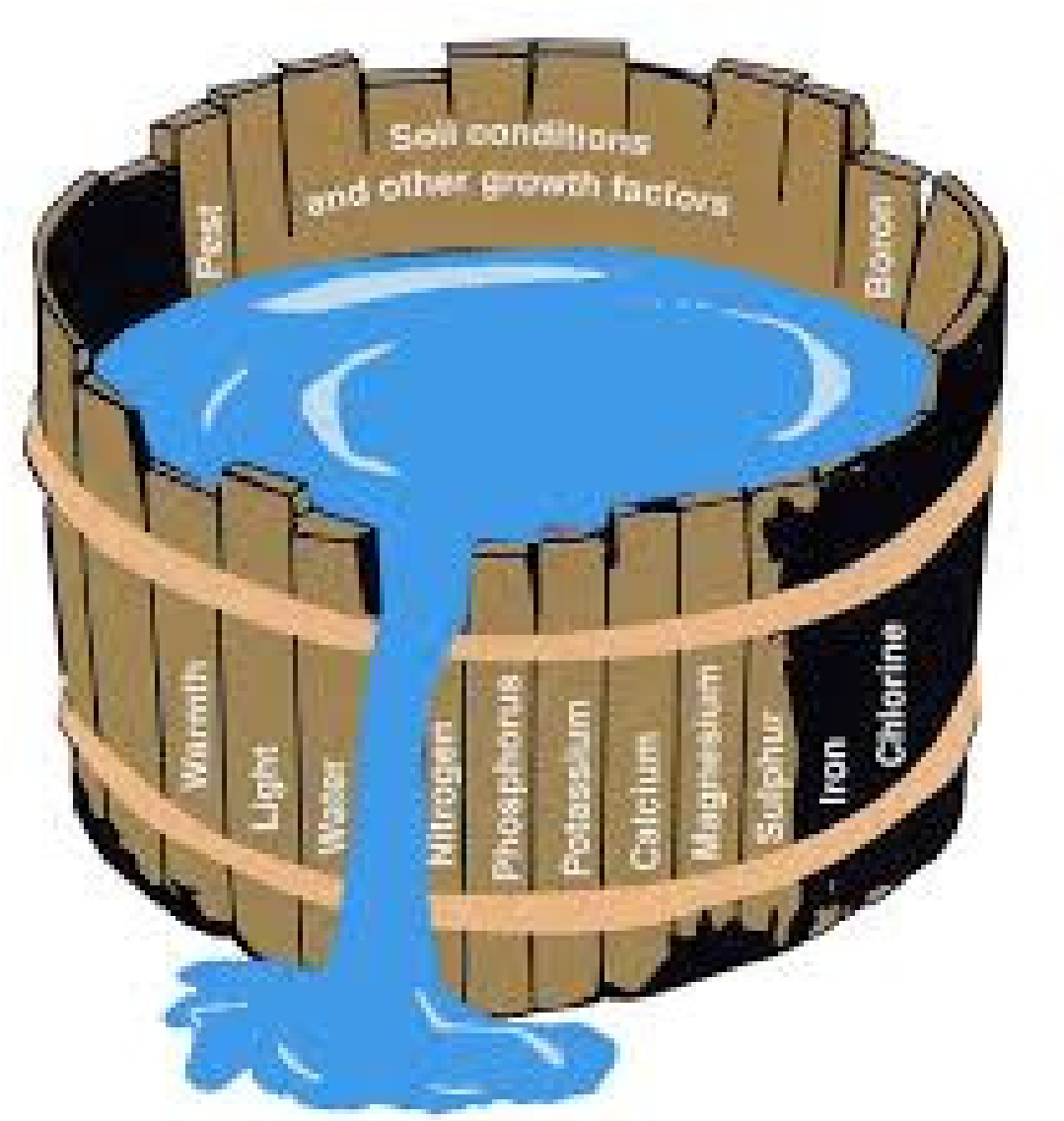

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The Importance of pH

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Why is pH so important?

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- 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

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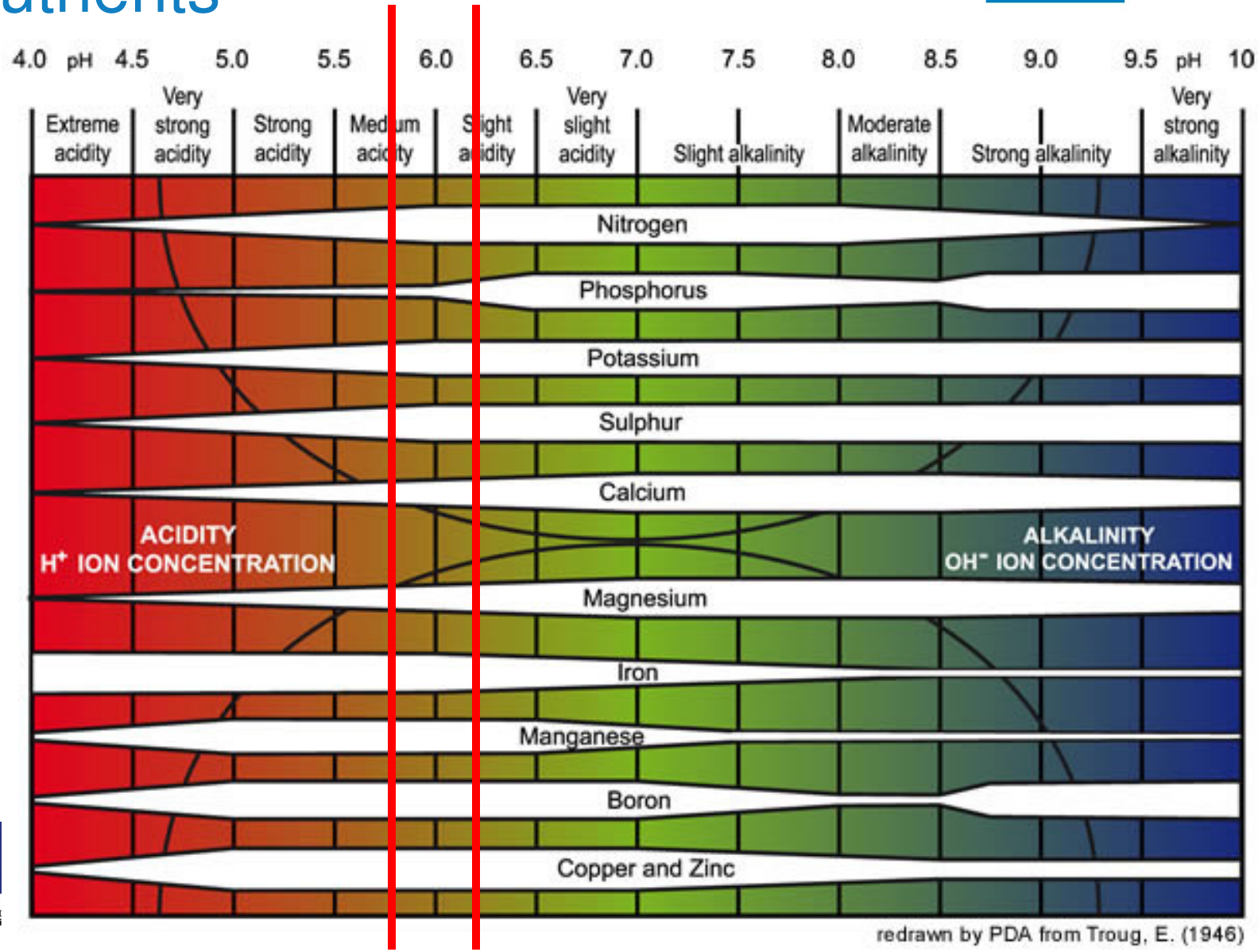

Importance of pH

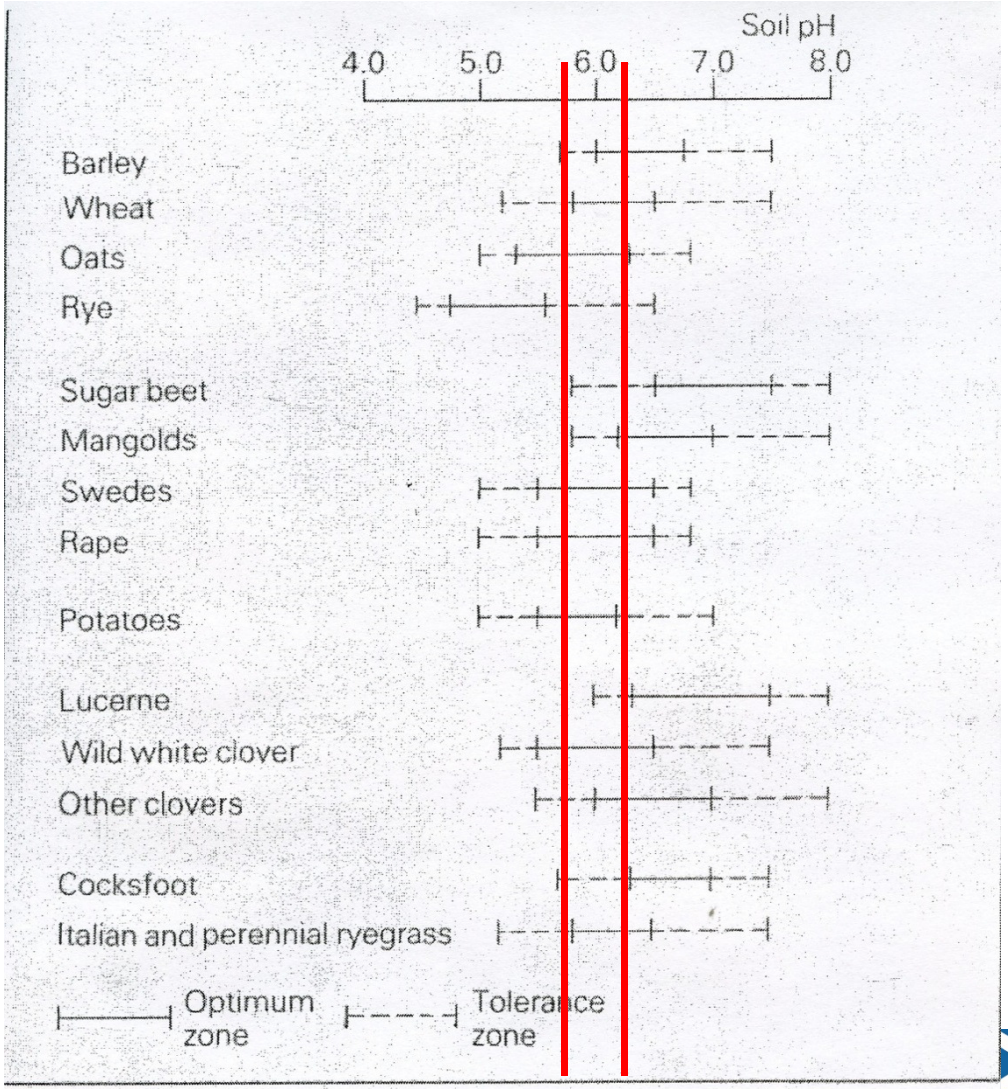

Figure 15.2 Acidity tolerance of the main crop species

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The Importance of phosphate

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Phosphate the facts!

