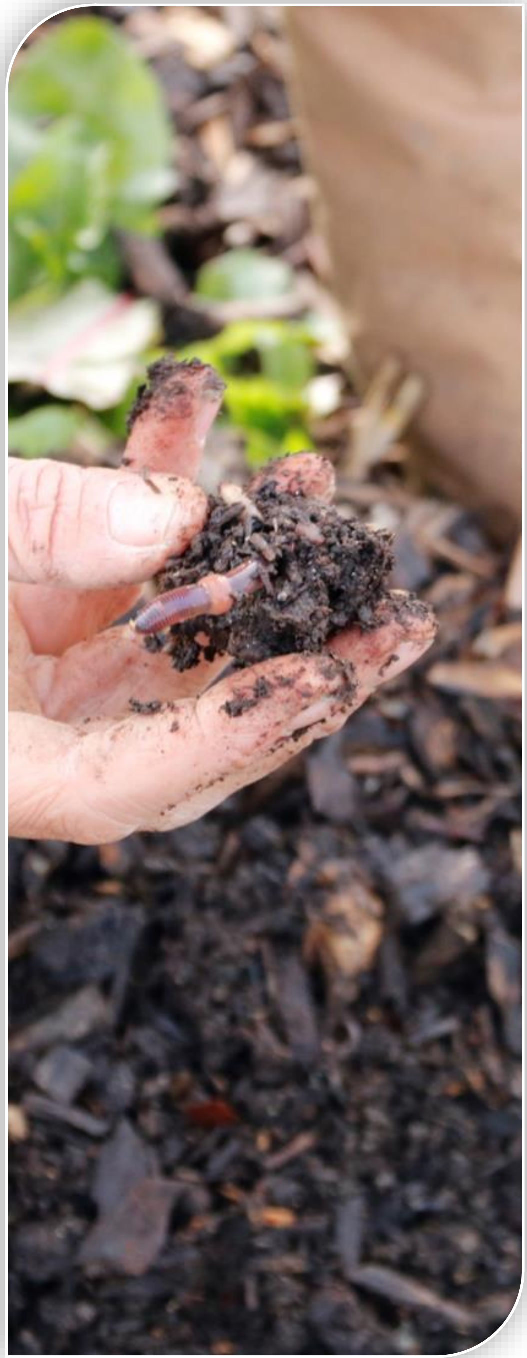
5 december 2022
Soil Health Conference



Knowledge erosion about soils

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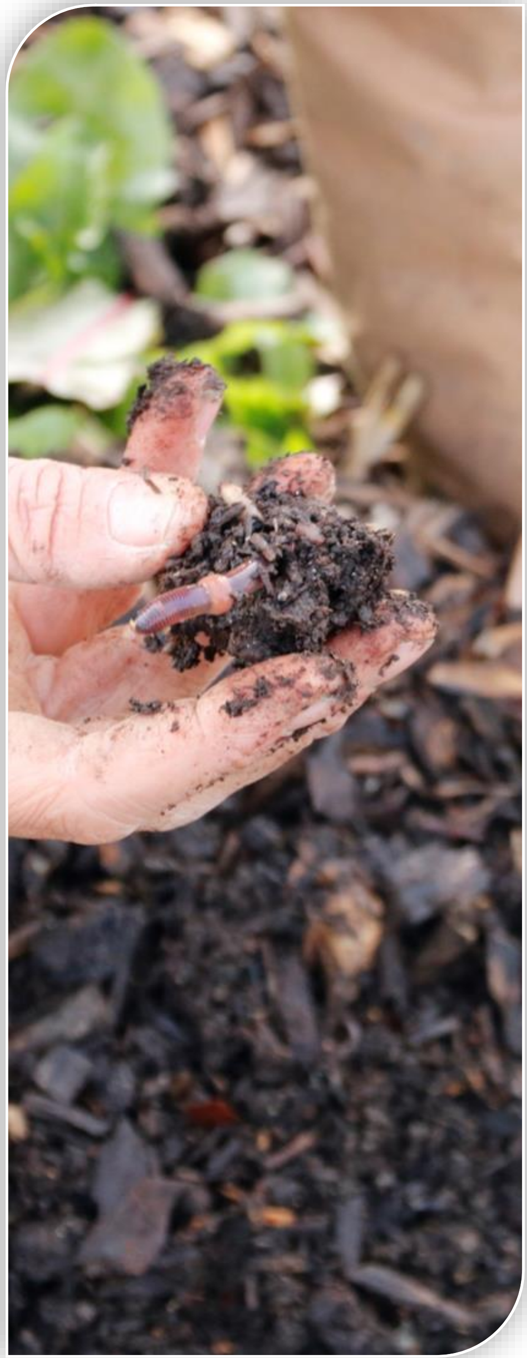
A vital soil is required for vital plants. Presentation for the Soil Health Conference:

December 5, 2022 in Brussels

Why are modern agricultural crops sick, and how can a different view on plant nutrition help us to revitalize our crops?

Anton Nigten, The Salt of the Earth. With the cooperation of Joost Visser.

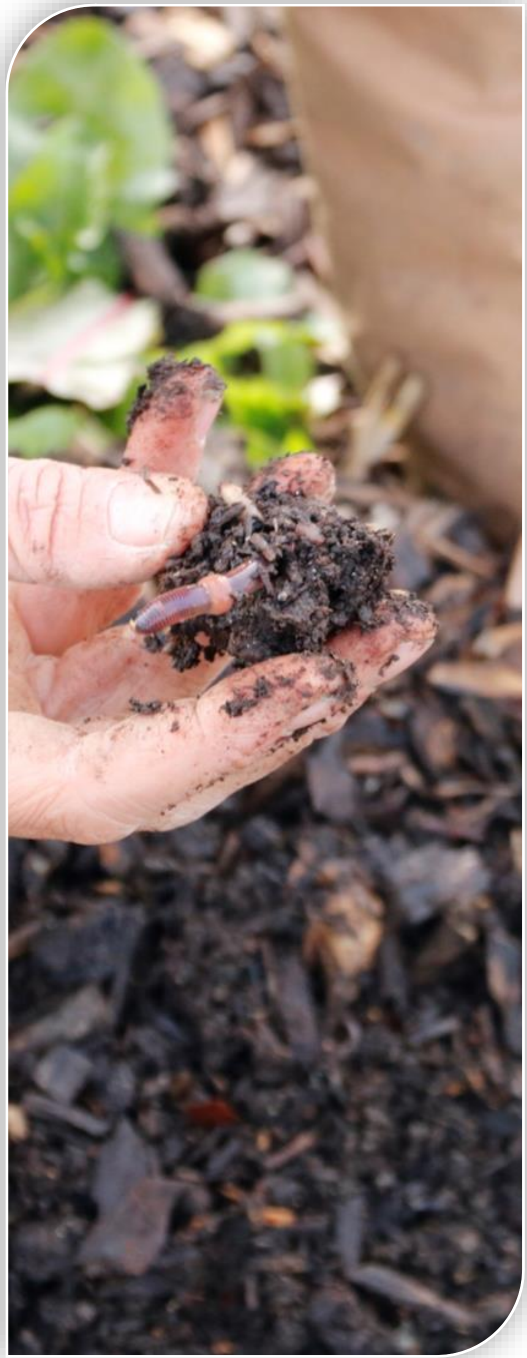


There are about sixteen to eighteen different fertilization systems worldwide. All these systems can be reduced to **two fundamentally different paradigms**.

> The salt paradigm.

> And the humus paradigm.

