Land Use Optimization
as a means for sustainable intensification of agriculture at high latitudes

Pirjo Peltonen-Sainio and

OPAL-Life team members

Natural Resources Institute Finland (Luke)

What is going on?

Global scale:

- Feeding the rising world population
  - Almost a billion of chronically hungry people
- Avoiding forest clearance to get m… …d for food production
- Meeting all the interp… …ges caused by:
  - Population gr… …demand for feed due to increase in stand… …ighly populated regions
  - I… …nd and unbalanced production of crop based …ed
  - …able land devoted to production of bioenergy
  - Climate change, extreme events, increased vulnerability and volatility

Conflict with the need to enhance global food availability by 100-180% without further endangering planetary bearing capacity

What is going on?

OPAL·Life

Global scale:

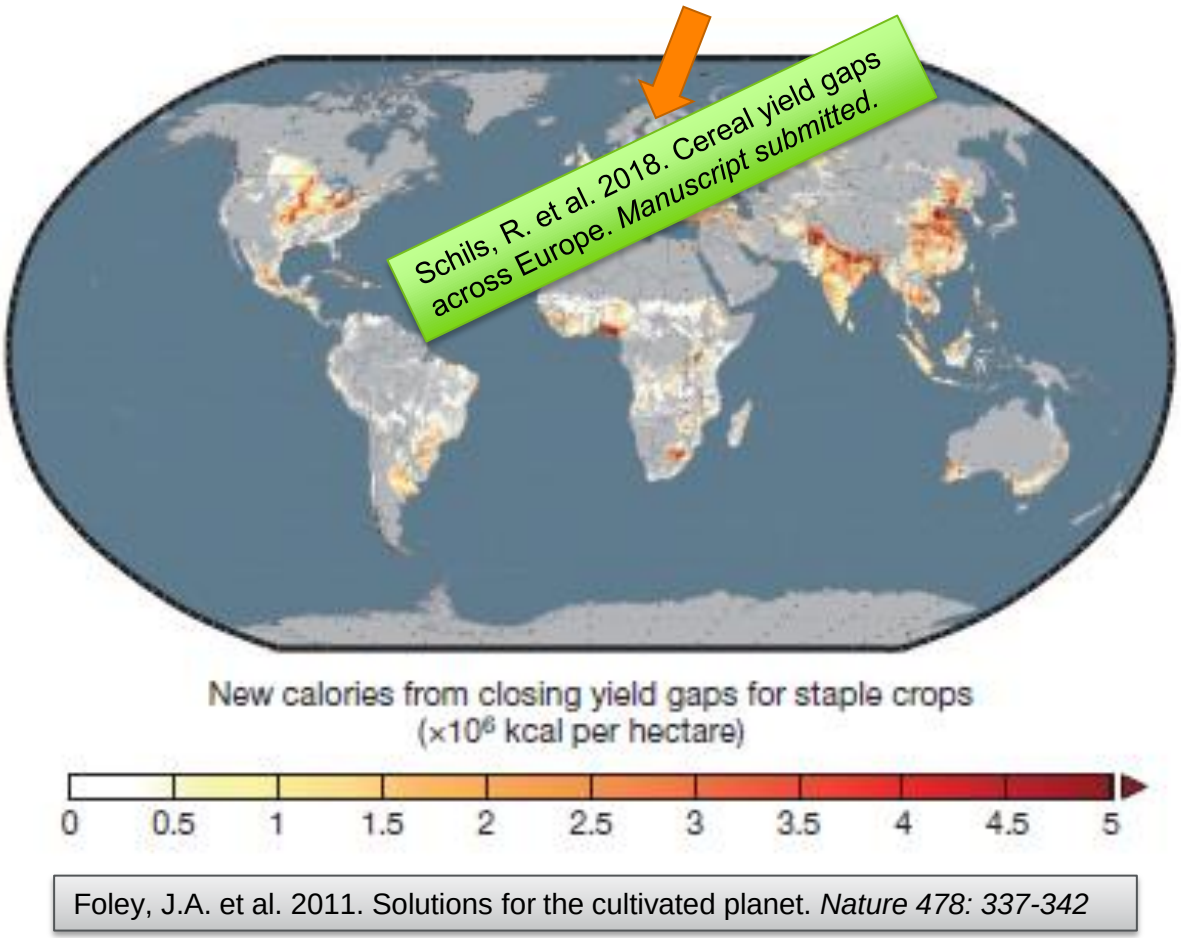
- More farming than ever in our planet
- High resource intensity (and de…
- High environmental foot… …ion
- High share of ag… …d to animals, bi… …es
  - >5…
  - …es, natural meadows
- … of global production regions have … dent yield stagnation or decline
  - …gaps have increased

Not only a question of agricultural production per se:

- Uneven distribution of goods
- High share of waste production at different steps of food chain
- High standard of living and wasteful lifestyle
- Low standard of living and high post-harvest losses

Luke NATURAL RESOURCES INSTITUTE FINLAND

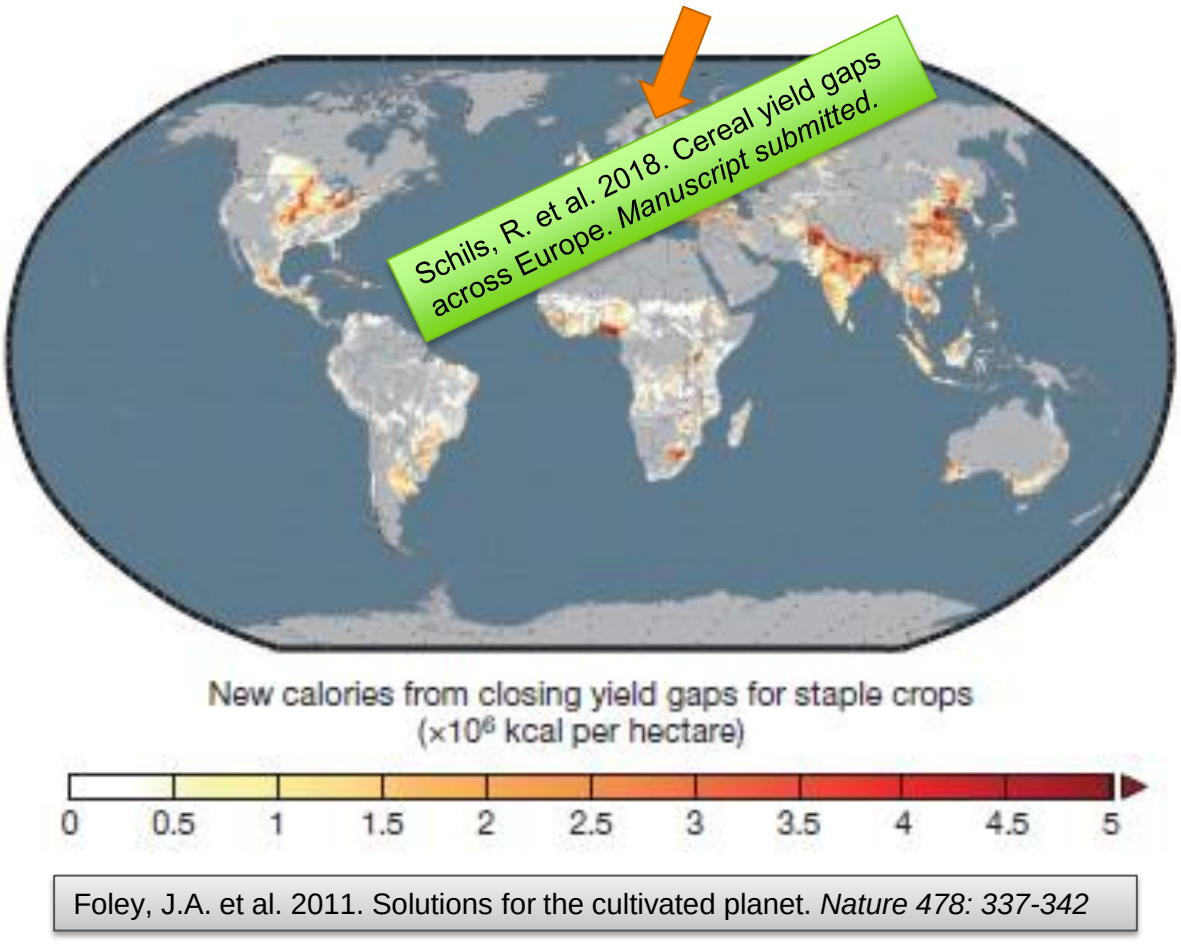
What is going on?



Foley, J.A. et al. 2011. Solutions for the cultivated planet. *Nature 478: 337-342*

- Yield gap is the difference between potential and attained yields
- Regional differences in yield gaps are high: in Europe eastern regions exhibit high yield gaps
- 16 most important staple crops
- 58% increase in food production available by closing yield gaps

What is going on?



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- Yield gap is the difference between potential and attained yields
- Regional differences in yield gaps are high: in Europe eastern regions exhibit high yield gaps
- 16 most important staple crops
- 58% increase in food production available by closing yield gaps
- Needs to be carried out in a sustainable manner

Sustainable intensification

Decrease environmental footprint while increase agricultural production and food security in a socially acceptable way

Sustainable intensification

Opposite for intensive…

Sustainable intensification

Opposite for intensive…

…is inefficient

Why to change direction?

OPAL·Life

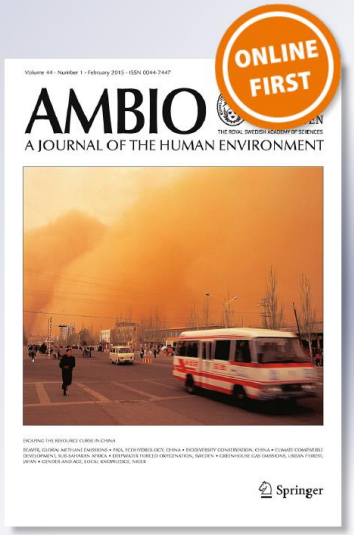
Static yields and quality issues: Is the agri-environment program the primary driver?

Pirjo Peltonen-Sainio, Tapio Salo, Lauri Jauhiainen, Heikki Lehtonen & Elina Sieviläinen

AMBIO
A Journal of the Human Environment

ISSN 0044-7447

AMBIO
DOI 10.1007/s13280-015-0637-9



Springer

- The Finnish Agri-Environmental program (AEP) has been in operation for >20 years with >90% farmer commitment
- AEP has been successful especially by reducing e.g. N balance
  - From 90 to 50 kg/ha already in the early phase of the AEP

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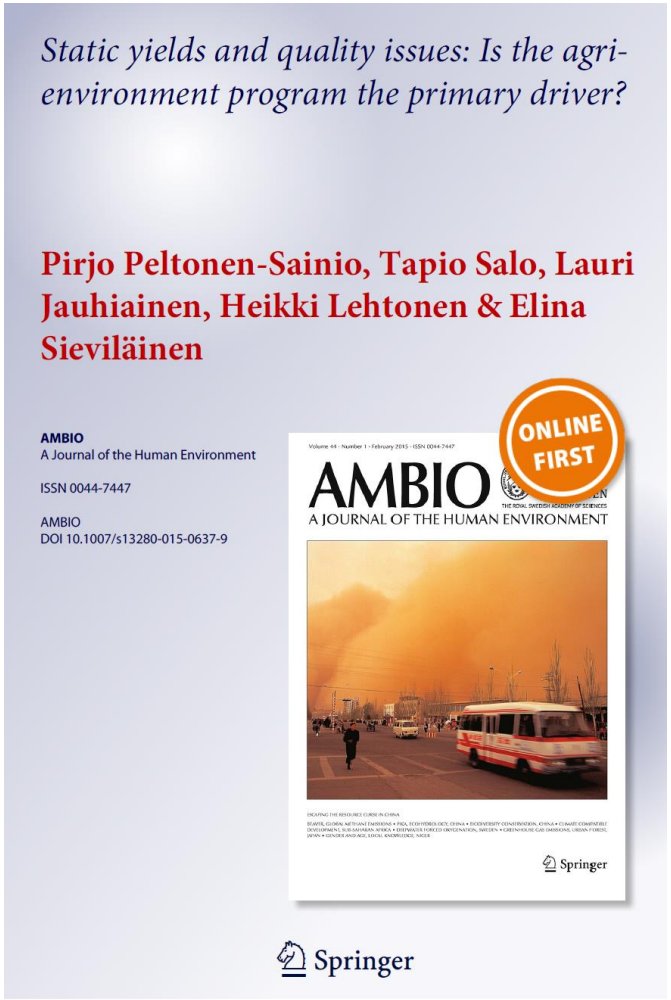
Why to change direction?



- Many contemporary changes in agricultural practices, driven by changes in prices and farm subsidies, also including the AEP, were likely reasons, together with reduced N use, for yield stagnation or decline and adverse changes in quality
  - Lack of basic investments → ? %
  - No-tillage → in total ≤5 %
  - Monoculture → e.g. in wheat 5-10 %
  - Soil degradation → ? %
  - Organic farming → in total ~1.4 %

Why to change direction?

OPAL·Life

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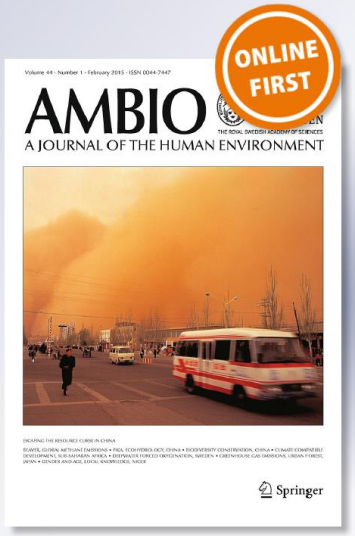


Springer

PLOS ONE

RESEARCH ARTICLE

Land Use, Yield and Quality Changes of Minor Field Crops: Is There Superseded Potential to Be Reinvented in Northern Europe?

Pirjo Peltonen-Sainio[1]*, Lauri Jauhiainen[1], Heikki Lehtonen[2]

- This agrees with both major and minor crops
- We do not need to be content with such trade-offs
- Instead we need to further develop the future policies to ensure that the changes are environmentally, economically and socially sustainable and acceptable

Luke NATURAL RESOURCES INSTITUTE FINLAND

Why to change direction?

