Measure, don't guess: monitoring in practice

What soil and plant data can tell a farmer

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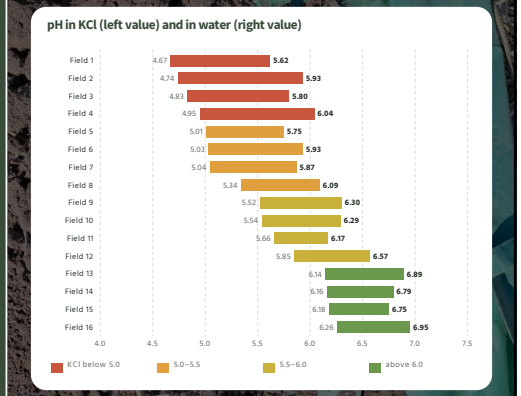
Understanding the numbers

Same fields, two pH tests. By water pH most field looks fine; by KCl pH, half of them need lime.

- Water pH: 5.6 to 7.0
- KCl pH: 4.7 to 6.3
- KCl also counts the acidity held on clay and humus
- 16 fields, Finnish farmer group, 2026



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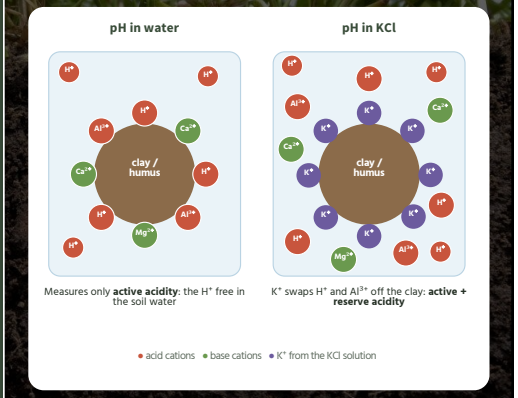
Two kinds of acidity

Water pH measures the acidity in the soil water. KCl pH also counts the acidity stored on clay and humus.

- Finnish soil tests report pH in water
- The stored acidity re-acidifies the soil after liming — water pH underestimates the lime needed
- KCl pH reads 0.5–1 unit lower, so it has its own targets
- Salt-based pH is steadier through the season — better for tracking



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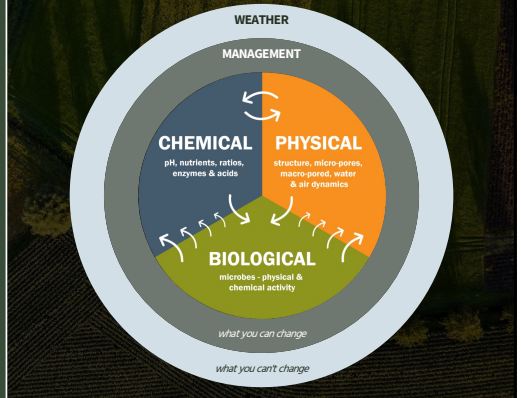
Soil, management, weather

Each layer needs its own tests or data collection — and the crop shows the result.

What to measure

- **Chemistry** lab test: KCl pH, CEC, balance
- **Physical** spade, penetrometer, water infiltr.
- **Biology** worms, rhizosheets, soil respiration
- **Management** your own field records
- **Weather** rain gauge, soil temperature
- **Crop** sap tests, tissue test, visual assesment and yield maps



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The monitoring toolkit

Each test answers a different question. None of them answers all of them.

- Cheap field tests, done often, at the same spots
- Lab tests less often: same lab, same month
- Sap tests when you can still act on them

Tool	What it answers	When
Lab soil test	What is in the soil, what it can hold, what is out of balance	Every 3–4 years, same month
Spade test (VESS)	Is the structure letting air, water and roots through?	Every year, moist soil
Penetrometer	At what depth does the soil get hard?	Every year, same moisture
Infiltration ring	Can rain get in, or does it run off and sit?	Every year
Worms and roots	Is the soil alive? Where do the roots stop?	Every year
Plant sap	What is the crop getting right now, and what is it short of?	Before key growth stages
Satellite and yield maps	Where does the field under- or over-perform, and is it consistent?	Every season
Field records	What went on, when, and with which machine? Explains what the tests show	Every pass
Rain gauge, soil logger	Was it wet, dry or cold? The context for every other reading	Continuous

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Read the signals together

One number rarely gives the cause. The combination does.