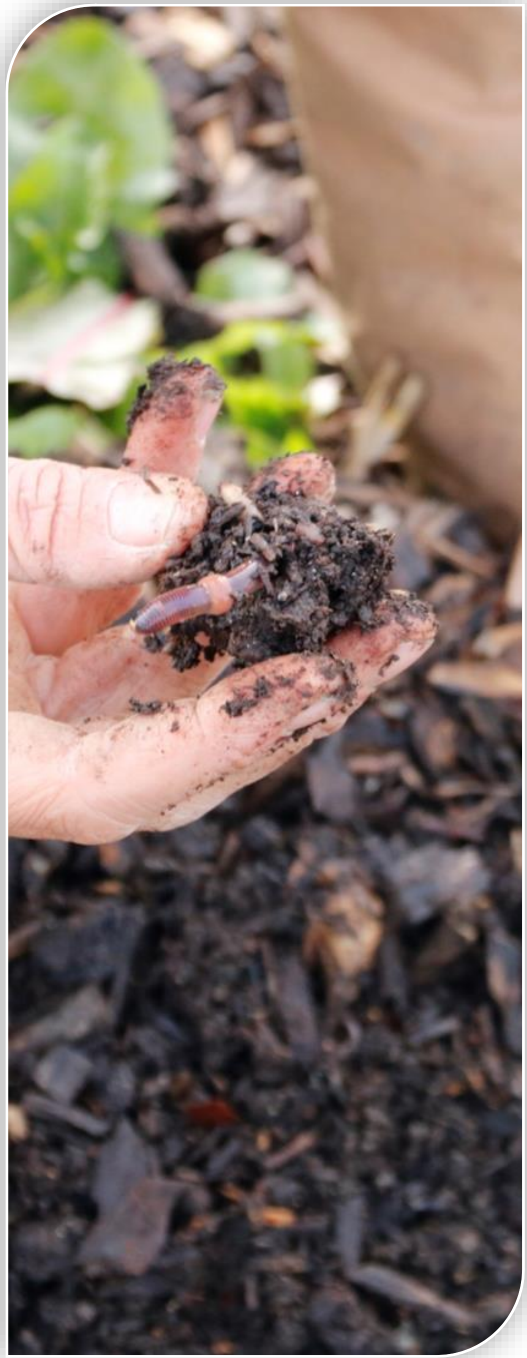
The battle over how to feed plants has been going on for over two centuries now.



According to the salt paradigm, the plants only need to have all the necessary salts to grow. You only have to know:

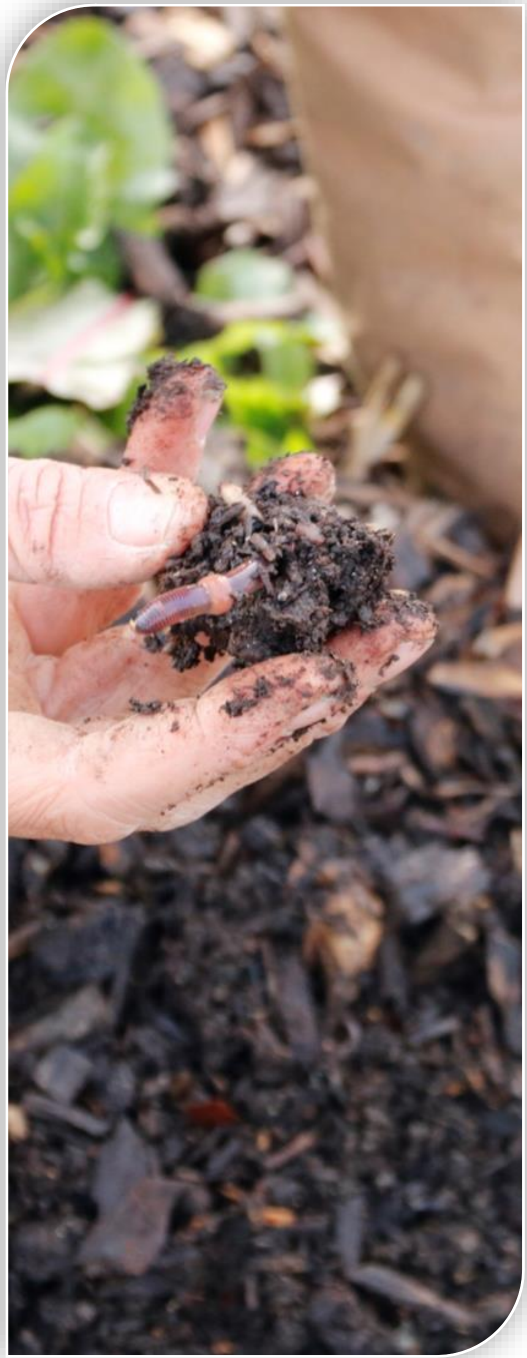
- Which salts does a specific crop need, and how much?
- How much is removed with the harvest?
- What stock is in the soil, and what should you add?
- This requires an ash analysis of the crop and a soil analysis;
- And you need to know how much, and how quickly the salts are released from the soil material through mineralization.

In this view the plants do well with sixteen elements.



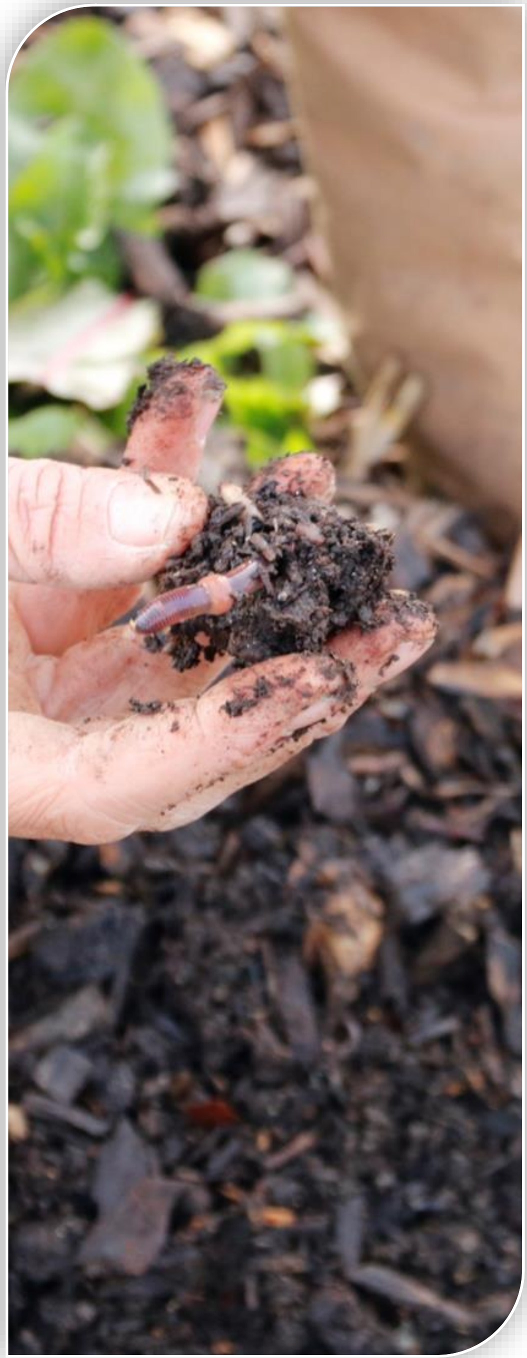
But numerous complications arose.

- Even if you give all 16 elements, the crops will still get sick;
- Each element inhibits or stimulates the absorption of other elements;
- Some salts are absorbed generously, other salts, on the other hand, only with difficulty;
- Deviations and problems occur on every type of soil and there are major differences between farms;
- It turns out that it is not possible to actually use the elements for the full 100%.



- The use of salts leads to serious biodiversity losses;
- Some salts are harmful to soil life and symbioses;
- Some salts are harmful or toxic to certain plants;
- Many salts lead to soil compaction and soil degradation;
- There are places in the world where the same plants grow but with a very different mineral profile;
- On many soils, fertilizer agriculture leads to salinization or soda formation;

The complications are no reason for this school to revise the basic principles.



