



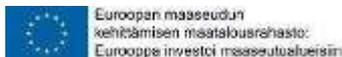
OSMO Soil Health project

-Collaborative learning and tools for assessing soil health contribute to farmers' understanding of problems and alternative management strategies

Jukka Rajala

University of Helsinki Ruralia Institute

7.9.2021



Viljavuuspalvelu

Rikalan Säätiö



Content



- Background and challenges of Soil Health
- OSMO-project objectives and workpackages
- Activities
- Main results
- Lessons learned



Important resources in agriculture



- Knowhow of Farmers
- Soil Health

=>OSMO- Knowhow and tools for resource-efficient soil health management in a collaborative network -project 2015-2019

<https://www.helsinki.fi/fi/ruralia-instituutti/koulutus/maan-kasvukunto/osmo-a-collaborative-network-testing-knowledge-and-tools-for-resource-efficient-soil-health-management>



Challenges on farms - Cereals



Challenges on farms - Clover leys



Challenges on farms - Vegetables



Symptoms vs Problems?

Kuvat Jukka Rajala

- Which are the problems?



Symptoms vs Problems?

Why tire lines grow worse?

Why tire lines grow better?

Winter rye in late fall

Photos: Jukka Rajala

OSMO

-Collaborative project at four provinces

2015-2019



Centre for Economic Development, Transport and the Environment in Southwest Finland (Rural Development Programme for Mainland Finland 2014-2020 / Special Funding for Water Protection and Nutrient Recycling)

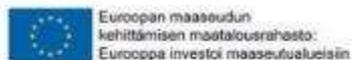
Actors:

University of Helsinki, Ruralia Institute
Rural Advisory Services ProAgria
(Southwestern Finland and South Bothnia regions)

Activity provinces at West- and South cost:

South Ostrbothnia, Satakunta Region, South-West Finland
and Uusimaa Region

Funding: Centre for Economic Development, Transport and
the Environment in Southwest Finland,
companies, farmers and foundations



Euroopan maaseudun
kehittämisen maatalousrahoitus:
Eurooppa investoi maaseutualueisiin



Elinkeino-, liikenne- ja
ympäristökeskus



PRO
Agria



HELSINGIN YLIOPISTO
RURALIA-INSTITUUTTI



SOIL
FOOD

Viljavuuspalvelu

Rikalan Säätiö

ecolan



LUONNONMUKAISEN
TUOTANNON EDISTÄMISSÄÄTIÖ

Objectives



- The main objective of the project was to **increase resource efficiency** in agriculture by managing the soil and its growth potential holistically. Sub-objectives:
 - **Improve methods for testing soil quality** and health.
 - **Improve farmers' know-how in soil health management.**
 - **Develop practical tools and study materials** for planning, implementing and evaluating soil health management at farm level.
 - **Inform the general public** about soil health and its management.