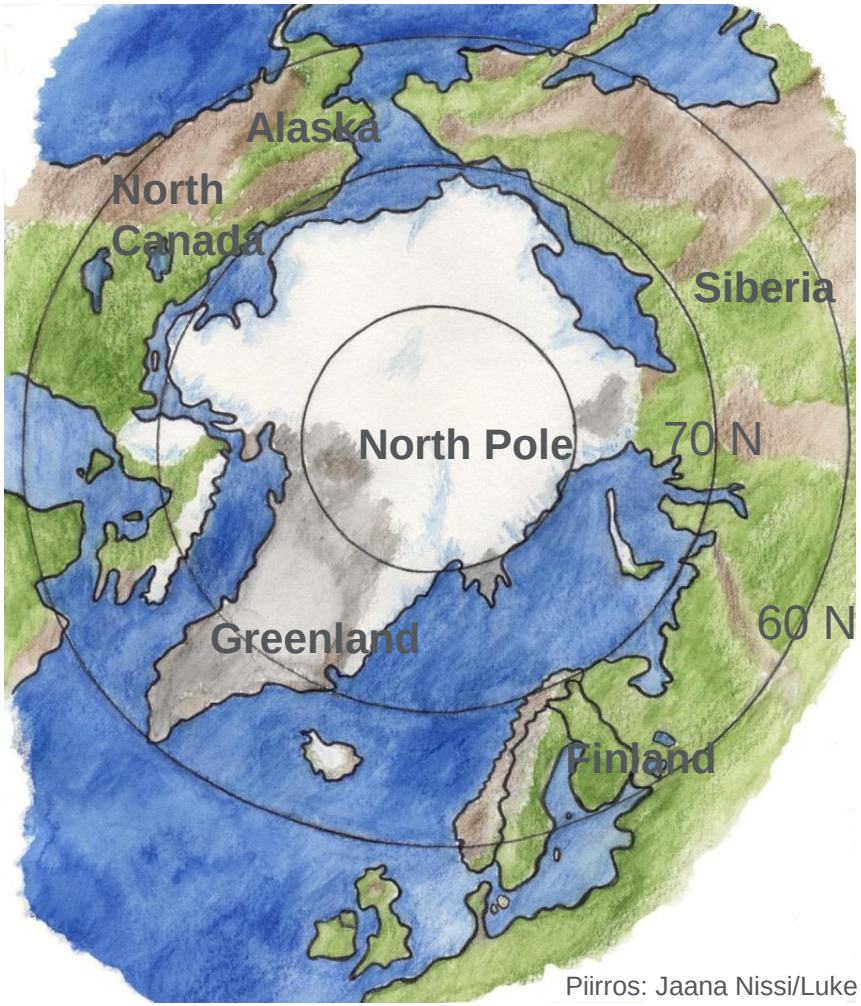
- To consider the existing policies, most notably the CAP
- To gain better understanding on potential policy related obstacles and benefits and possible synergies with respect to the targets of OPAL-Life project:
  - increase agricultural productivity
  - reduce greenhouse gas emissions from agriculture
  - Increase biodiversity

Sustainable intensification

…hungers for

non-averaging activities

Finland – a pilot region?



Piirros: Jaana Nissi/Luke

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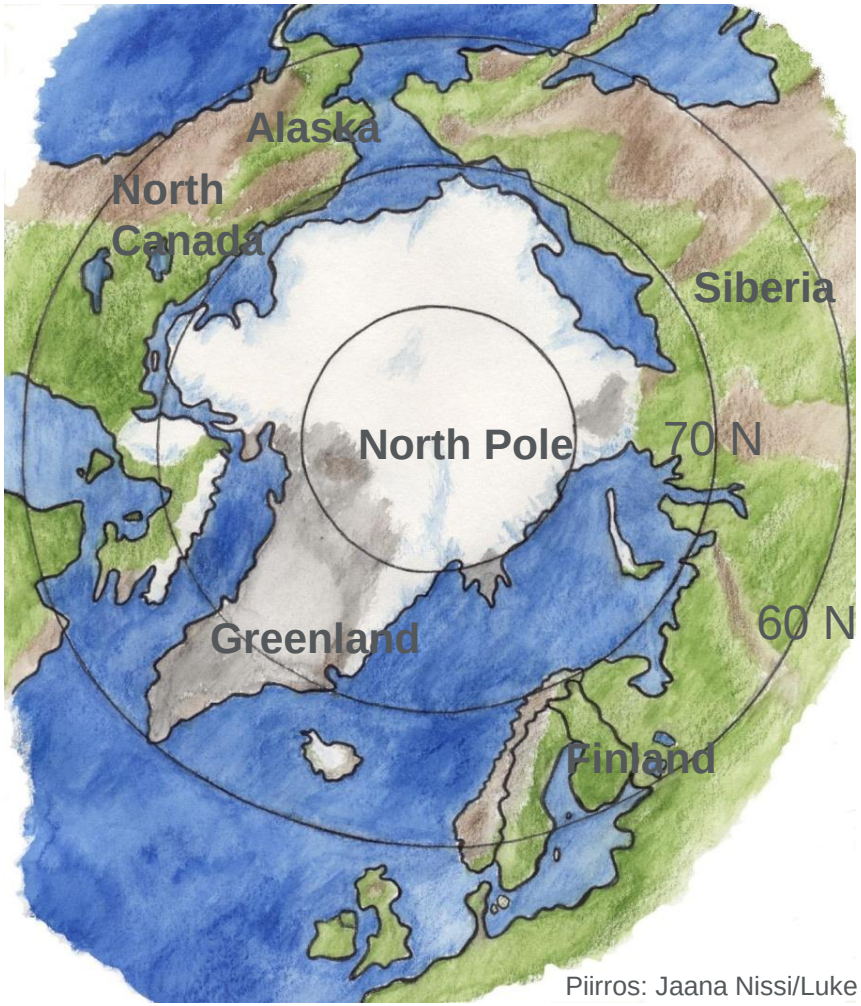
- Changing climate
  - Longer growing season, potential for higher yields
  - Potential for novel crops and more diverse crop rotations
  - Need for autumn sown and cover crops
- High variation among field parcels
  - In their productivity
  - In their physical characteristics
  - Need and potential for large-scale land use planning and optimization
- Valuable ecosystem services but also natural handicaps and vulnerable environment

Finland – a pilot region?



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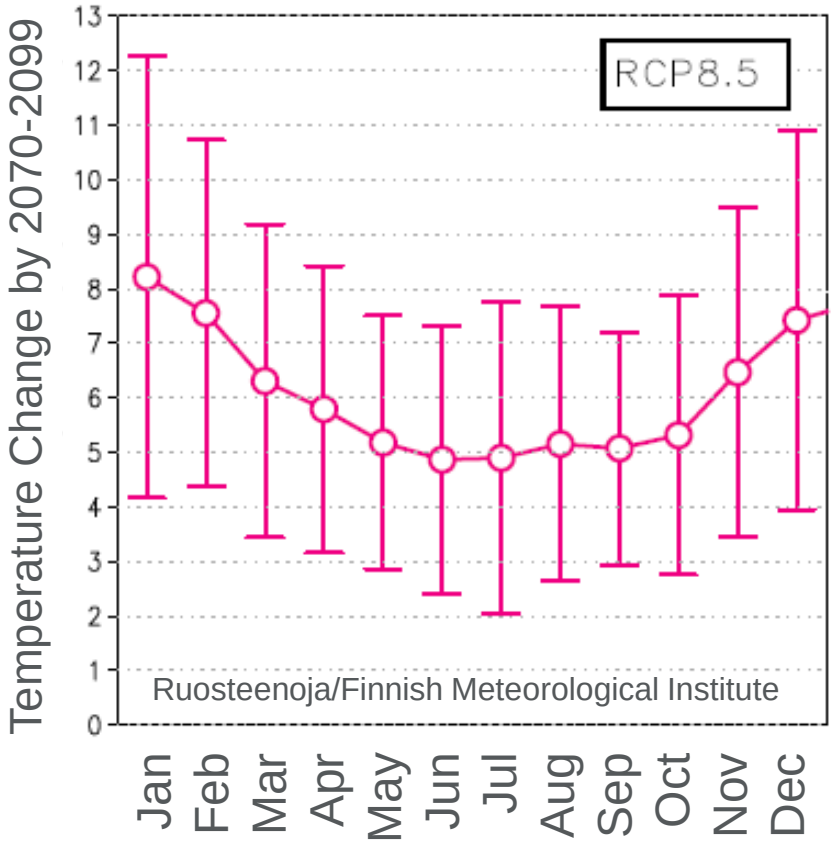
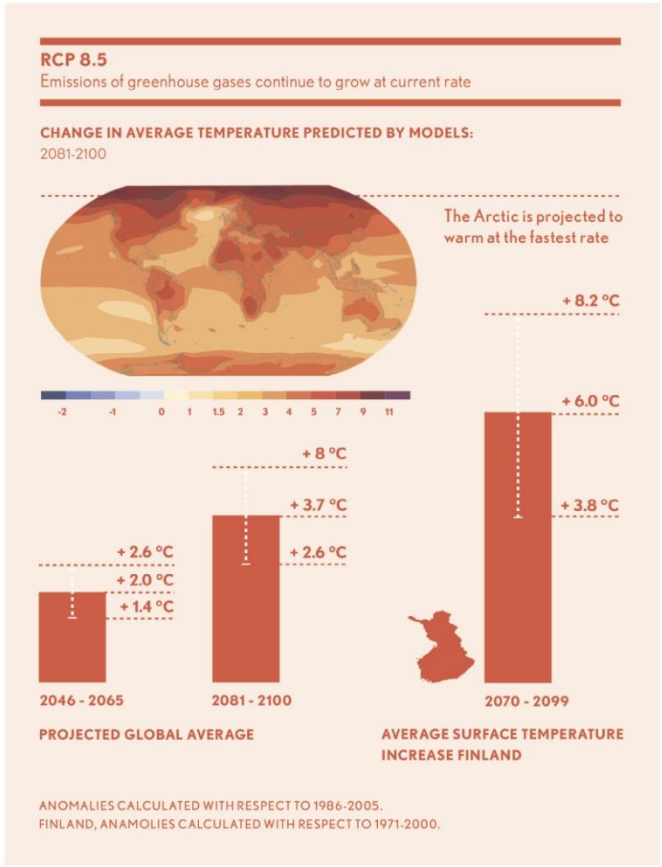
Climate change





Future estimates include a calculated best estimate and a confidence interval.
Based on IPCC Assessment Report 5, Working Group 1. Values for Finland by Finnish Meteorological Institute.

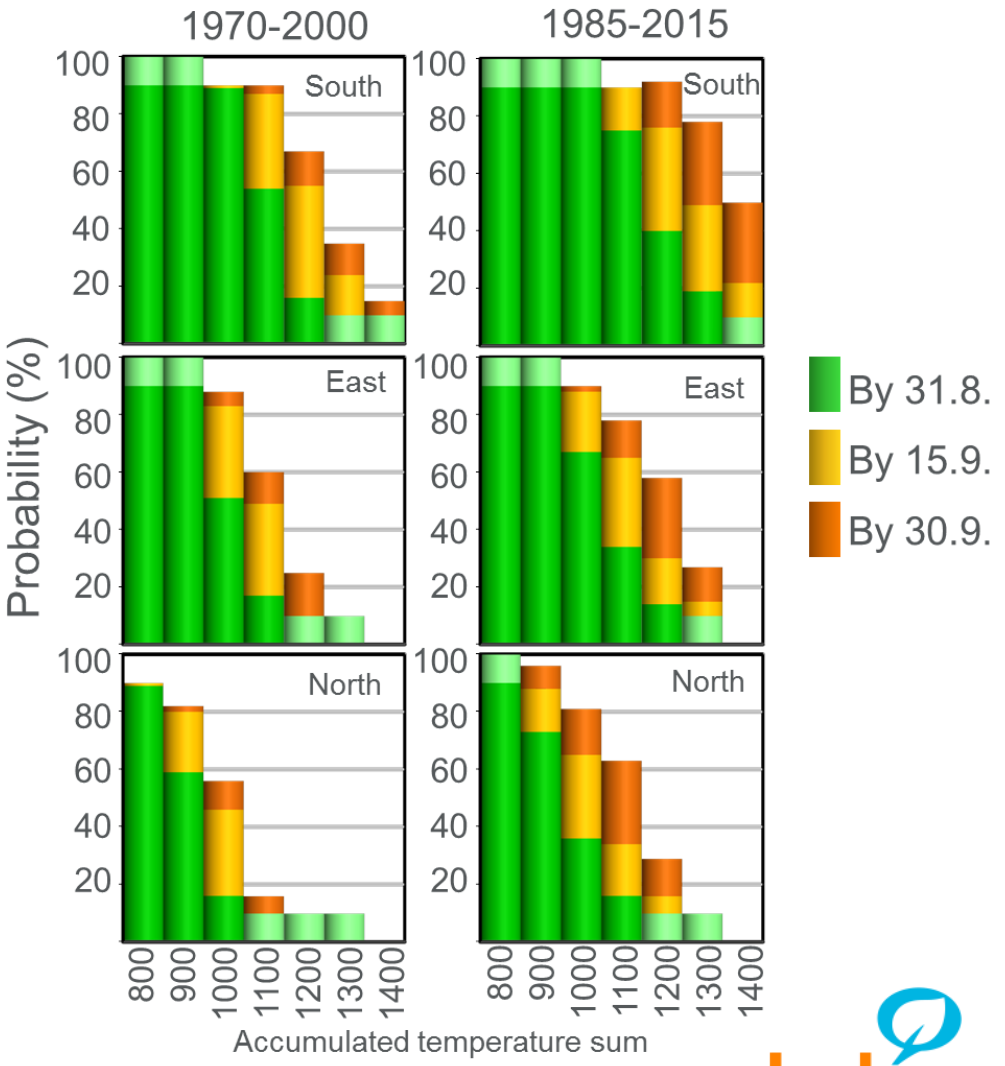
Climate change

The probability for different accumulated temperature sums depending on region

- Early and late 30-year period

Farmer can improve resilience to climate variability by selecting regionally adapted crops and cultivars

Data: Finnish Meteorological Institute



Climate change

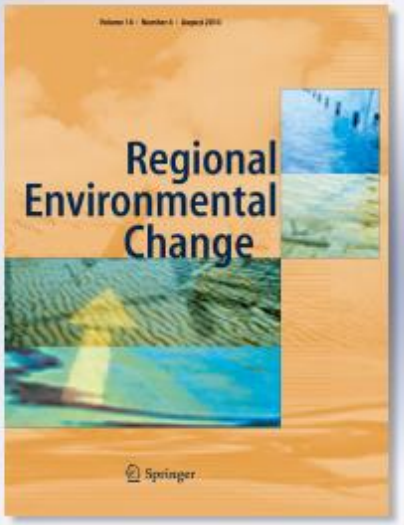
Lessons from the past in weather variability: sowing to ripening dynamics and yield penalties for northern agriculture from 1970 to 2012