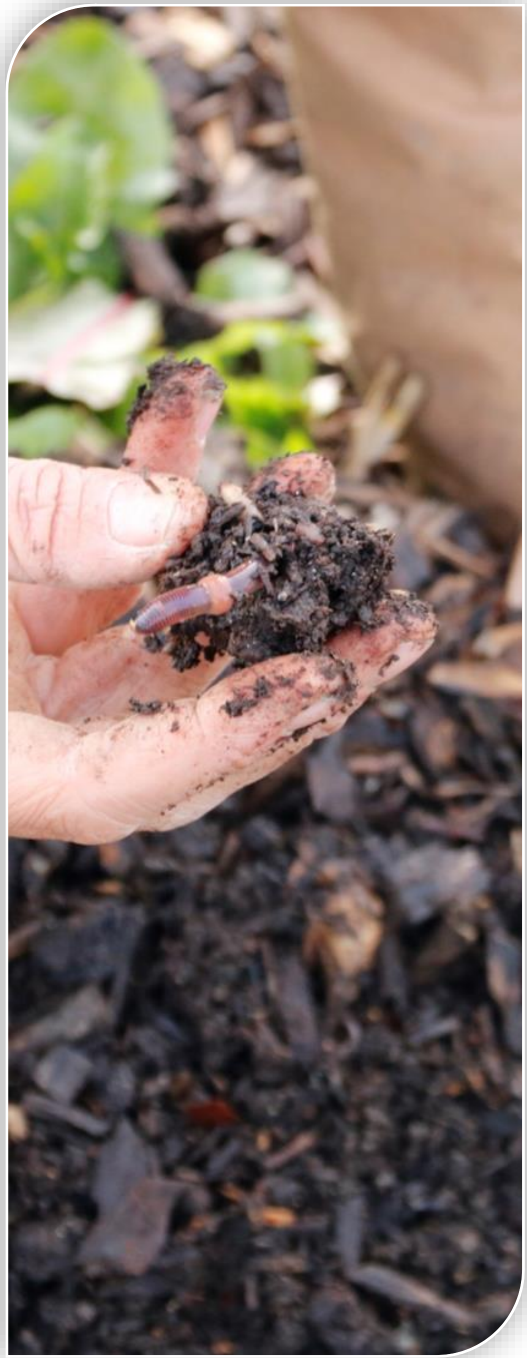
The main starting point of the humus paradigm is that plants (also) or perhaps exclusively feed on organic compounds.

Based on historical research, Mr. Visser has shown that there was already serious doubt about the salt paradigm of Liebig et al. around 1840.

The authors mentioned by Visser entered into a discussion with Liebig about his starting points, but Liebig hardly addressed their arguments.

Something similar happened in thinking about food quality (Harvey Wiley, 1906) and about the role of bacteria in diseases between 1870 and 1912 (Béchamp versus Pasteur).

That is why we speak of knowledge erosion...

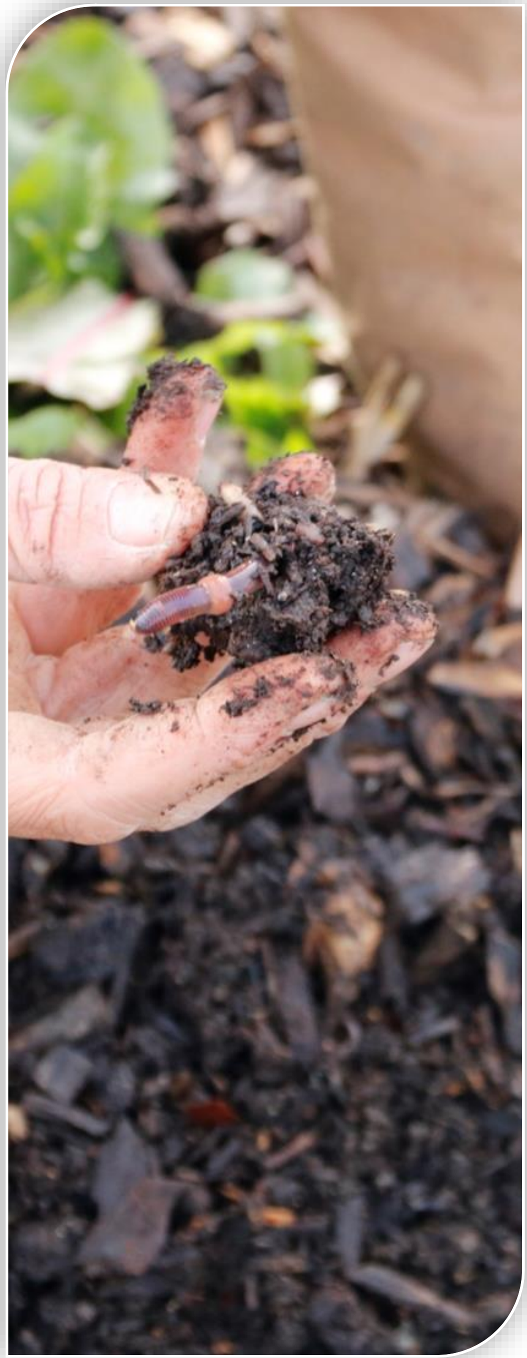


The conflict over the salts revolved around three areas:

- **Where does the plant get its nitrogen from and in what form does it absorb it?**
  Are ammonium and nitrate harmful to plants?

- **How harmful is superphosphate?**

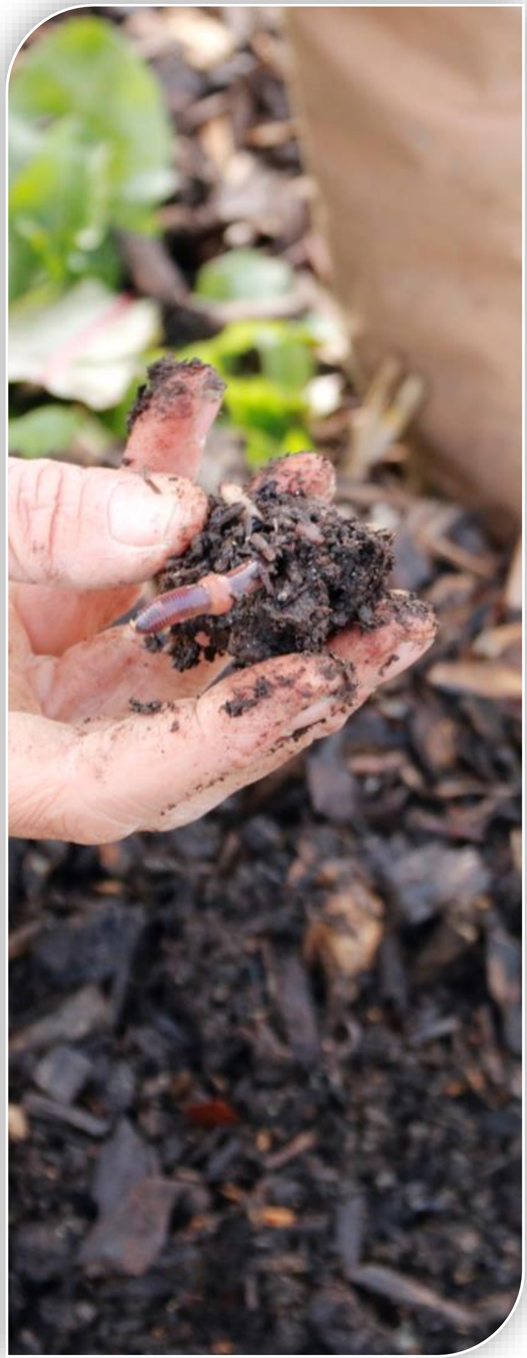
- **Why do plants absorb so much potassium? How harmful is potassium chloride?**



The battle for nitrogen went roughly as follows:

- Do the plants extract nitrogen or ammonia from the air? That was the view of Liebig and some others;
- But Boussingault distanced himself from his previous views on atmospheric nitrogen uptake;
- Around 1850, common sense was that plants only extract nitrogen from the soil;
- Legumes support the growth of non-legumes;
- But it was only after 1883 that agricultural science began serious research on legumes, based on the research of Schultz Lupitz, a farmer;

The research by Hellriegel and Willfahrt then led to the discovery that the rhizobium bacteria in the root nodules of the legumes were responsible for fixing nitrogen from the air. But that was not taken for granted.



Meanwhile, research into nitrogen fixation by non-legumes continued steadily.