- Measure at the same spot so signals can be combined
- Check how consistent a sign is across a zone
- Then check the records: traffic, tillage, drainage

What you see together	What it usually means
Hard layer + poor spade score + slow water + shallow roots	**A compacted layer** — check traffic and tillage
Soil test says enough, sap says short	**The plant can't get at it** — roots, structure, nutrient balance
Big reserve, little available	**The soil isn't releasing it** — biology or pH
Few worms, low respiration, chemistry fine	**A biological problem** — residues, organic matter
Same nutrient short in sap in every zone	**A real shortage** — a target for fertiliser or foliar
Poor ground follows the low, wet spots	**Drainage**
Poor ground follows tramlines or headlands	**Traffic**

At Sadala, Field A: water 15× slower, hard soil at 10 cm, half the worms → likely a compacted layer. The pits will confirm the cause.

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Case A: a good test, a poor soil

The soil test looked balanced. The spade showed compaction and no life.

What we changed

- Stopped deep tillage
- Biology on the seed
- Fed the soil microbes

Result

- Once the biology was active again, the structure changed greatly

The soil test

	Found	Aim
pH	6.8	
CEC	15.2	
Calcium	74%	69%
Magnesium	12%	11%
Potassium	4.4%	3.4%
Sodium	0.7%	0.9%

On paper: close to target on every line. Nothing to correct.

Base saturation, % of CEC. Aims: Albrecht targets.

Dug: dense, compacted block, no soil life

After: crumbly, open structure

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Case B: soil on limestone

The limestone underneath keeps resupplying calcium. Don't chase the ideal Ca:Mg — find what grows the crop each season.

Not cost-effective

- Dolomitic lime to fix the ratio: more carbonate on a soil that already has plenty

Works every season

- Magnesium sulphate: magnesium the crop can take up
- Sulphur: a nutrient, and it acidifies locally around the roots
- Nutrition on the seed and through the leaf

The soil test

	Found	Aim
pH	8.2	
CEC	16.5	
Calcium	90%	69%
Magnesium	4.7%	11%
Ca : Mg	19 : 1	6 : 1

In reserve: 108 t/ha of calcium against 7 t/ha of magnesium — with limestone below.

Base saturation, % of CEC. Aims: Albrecht targets.

Dug: dense and airless

Feed the crop each season instead

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Case C: light sand

89% sand and a CEC of 11: the soil can't hold on to nutrients. Organic matter builds that capacity — and lifts the low phosphorus.

Build the holding capacity

- Manure, compost and other organic amendments
- Organic matter adds CEC — in a sand it carries most of it
- It holds phosphorus where roots and biology can reach it

Meanwhile, feed the crop

- Nutrition and biology on the seed, little and often through the leaf

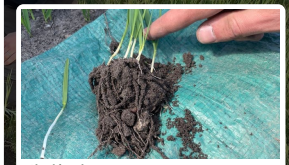
The soil test

	Found	Aim
Sand	89%	
CEC	11.0	
pH	7.3	
Phosphate P_2O_5, kg/ha	43	111
Magnesium	6.5%	12%

Texture: 89% sand, 8% silt, 3% clay. Little clay to hold nutrients, so organic matter has to do it.

Magnesium as % of CEC. Aims: Albrecht targets.

Dug: no structure, weak rooting



Checking the young roots

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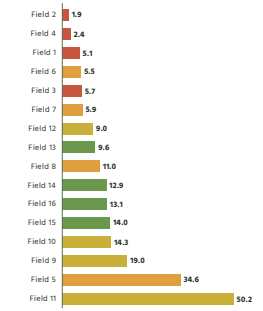
In the soil is not in the plant

A soil test shows what is there. Only part of it reaches the crop.

- Phosphorus: only 2–6% plant-available on the most acidic clays
- Raising pH and feeding biology unlocks it
- Sap shows what actually reaches the crop

Plant-available share of soil phosphorus

Mehlich-3 P as % of total P. Same 16 fields, coloured by KCl pH.



Fields 5 and 11: sandy, long manure history

Calcium: in the soil, not in new leaves

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early-June sap samples had too little calcium in the young leaves

Even on a soil with 80% calcium saturation.

Old leaves held 2–4× more: the calcium was in the plant but not reaching new growth. It moves with the water the plant transpires — lack of energy and growth, or cool June days slow it down.

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Sap as an early warning

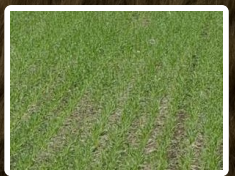
Sap tests flag a shortage 14–20 days before you can see it — if you sample ahead of the stage.

- Sample 10–14 days before the stage you want to influence
- Young and old leaves: which way nutrients are moving
- Test and control the same morning, before 9 am

Count back from the growth stage

Day 0	Day 1–8	Day 8–11	Day 10–14
Sample young and old leaves	Courier and lab: median 7 days	Decide the mix, get product and sprayer	Key stage: the crop uses it

Sample at the stage itself and the report arrives after the window has closed. Turnaround from the 2026 Finnish season: 2–14 days, median 7.