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- Helps root development and early growth
- Availability of P reduced in low temperatures
- Essential to have available P in a reseed and spring cropping

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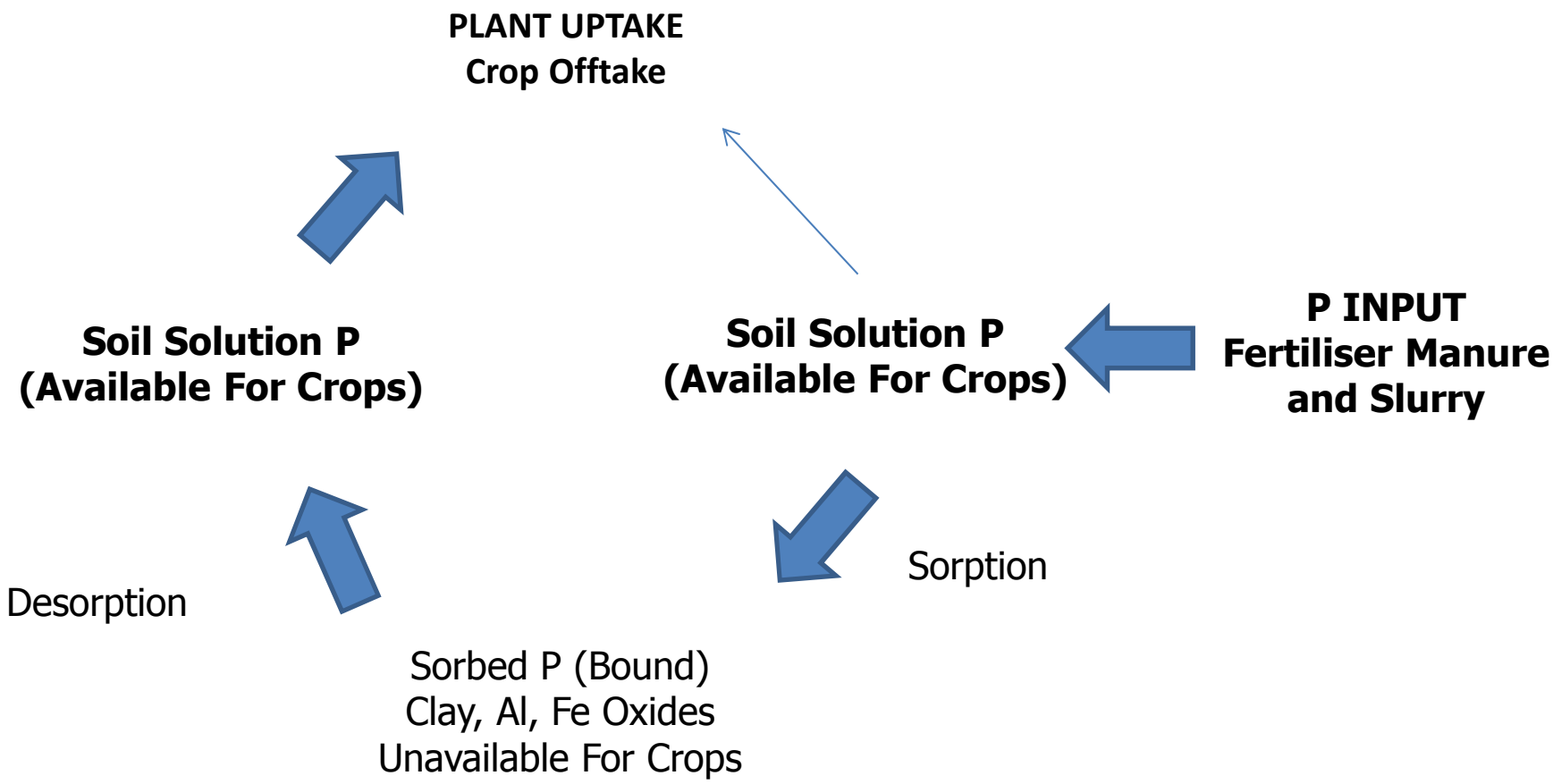
Phosphate supply to crops



Knowing our soils - Phosphate

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PSC 1	PSC 2	PSC 3
Arkaig	Ettrick	Darleith/Kirktonmoor
Countesswells/ Dalbeattie/ Priestlaw	Strichen	Rowanhill/ Giffnock/ Winton
Corby/ Boyndie/ Dinnet	Alluvial Soils	Foundland
Balrownie	Sourhope	Tarves
Thurso	Yarrow/ Fleet	Insch
Sorn/ Humbie/ Biel	Forfar	Kintyre
Kippen/ Largs	Darvel	Stirlng/ Duffus/ Pow/ Carbrook
Millbuie	Kilmarock	Bargour
Gleneages/ Auchenblae/ Collieston/ Darnaway	Eckford/ Innerwick	Lanfine
	Mountboy	

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Adjustment required to P application

P Sorption Capacity	Soil P Status				
	Very Low (VL)	Low (L)	Mod (M-)	Mod (M+)	High (H)
PSC1	+40	+20	0	-10	-20
PSC2	+60	+30	0	-20	-30
PSC3	+80	+40	+20	0	-40

- The additional P required to raise the P status to moderate status

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The Importance of Potash

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Potash the facts!

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- Deficiency affects
  - Nutrient uptake
  - Photosynthesis
  - Rate of growth
  - Feed value
- Clover sensitive to low potash
- Be aware of applying in the spring for risk of staggers

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Phosphate and Potash and grass

- Application to reseeds is a must to help establish clover and grass
- Grazing
  - Apply enough to maintain soil status
- Silage/Hay
  - Replace offtake to maintain status

Raising a Potash Status

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Grass Management	K_2O Soil K Status			
	Very Low	Low	Moderate	High
Grass with high clover, red clover	+60	+20	0	K Offtake x 0.5
All other grass management Options	+60	+20	0	K Offtake x 0.5

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Importance of Sulphur

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Sulphur

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- Required for the efficient use of Nitrogen
- In the past enough received from the atmosphere

- New Technical Note on Sulphur about to be published

- Apply Sulphur with your Nitrogen

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+ 90kg/S

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+90kg/ha S

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No S

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Why use GPS soils sampling?

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Why use GPS soil sampling?

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- Reduce in-field nutrient variation
- Reduce crop variability
- Optimise growing conditions
- Maximise resource efficiency
- Increase average yield
- Increase profitability

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Why is pH variable?

- Traditionally one rate for the field lime spreading techniques make it unpredictable to know where high and low pH may be
- Amalgamation of several fields into one may result in varied soil types
- Different cropping history/land management

Why is pH variable?

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- Light and heavy soil types
- Yield differences
- Previous application error (overlap or over/under application)
- Lime tipped in fields

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The differences in sampling systems

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What happened in the past?

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Electromagnetic Induction (EMI)

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- Sample field based on scanned zones usually at 24m intervals but can be less

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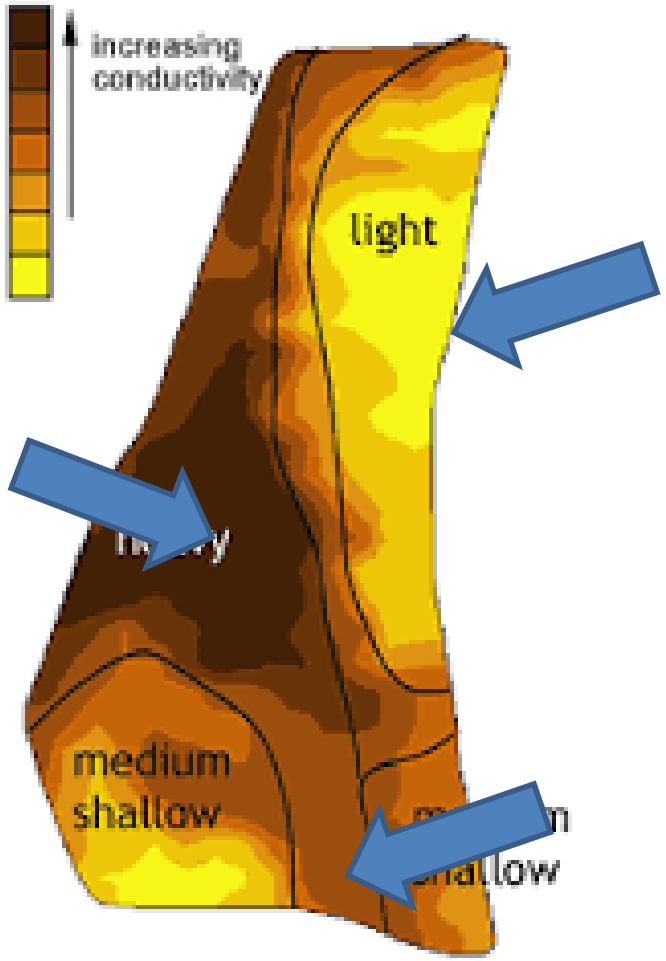
Electromagnetic Induction (EMI)



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Electromagnetic Induction (EMI)

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- Map generated similar to scanned map for pH, P and K

- Questions
  - Can a spreader/operator cope with wavy results?
  - At what point should a field be scanned (field capacity)?

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Hectare sampling

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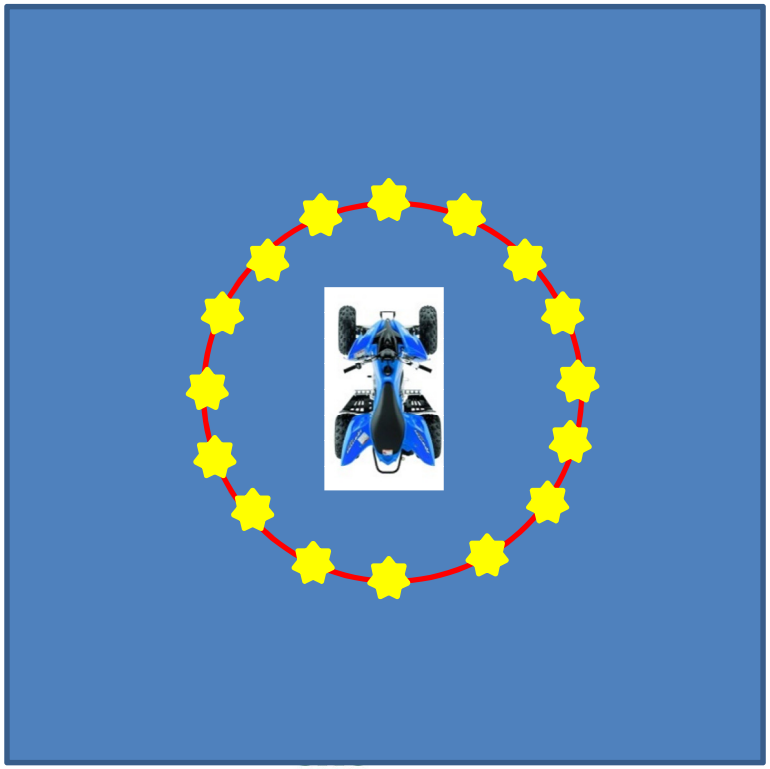
- Generally offer 1 sample per ha pH, P and K
- 16 sub samples taken from the ha



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Hectare sampling

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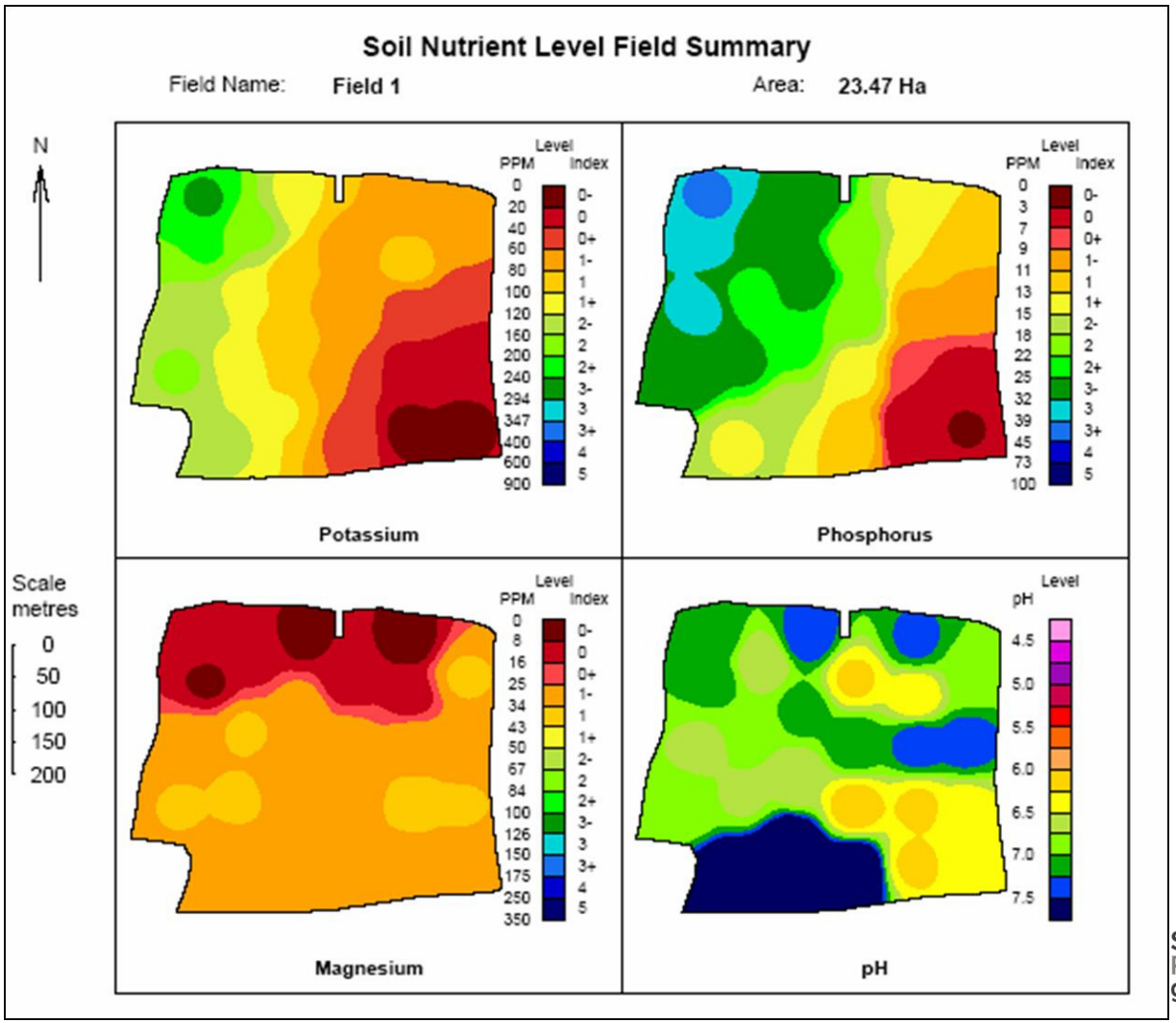

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Hectare sampling

- Questions
  - Can a spreader/operator cope with wavy results?