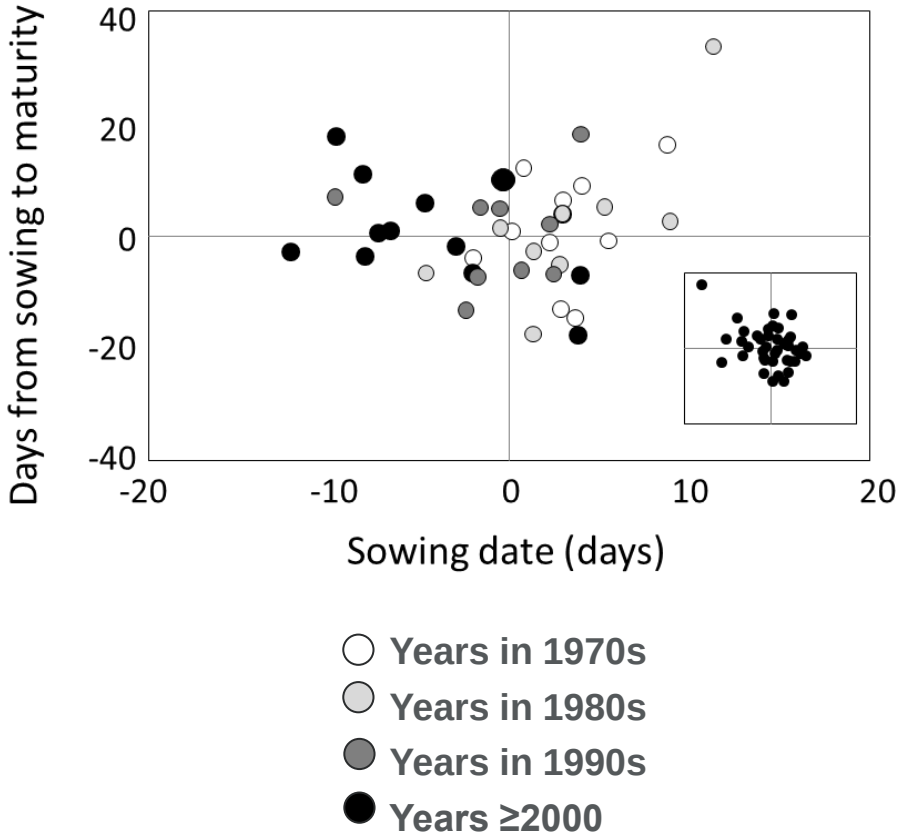
Pirjo Peltonen-Sainio & Lauri Jauhiainen

Regional Environmental Change

ISSN 1436-3798
Volume 14
Number 4

Reg Environ Change (2014)
14:1505-1516
DOI 10.1007/s10113-014-0594-z





Climate change

Biological Conservation 217 (2018) 166–172

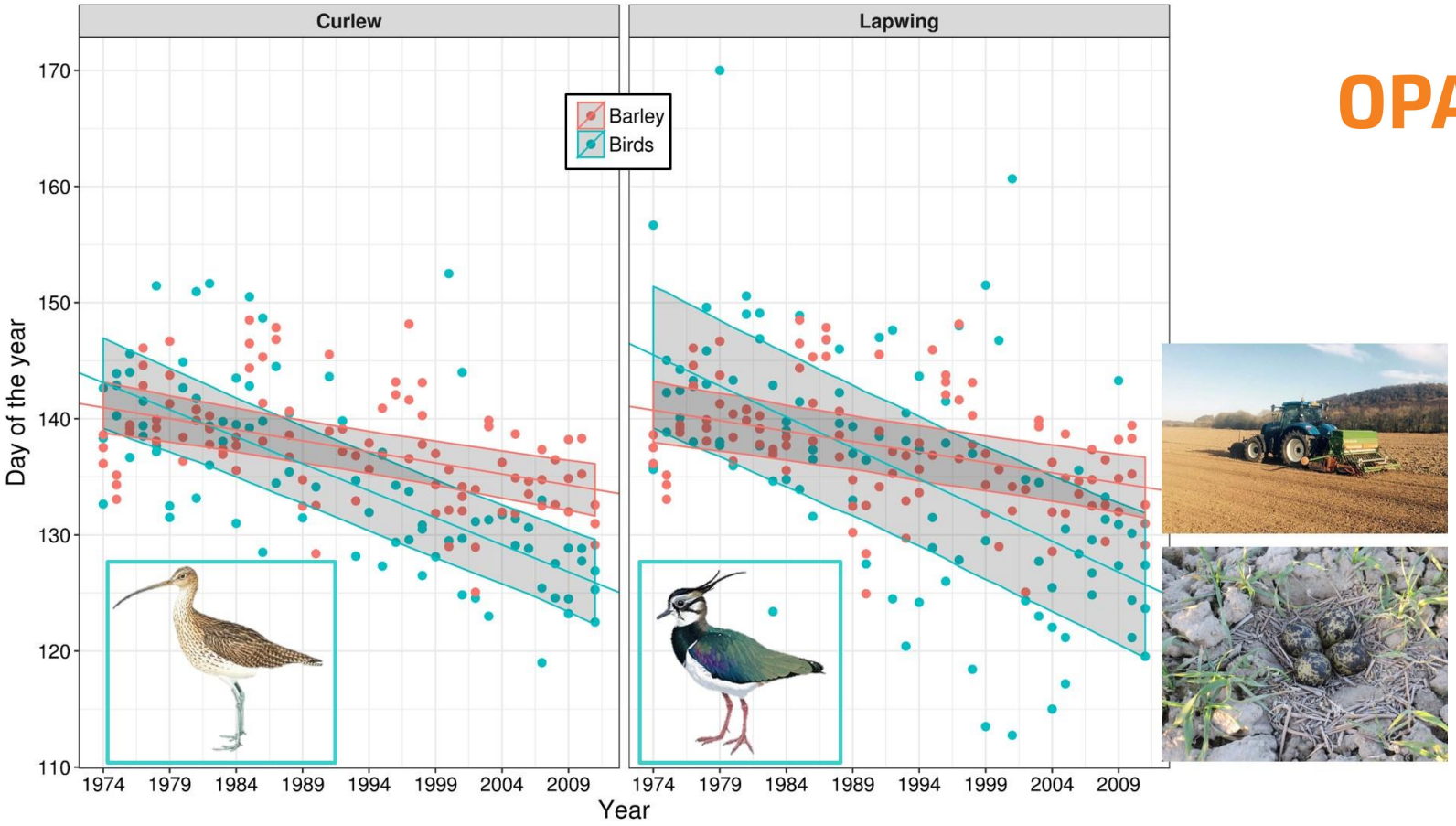
Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Stronger response of farmland birds than farmers to climate change leads to the emergence of an ecological trap

Andrea Santangeli[a,*], Aleksi Lehikoinen[a], Anna Bock[b,c,d], Pirjo Peltonen-Sainio[e], Lauri Jauhiainen[f], Marco Girardello[g], Jari Valkama[h]



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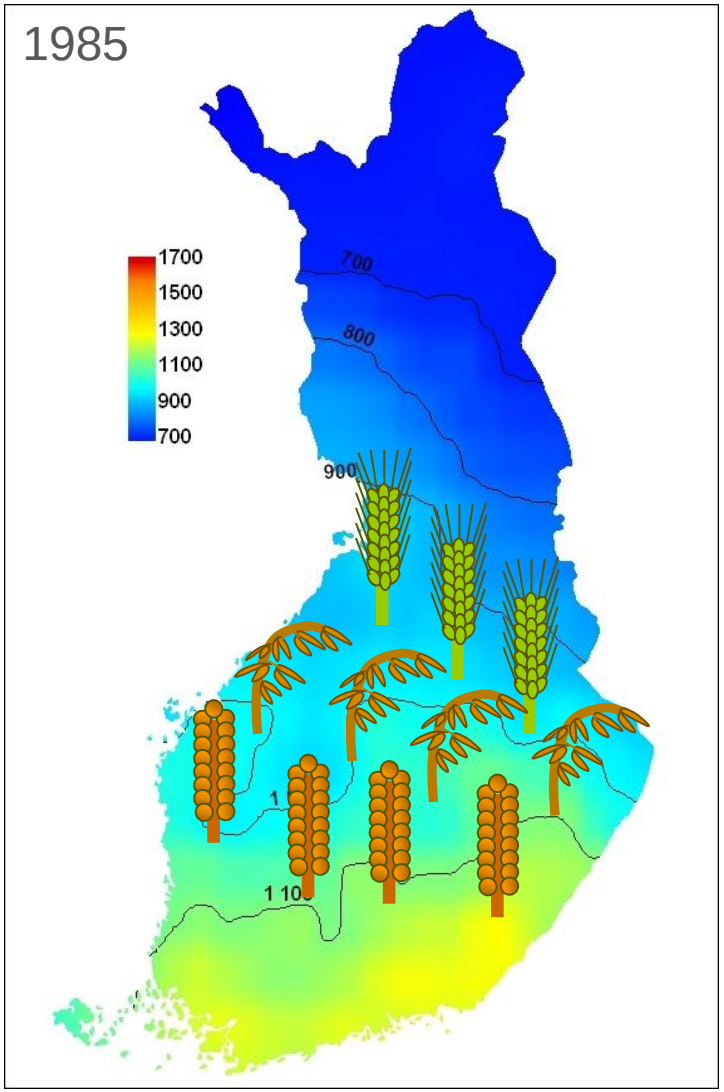

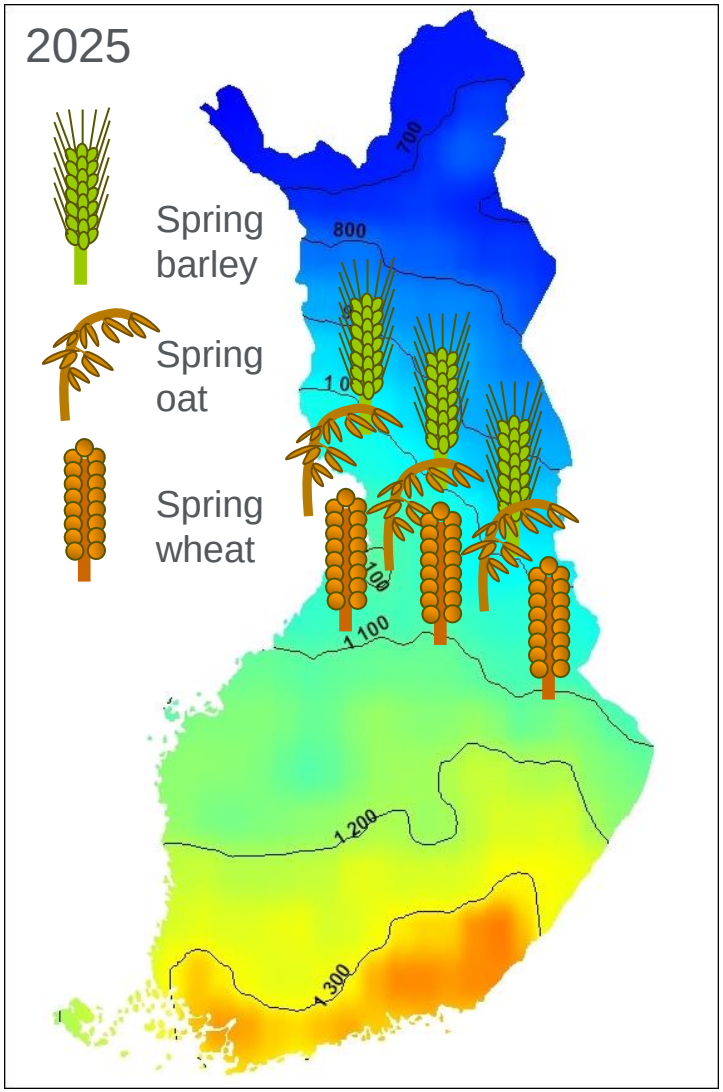

19 climatic models, Finnish Meteorological Institute (±15 years)

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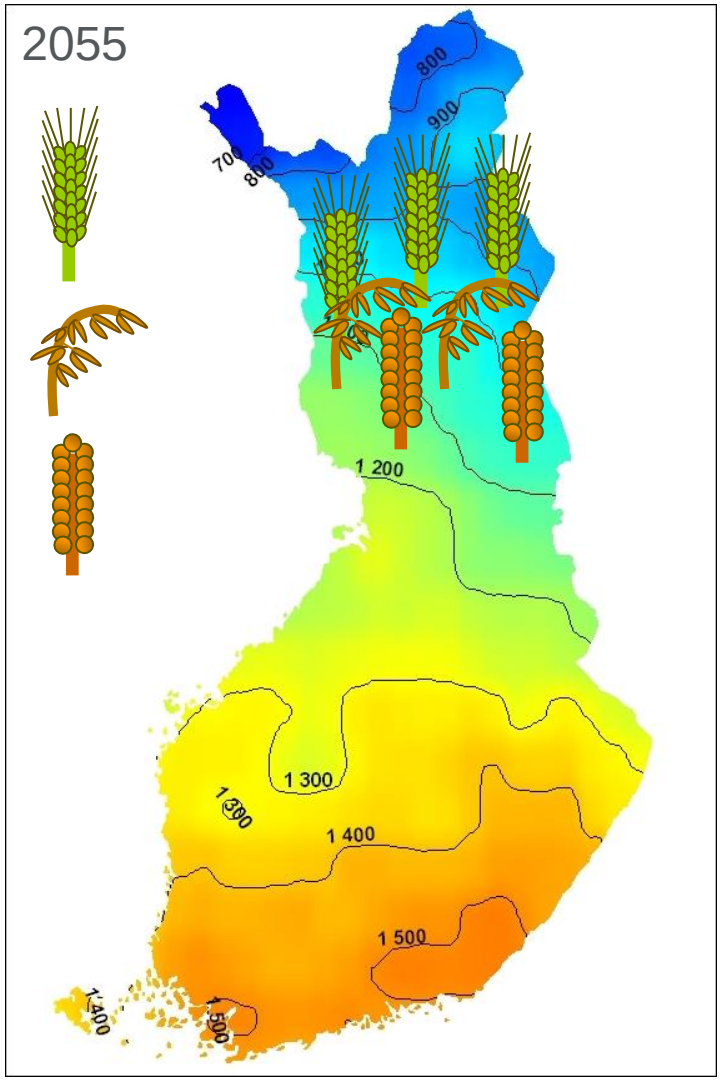