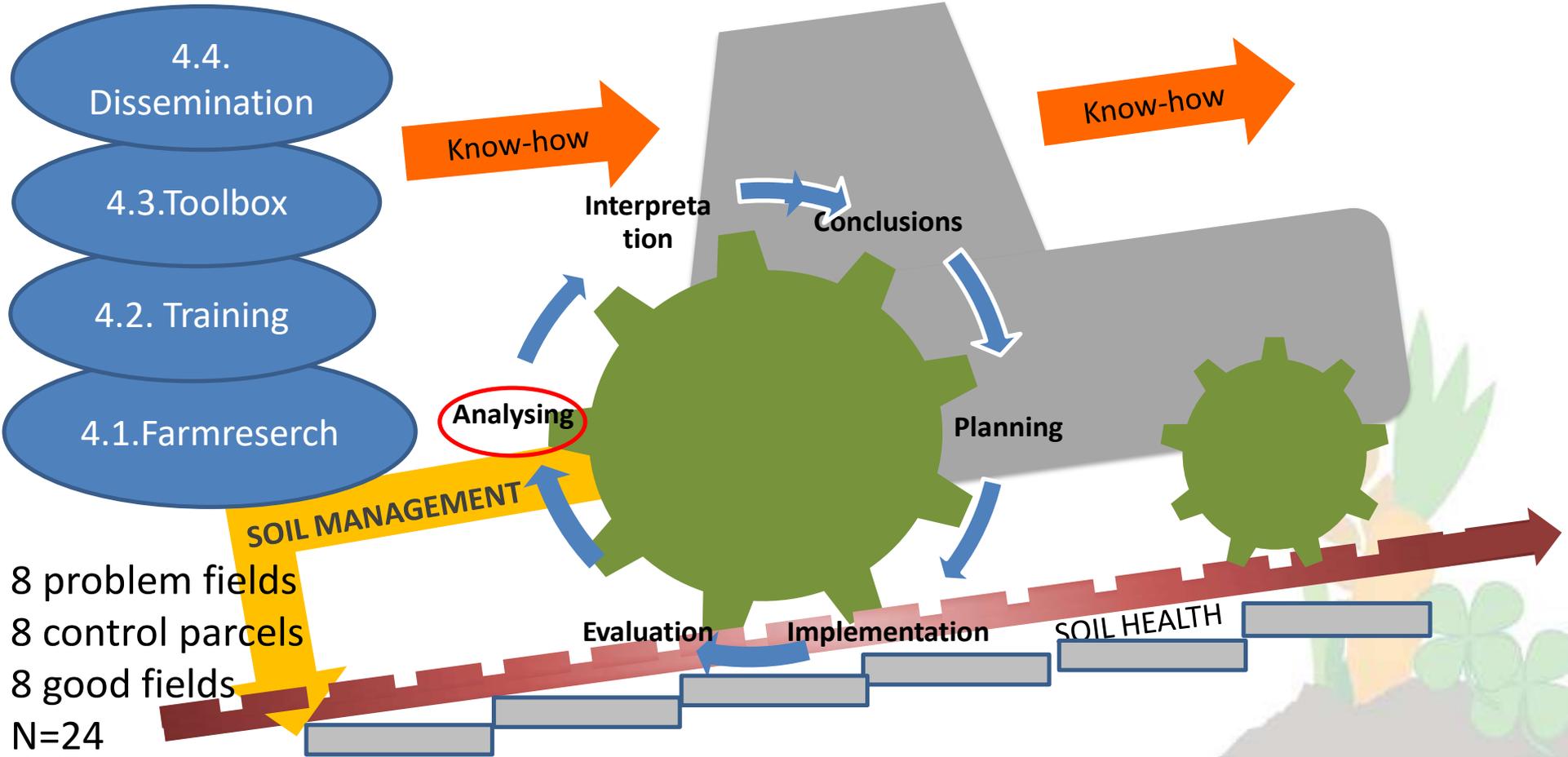
Questions to be answered



- What is wrong in poor growing fields?
- How to assess it?
- Why? X 5
- What can be done to fix this?
- Does it work?
- Does it pay?



Project objectives and work packages



8 problem fields
 8 control parcels
 8 good fields
 N=24

Many methods tested to assess the soil health at farm level

Project model



- Dynamic farm research with farmers and advisers
- Diverse trainings for farmers with interaction and peer support
- Development of tools for soil health planning in training groups and producing study materials
- Collaborative network
- International knowledge transfer



Project model



Farm research

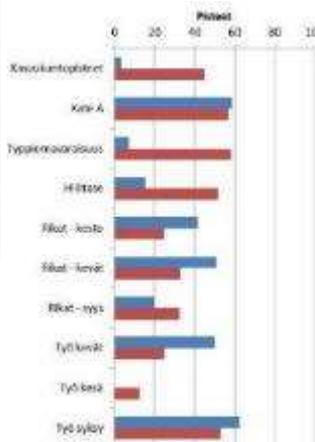
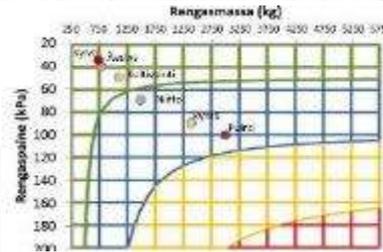
Training

Toolbox

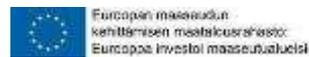
Dissemination



| Analyysitulokset | | mg/l | | | | | meq/dl | | | % KVK | | |
|------------------|---------|------------|-----|------|-----|------|--------|-------|-----|-------|------|------|
| Näyte | Näiteji | Muuttuvuus | pH | Ca | Mg | K | Na | Ca:Mg | KVK | Ca | Mg | K |
| Kotopello | HES | 01-11 | 6,3 | 3400 | 960 | 348 | 50 | 4 | 28 | 61 % | 28 % | 3 % |
| Riisipelti | HES | 01 | 6,3 | 2000 | 270 | 456 | 50 | 4 | 28 | 50 % | 23 % | 4 % |
| Kotopello | HES | 01-15 | 6,3 | 3400 | 960 | 1420 | 50 | 4 | 34 | 55 % | 22 % | 3 % |
| Urtapello | K23 | 01-15 | 6,3 | 2100 | 170 | 80 | 50 | 18 | 14 | 74 % | 8 % | 2 % |
| Urtapello | K23 | 01-22 | 6,3 | 2500 | 90 | 230 | 20 | 6 | 9 | 56 % | 15 % | 11 % |
| Urtapello | K23 | 01-24 | 6,3 | 1300 | 190 | 20 | 20 | 8 | 9 | 76 % | 17 % | 1 % |
| Urtapello | K23 | 01-21 | 6,3 | 3000 | 880 | 230 | 50 | 4 | 33 | 55 % | 22 % | 2 % |
| Tavotte: 6-12 | | | | | | | | | | | | |
| 68 % 12 % 2,5 | | | | | | | | | | | | |
| 80-70 10-20 2 | | | | | | | | | | | | |



Rajala J. OSMO Project



In which direction the soil health is developing?