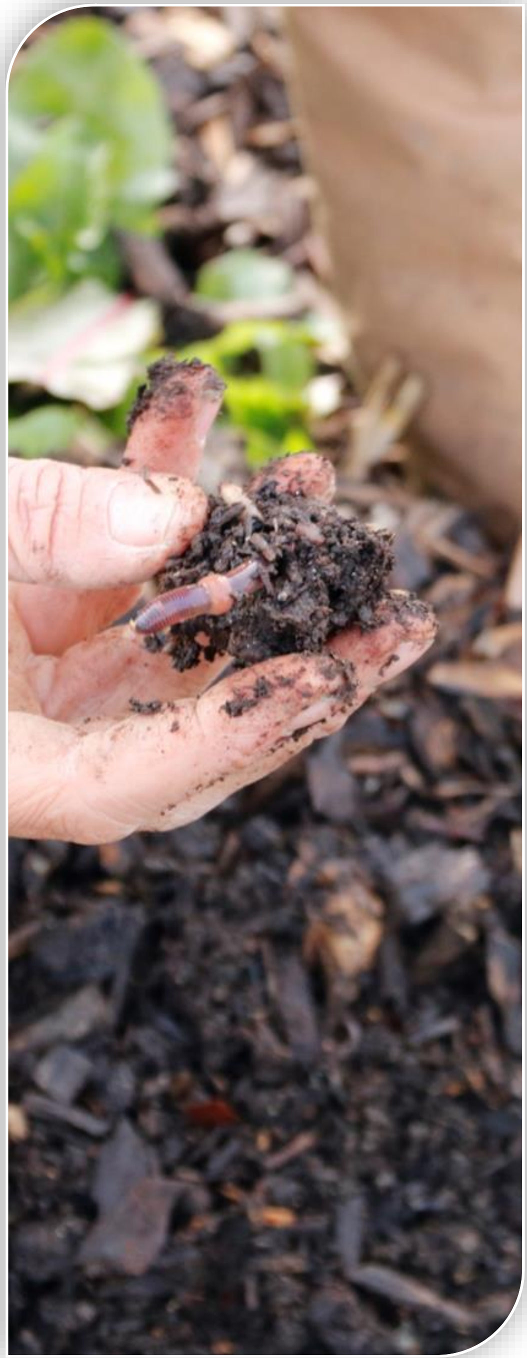
I would like to elaborate on three authors here: Ville, Stoklasa, and resp. Jamieson.

Ville built a test setup in 1853 to measure whether plants could assimilate nitrogen from the air. He showed that this was the case. That led to a renewed struggle.

Stoklasa questioned the function of root nodules on the roots of leguminous plants:

Lupins, his experiments showed, assimilate atmospheric nitrogen independently of the presence or absence of root nodules. The lupins without nodules showed no nitrogen deficiency in any way;

The N yields were higher in lupins without nodules or with imperfect nodules than in lupins with numerous, well-developed root nodules;

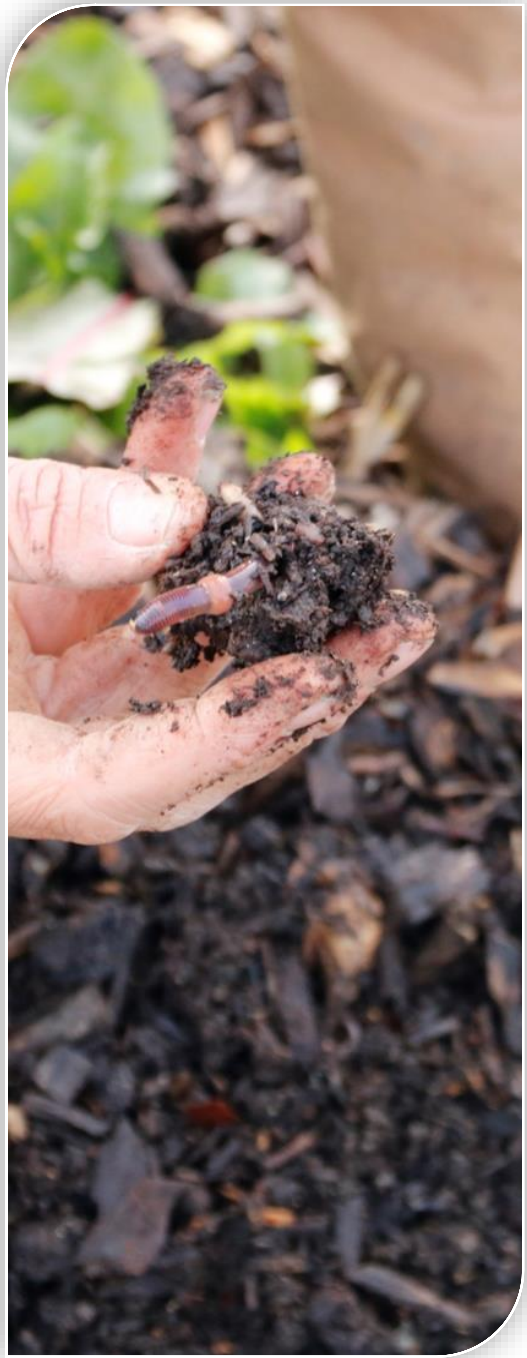


Jamieson conducted research in Scotland into the question which organ plants use to extract nitrogen from the air.

He discovered that this happened in special hairs on the leaves (1910). I assume that the cells in the hairs where nitrogen assimilation takes place are almost identical to the heterocysts of cyanobacteria.

Jamieson's results were completely ignored.

One year before Jamieson published his results, Haber and Bosch had discovered a method for converting atmospheric nitrogen into ammonia using a chemical process, more efficiently than their Norwegian predecessors. Their proces needs a lot of energy.



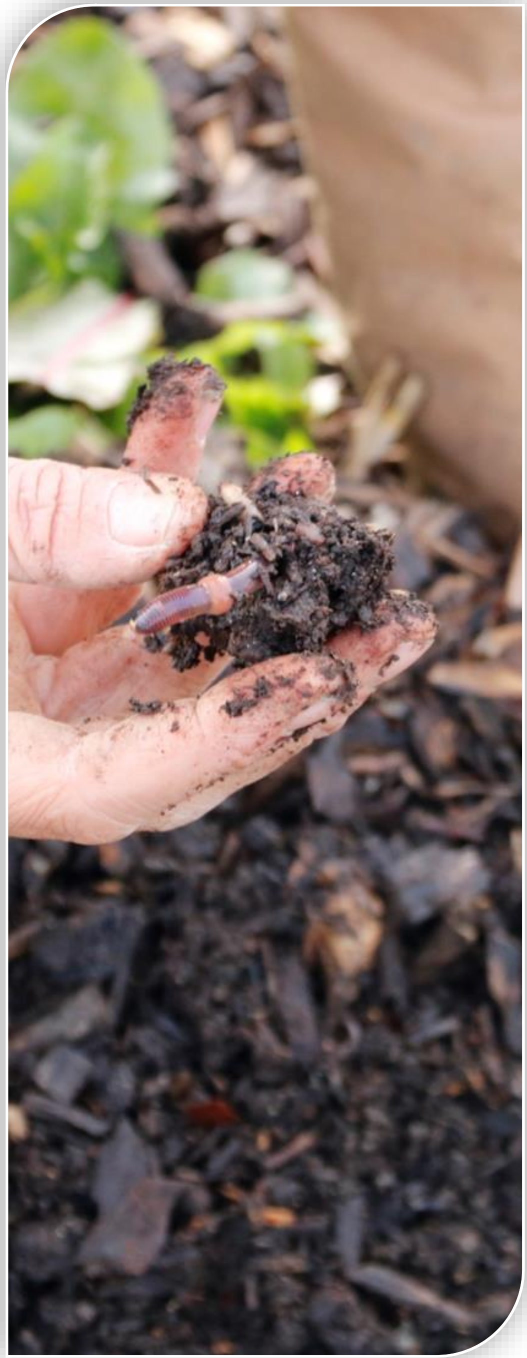
After 1950 there is a pause in research into nitrogen assimilation **by non leguminous plants**.

But that has changed rapidly since the eighties.

In grasses in particular, several resident bacteria are discovered that assimilate nitrogen from the air:

In addition to the absorption of nitrogen salts, five more ways in which plants collect their nitrogen have been discovered so far. And it always revolves around organically bound nitrogen.

White and his team at Rutger University discovered that plant roots eat 'their' bacteria and then strip them of their nutrients. And sent them back into the soil.