Grid Based Sampling

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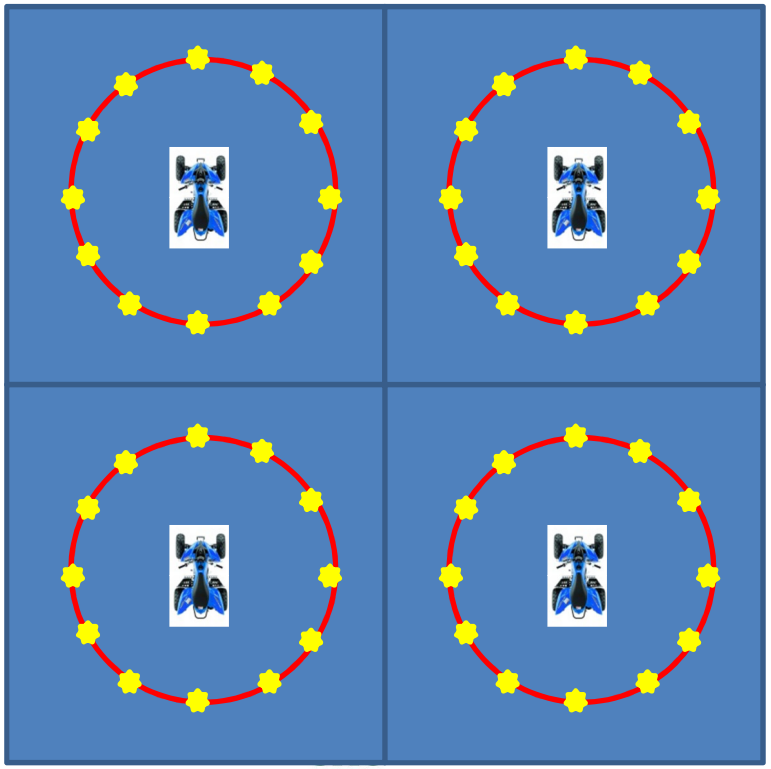
- 4 samples per ha
- 12 sub samples (48 per ha)



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Grid Based Sampling

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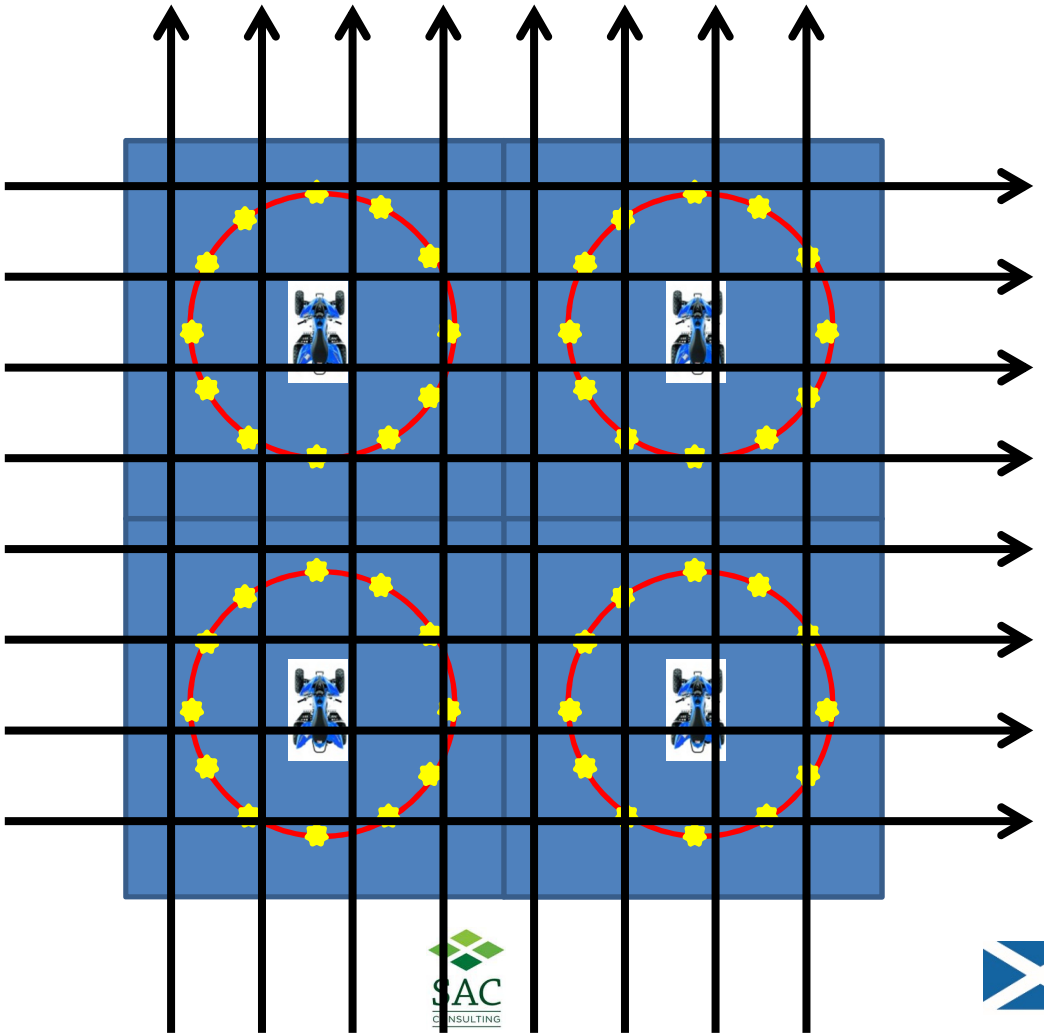

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Grid Based Sampling

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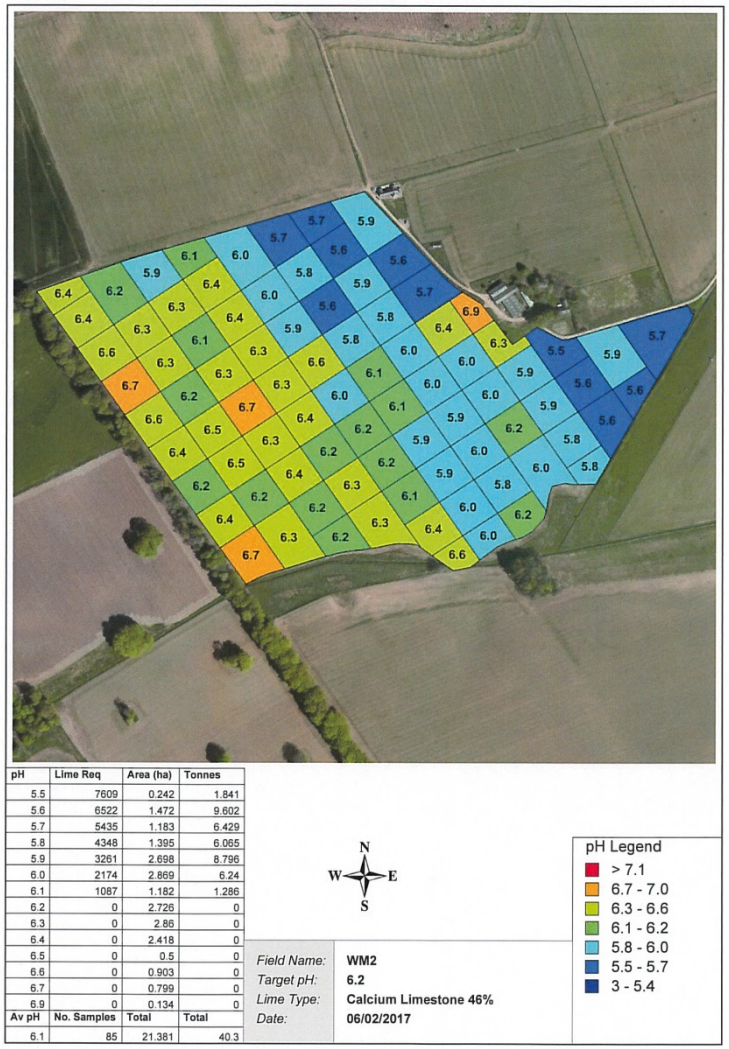

pH	Lime Req	Area (ha)	Tonnes
5.5	7609	0.242	1.841
5.6	6522	1.472	9.602
5.7	5435	1.183	6.429
5.8	4348	1.395	6.065
5.9	3261	2.698	8.796
6.0	2174	2.869	6.24
6.1	1087	1.182	1.286
6.2	0	2.726	0
6.3	0	2.86	0
6.4	0	2.418	0
6.5	0	0.5	0
6.6	0	0.903	0
6.7	0	0.799	0
6.9	0	0.134	0
Av pH	No. Samples	Total	Total
6.1	85	21.381	40.3

N W E S

Field Name:	WM2
Target pH:	6.2
Lime Type:	Calcium Limestone 46%
Date:	06/02/2017

pH Legend
- > 7.1
- 6.7 - 7.0
- 6.3 - 6.6
- 6.1 - 6.2
- 5.8 - 6.0
- 5.5 - 5.7
- 3 - 5.4

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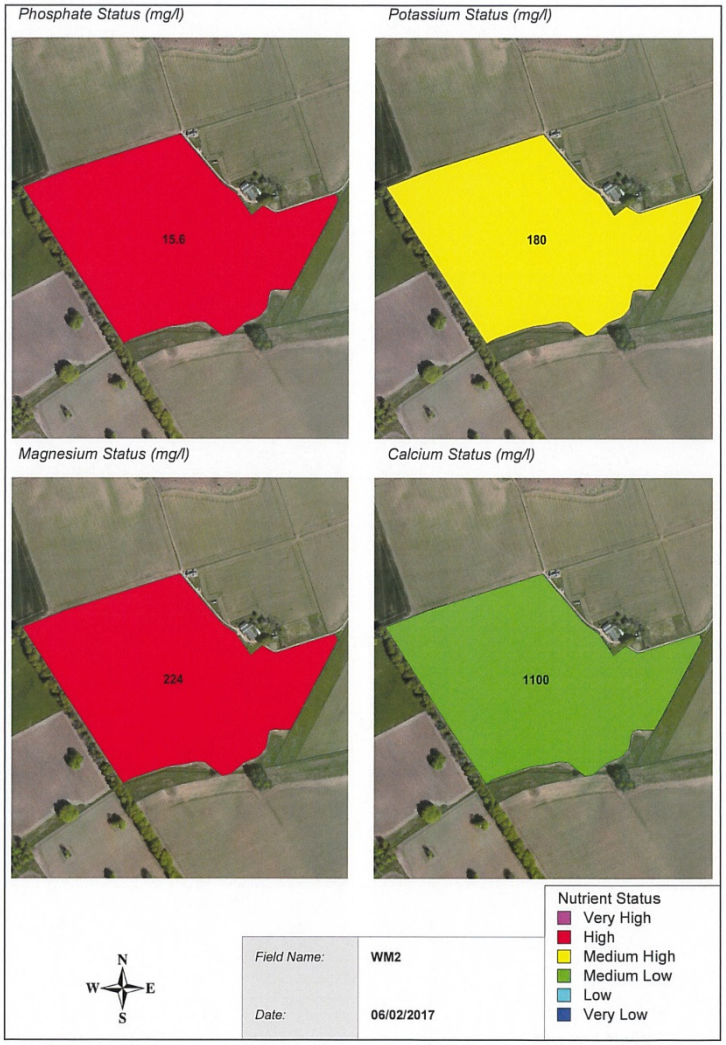

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Results from the fields tested at Limekilns