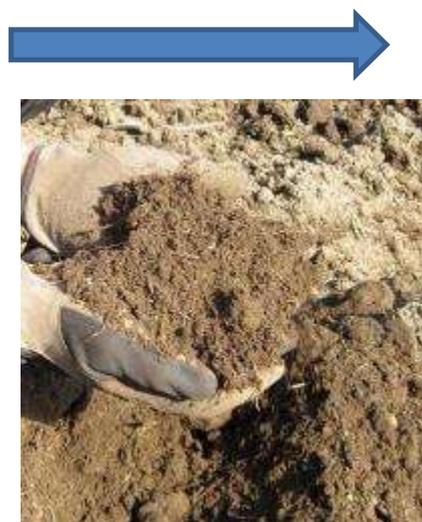


Agriculture

Degenerative

Regenerative

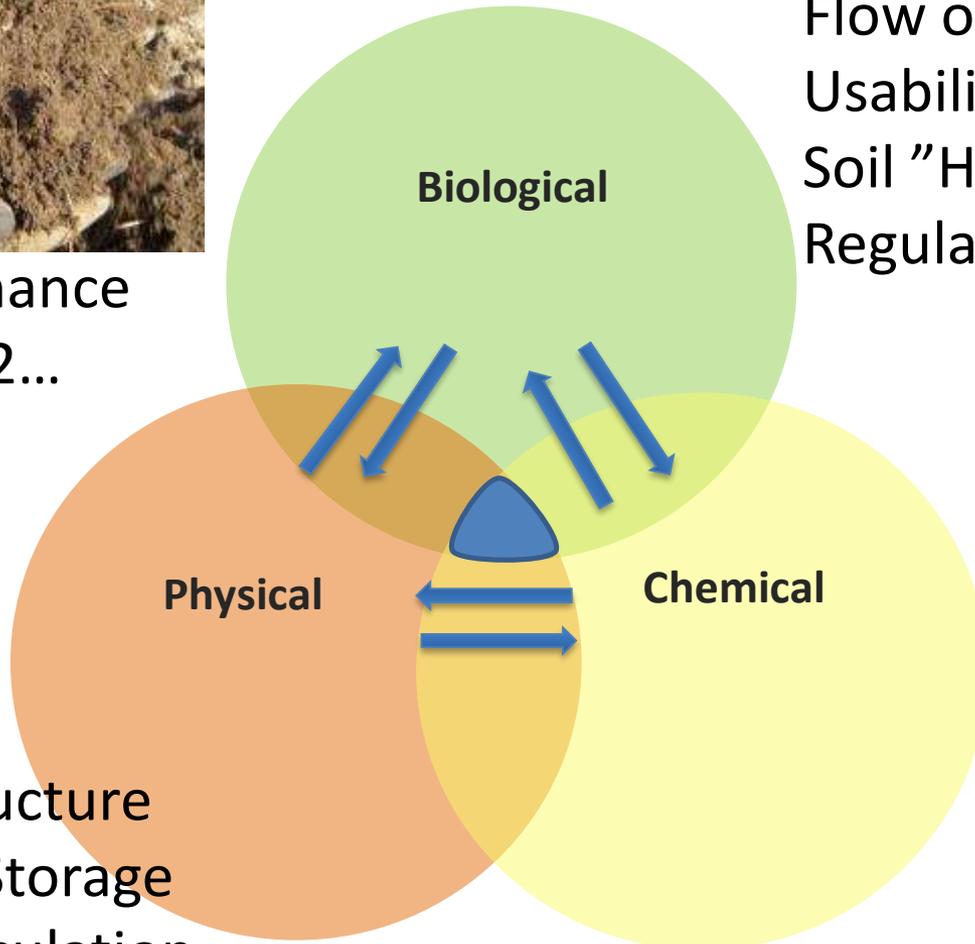
Conservation



Holistic view of Soil Health



Gas Exchange
O₂, CO₂...



Flow of Energy /Carbon
Usability of Nutrients
Soil "Health"
Regulation of Soil Functions

Nutrient Storage and
Circulation



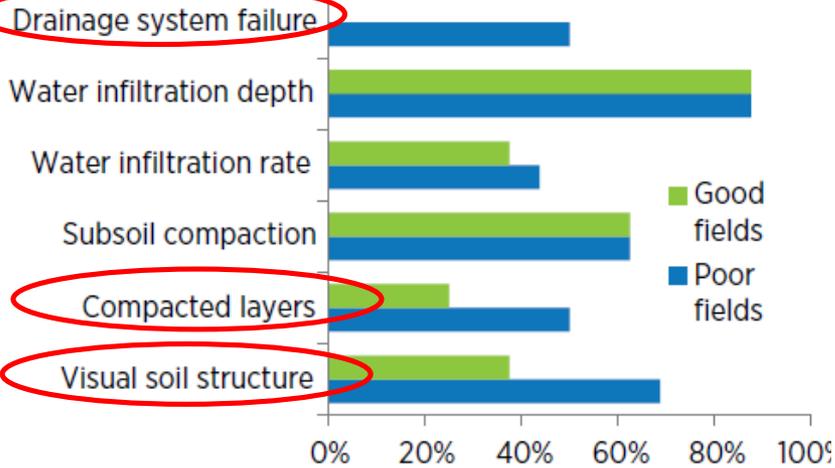
Soil Structure
Water Storage
and Circulation