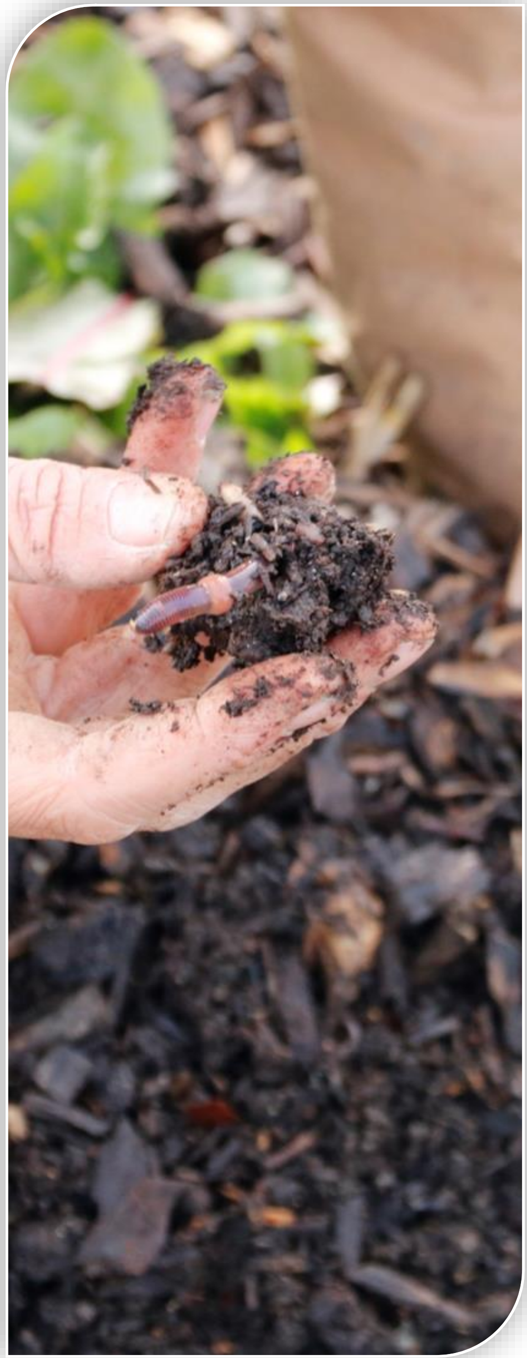


Christine Jones summarises as follows:

All green plants form associations with nitrogen-fixing bacteria. This phenomenon is not restricted to legumes. (..) In well-functioning soils, 85-90% of plant nutrient uptake is microbially mediated and N is no exception.

The first-formed product of biological nitrogen fixation, NH3, is rapidly converted (within milliseconds) to non-toxic NH4+, which in turn is rapidly transformed to amino acids. (Christine Jones, 2017).

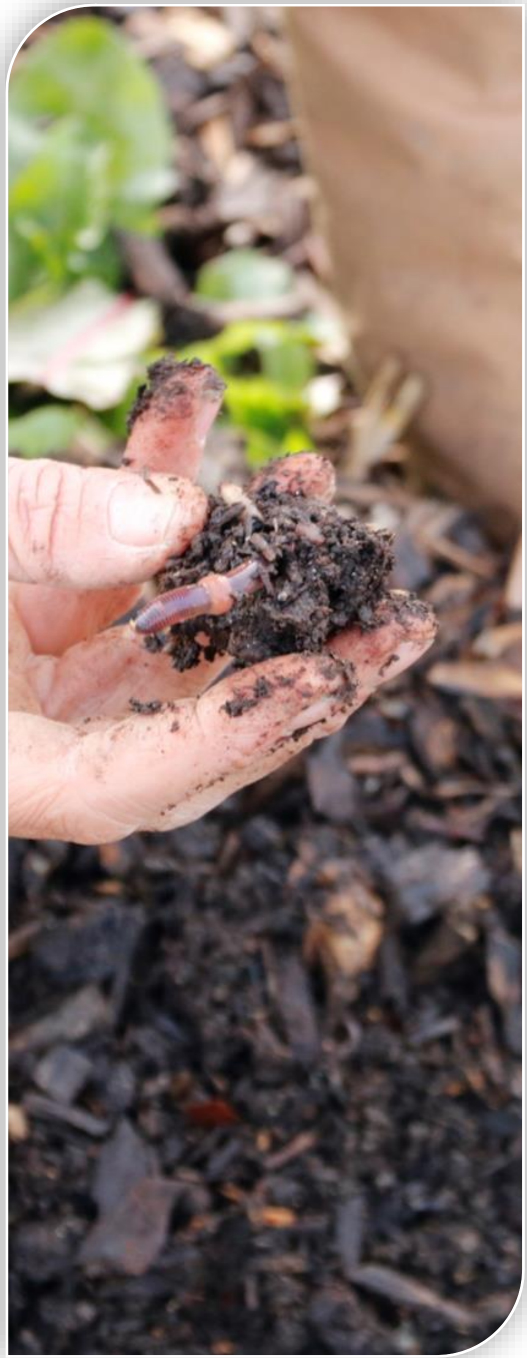
Now we will look at the consequences of fertilizing with salts for
the health of crops, animals and people.



The quality of feed for dairy cows is measured much more intensively in the Netherlands and elsewhere than the quality of humane food.

Today I want to answer two questions:

1. **Is the quality of the cow feed properly measured?**
2. **And can we learn something from it for measuring the quality of humane food?**



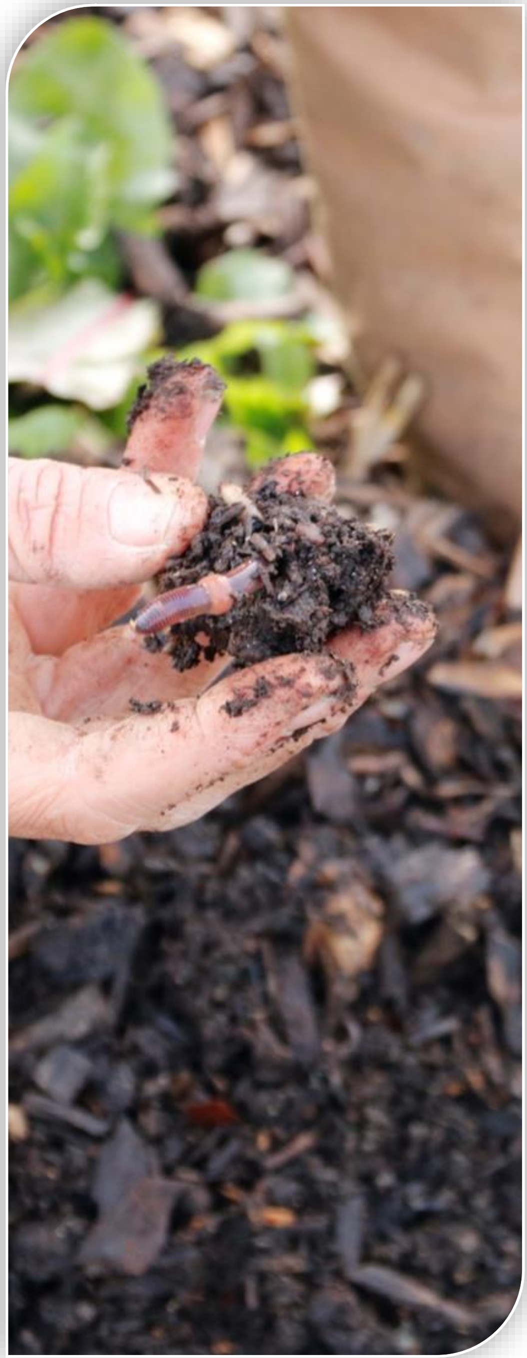
Which elements and which compounds should we measure?