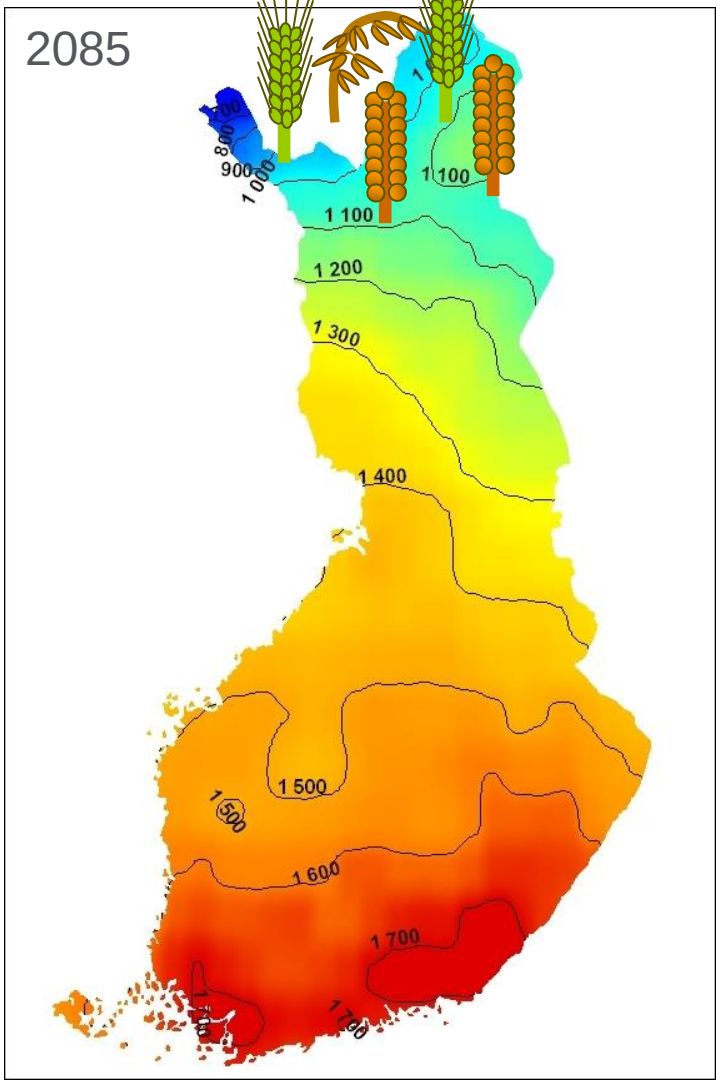

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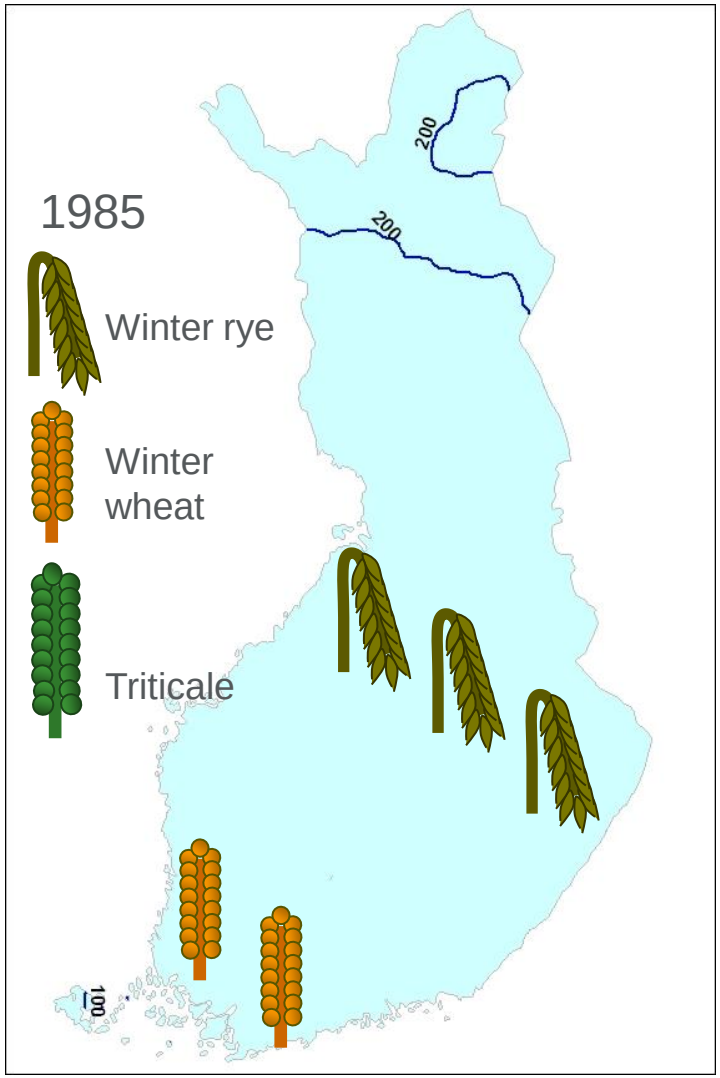

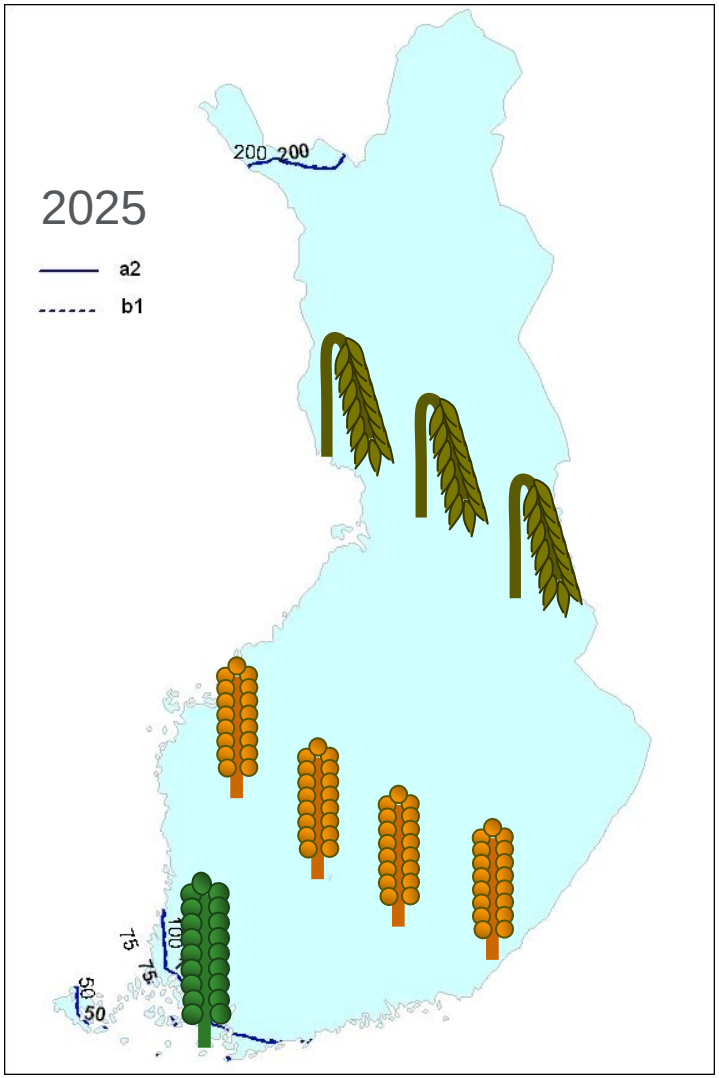

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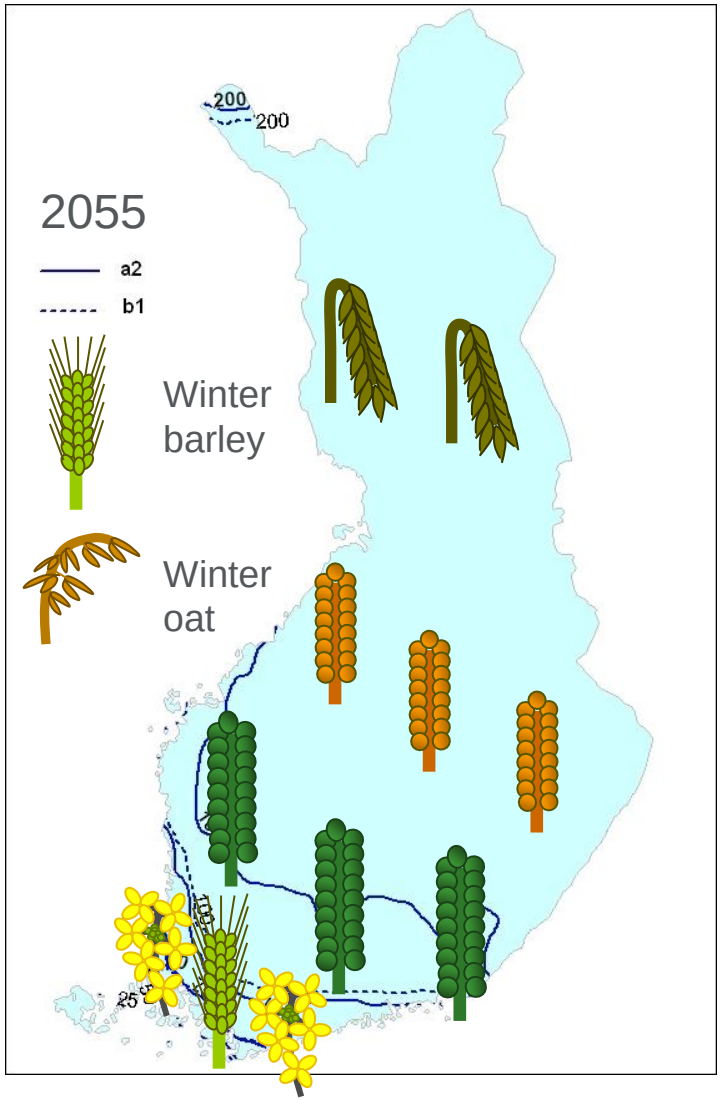

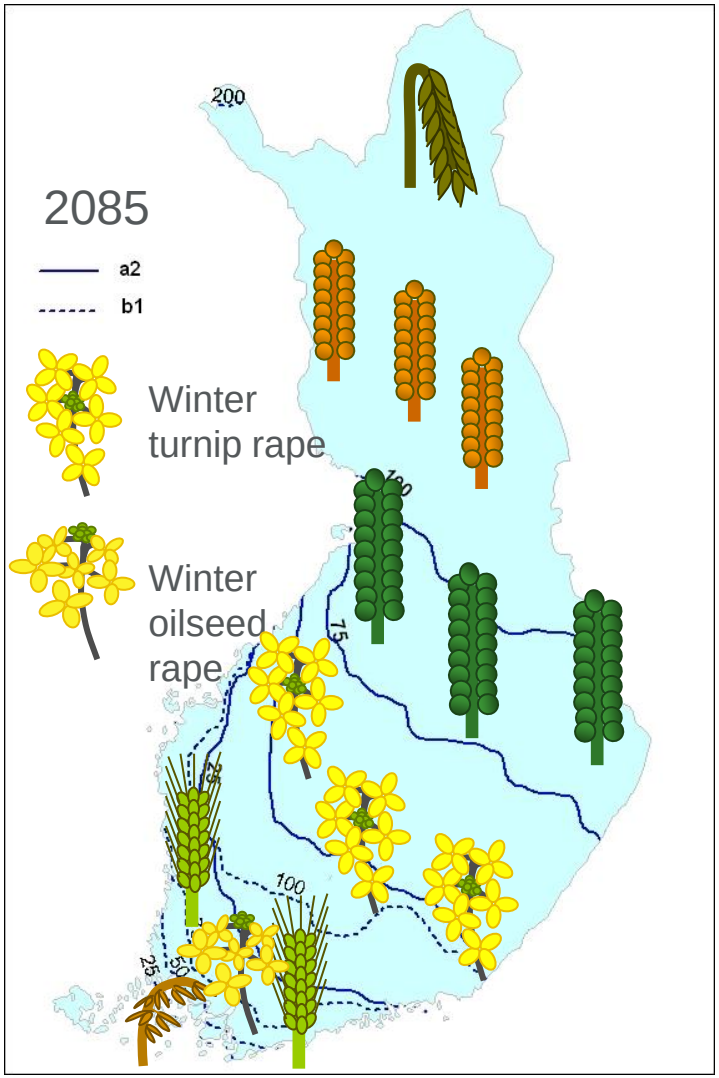

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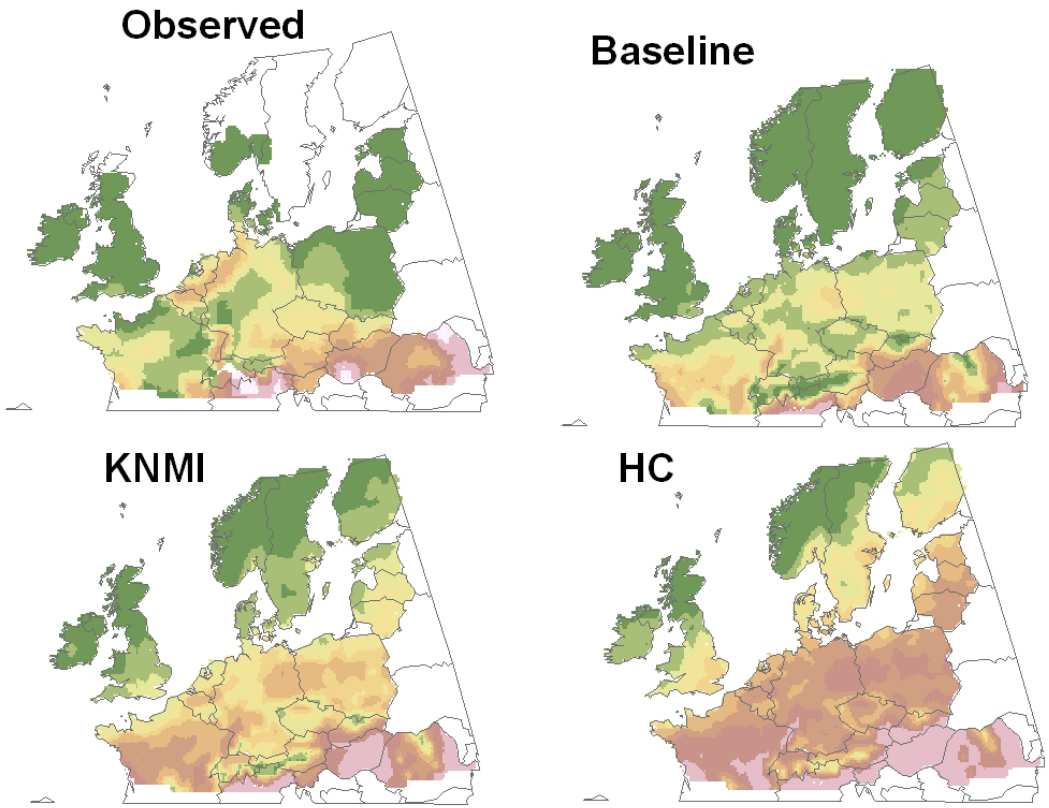
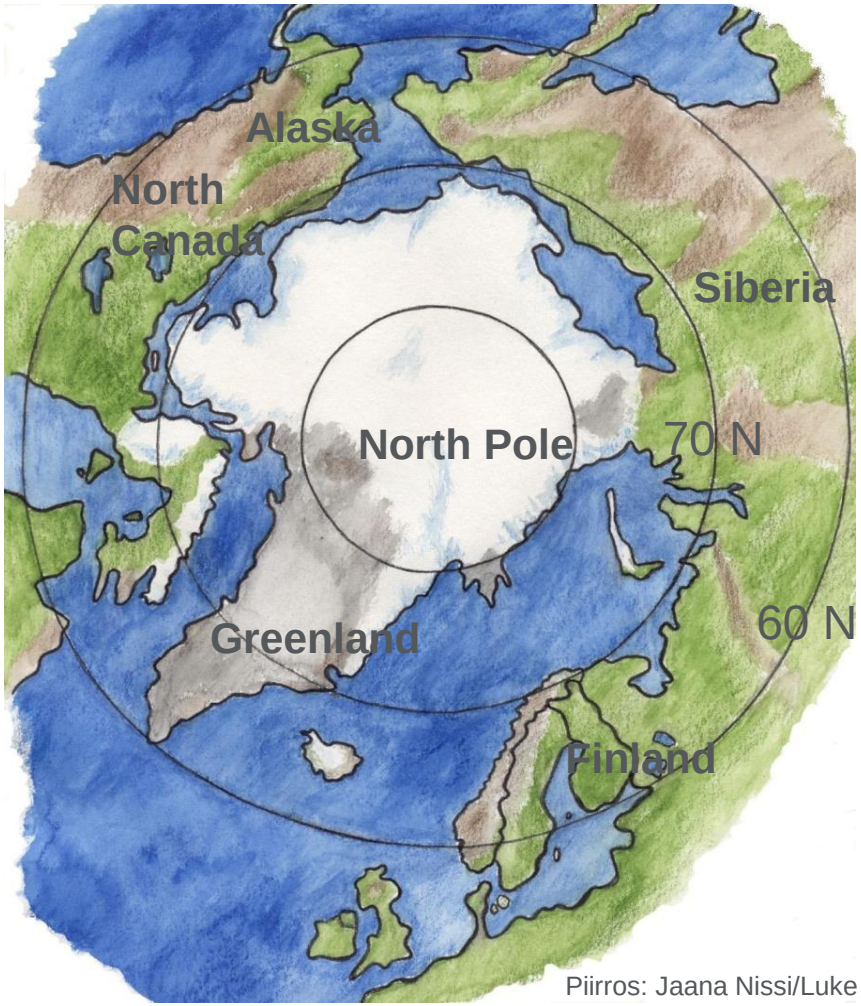


Food Additives & Contaminants: Part A
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tfac20

Shifts in comparative advantages for maize, oat and wheat cropping under climate change in Europe

L. Elsgaard [a], C.D. Børgesen [a], J.E. Olesen [a], S. Siebert [b], F. Ewert [b], P. Peltonen-Sainio [c], R.P. Rötter [c] & A.O. Skjelvåg [d]

Finland – a pilot region?