Healthy soil = Soil/Plant Ekosystem is functioning well

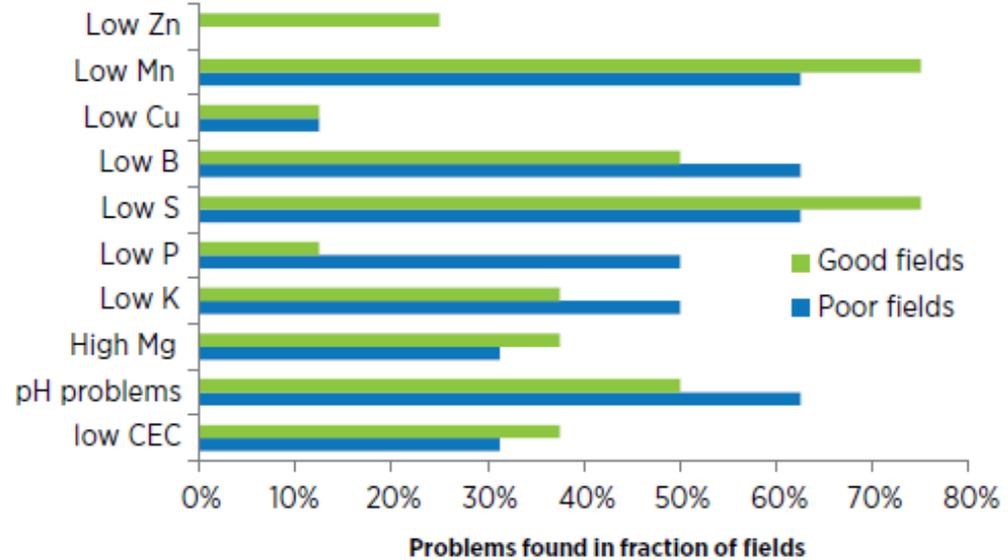
Identifying problems at 8 farms



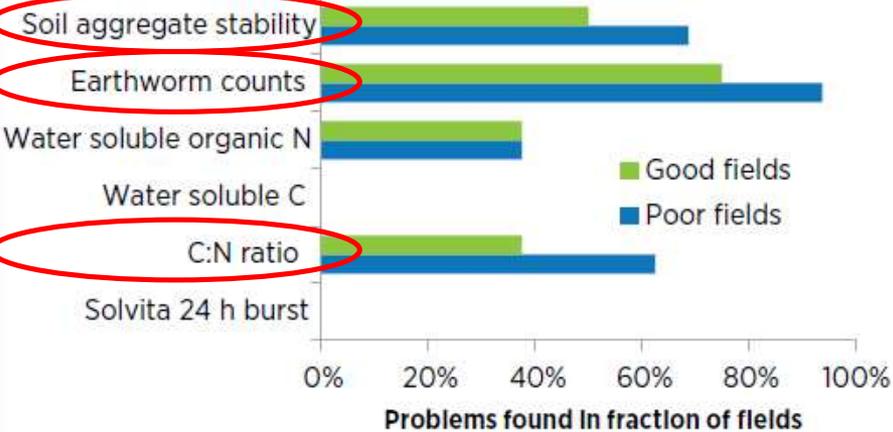
Physical properties



Chemical properties



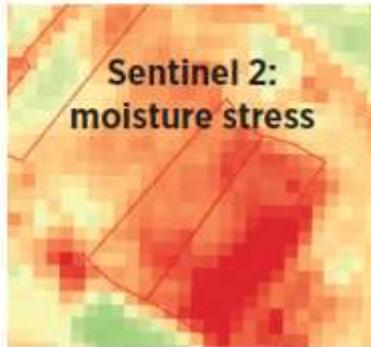
Biological properties



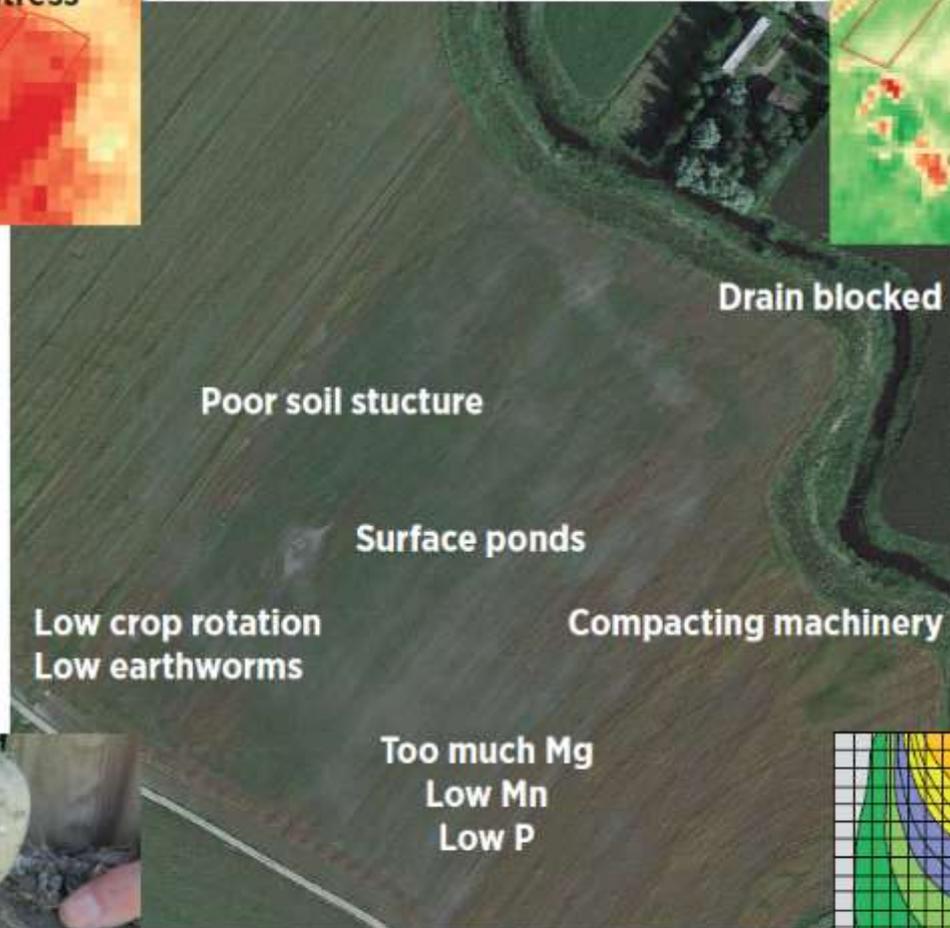
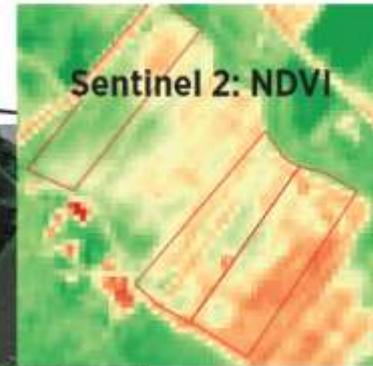
[Mattila ym: Mistä ja miten tunnistaa maan hyvän kasvukunnon?](#)

[HY, Ruralia-instituutti. Raportteja 171. 2017.](#)

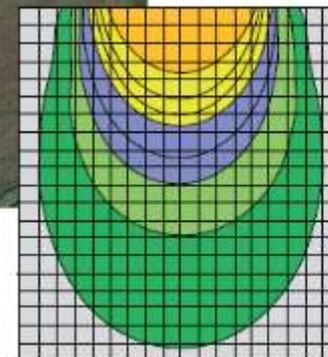
Example field Ju 2015



Low photosynthesis



- Drain repair
 - Field levelling
 - Gypsum
 - Subsoiling
 - Cover crop
 - Winter wheat
 - Manganese
 - Microbes
- Results ???



Interpretation: Why the field is compacting?