Eurofins, the largest laboratory in the Netherlands, measures the following elements and compounds in cow feed:

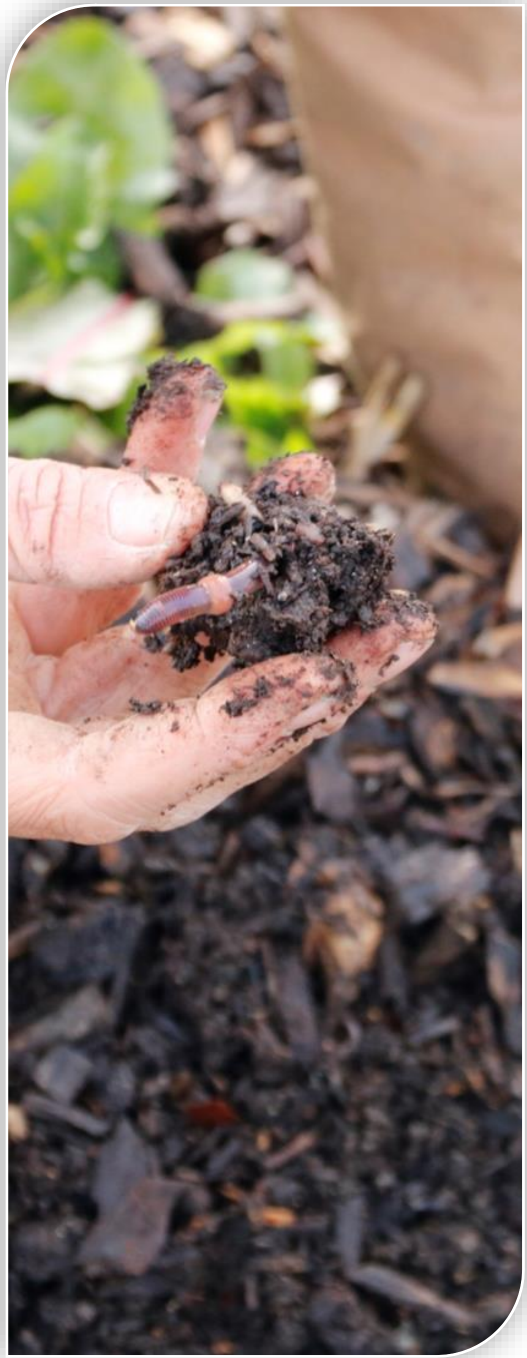
- **The macro elements:** potassium; sodium; calcium; magnesium; phosphorus; sulfur and chlorine;
- **The trace elements:** selenium; zinc; iron; buyer; iodine; boron; cobalt; molybdenum and manganese;
- With **nitrogen** they measure nitrate; ammonium and N total. From N total they calculate crude protein;

Not everything is measured: not silicon; amino acids and total non protein nitrogen. Also a number of harmful compounds, such as hydrogen sulfide; sulfate; phosphate; nitrite; nitric oxide; urea; and cyanide in the feed are not measured.

But, compared to human food, a lot is measured. In our food, only the red colored macro-elements are measured. And the red trace elements, and total N. Establishing the ratios between the macro elements is critical. But that doesn't happen. And important standards, including their own standards, for animal feed are ignored, trivialized or deliberately adjusted.

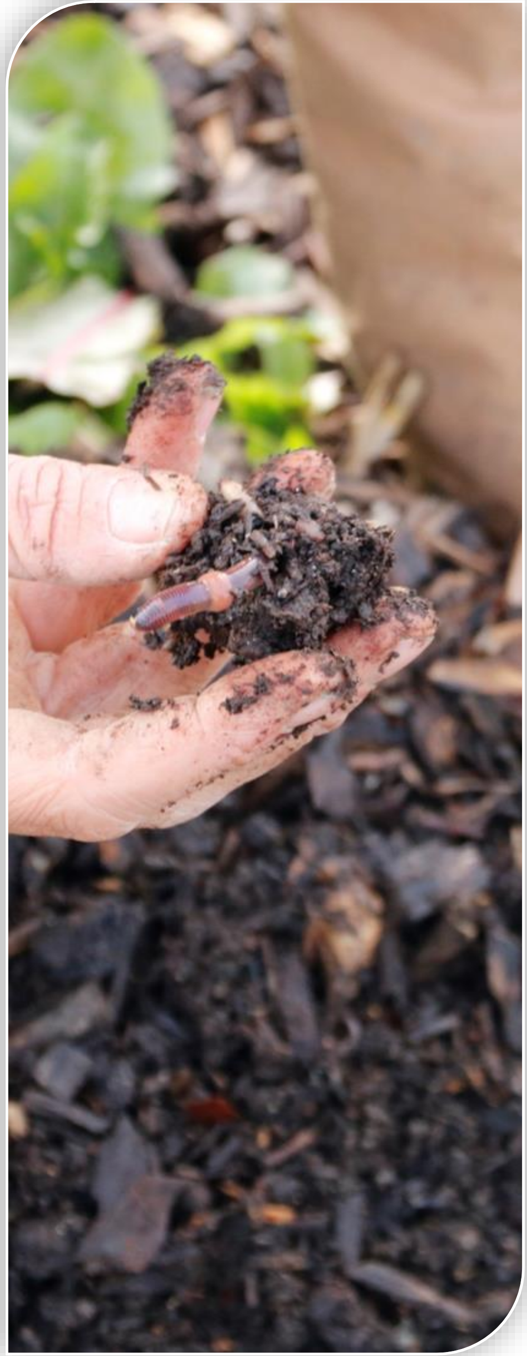


Ratio's	Optima	Grassdata from 1853 dairy farms in 2014 (DMS)	All 71 vegetables from the RIVM table. NEVO online, 2020.
Potassium/natrium	2–5 (max 7)/1	14,7	16,8
Potassium/magnesium	2–5 (max 7)/1	14,7	16,6
Calcium/Magnesium	1–2/1	2,3	3,2
Calcium/Phosphor	1–2 /1	1,3	1,3
Mg/(K+Na+Ca+P)	0.15–0.25; min. 0.10	0,05	0,043
K/(Ca+Mg) in mEq	< 2–2.2/1	1,9	1,73
nitrate	< 2.1–3.5 gram NO_3/kg ds	2,4	?
sulfur	< 2 á 3 gr/kg ds	3,5	?
NPN /N totaal	max 33%	46 %	?
Ammonium N plus nitrate N	Max 140 gram/day	216 gram/day	?
Potassium	max 20 (USA)	35,2	41



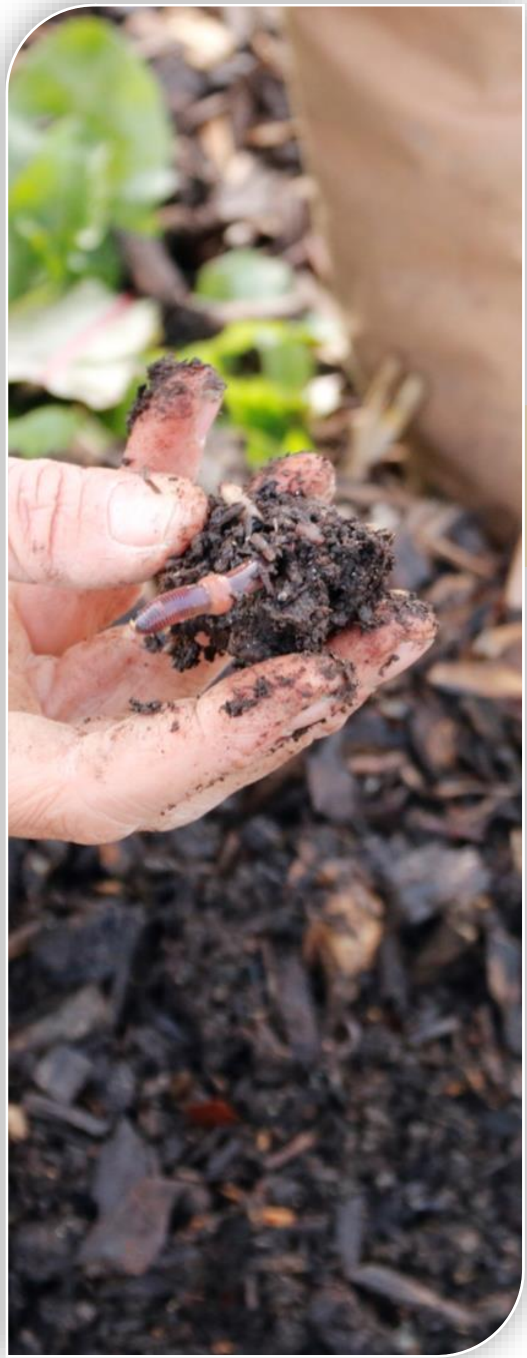
The effect of seaminerals and resp. volcanic stonemeal. Column 4 and 5.