Two leaves, one picture

Young leaves: what new growth is getting.

Old leaves: what the plant has in store.

If old leaves are being emptied to feed new ones, uptake is falling short — before any symptom shows.

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NUE trial: the set-up

One malting barley field split in two: the farm's standard programme against a sap-guided one.

- Southern Finland, variety Brienne
- Same field, same sowing date (23 April)
- 5 ha + 5 ha
- The trial side started with less magnesium and a lower pH

← Trial Control →

	Control	Trial
Nitrogen, kg/ha	119 granular	42 granular + 12 foliar = 54
Seed	Standard dressing	Nutrient seed coating
Foliar feeds	—	Written from two sap tests
Fungicide	Yes	None

N-uptake map

Satellite map in the season: the trial block (outlined) took up as much nitrogen as the control, or more.

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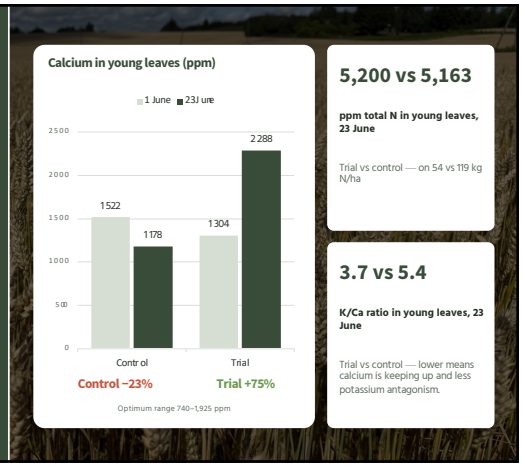
NUE trial: what the sap showed

No need for fungicides due to higher calcium levels in trials – cumulative foliar applications build calcium over the season.

- Sap tests on 1 and 23 June, young and old leaves.
- Each test set the next foliar feed
- Calcium builds the cell walls of new growth and when adequate builds strong cell walls that fungi struggle to penetrate.
- Control: higher available Ca in soil, and higher amount of Nitrate which pulled calcium into leaves.
- Key nutrients in trial: Boron, and balanced K/Ca ratio.



5,200 vs 5,163

ppm total N in young leaves, 23 June

Trial vs control — on 54 vs 119 kg N/ha

3.7 vs 5.4

K/Ca ratio in young leaves, 23 June

Trial vs control — lower means calcium is keeping up and less potassium antagonism.

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NUE trial: the harvest

More grain from less than half the nitrogen — and the malting quality held.

- The trial barley goes into Carlsberg's regenerative beer programme
- One field, one season: a strong signal, not yet proof. Next season slightly more N for better protein.
- Next: winter rye on the same farm, sap-guided again

8.0 vs 7.5

t/ha yield

Trial vs control

54 vs 119

kg N/ha applied

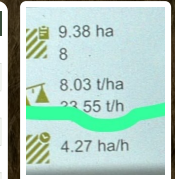
Less than half

149 vs 63

kg grain per kg N

2.4× the return on N

Grain quality	Trial	Control
Protein	9.4%	11.1%
Germination	98.8%	97.3%
Plump grain (I + II)	94.7%	95.3%
Starch	61.5%	60.2%
Hectolitre weight	66.0 kg/hl	68.3 kg/hl
Cracked kernels	0.3%	2.3%
Green kernels	0.1%	0.9%
Skinned kernels	1.2%	0.5%



Combine display on the trial side: 8.03 t/ha

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Making data usable

Data only pays when it is tied to a place and comparable from year to year.

- Same field, four tests, four different patterns
- Each map shows a different limit
- Year 2 is read against year 1, spot by spot

Six habits that make data comparable

- ✓ Same spot: GPS-marked, every year
- ✓ Same season and soil moisture
- ✓ Same depth, lab and method
- ✓ Recorded on the spot, with the zone
- ✓ Mapped per zone, not per field
- ✓ A control strip to compare against

Field I at Sadala, Aug 2026. Maps: GeoPard; imagery © Mapbox, © OpenStreetMap.

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Start monitoring tomorrow

Start small: a few zones, the same spots, every year — and always something to compare against.

What it gives you

- Spend where it pays, save where it doesn't
- See problems weeks earlier
- Evidence from your own fields

What	When	How often
Field tests spade, penetrometer, water ring, worms, roots	After harvest, moist soil	Every year, 1 spot per zone
Lab soil test incl. KCl pH, CEC, base saturation, organic carbon	Same month every time	Every 3–4 years per zone
Satellite and yield maps to draw and check the zones	Every season	Always
Sap tests young and old leaves	10–14 days before key stages	On the fields where you will act
A control strip left as before	Every season	Always: it turns data into evidence

Budget about 45 minutes per spot for the field tests, done in one visit.

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