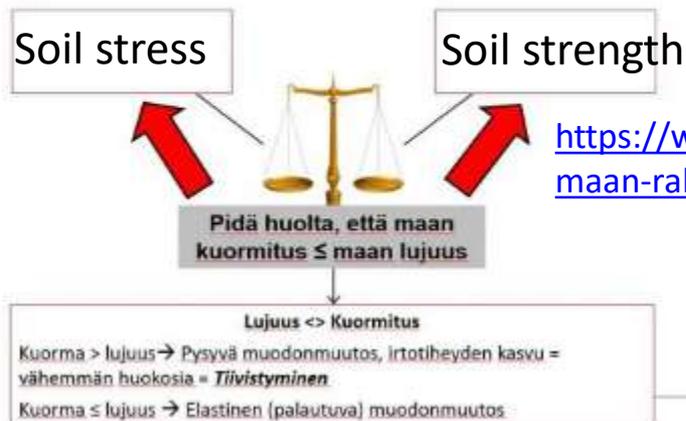
Prof Thomas Keller

Photo: Jukka Rajala

- Help for interpretation
- Varying results from subsoiling.
Fixing basic causes.
- One day scientific workshop, recording, PP-slides in finnish



How to avoid soil compaction?



<https://www.helsinki.fi/fi/ruralia-instituutti/koulutus/maan-kasvukunto/maan-rakenne-tiivistyminen-ja-muokkaus-kurssin-aineistot>

18.11.2016

Conclusions and planning

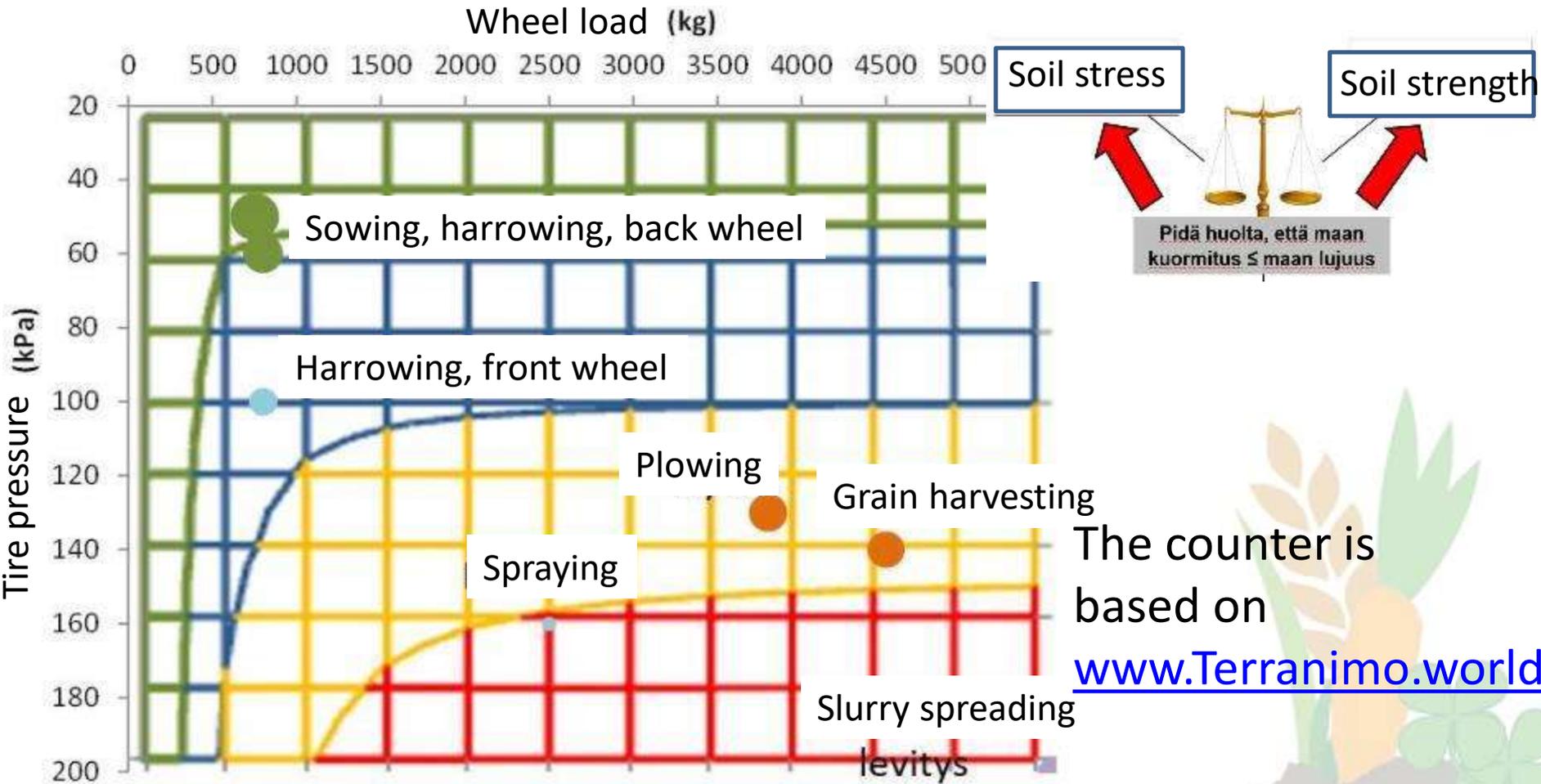


- Farmers don't understand factors of soil compaction for practical applications...
- Practical fieldday: measuring wheel loads, contact areas, soil stress of different machinery and tire pressures



18.7.2017

Scan the risks for soil compaction



The counter is based on www.Terranimo.world

[Mattila ym 2018. How to avoid soil compaction with better tires. HU Ruralia Institute, Raport 175. https://www.helsinki.fi/fi/ruralia-instituutti/koulutus/maan-kasvukunto/laskurit-maan-tiivistymisriskien-maarittamiseen](https://www.helsinki.fi/fi/ruralia-instituutti/koulutus/maan-kasvukunto/laskurit-maan-tiivistymisriskien-maarittamiseen)