Ratios	Optimal ratios for food for humans and animals per day (Nigten, 2017) NPN and NPS are missing.	Potato trial of the Louis Bolk institute. The average of 13 fertilizations (v/d Burgt, 2012). The Netherlands	Three potato varieties: Parmentier, Patraques and Vitelottes in Normandy (1864). The potatoes were fertilized with guano manure; seaweed; fish remains and manure (Wolff, 1871).				Potatoes in Pomerania, fertilized with rock meal (1890). Julius Hensel.
			Par	Pat	Vit	average	
K/Na	Optimum 2 – 5 /1	230	6	1.44	1.35	1,.95	12,2
K/Mg	Optimum 2 – 5 /1	25.5	9.61	10.5	11.6	10.36	1,8
Ca/Mg	Optimum 1 – 2 /1	0.77	0.72	0.91	2.6	1.29	2,3
Ca/P	Optimum 1 – 2 /1 (Max 3)	0.23	1.6	0.55	1.15	0.98	6,6
Mg/ (Na+K+Ca+ P)	0.15 – 0.25 (min 0,10)	0.033	0.08	0.049	0.04	0.054	0,21



Ideal ratios	71 Dutch vegetables 2020 (RIVM)	Ten vegetables from South West Nigeria (Adebisi, 2009).	Three vegetables from south West Nigeria. Sobowale ea. 2011. Mg/100 gram
K/Na: 2 - 5	16,8	1,15	3,35
K/Mg: 2 - 5	16,7	1,72	2,85
Ca/Mg: 2 - 1	3,3	0,94	1,1
Ca/P: 2 - 1	1,3	0,8	1,18
Mg/(K+Na+Ca+P): 0,15 – 0,25. Min. 0,10	0,048	0,19	0,17

Presumably in Nigeria it is a volcanic soil of basalt. However, I have not been able to verify it. Most farmers over there do not use fertilizers.



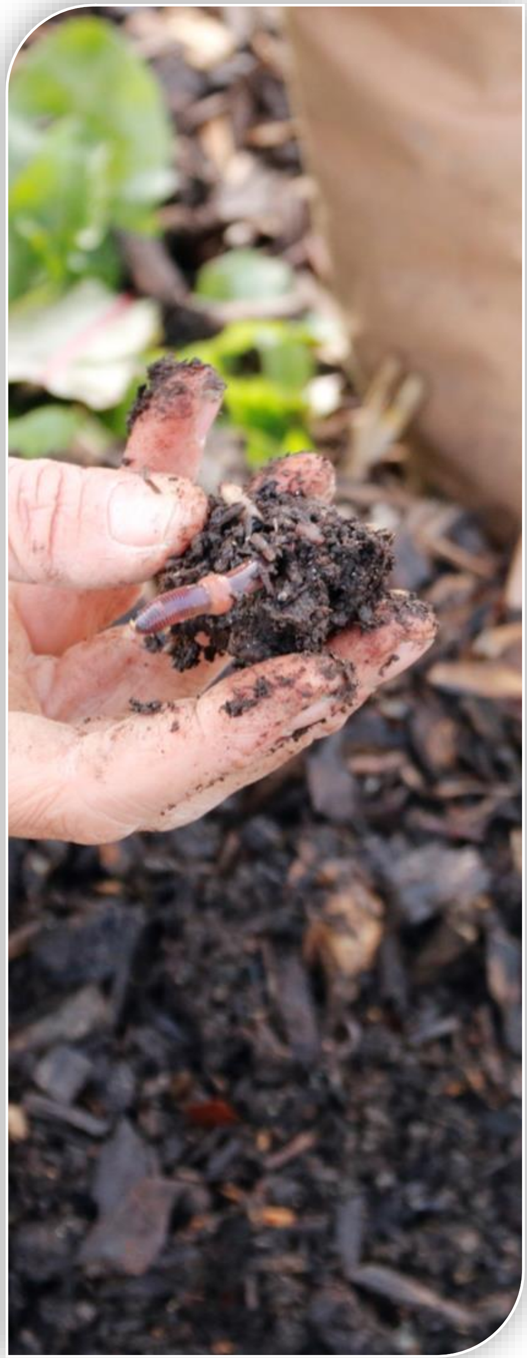
In the past, attention has been given to the risks of nitrate in food.

That attention has faded and the food authorities have declared nitrate harmless (2014).

And only in the last decade there has been done serious research into the risks of too much
phosphorus in our food.

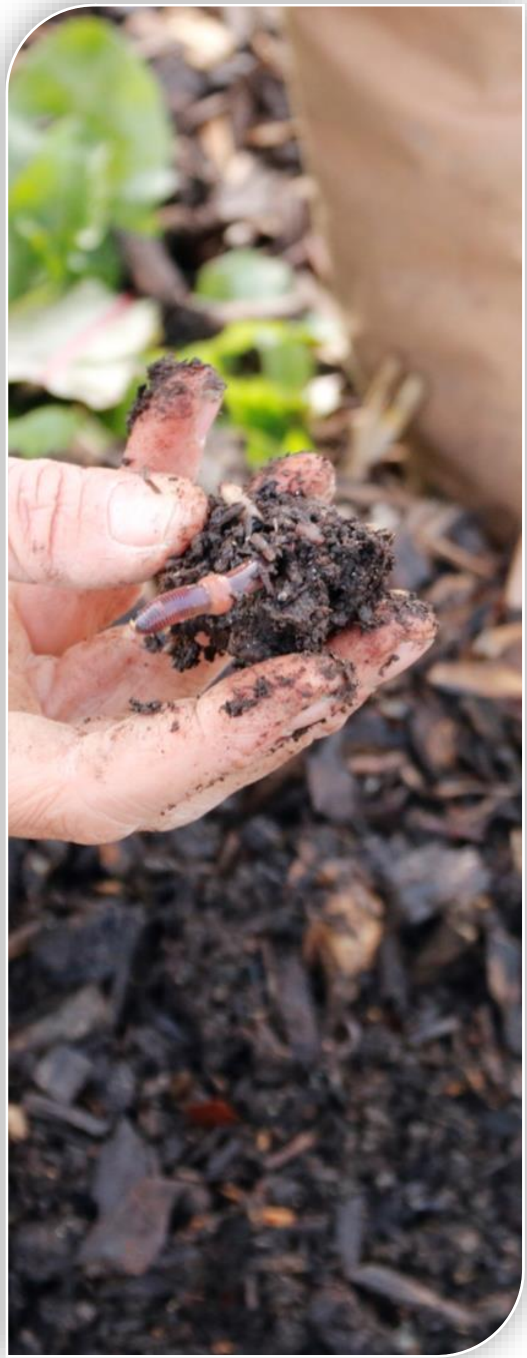
Calcification almost always involves calcium phosphate. And the mechanism is also clear:
because our food contains too many phosphates, calcium is extracted from the bones to
neutralize these phosphates. Just like nitrate is neutralized by sodium.

Because there is too little magnesium in our food, the calcium phosphates accumulate in
the most unlikely places in the body. It would therefore be better to talk about phosphatisation
rather than calcification.



The proven health damage of too much phosphorus is as follows:

- It leads to soft tissue calcification and at the same time weakening of bones and teeth;
- Too much phosphate encourages skin cancer; lung cancer, breast cancer; kidney cancer and prostate cancer .
- Calcification (= phosphatisation) of the heart muscle can result in heart failure;
- Calcification of the kidneys leads to kidney stones and kidney failure;
- Too much phosphate causes obesity; gingivitis; tissue damage; cell death; and mitochondrial oxidative stress;