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Field 1 - pH

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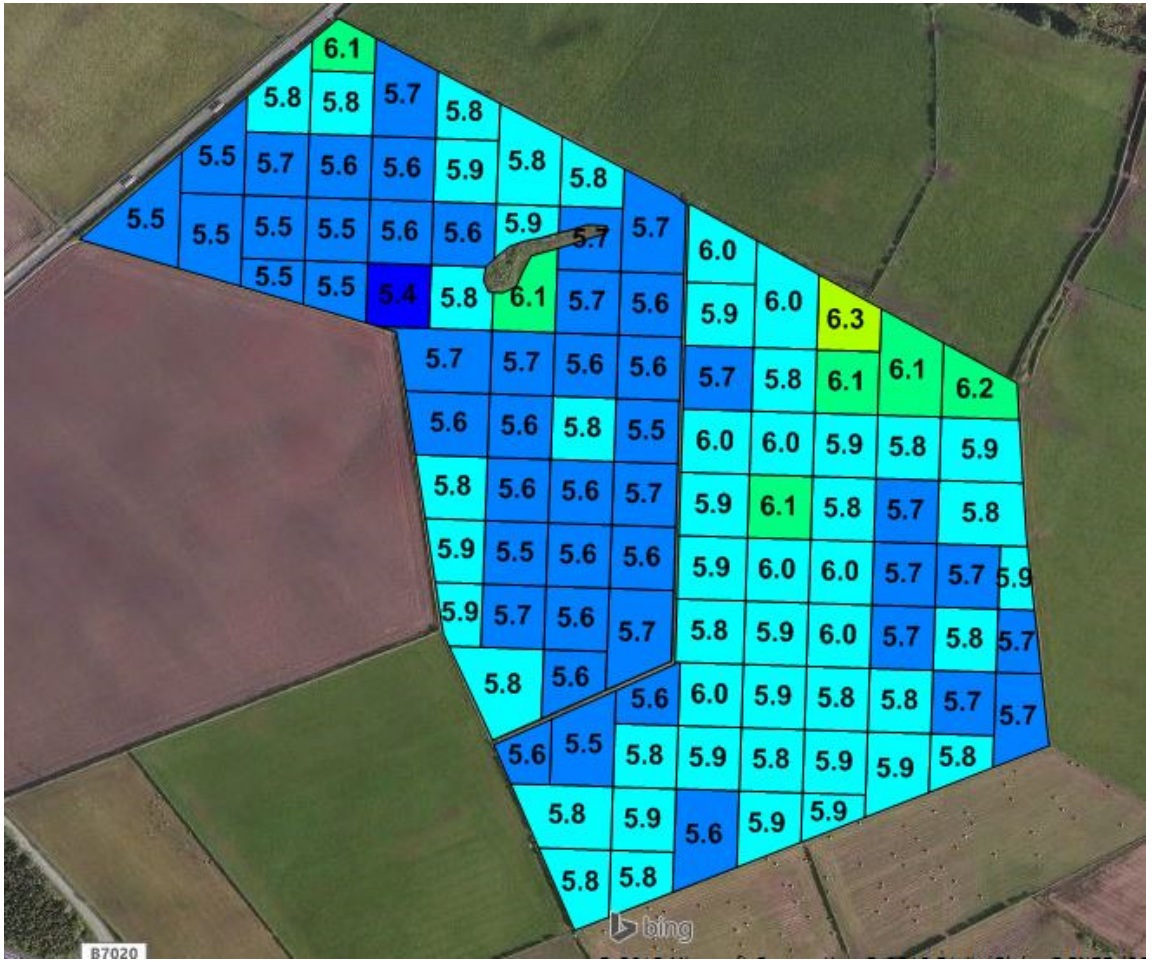

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Field 1 - Results

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Routine Sampling

- Average pH = 5.8
- Arable lime requirement = 4t/ha
- Field Size = 12.76ha
- Total lime required = 51.04t

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Field 1 Results

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GPS Sampling

- Average pH = 5.7
- Range in pH = 5.4 – 6.1
- Range in lime required = 8.7t/ha – 1.1t/ha
- Total lime required = 73.20t

- Difference +22t of lime

Field 2 pH

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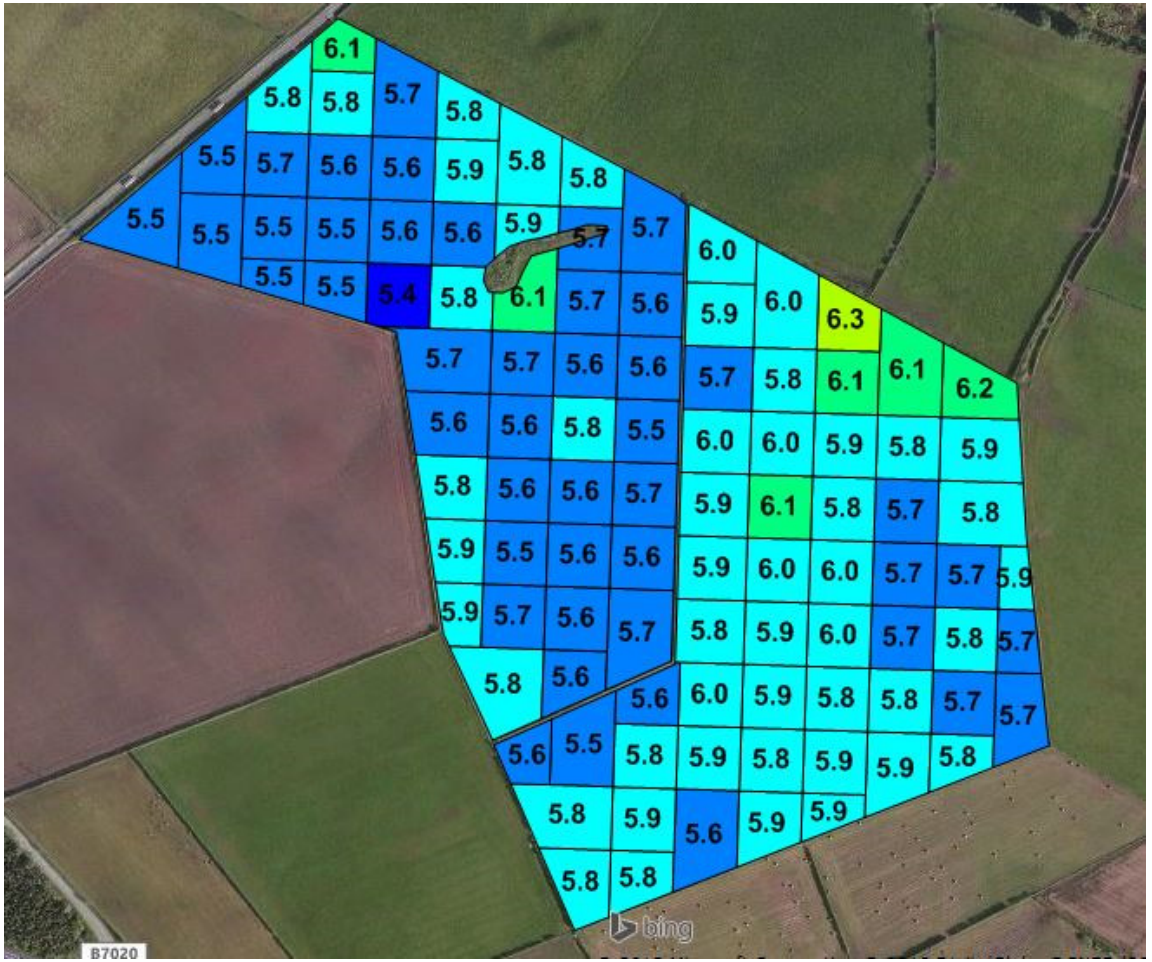

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Field 2 - Results

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Routine Sampling

- Average pH = 5.9
- Arable lime requirement = 3t/ha
- Field Size = 13.52ha
- Total lime required = 40.56t

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Field 2 - Results

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GPS Sampling

- Average pH = 5.9
- Range in pH = 5.5 – 6.3
- Range in lime required = 7.6t/ha – 0t/ha
- Total lime required = 50.10t

- Difference +9.54t of lime

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Field 3 pH

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Field 3 - Results

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Routine Sampling

- Average pH = 5.5
- Arable lime requirement = 7t/ha
- Field Size = 6.11ha
- Total lime required = 42.77t

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Field 3 - Results

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GPS Sampling

- Average pH = 5.7
- Range in pH = 5.3 – 6.5
- Range in lime required = 9.7t/ha – 0t/ha
- Total lime required = 36t

- Difference in lime -6.77t of lime

Field 4 pH

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Field 4 - Results

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Routine Sampling

- Average pH = 5.7
- Arable lime requirement = 5t/ha
- Field Size = 6.10ha
- Total lime required = 30.5t

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Field 4 - Results

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GPS Sampling

- Average pH = 5.7
- Range in pH = 5.4 – 5.9
- Range in lime required = 8.7t/ha – 3.3t/ha
- Total lime required = 34.1t

- Difference in lime +3.6t

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What happens over time?

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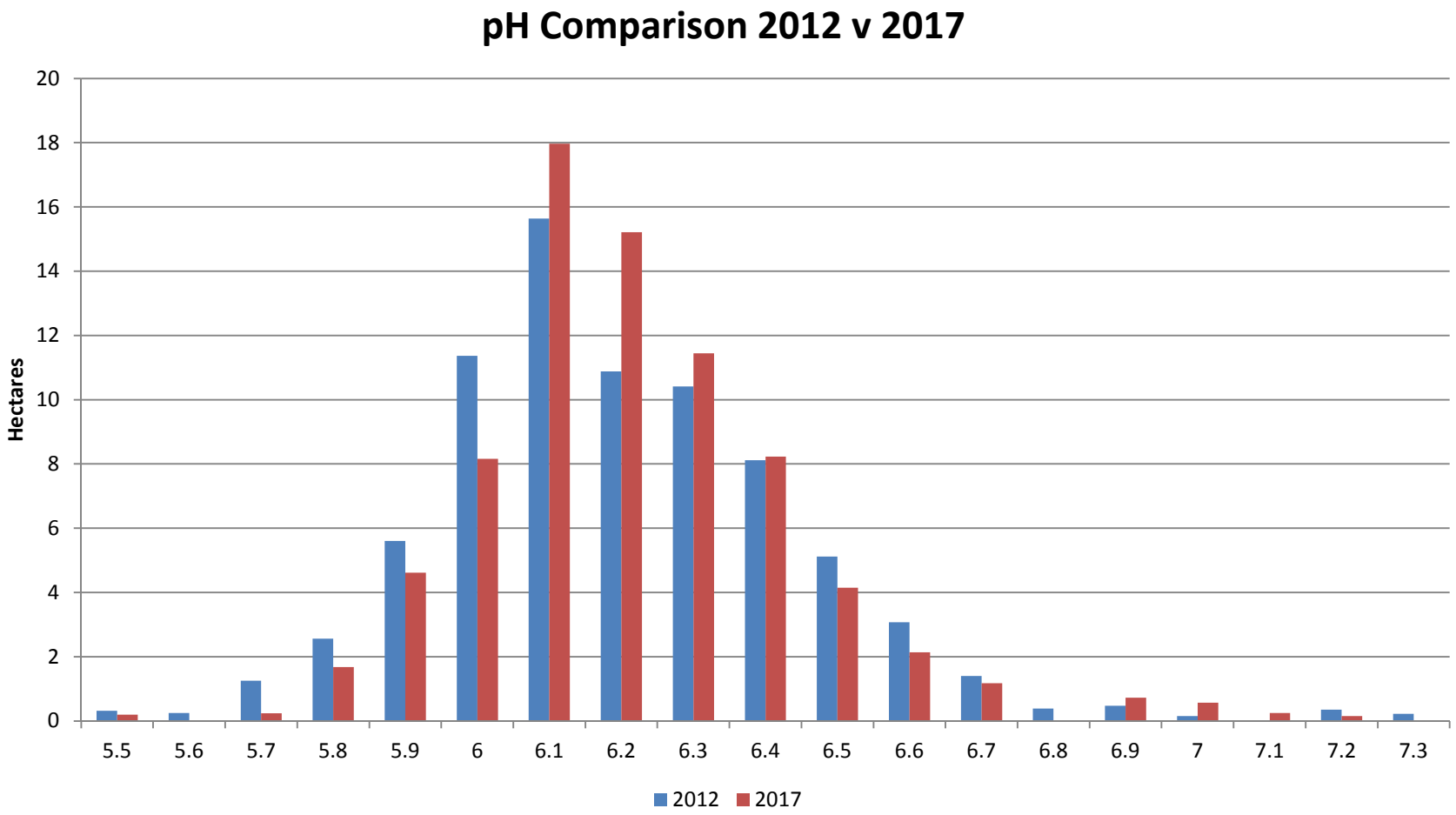

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Remember the golden rules

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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

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Cost benefit

- Sampling costs vary typically £25-30/ha
- In this case no saving in lime in first year
- Typical cost benefit of applying lime is between 2:1 and 8:1 but very dependent on situation.

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Sampling for P and K

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What are you sampling for?

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- Available phosphate
- Available potash

What is the availability of P and K dependent on?