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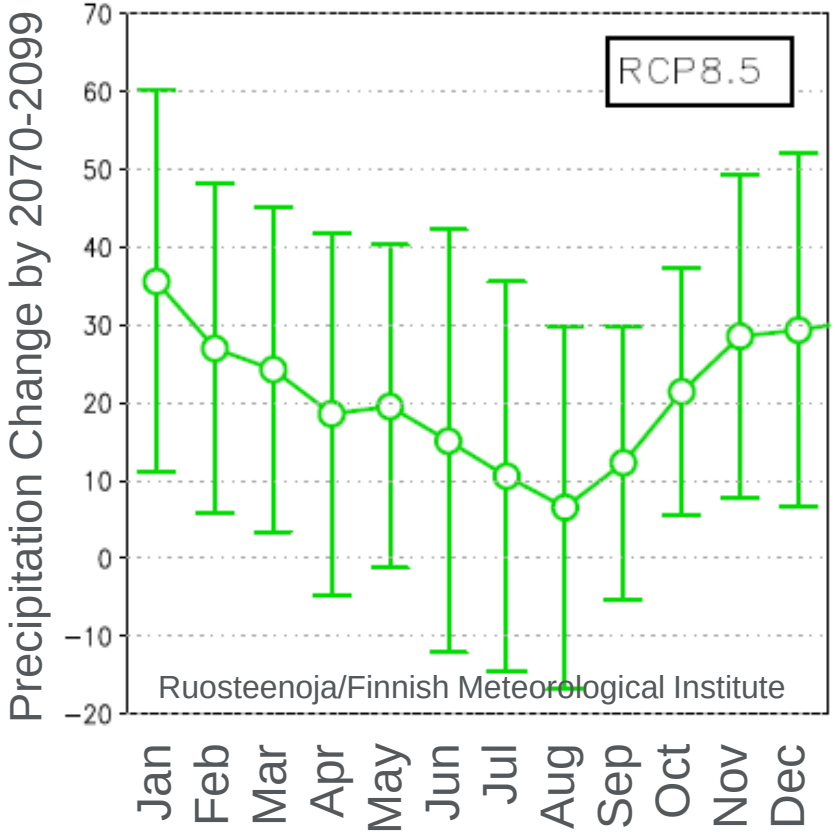
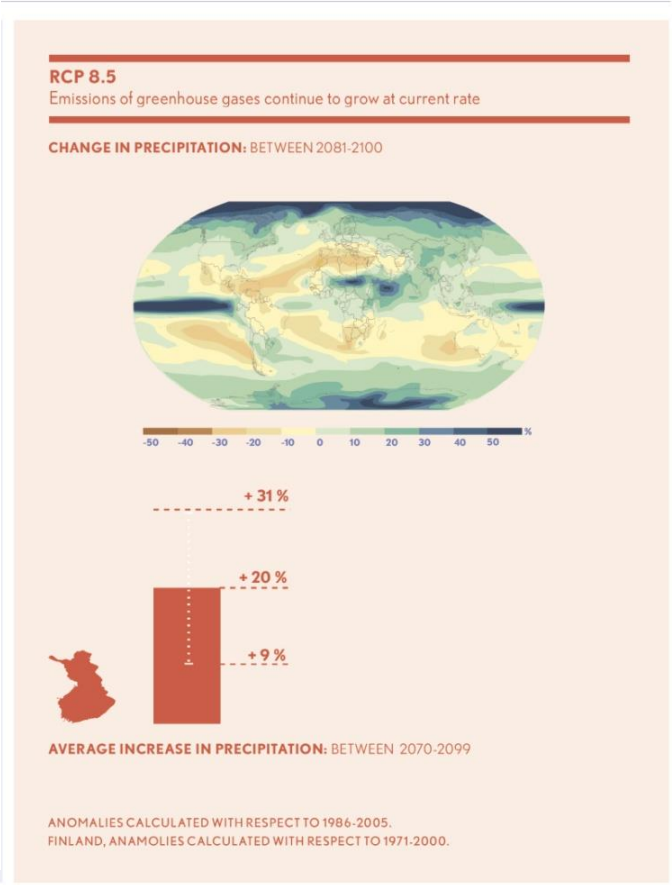
Climate change





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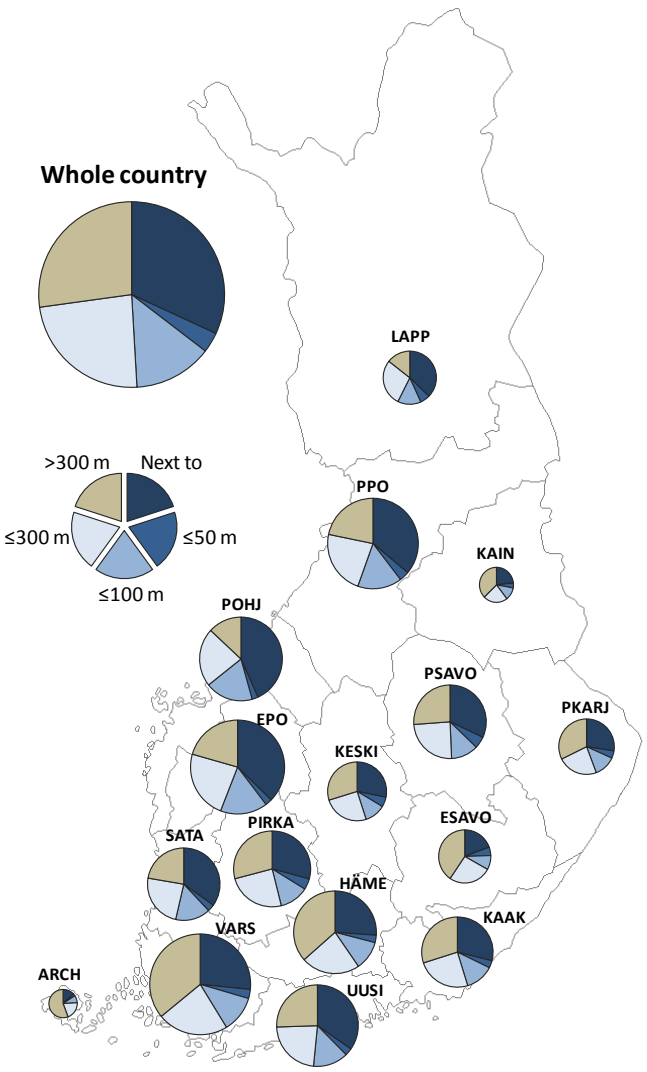
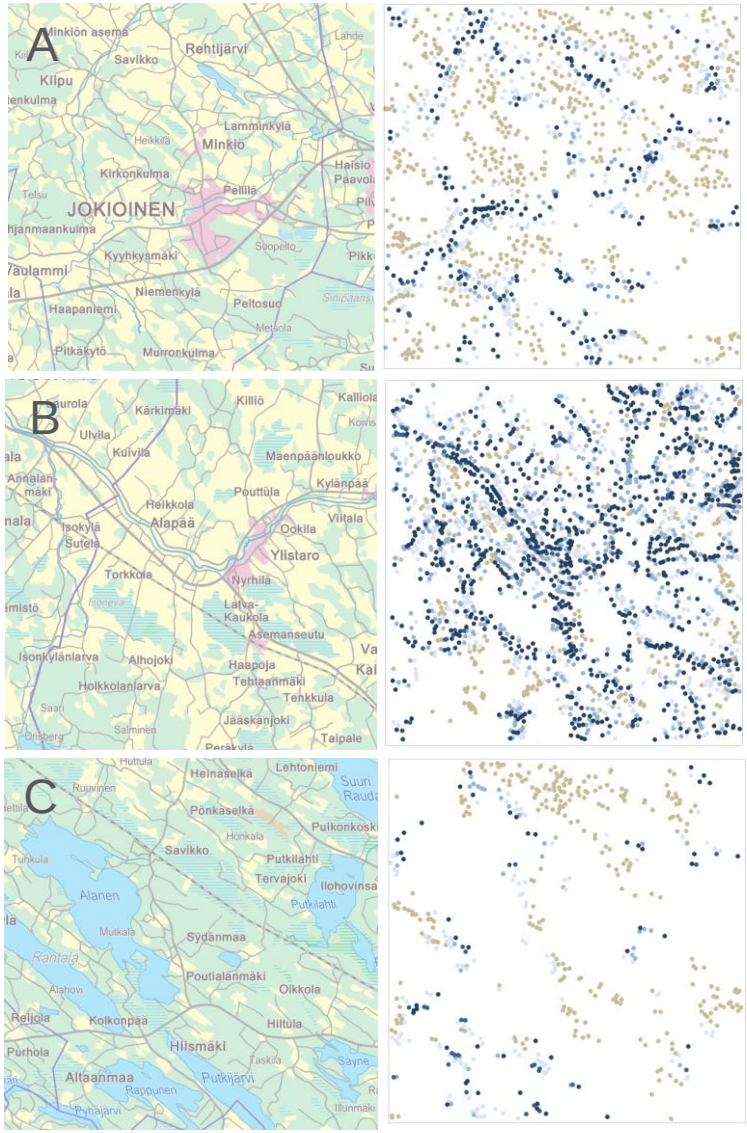




Peltonen-Sainio, P., Laurila, H., Jauhiainen, L. & Alakukku, L. 2015. Proximity of waterways to Finnish farmlands and associated characteristics of regional land use. *Agricultural and Food Science, in press.*

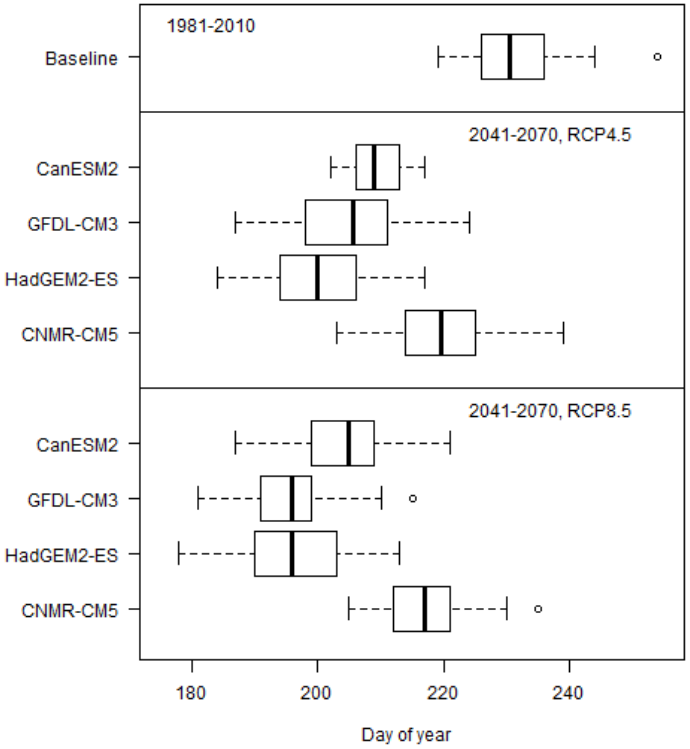
Climate change

Regional Environmental Change
https://doi.org/10.1007/s10113-017-1275-5

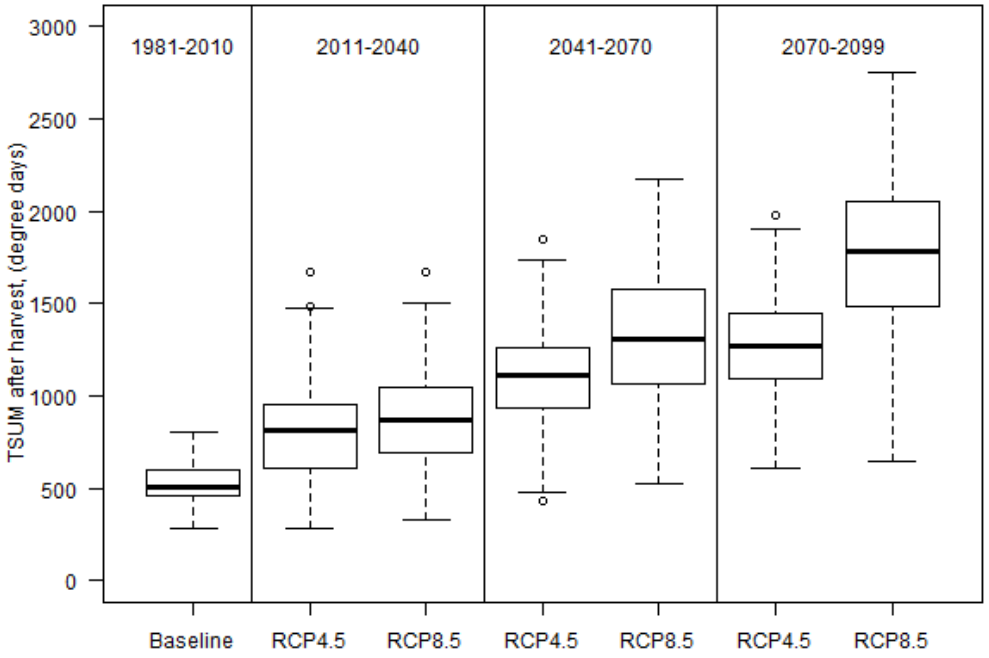
ORIGINAL ARTICLE

Warming autumns at high latitudes of Europe: an opportunity to lose or gain in cereal production?