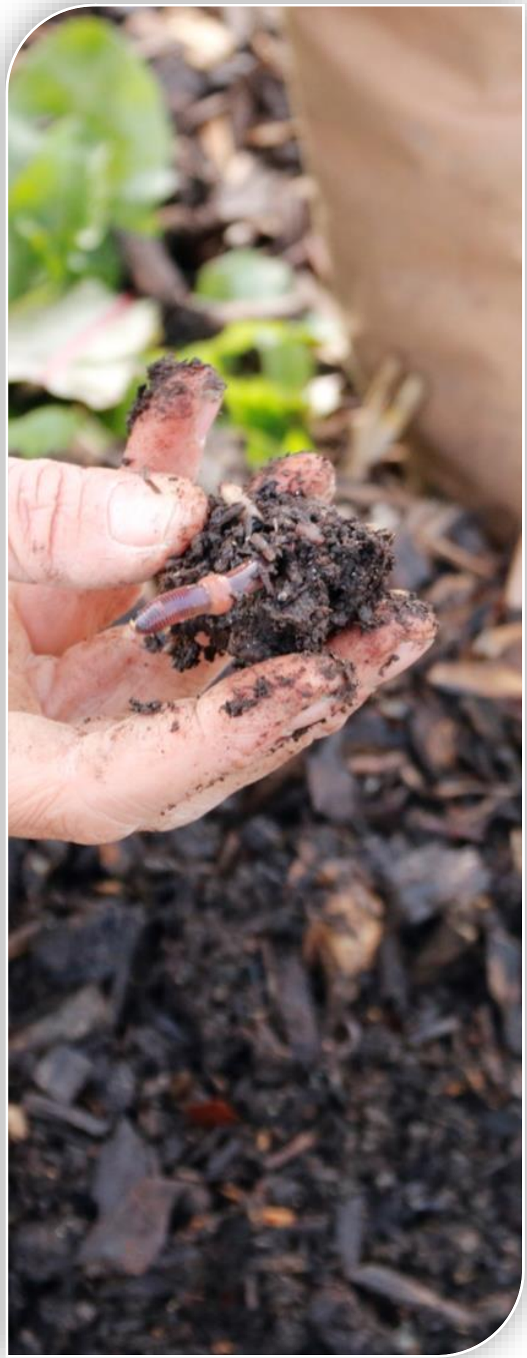
Between 1880 and 1910, the phosphate war raged in Great Britain – the battle of the phosphates.

Jamieson and his team had shown that superphosphate, in contrast to rock phosphate, led to clubroot formation in turnips. This was disputed by Lawes.

Potassium.

In the thirties of the 20th century, more and more cows suffered from head disease (grass tetany), partly due to too much potassium.

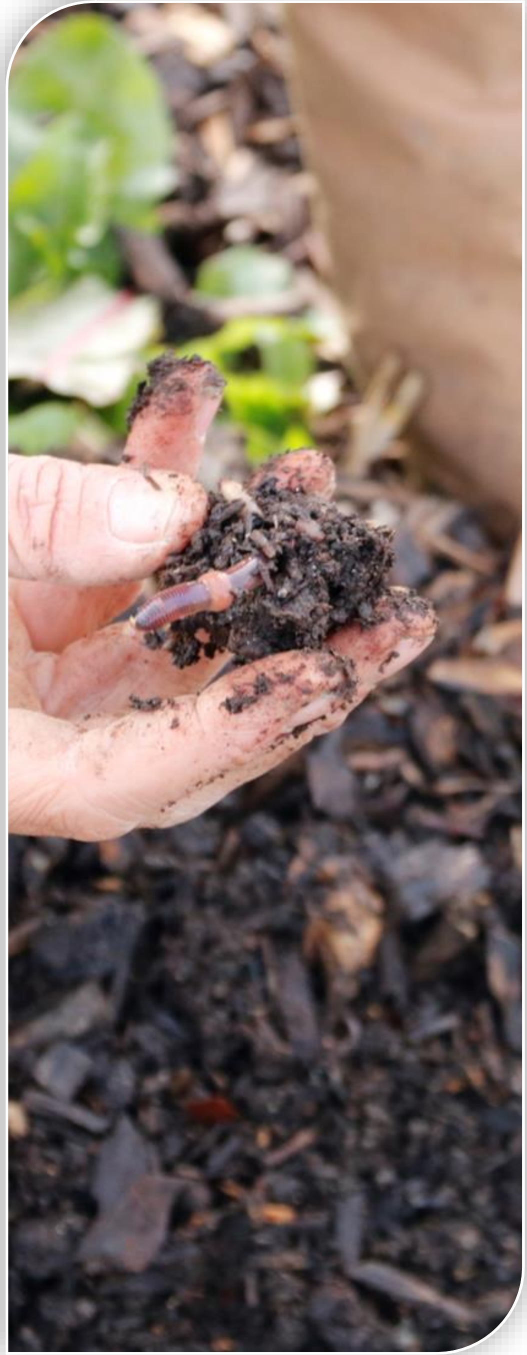
In 1933 Theel found in Germany that potassium, sulfur and chlorine in the hay had almost doubled compared to 1870. The levels of potassium in our fruit and vegetables and potatoes are still extremely high and sodium and magnesium far too low.



Conclusions:

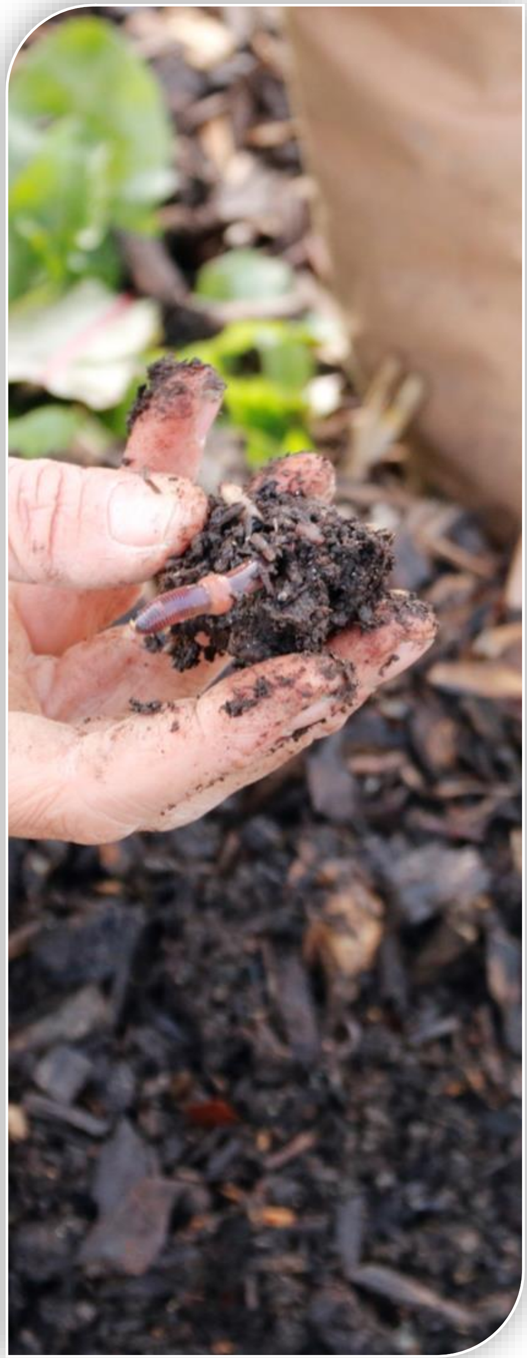
1. Our cow feed is measured much more thoroughly than human food;
2. But the standards for cow feed are often being disregarded;
3. The Dutch potatoes – conventional and organic – and the Dutch vegetables are not in balance;
4. The vegetables in South West Nigeria are often much better balanced;
5. Sea minerals, worm compost and rock meal can help restore balance. And soil in the manure helps too;
6. Phosphates are not only a problem for nature (algae growth), but also for people;
7. As with nitrogen, phosphate and sulfur must also be measured in what form we ingest it and how much;

NPK – the magic formula of modern agriculture – not only causes great damage to agriculture and nature, but also to people and animals that eat NPK-food. We get all three elements in too much and partly in the wrong form. We don't get enough other macro elements and trace elements.



Annex:	Ten vegetables from South West Nigeria: Adebishi 2009.			
Average Mineral content mg/100 gram air dried products	All vegetables Average protein 4,65 gr/100 gram	Low protein vegetables < 3 gr/100 gram: 3 x (adebishi 2009) average: 2,5	Low protein vegetables < 4,5 gr/100 gram: 4 x (adebishi 2009) average: 2,97	High protein vegetables > 4,5 gr/100 gr : 6 x (adebishi 2009) Average: 5,7
Na	3,82	3,31	3,28	4,18
K	4,41	3,15	3,89	4,75
Ca	2,41	2	2,9	2,08
Mg	2,55	1,67	1,99	4,38
P	3,02	2,34	2,28	3,51
sum	16,21	12,47	14,34	18,9
Ash content	1,87	1,43	1,47	2,13

You see a shift in mineral composition: more sodium, potassium, magnesium and phosphorus in crops with a high protein content (right column). Calcium varies. Magnesium in high protein crops is sky high. Ash content and sum increase.



Questions?