Limits the availability of other nutrients

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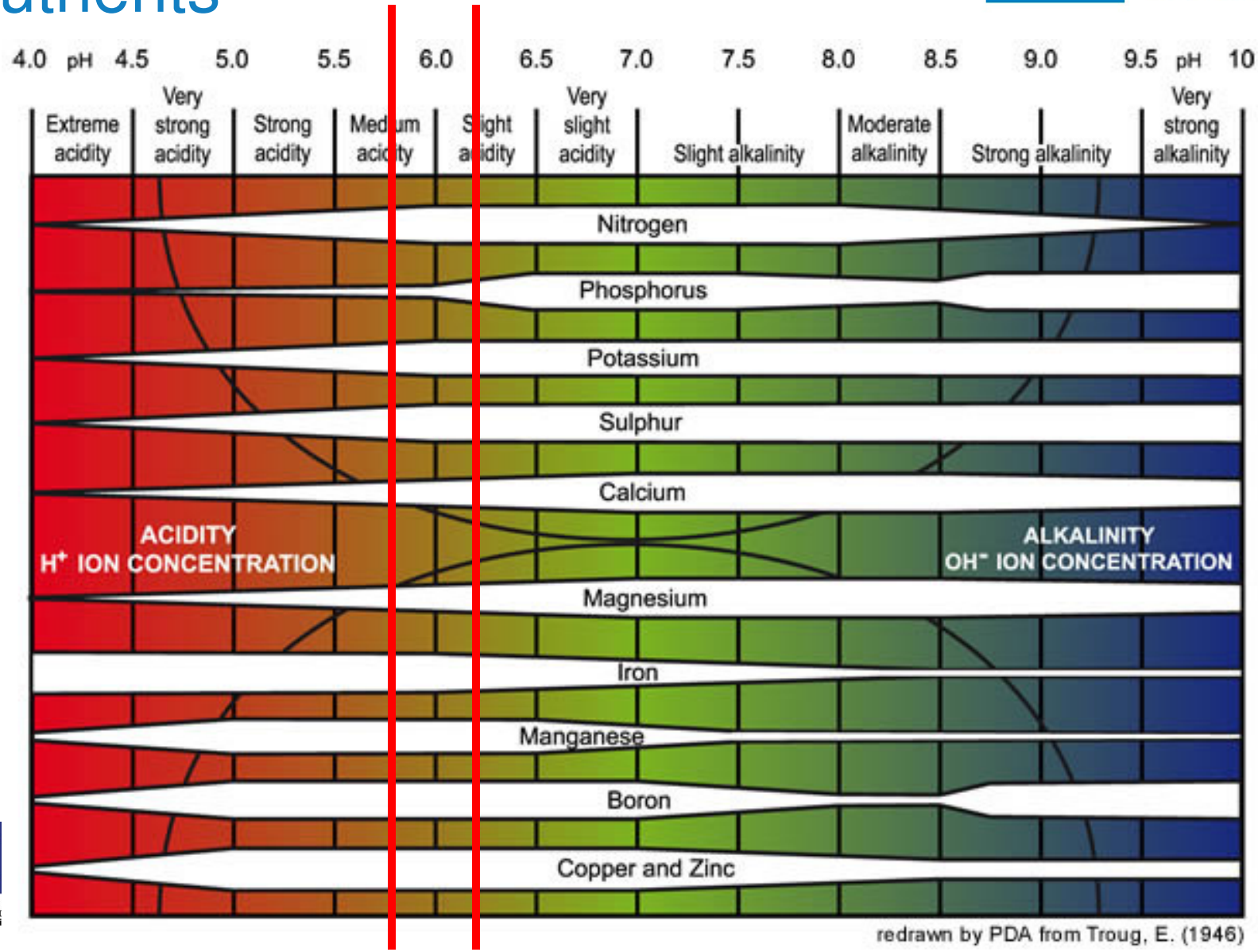

Therefore…..

Soil P and K levels may be adequate but they are not available to the plant due to low pH

=

Savings on P and K by correcting pH

Hectare sampling

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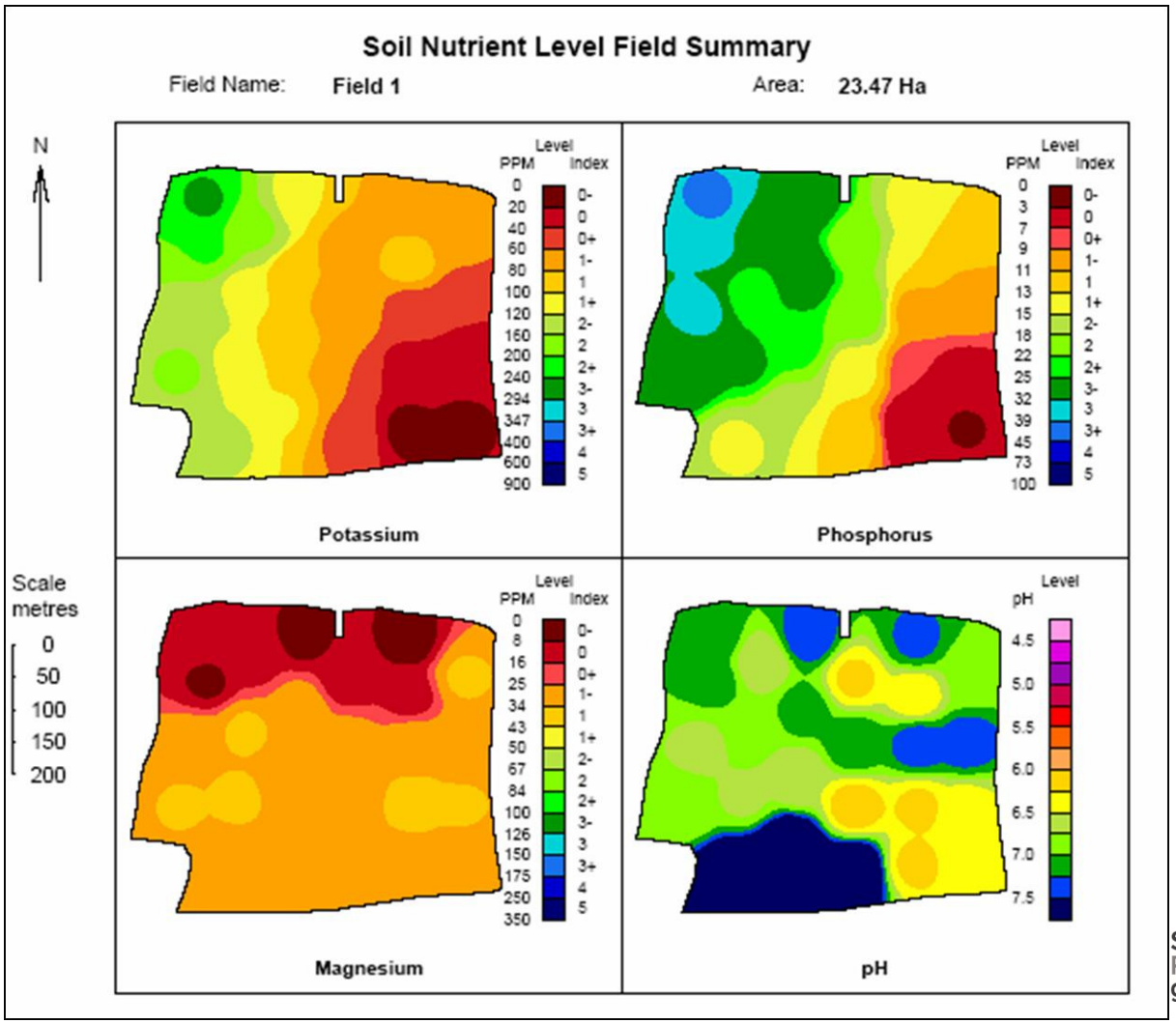

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Zoning Fields for P and K – Principles.

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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

- 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.

- 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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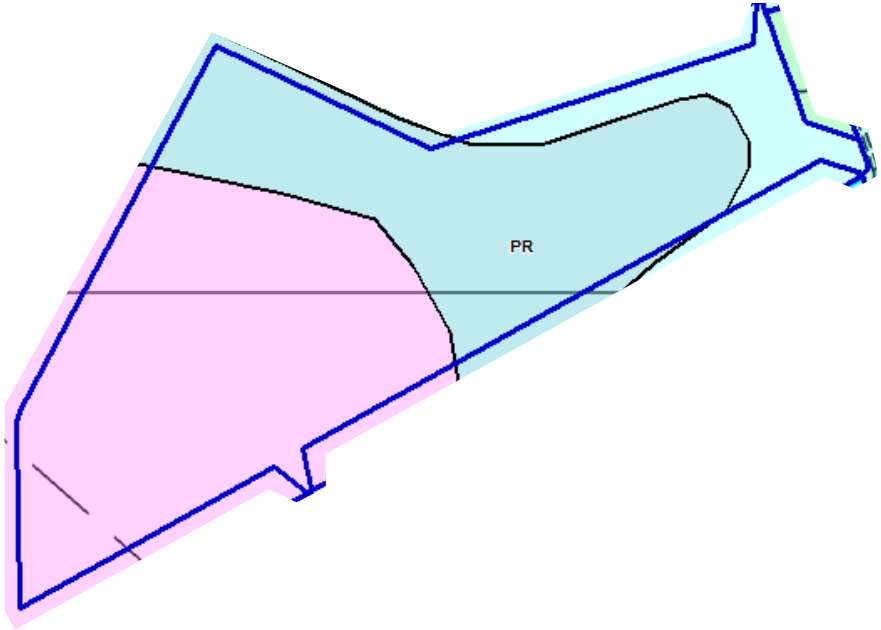