Practical implementation



- Tires have big influence to compaction risk; how to plan on farm level?
 - What should be important to know of tires?
 - 3-evening course
 - Qualities of tires
 - Risks for soil compaction
 - Planning machinery chains

13.11.2017-
18.1.2018



Kuvat: Jukka Rajala

Coarse materials

<https://www.helsinki.fi/fi/ruralia-instituutti/koulutus/maan-kasvukunto/maakosketusta-ja-vetokyky-mita-kaikkea-tulisi-tietaa-renkaista-kurssin-materiaalit>

Farm example Sa: Increasing soil physical fertility



Visual soil structure assessment

0-5 cm good structure



6-20 cm compacted
Few roots



Tillage: Light disk + direct sowing

In subsoil few roots, compacted



Kuvat: Jukka Rajala

...and in rainy periods

The permeability of soil is too poor

=>Lower part of soil is water logged

=>Deficiency of oxygen

=>Roots and soil life is suffering, and soil structure



Kuva: Jukka Rajala

Sa: Deficiencies of physical soil fertility

- Site ditches too low
- Water ponds on the field
– need field leveling
- Permeability too low
- Poor root growth/root channels
- Earthworms at the 0-5 cm, but not deeper
- Water level at river is variable
When water is high, the field will be wet



Kuva: Jukka Rajala

Recipe for soil healing

Sa: Measures 2016-2017



- Deeper tillage; From shallow disk to deep cultivating
- Cleaning the side ditches
- Diversifying crop rotation with grass leys and winter cereals
- Subsoiling in summer in grass ley
- Field leveling with soil from site ditches and automatic grader
- Gypsum for correcting Ca:Mg
- Subsoiling by sowing winter rye



Grass clover ley + subsoiling works well



SA Subsoiled

SA Not subsoiled



Kuva: Jukka Rajala

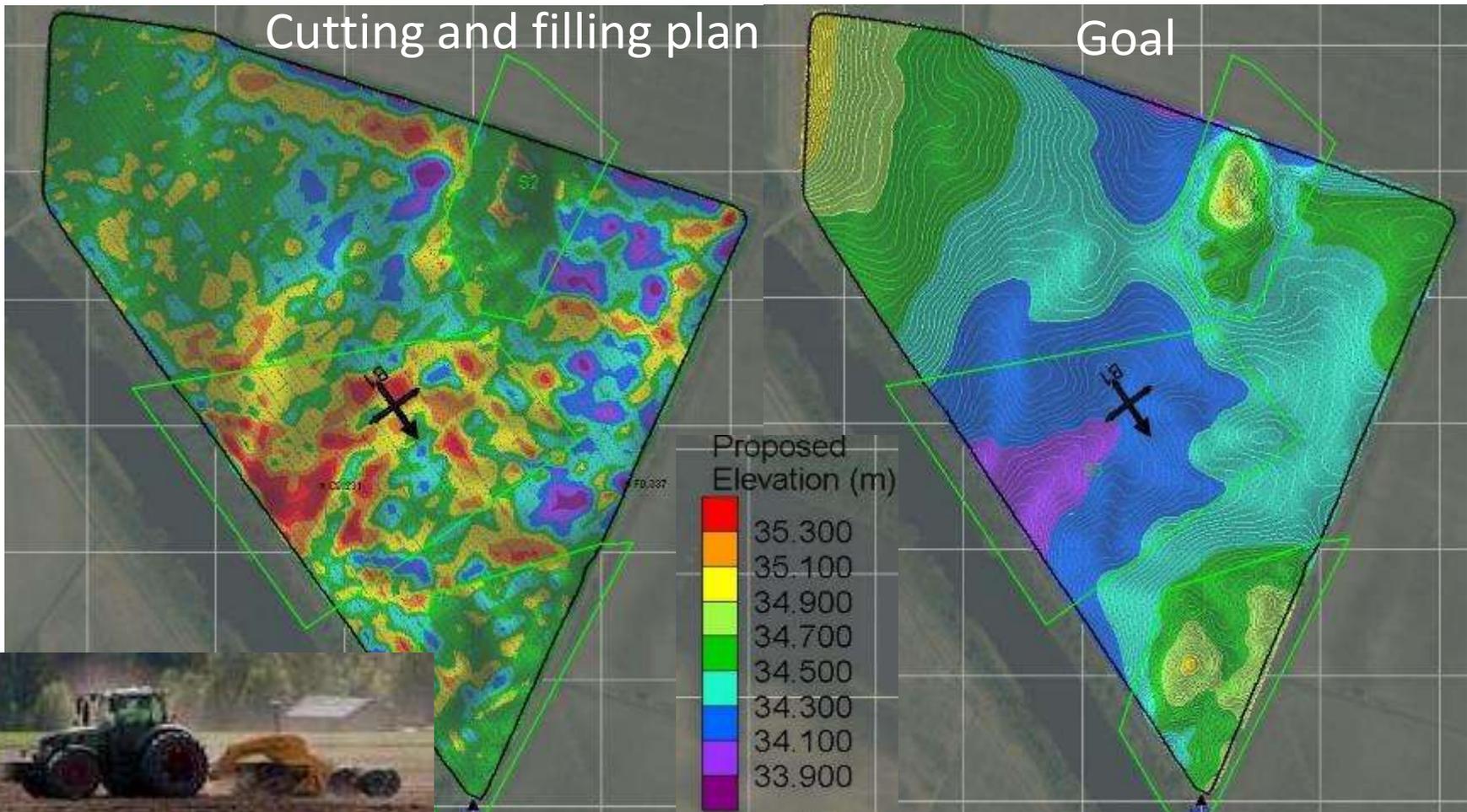


Kuva: Jukka Rajala



Kuva: Jukka Rajala

Well planned field leveling



Automatic grader in work

Monitoring: Fixing measures were good enough

- Changes in crop rotation
- Changes in tillage
- Biol. tillage with deep rooting plants
- Field leveling and cleaning site ditches
- Mechanical subsoiling



Physical Fertility

– Methods for assessment

- Satellite/drone photos
 - where to evaluate
- Spade pit,
 - groundwater level
- Digger pit
 - structure of subsoil



Physical Fertility

- Methods for assessment

- Spade diagnosis VESS /MARA
 - Soil structure
- Penetrometer/Soil stick
 - Compacted layers
- Bottle test
 - Infiltration of soil surface
- Pantest
 - Infiltration of topsoil/ subsoil
- Crumb hardness
 - sensitivity to silting up



Infiltration of water



Testmethod

Where the water flows? How fast? How much?