Pirjo Peltonen-Sainio[1] · Taru Palosuo[1] · Kimmo Ruosteenoja[2] · Lauri Jauhiainen[3] · Hannu Ojanen[4]



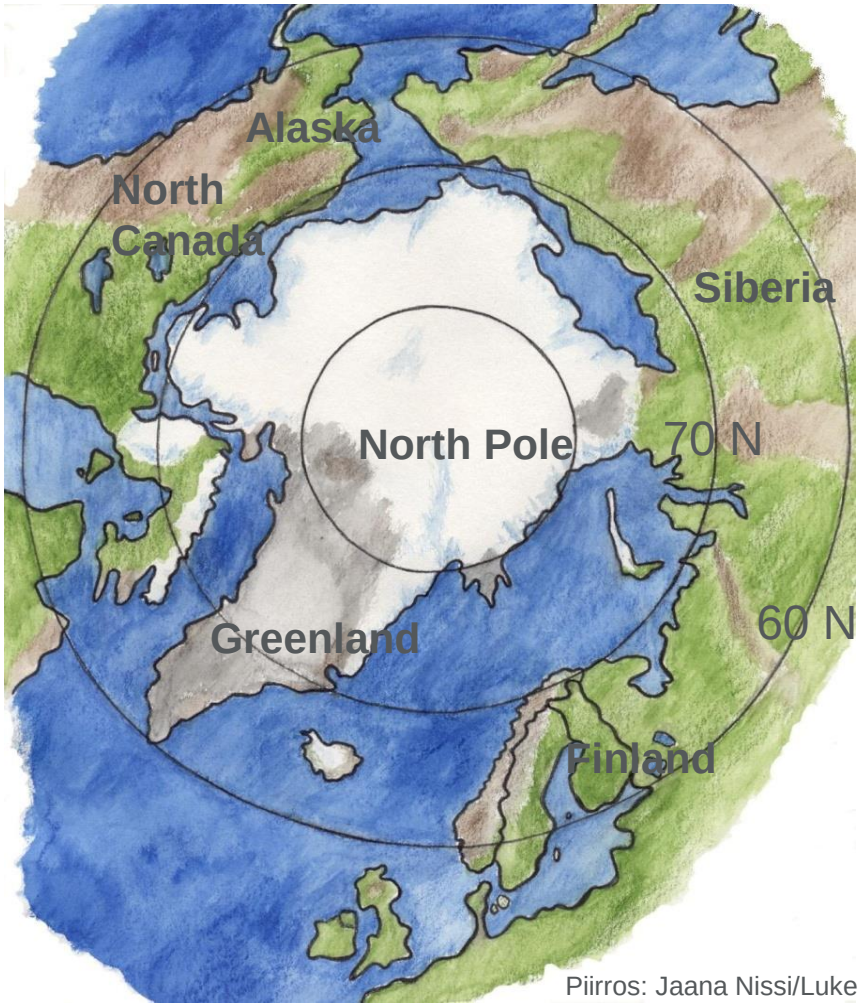
In the future, spring wheat matures earlier in spite of later maturing cultivars…



… which improves opportunities, but also increases need for double cropping to provide resilience against increasing environmental challenged caused by autumn precipitation

Luke NATURAL RESOURCES INSTITUTE FINLAND

Finland – a pilot region?



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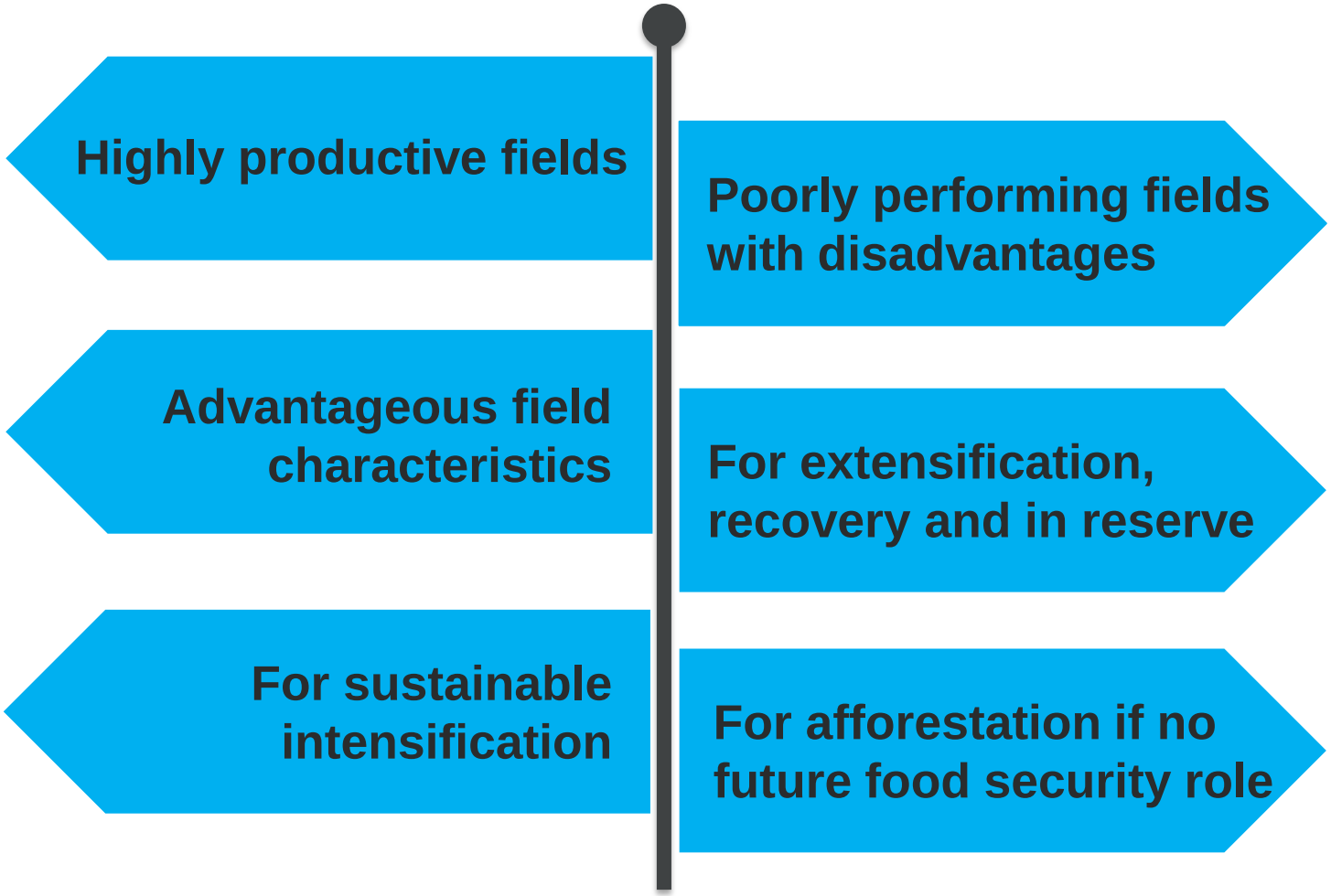
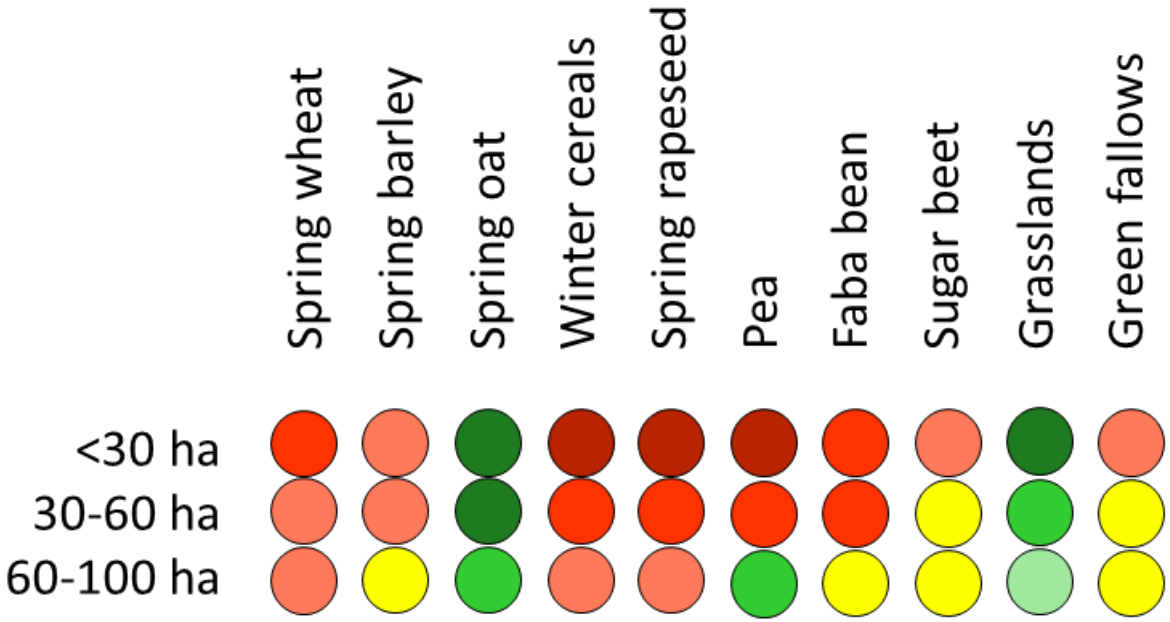
Land use optimization



Land use optimization

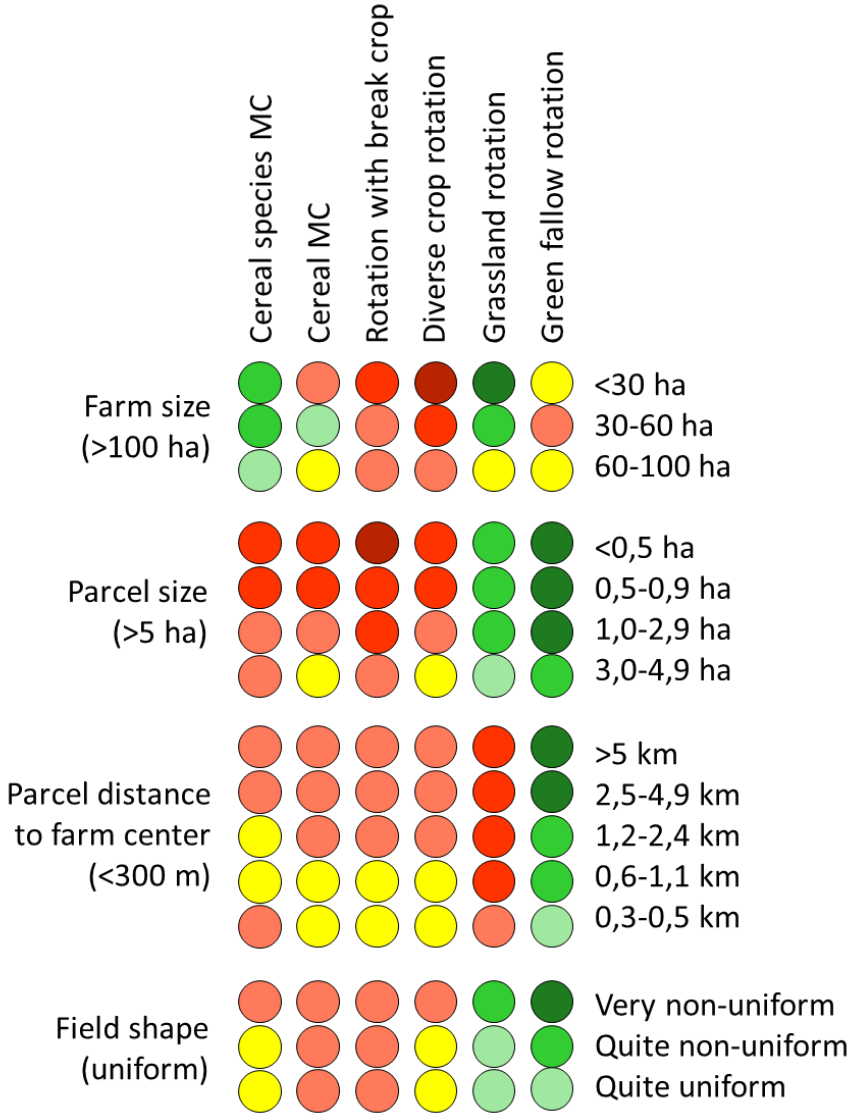
Farm size impacts on crop selection

- compared to >100 ha farm



Luke NATURAL RESOURCES INSTITUTE FINLAND

Land use optimization



Agricultural Systems 154 (2017) 25–33

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Diversity of high-latitude agricultural landscapes and crop rotations: Increased, decreased or back and forth?

Pirjo Peltonen-Sainio *, Lauri Jauhiainen, Jaana Sorvali

Natural Resources Institute Finland (Luke), Management and Production of Renewable Resources Latokartanonkaari 9, FI-31600 Jokioinen, Finland

Land Use Policy 71 (2018) 49–59

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Field characteristics driving farm-scale decision-making on land allocation to primary crops in high latitude conditions

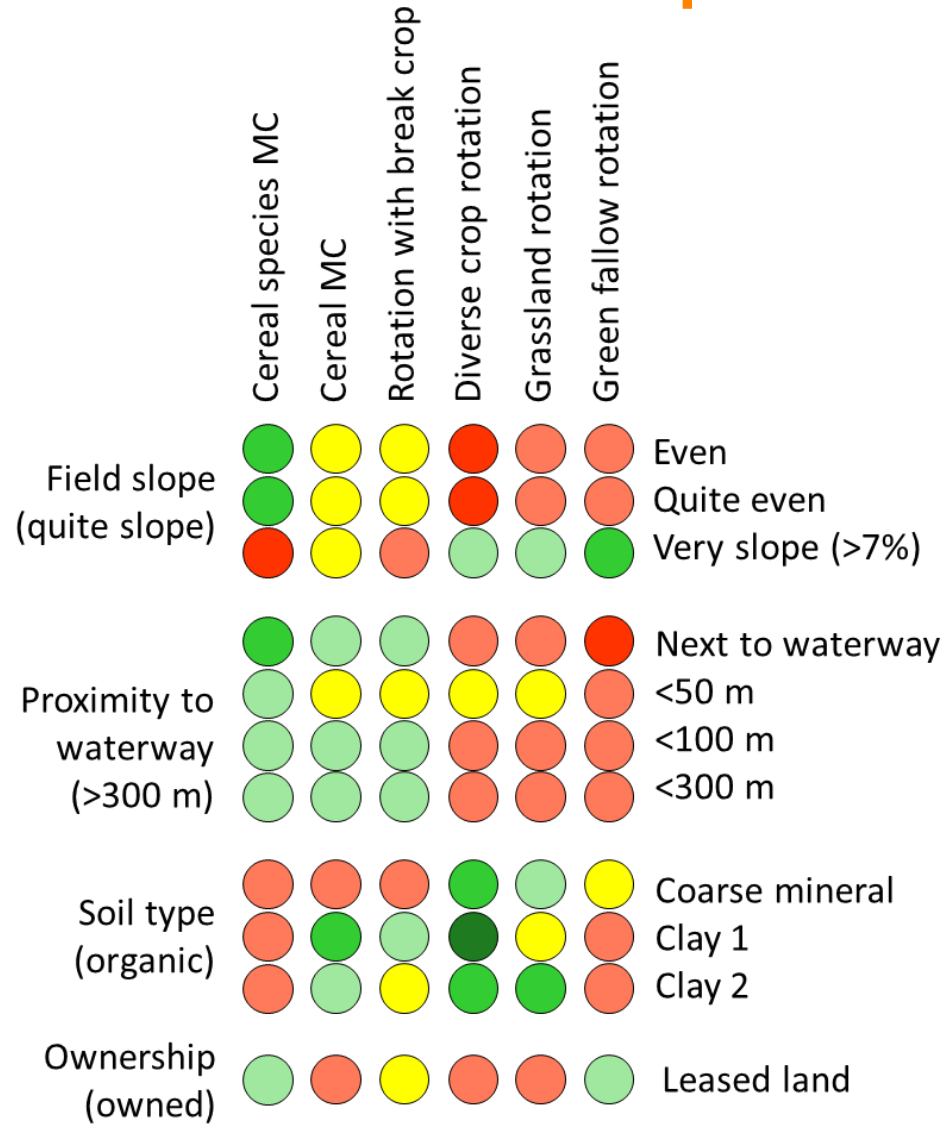
Pirjo Peltonen-Sainio[a,*], Lauri Jauhiainen[b], Jaana Sorvali[a], Heikki Laurila[b], Ari Rajala[b]