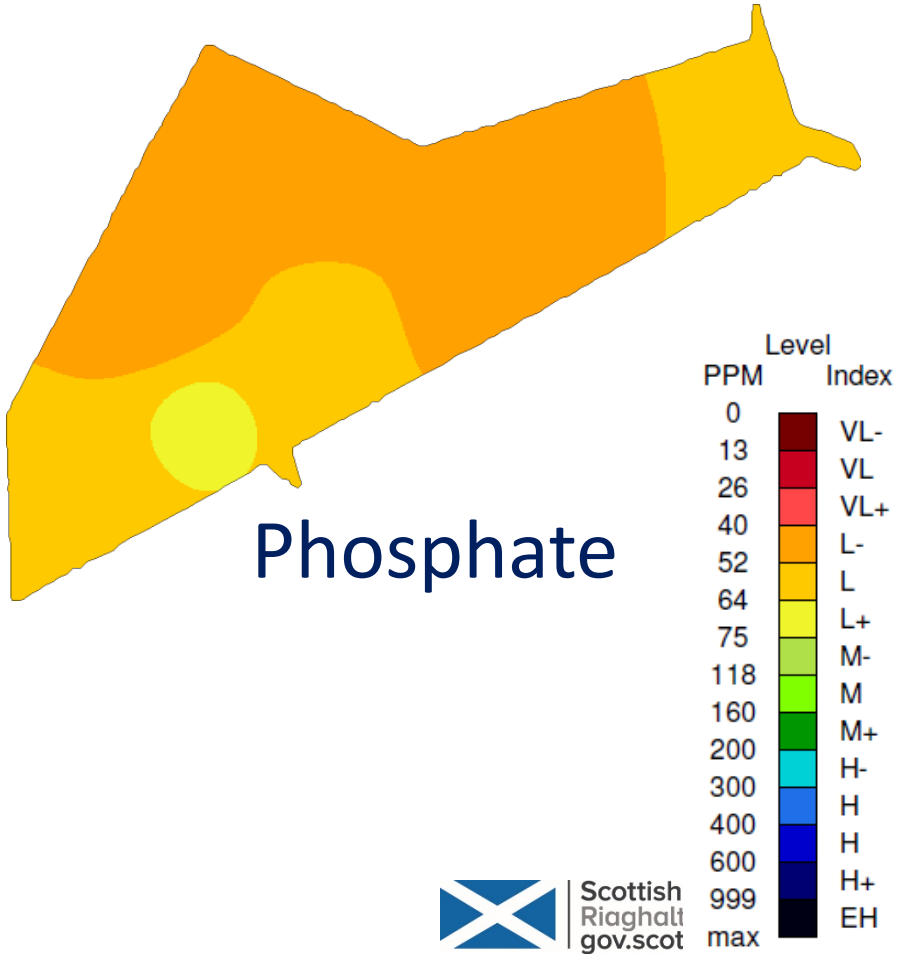

Phosphate

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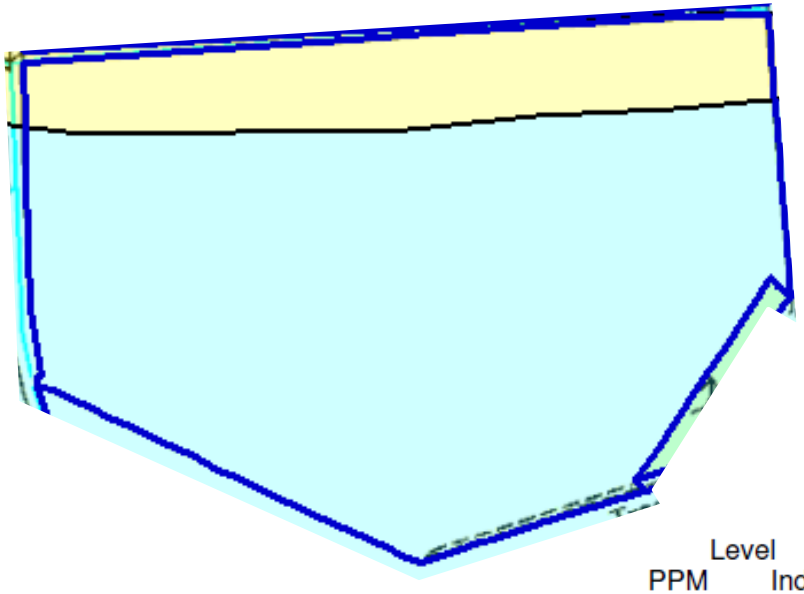
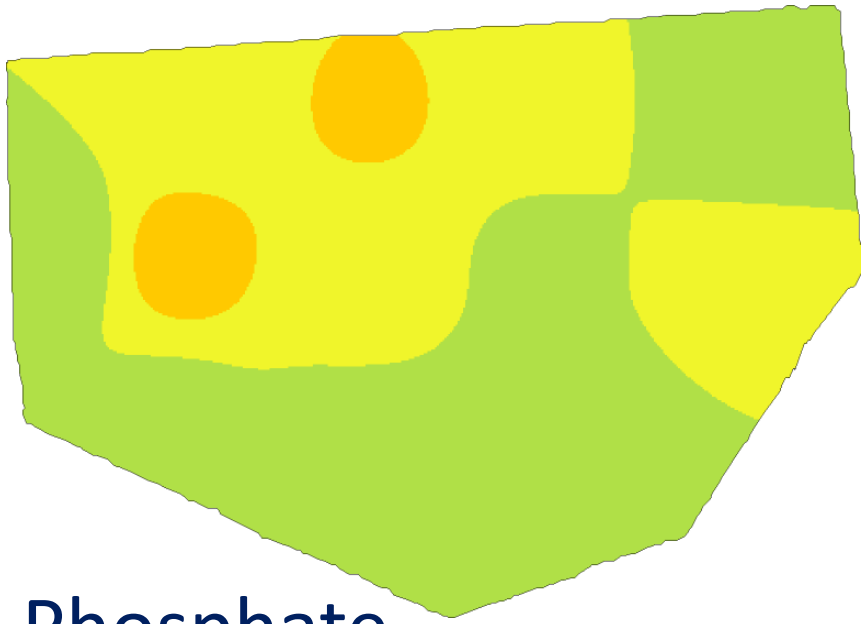
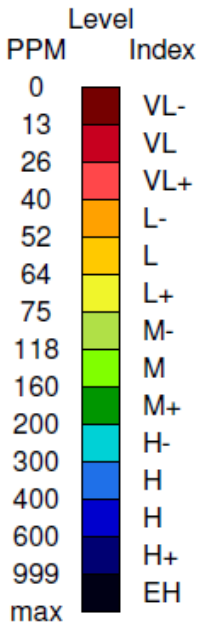
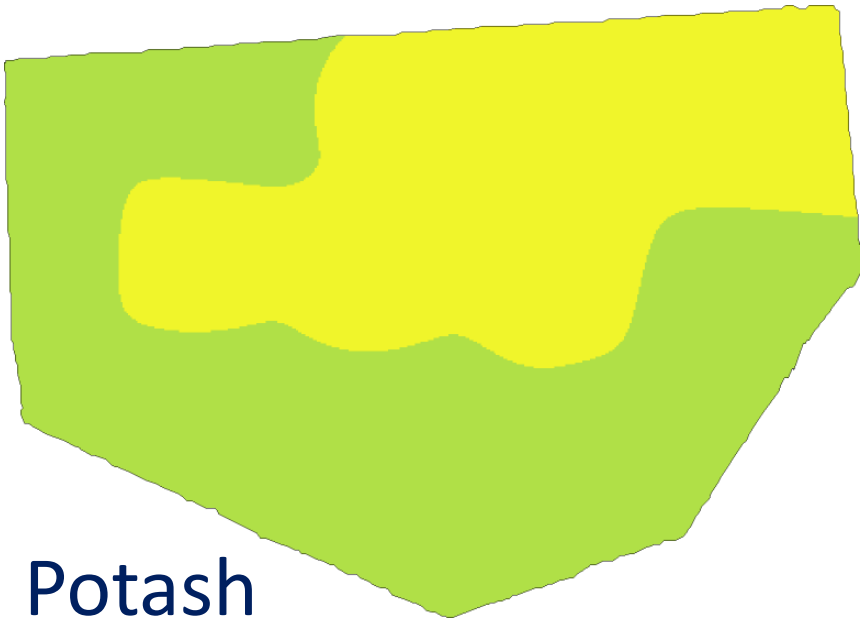
Alluvial bank





Phosphate





Potash

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Old midden sites?

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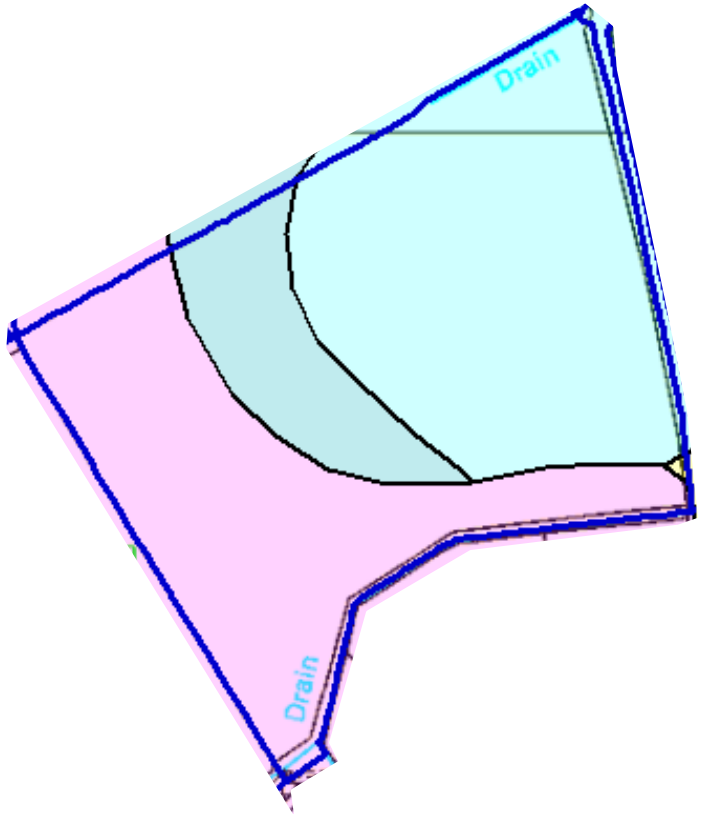

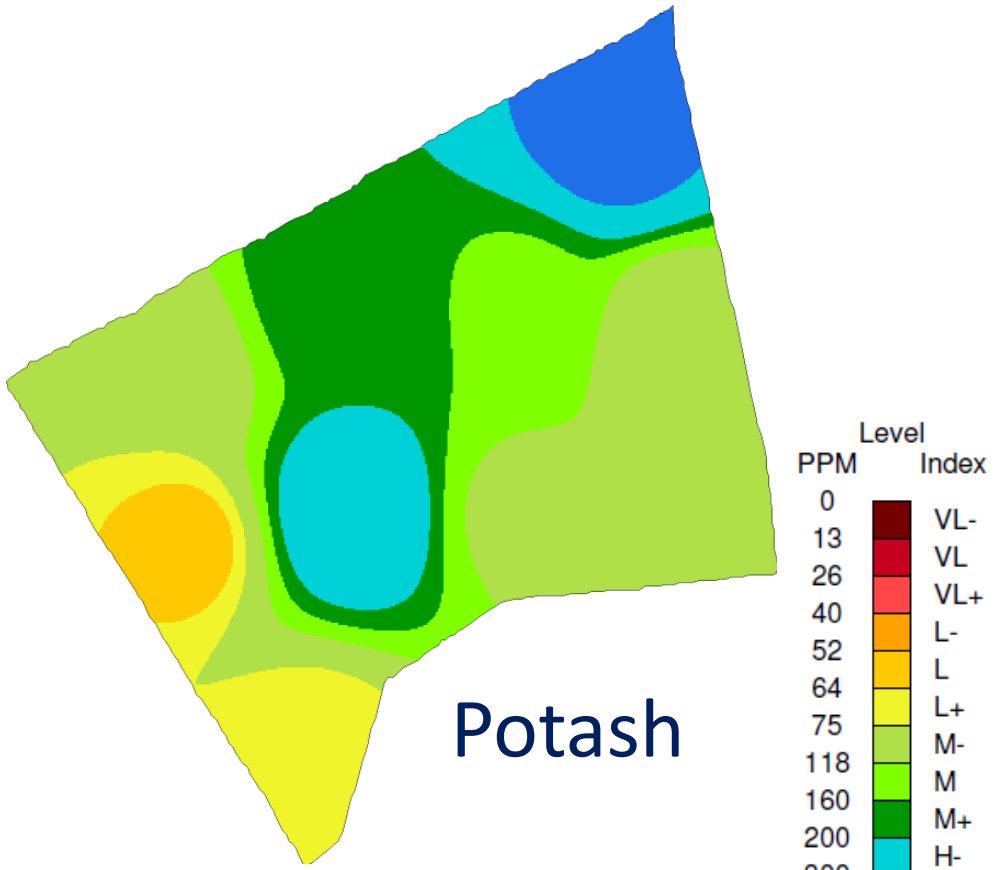

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Zoning

- 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.

Field 1 and 2 P Results

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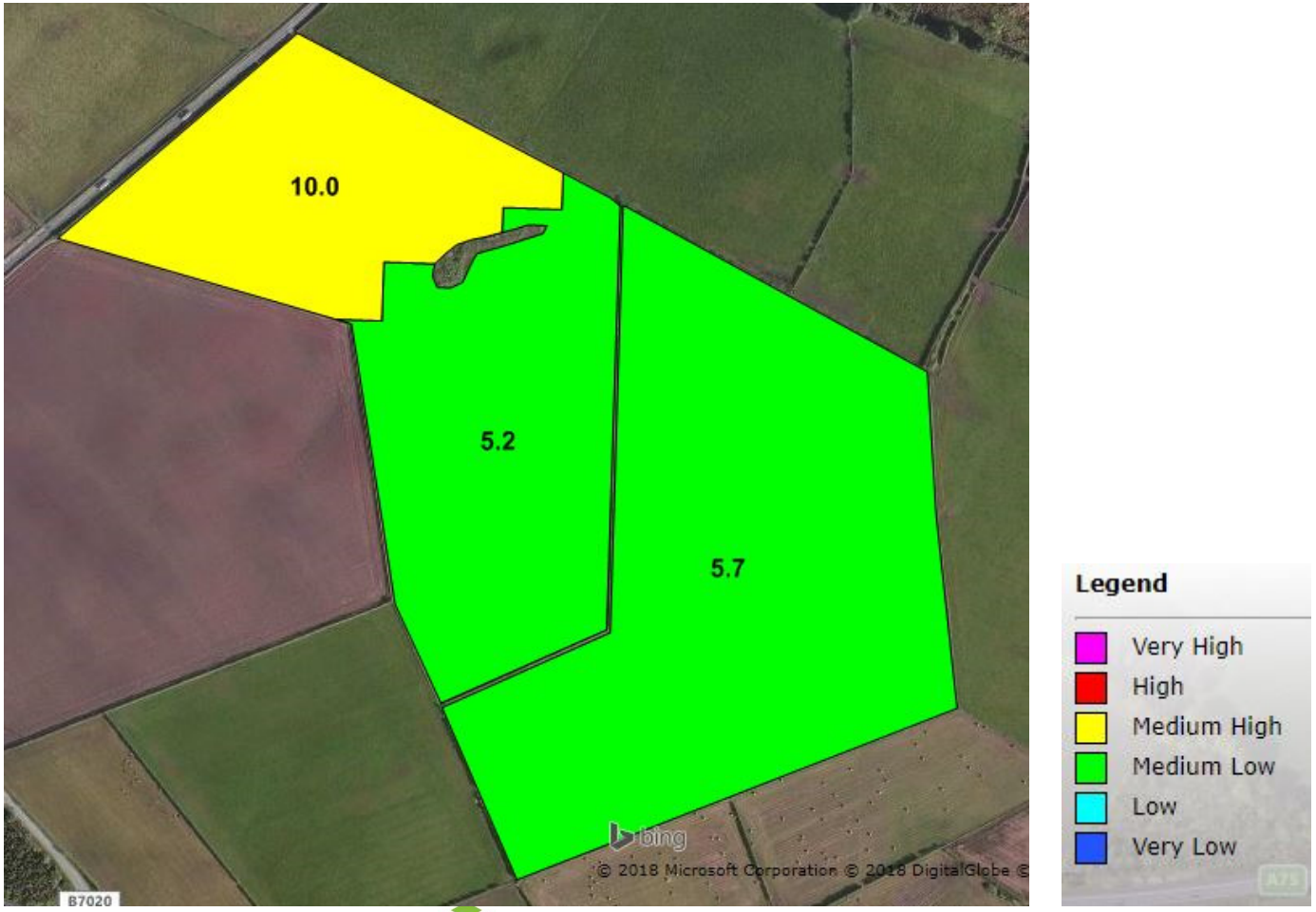

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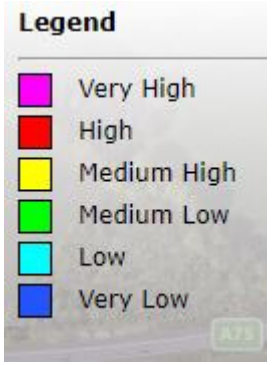
Field 3 and 4 Phosphate



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Field 3 and 4 Potash

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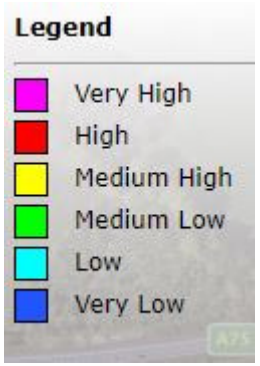