CEC-counter



| Analyysitulokset | | | | mg/l | | | | cmol/l | | | | % KVKsta | | | |
|------------------|---------|----------|-----|------|------|-----|----|--------|-----|-------|-------|----------|-------|------|--|
| Lohko | Maalaji | Multavuu | pH | Ca | Mg | K | Na | Ca:Mg | KVK | Ca | Mg | K | Na | Muut | |
| Luoma | HtMr | vm | 5,6 | 336 | 40 | 75 | 15 | 8 | 3 | 49 % | 10 % | 6 % | 2 % | 33 % | |
| Haavisto | Hht | rm | 6,7 | 2280 | 44 | 110 | 15 | 52 | 13 | 86 % | 3 % | 2 % | 0 % | 8 % | |
| Joenranta | HeS | rm | 7,0 | 3700 | 890 | 200 | 20 | 4 | 27 | 67 % | 27 % | 2 % | 0 % | 3 % | |
| Poikaro | HtS | rm | 6,3 | 4200 | 1200 | 330 | 30 | 4 | 38 | 56 % | 26 % | 2 % | 0 % | 15 % | |
| Tavoite | | | | | | | | 6-12 | | 68 % | 12 % | 4 % | 1 % | 15 % | |
| Tulkitsija | | | | | | | | | | 60-75 | 10-20 | 2-5 | 0,5-3 | | |

CEC

Ca, Mg, K, Na %

Muut = Share of other nutrients %

Ero tavoitetasoon = Need to change in kilos

Kalkitussuositus = Recommended liming

CEC-counter på svenska

<https://drive.google.com/file/d/1d9g3eaNKzlyfKP1FmLsEXcnXsmLzqRWq/view>

| OSMO | | | | Ca | Mg | K | Ca |
|-------------------|-------|-----|-----|------------------|------------|-----------|-------|
| | | | | 33,0% | 8,0% | 3,7% | 26,0% |
| Ero tavoitetasoon | | | | Kalkitussuositus | | | |
| kg/ha | | | | Ca | Mg | K | |
| Ca | Mg | K | Na | Kalsiitti | Dolomiitti | Biotiitti | Kipsi |
| 253 | 18 | -84 | -14 | | | | |
| -959 | 293 | 38 | 31 | | 3,7 | 1,0 | |
| 66 | -989 | 135 | 86 | | | 3,7 | 2,3 |
| 1869 | -1313 | 76 | 114 | 5,7 | | 2,1 | 3,0 |

Results ½ - Farm research



- In analyzing the soil health of eight test fields, each field was found to have its own set of problems. Poor growth was caused by poor drainage, compaction in the top soil and subsoil, nutrient deficiencies (especially micronutrients), poor biological activity, and low soil organic matter.
- Upon identifying the factors impacting soil health and by reducing crop yield, the farmers used the information and tools developed through the project to plan effective ways to remedy them.
- 11 study reports, 8 planning tools, 30 leaflets and many PowerPoint presentations have been published.
- 45 articles have been published in professional magazines ensuring a wide dissemination of relevant information about soil health management.

Research Reports of Soil Health

<https://www.helsinki.fi/fi/ruralia-instituutti/koulutus/maan-kasvukunto>



RAPORTTEJA 171

MITÄ JA MITEN TUNNISTAA MAAN HYVÄN KASVUKUNNON?

HAVAINTOJA KAHDEKSALTA TILALTA VARSINAIS-SUOMESTA, SATAKUNNASTA JA ETELÄ-POHJANMAALTA

TUOMAS J. MATTILA JA JUUKA RAJALA



RAPORTTEJA 175

MITEN VÄLTÄN MAAN HAITALLISEN TIIVISTYMISEN MAATALOUSRENKaidEN AVULLA?

TUOMAS J. MATTILA, VEERA NANKA JA JUUKA RAJALA



RAPORTTEJA 179

KATIONINVAIHTOKAPASITEETIN MÄÄRITYS JA KÄYTTÖ VILJAVUUSANALYYSIN TULKINNASSA

OSKARI J. MATTILA JA JUUKA RAJALA



RAPORTTEJA 192

KIPSI MAANPARANNUSAINEENA - HYÖDYT JA HAITAT MAAN KASVUKUNNOLLE

TUOMAS J. MATTILA, VEERA NANKA JA JUUKA RAJALA



RAPORTTEJA 185

PIKAMENETELMÄT KASVIN RAVINNETILAN KUVAAJANA

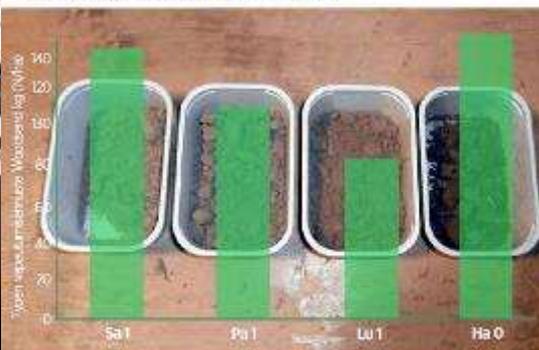
TUOMAS J. MATTILA, VEERA NANKA JA JUUKA RAJALA



RAPORTTEJA 188

UUSIA MENETELMIÄ MAAPERÄSTÄ VAPAUTUVAN TYPEN MÄÄRÄN ARVIOINTIIN

OSKARI J. MATTILA, TUOMAS J. MATTILA JA JUUKA RAJALA



RAPORTTEJA 189

KUUKA MAAN KASVUKUNTOA KEHITETÄÄN? KUUKA MAAN KASVUKUNTOA KEHITETÄÄN? KUUKA MAAN KASVUKUNTOA KEHITETÄÄN?