Impacts of physical characteristics of field parcels on crop rotations

- Compared to that on left hand side

- Very rarely
- Rarely
- Less frequently
- Very frequently
- More frequently
- Slightly more frequently
- Non-significant difference

Land use optimization



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Impacts of environmentally important characteristics on crop rotations

- Compared to that on left hand side

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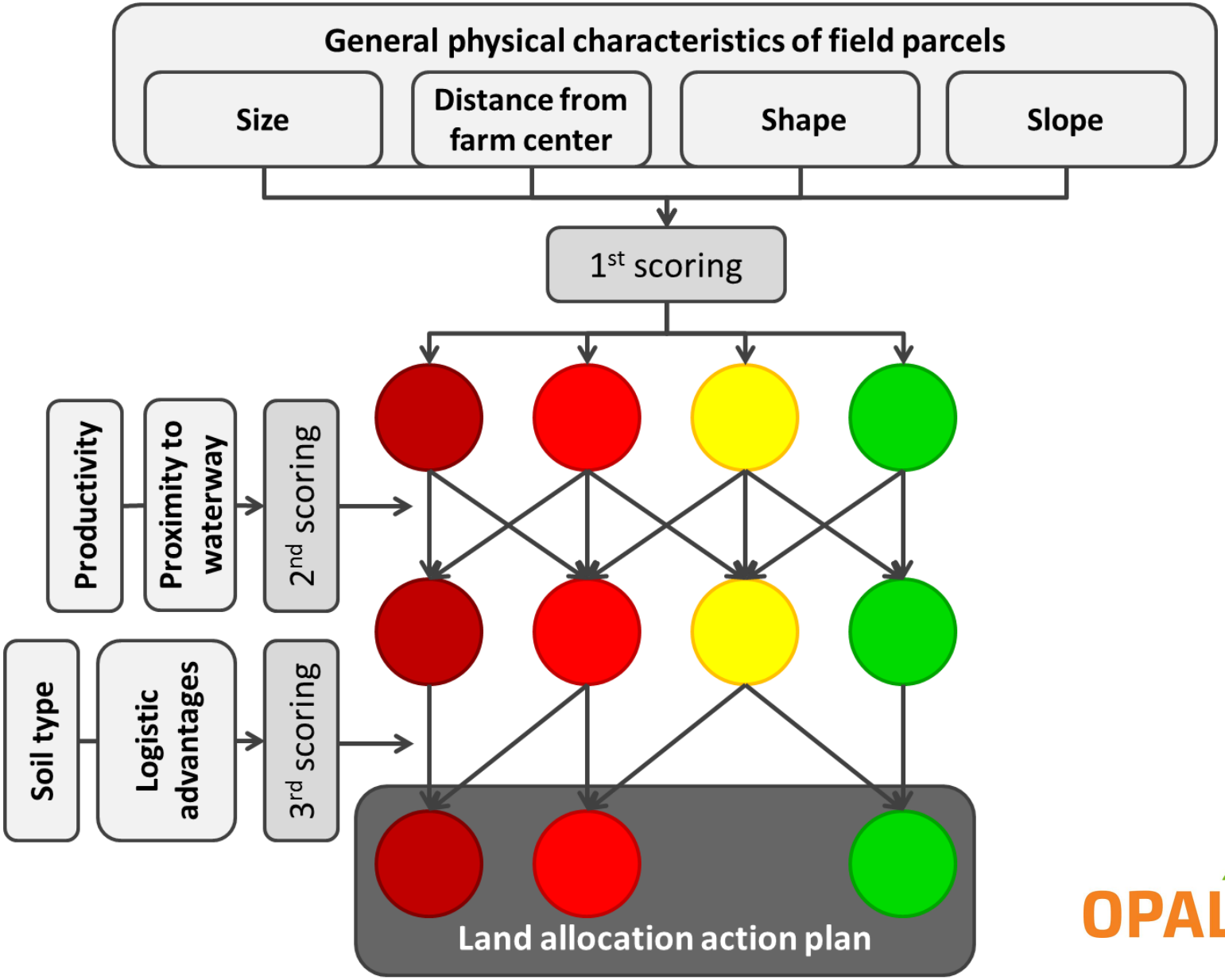
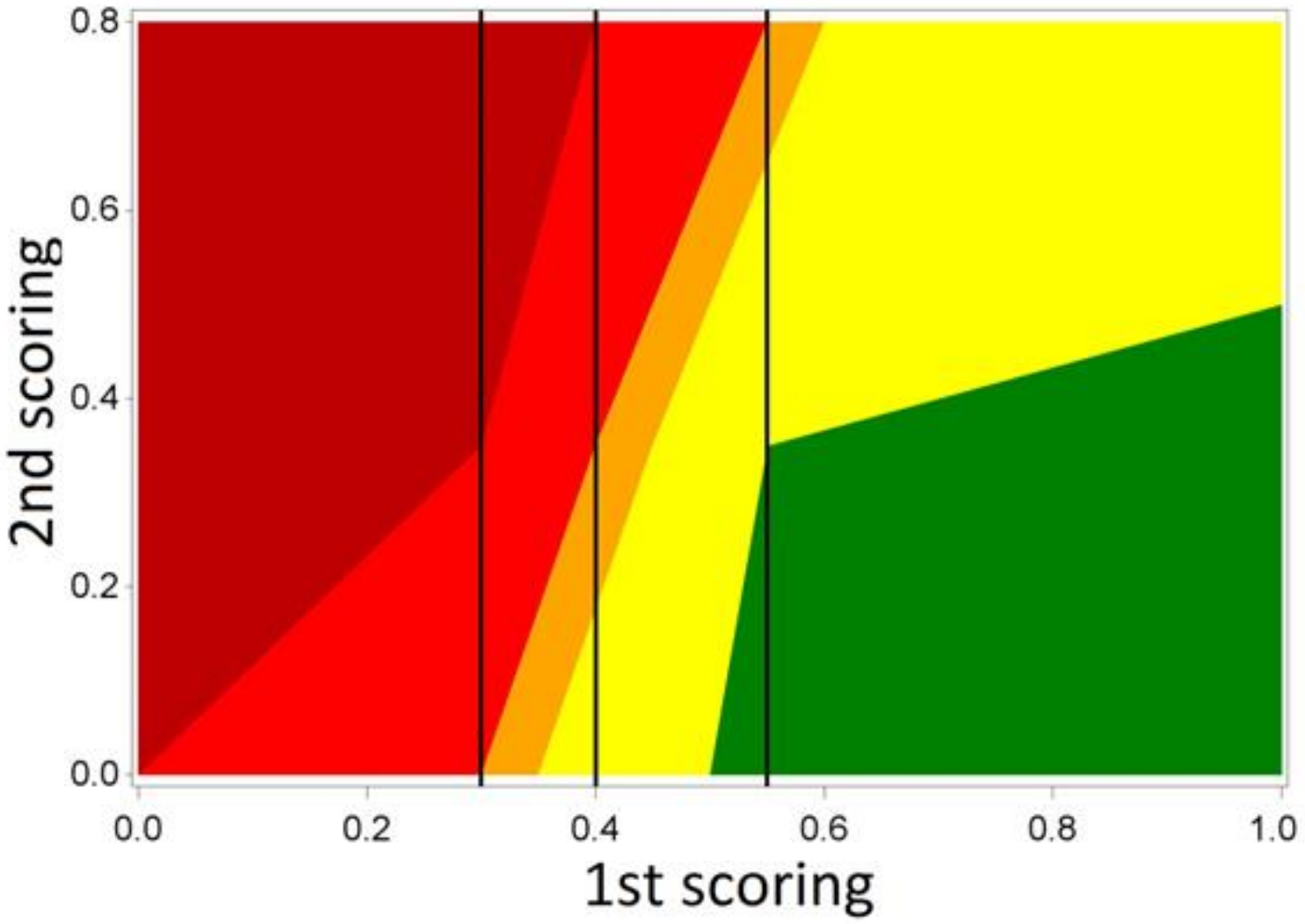
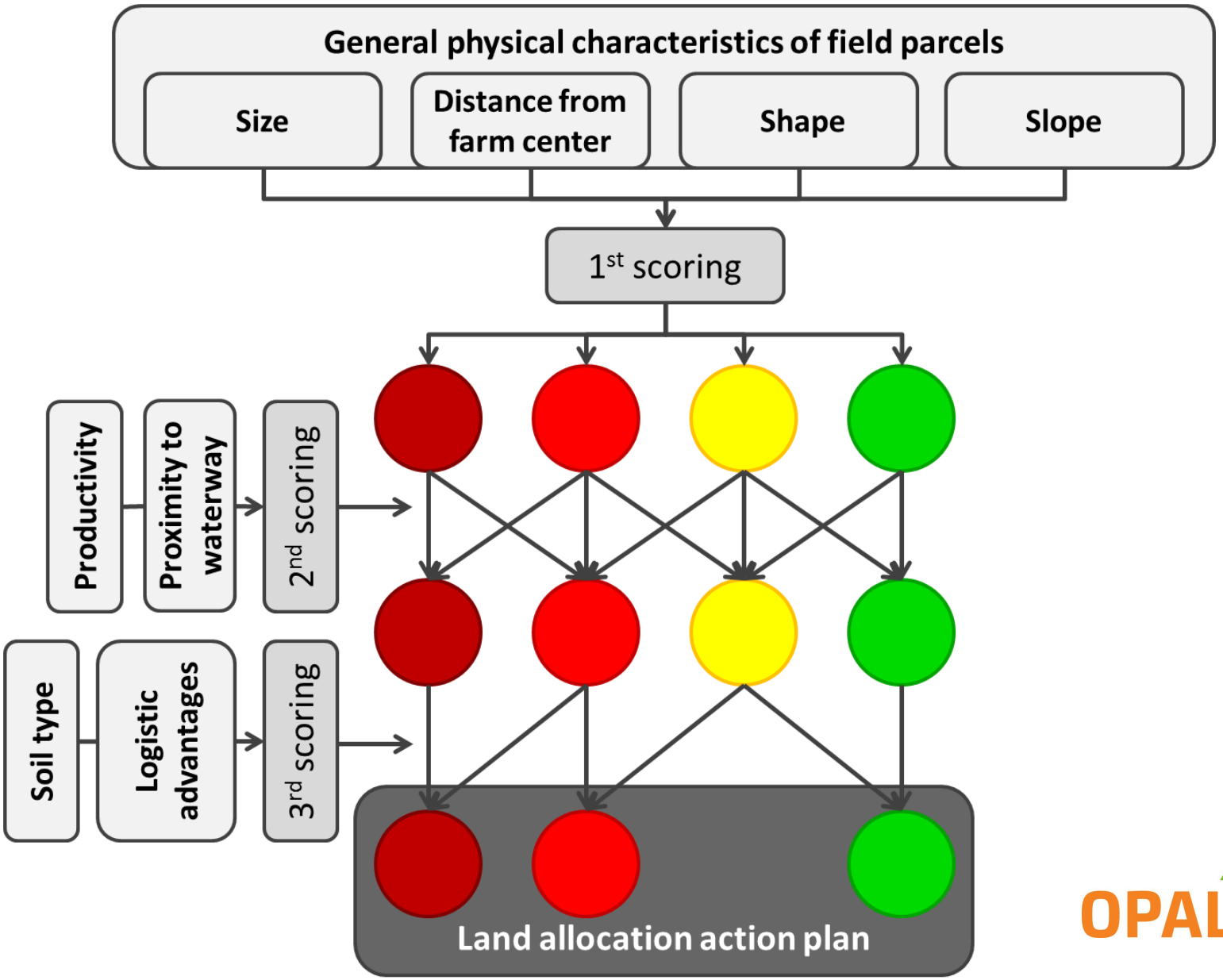