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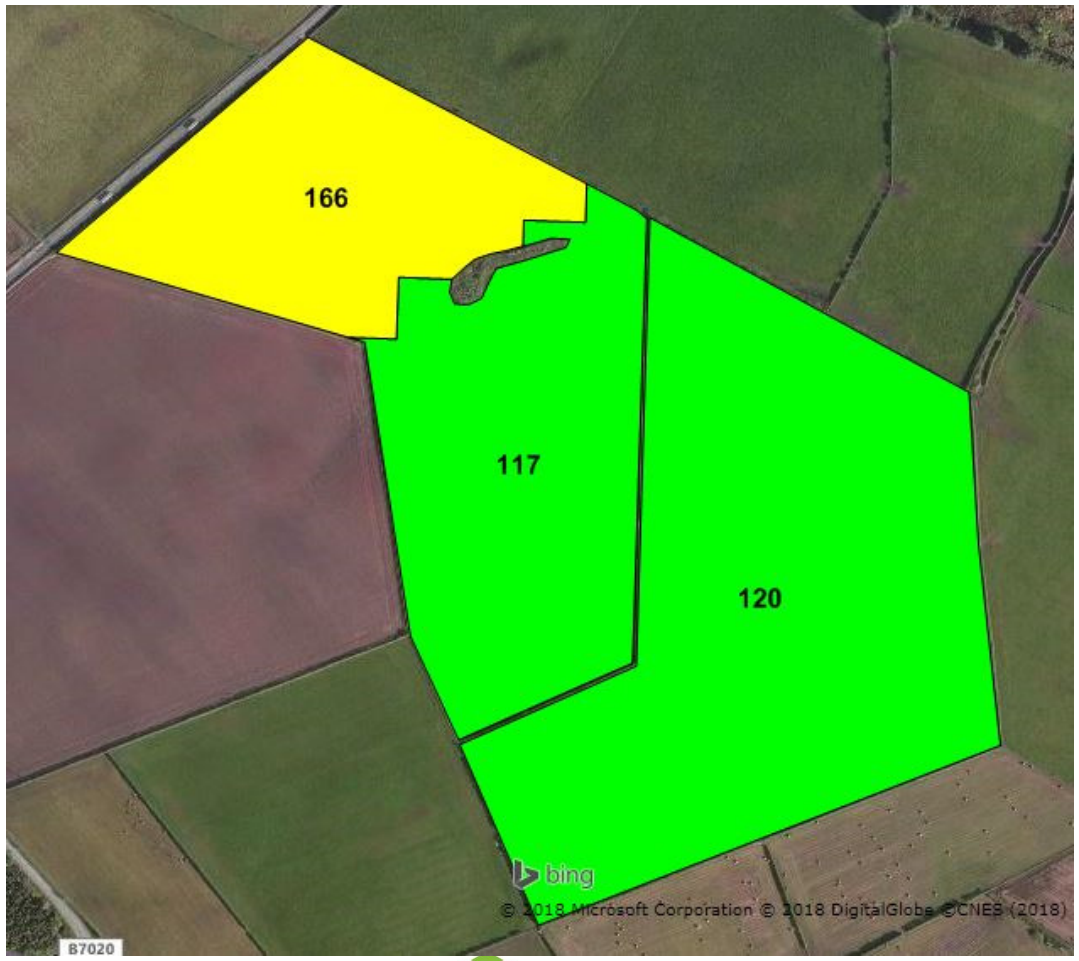
Field 1 and 2 Potash



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Fields 3 and 4

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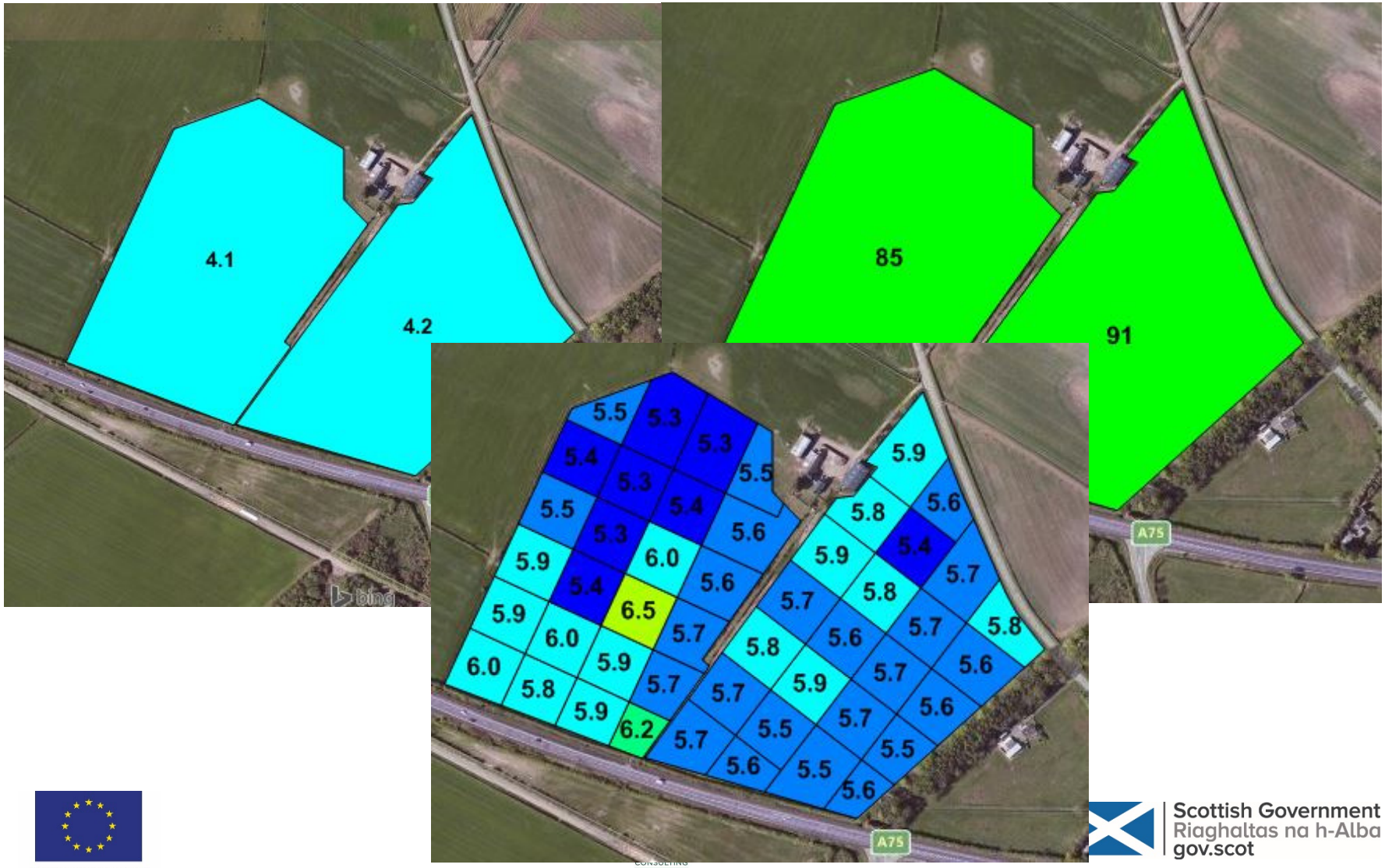

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Sampling Differences – Phosphate

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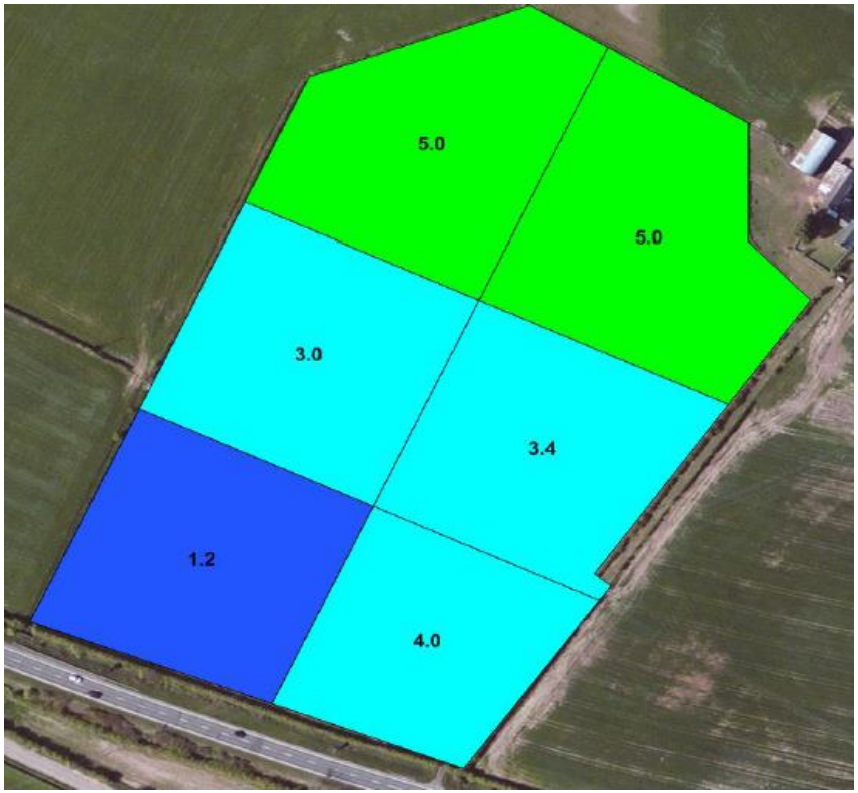

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Potential savings - Phosphate

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- Standard
  - 6ha x 30kg/ha = 180kg
  - Applied for 4 years = 720kg

- GPS
  - 3 ha @ 30kg/ha = 90kg
  - 1 ha @ 60kg/ha = 60kg
  - Applied for 4 years = 600kg

Potential savings - Phosphate

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- Difference = 120kg of P
  - 120/46x100 = 260kg of TSP
  - TSP at £362/t
  - Saving = £94
  - Additional sampling cost £26
  - Net saving on P £68

Sampling Differences - Potash

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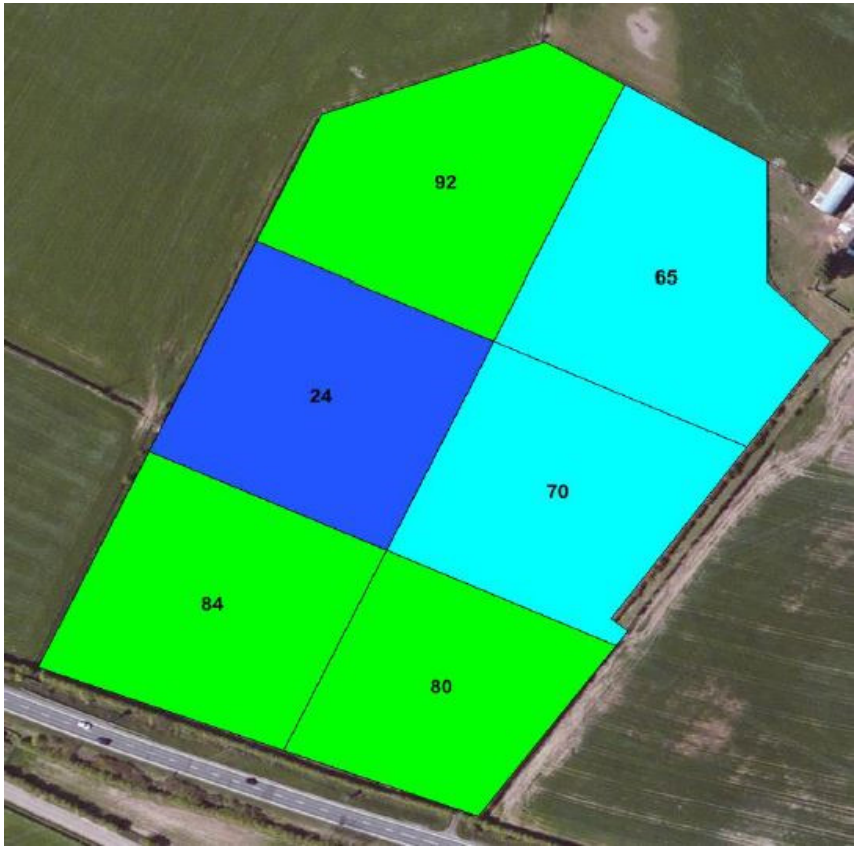

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Potential Savings - Potash

- Standard
  - 6ha x 20kg/ha = 120kg
  - Applied for 4 years = 480kg

- GPS
  - 2 ha @ 20kg/ha = 40kg
  - 1 ha @ 60kg/ha = 60kg
  - Applied for 4 years = 400kg

Potential savings - Potash

- Difference = 80kg of K
  - 80/60x100 = 133kg of MOP
  - MOP at £290/t
  - Saving = £39
  - Additional sampling cost £26
  - Net saving on P £13

- Total savings £81 or £13.50/ha

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What factors do you need to think about?

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Target pH

- What should your target pH be?
  - Arable rotation?
  - Grassland rotation?
  - Soil Type?
  - Starting pH values?