TUOMAS J. MATTILA, VEERA NANKA, JUUKA RAJALA, HEIKKI A. JOSEFINEN, JOUKKA KALLIO JA MARJA TUONONEN



MURUKESTÄVYYS MAAN KASVUKUNNON MITTARINA

JARNA SAVONEN, TUOMAS J. MATTILA JA JUUKA RAJALA



Results 2/2 – Training with farmers



- "Wake up courses"
- 5 intensive training groups with 20 farmers and two advisers
- In dept courses and workshops of different subjects of soil health
- Open field days and demonstrations
- Internet tools for e-learning; Zoom, Moodle, Support
- About 1500 participants were involved in 109 training events. Participants acquired new knowledge and skills and made significant improvements in soil health management at farm level.
- The farmers responded well to the blended learning approach, involving e-learning as well as theoretical workshops and practical field days.
- Collaboration; 26 local, regional and national projects.
- Recommendations for soil health management to farm, regional and country level

<https://www.helsinki.fi/fi/ruralia-instituutti/koulutus/maan-kasvukunto/osmon-suositukset-maan-kasvukunnon-hoidon-kehittamiseksi-suomessa>

How to be successful in training?



- Discussing topics which are relevant to farmers theoretical and practical level, helping farmers apply the new knowledge to their own farms
- Helping farmers solve their problems
- Training farmers to make right questions
- Talking language which farmers understand
- Acting at the same level with farmers in close interaction and discussions
- Using good pedagogical methods suitable for farmers
- Use peer support from farmer to farmer
- In good atmosphere



Feedback from participants



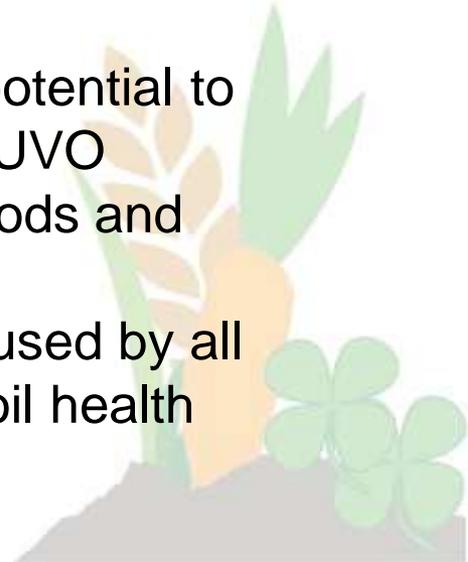
- *Theoretical knowledge and practical tools in good mix/balans*
- *Present of course day was very good, in every farmers lectures was the theory brought into practical farm level*
- *The course day was very useful for my farm*
- *Good package and wake up to think in own mind and doing*
- *Relaxed atmosphere and very profitable discussions*
- *Now I'm looking my farming with new eyes and the course gave me the motivation to try new methods at my farm*
- *The experience of teachers is visible*
- *Motivating meeting*
- *Thanks for good course day!*



Key lessons



- **Identifying and remedying soil health problems** and enhancing soil quality, organic matter and structure may increase farm productivity, but it also reduces the potential impacts from extreme climate conditions by building agroecosystem resilience and adaptation capacity.
- **Simplified decision support tools** are needed, but they must account for the complexity of soil systems in relation to the potential options and recommendations for farm management.
- **The project's results are transferrable** and have the potential to have a wider impact, with 30 advisers under the MAANEUVO project are in training on how to effectively use the methods and tools developed in the OSMO project.
- Additionally, **the results are applicable** to and may be used by all farmers, advisers, trainers and researchers to improve soil health management.



More information



OSMO project at University of Helsinki webpage

<https://researchportal.helsinki.fi/en/projects/knowhow-and-tools-for-resource-efficient-soil-health-management-i>

OSMO project at University of Helsinki webpage

OSMO in Rural Inspiration Awards 2020 https://enrd.ec.europa.eu/news-events/events/rural-inspiration-awards-2020_en

https://enrd.ec.europa.eu/sites/default/files/project/attachments/ria_2020_gp_fi_osmo_4.pdf

Materials of Soil Health produced by the project www.maan-kasvukunto.fi

MAANEUVO-project <https://www.helsinki.fi/fi/ruralia-instituutti/koulutus/maaneuvo>
<https://carbonaction.org/fi/maaneuvo-hanke/>

Scientific articles:

Mattila T.J. and Rajala J. 2021. Do different agronomic soil tests identify similar nutrient deficiencies? Soil Use and Management, 04 July 2021. <https://doi.org/10.1111/sum.12738>

Mattila T.J. and Rajala J. Estimating cation exchange capacity from agronomic soil tests: comparing Mehlich-3 and ammonium acetate sum of cations. Soil Science of America Journal. In press.

Questions to discuss



- What is wrong in poor growing fields?
(There are poor growing fields also in CA)
- How to assess it on farm level?
- Why there are problems? Basic causes? X 5
- What can be done to fix this?
- Does it work?
- Does it pay?
- Is it sustainable?





OSMO

Project manager

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Ruralia Institute Mikkeli

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<https://www.helsinki.fi/fi/ruralia-instituutti>

www.maan-kasvukunto.fi



Kuvat: Jukka Rajala

<https://www.helsinki.fi/fi/ruralia-instituutti/koulutus/maan-kasvukunto>