LIME ANALYSIS SUMMARY

Lime	Limehillock	Parkmore	Boyne Bay	Ullapool	Syke (Torrin)	North England	Fenstone (Yorkshire)	Calcipril
Sample Properties								
Neutralising Value (NV)	44.9%	45.1%	44.2%	54.7%	56.2%	56.9%	51.1%	52.6%
Calcium (Ca) Content	24.2%	24.1%	22.3%	17.7%	16.9%	17.2%	26.8%	27.2%
Magnesium (Mg) Content	1.3%	1.5%	0.9%	9.6%	10.8%	10.9%	0.1%	0.3%
Sample Grading								
Seive Size (mm)	% passed through				% passed through			
4mm	100.0%	100.0%	99.6%	100.0%	100.0%	97.8%	100.0%	14.2%
2mm	43.0%	76.8%	78.0%	87.3%	98.1%	75.7%	100.0%	0.4%
1mm	36.6%	65.0%	56.5%	59.7%	58.2%	57.8%	100.0%	0.1%
0.6mm	29.8%	51.9%	40.8%	41.3%	40.6%	47.6%	81.8%	0.1%
0.2mm	12.8%	48.4%	11.2%	27.2%	12.7%	17.4%	60.8%	0.0%
0.1mm	4.6%	22.8%	3.8%	17.7%	4.6%	12.1%	39.5%	0.0%
Sample Characteristics								
Dry Matter	97.4%	99.1%	97.9%	96.5%	95.9%	96.2%	94.2%	99.4%
Sample Size	1,560.1g	1,321.9g	1,640g	696.1g	1,358g	1,455.4g	229.6g	1,244.7g

The finer the lime product the more rapid the rate at which neutralisation in the soil occurs.

Please note that as lime products are derived from a naturally occurring source that variations will occur.

Example Cost Comparision of Lime

Lime A = 45% NV @ £20/t delivered
= £0.44/NV %

Lime B = 56% NV @ £30/t delivered
= £0.54/NV %

In this case Lime A works out the best buy when comparing the Neutralising Value (NV)

Calcium : Magnesium Ratio (Ca : Mg) in the Soil

- Calcium is the element that causes the soil particles to move apart for aeration and drainage.
- Magnesium makes the soil particles stick together.
- Scottish soils generally have a high Mg content.
- After much research it has found that it is not the extractable Ca and Mg in the soil that's important, it is the ratio of the two nutrients
- e.g. both extractable Ca and Mg can be low or high, yet have the right ratio in the soil.
- In a clay soil the extractable Ca:Mg ratio between 4:1 and 7:1 is expected to ensure that the magnesium is not excessive and detrimental to soil structure and aeration.
- In general, if your soil test is showing high magnesium levels in the soil there is no need to apply more and doing so may also impact soil structure.

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Lime Recommendations

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Routine pH sample

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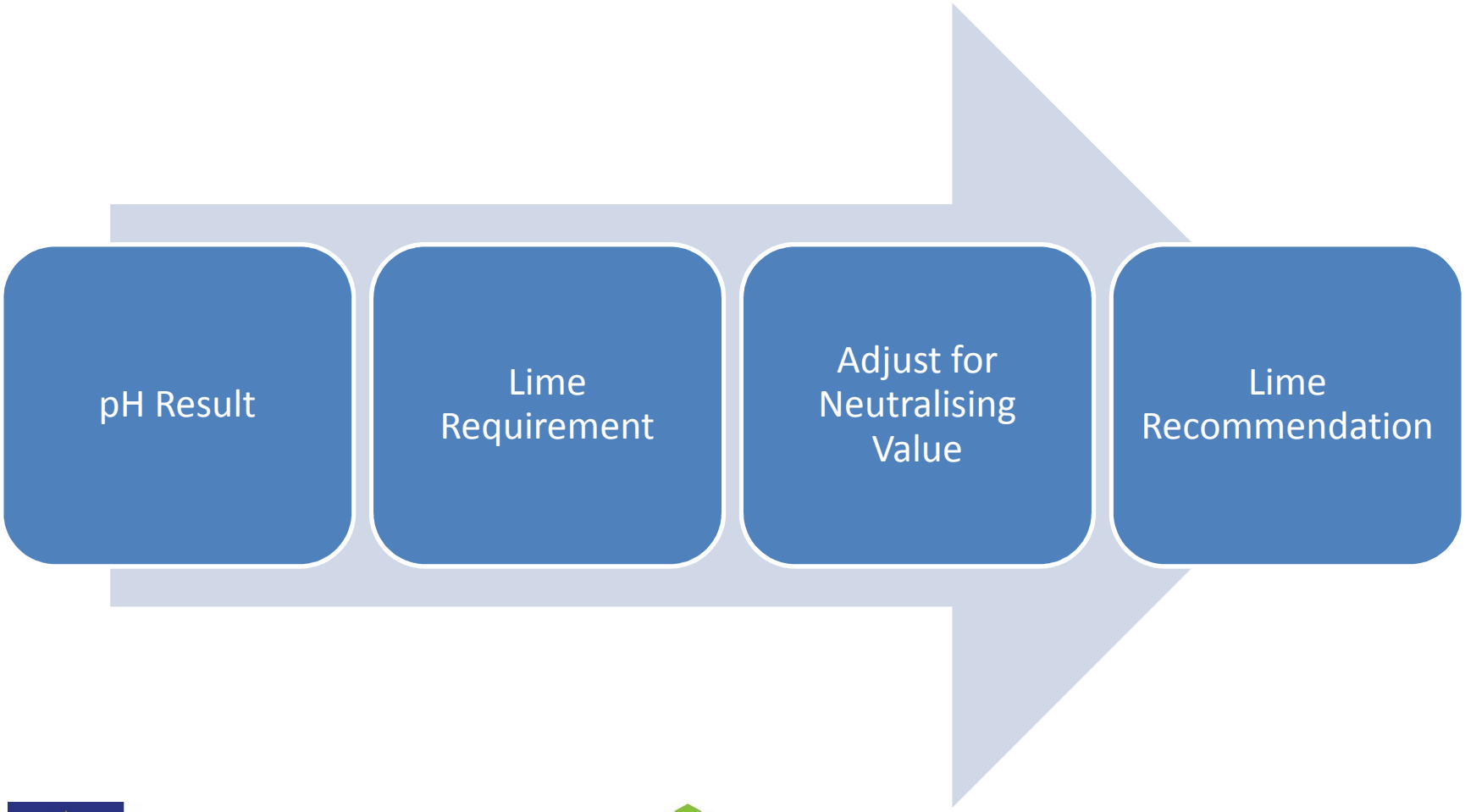

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TN656 rates at 50% NV

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Soil pH	Sands (S, LS)		Sandy loams		Other mineral soils		Humose soils		Peaty soils	
	Arable & rot. grass	Perm. grass	Arable & rot. grass	Perm. grass	Arable & rot. grass	Perm. grass	Arable & rot. grass	Perm. grass	Arable & rot. grass	Perm. grass
6.3	0	0	0	0	0	0	0	0	0	0
6.2	0	0	0	0	2	0	0	0	0	0
6.1	0	0	2	0	3	0	0	0	0	0
6.0	2	0	3	0	4	0	0	0	0	0
5.9	2	0	4	0	5	0	2	0	0	0
5.8	3	0	4	0	5	2	3	0	0	0
5.7	4	2	5	2	6	2	4	0	0	0
5.6	4	2	6	3	7	3	5	0	2	0
5.5	5	3	6	4	8	4	6	2	4	0
5.4	5	4	7	4	9	5	7	2	5	0
5.3	6	4	8	5	10	6	8	3	6	0
5.2	7	5	8	6	10	6	9	4	7	0
5.1	7	5	9	6	11	7	10	5	8	2
5.0	8	6	10	7	12	8	11	7	10	4
4.9	8	7	10	8	13	9	12	8	11	5
4.8	9	7	11	8	14	10	13	9	12	6

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Adjusting lime rates

- 5t/ha at 50% NV
  - At 56% NV = 50/56*5t/ha = 4.5t/ha
  - At 44% NV = 50/44*5t/ha = 5.7t/ha

Comparing limes

- 45% NV for £20/t
  - 20/45= £0.44 per % of NV

- 56% NV for £30/t
  - 30/56 = £0.54 per % of NV

GPS files

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Phosphate and Potash Recommendations

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P and K Recommendations

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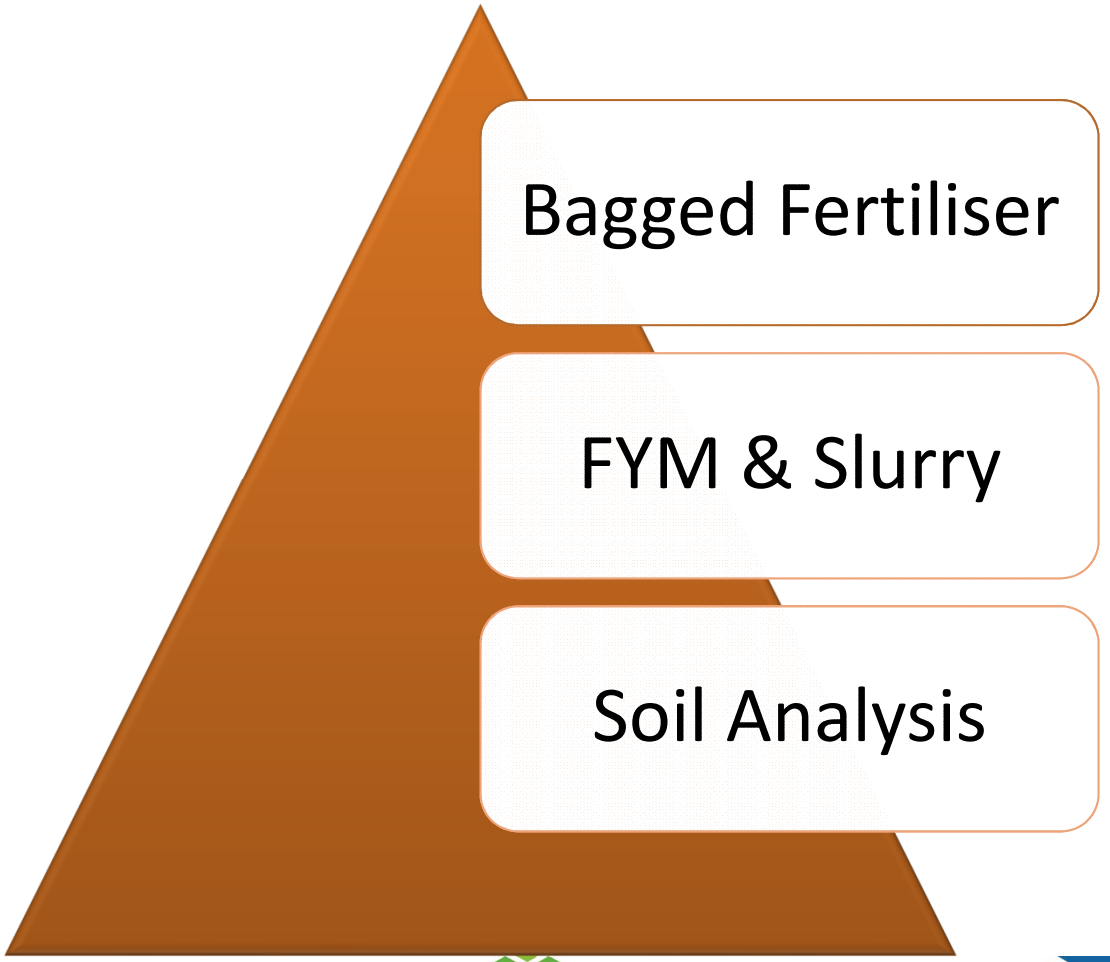

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Organic Manures – What's in Them? (TN650)

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Manure Type	Total N	Total (P_2O_5)	Total K (K_2O)
Cattle FYM	6	3.2	8.0
Pig FYM	7	6.0	8.0
Layer Manure	19	14	9.5
Broiler Litter	30	25	18
Cattle Slurry (3% DM)	4	1.2	3.5
Pig Slurry (3% DM)	3.6	2.2	1.6
Green Compost	7.5	3.0	5.5

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

Crop	P Removal (kg/t)	K Removal (kg/t)
Winter Barley	8.4	10.4
Winter Wheat	8.4	10.4
Spring Barley	8.6	11.8
Spring Oats	8.8	17.3
Winter Oats	8.8	17.3
Potatoes	1.0	5.8

Grass P and K Removal (TN652)

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Utilisation	Defoliation	Yield (t/ha)	P Offtake (kg/ha)	K Offtake (kg/ha)
Silage	1st Cut	23	39	138
Silage	2nd Cut	12	20	72
Silage	3rd Cut	9	15	54
Hay		7	41	126
Grazing		10	3	2

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Building a Recommendation – Arable

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		Phosphate (kg/ha)	Potash (kg/ha)
Soil Analysis Status		Low	Moderate
Required adjustment		-30	0
Spring barley removal	5t/ha	-43	-59
FYM	25t/ha	+80	+200
Balance		+7	+141

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Building a Recommendation – Grass

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		Phosphate (kg/ha)	Potash (kg/ha)
Soil Analysis Status		Low	Moderate
Required adjustment		-30	0
1st Cut Removal	23t/ha	-39	-138
2nd Cut Removal	12t/ha	-20	-72
Slurry spring	30m^3/ha	+36	+105
Slurry after 1st cut	30m^3/ha	+36	+105
Balance		-17	0

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Thanks for listening

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