Land use optimization





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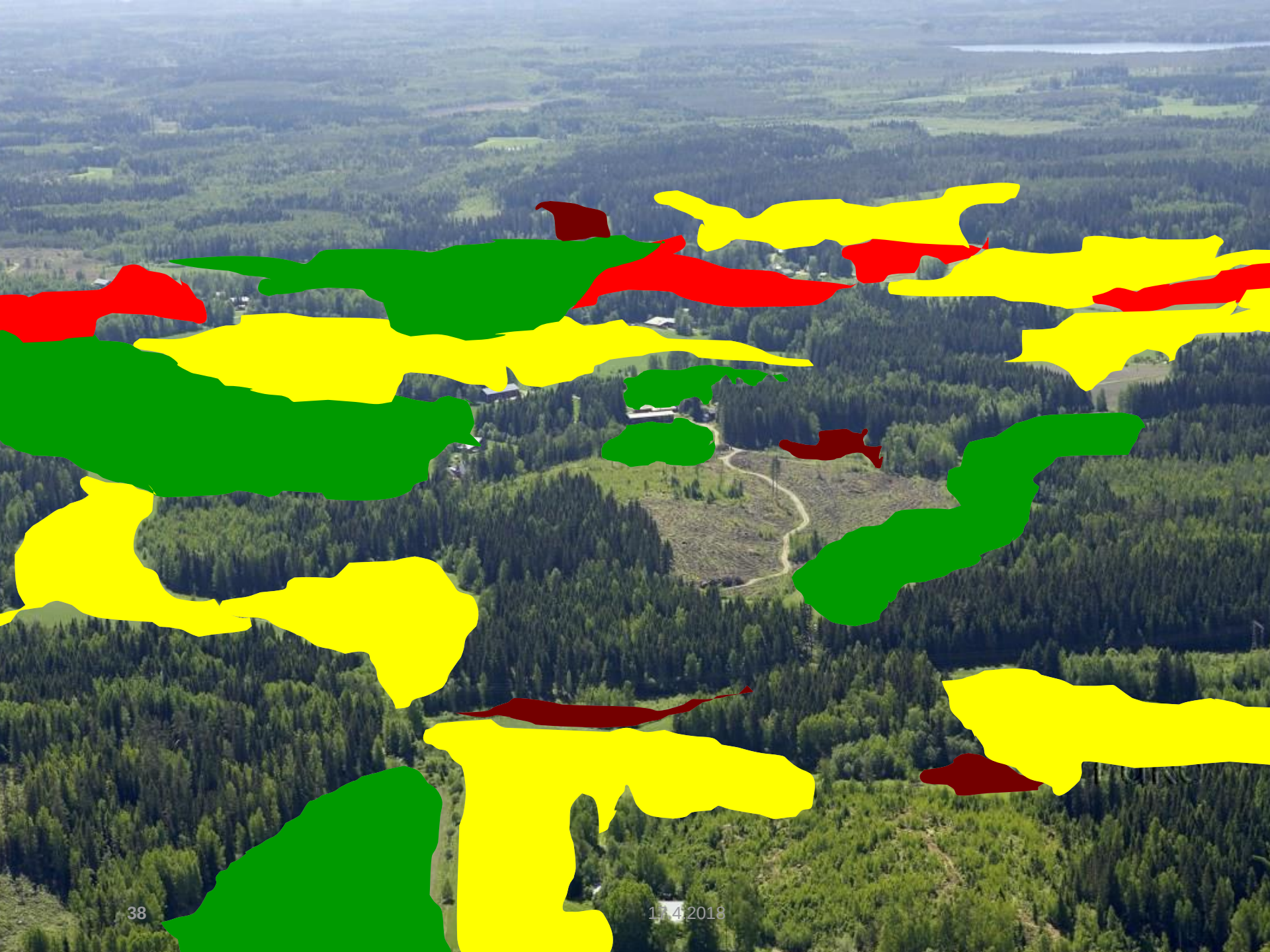
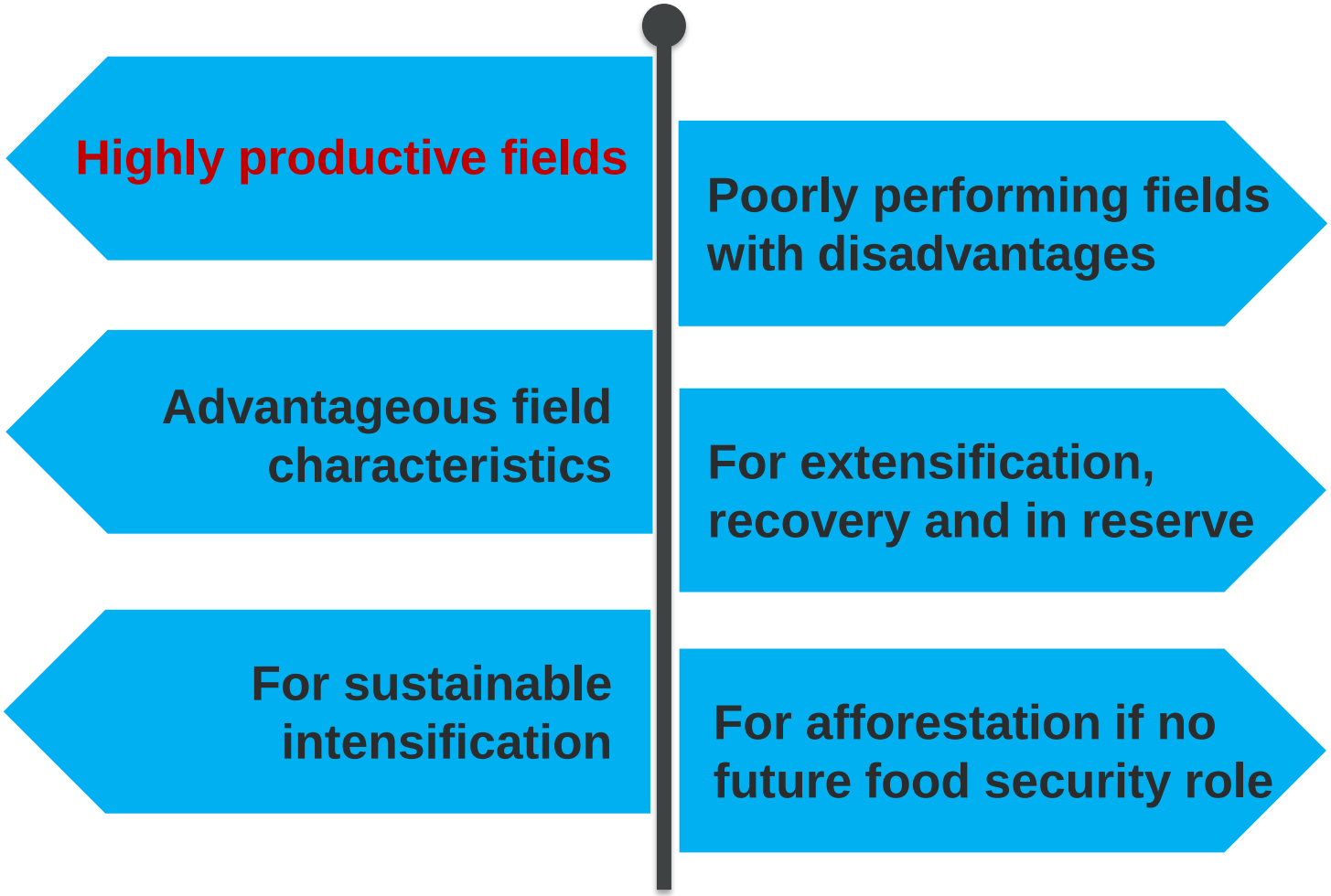


Land use optimization

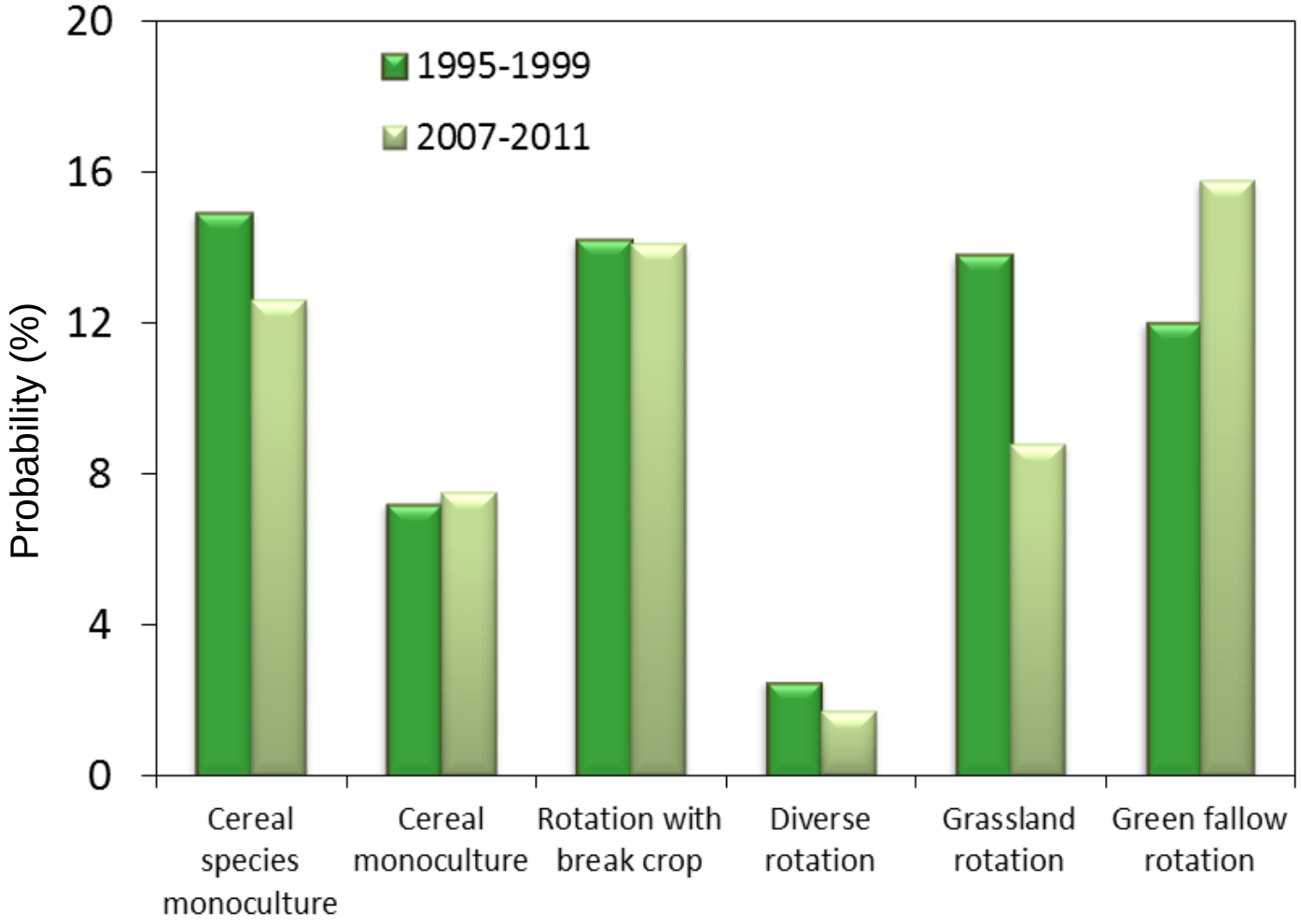


Land use optimization

Agricultural Systems 154 (2017) 25–33
Contents lists available at ScienceDirect
Agricultural Systems
journal homepage: www.elsevier.com/locate/agsy

Diversity of high-latitude agricultural landscapes and crop rotations: Increased, decreased or back and forth?

Pirjo Peltonen-Sainio *, Lauri Jauhiainen, Jaana Sorvali
Natural Resources Institute Finland (Luke), Management and Production of Renewable Resources Latokartanonkaari 9, FI-31600 Jokioinen, Finland



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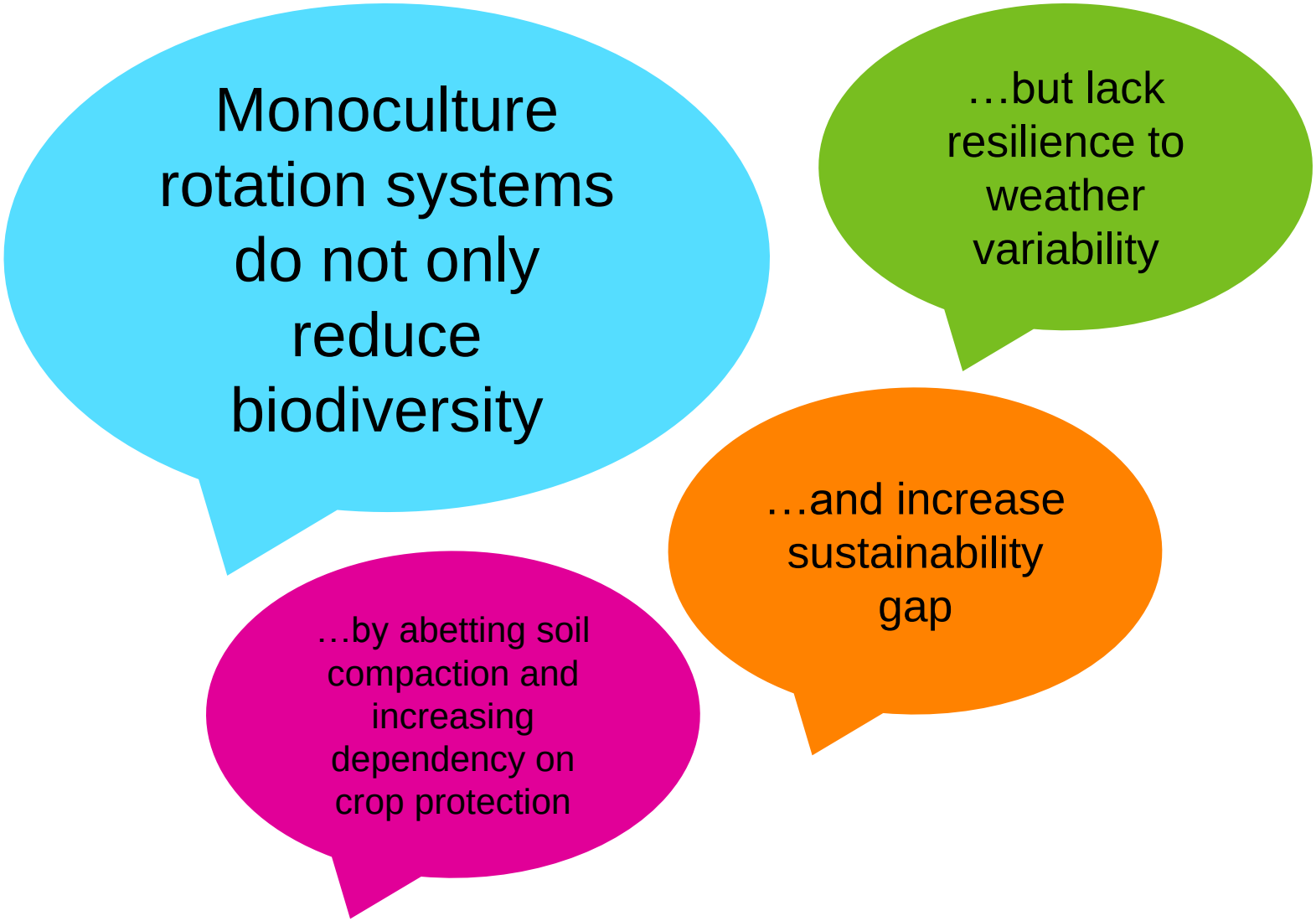


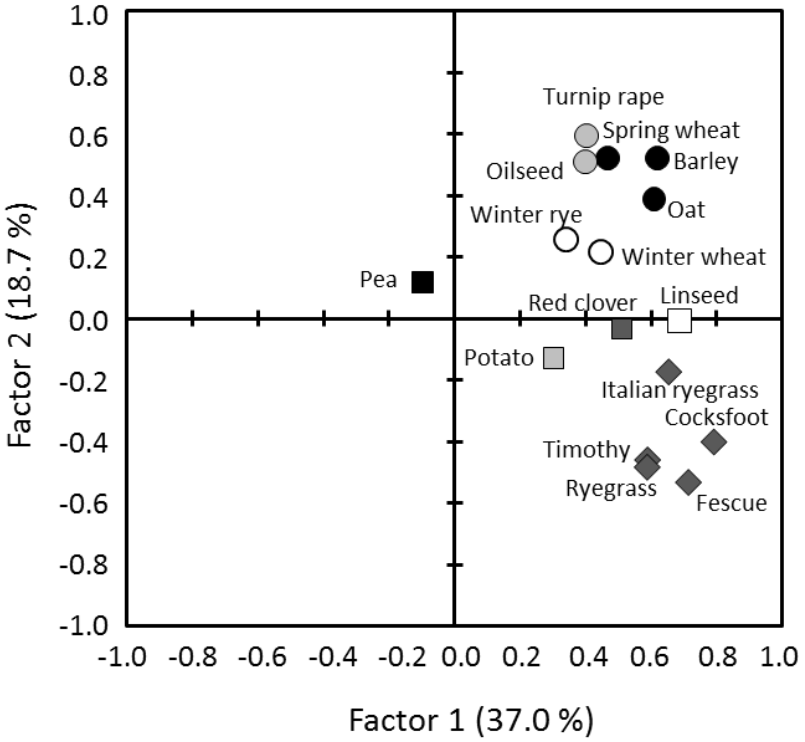
Resilience with diversity

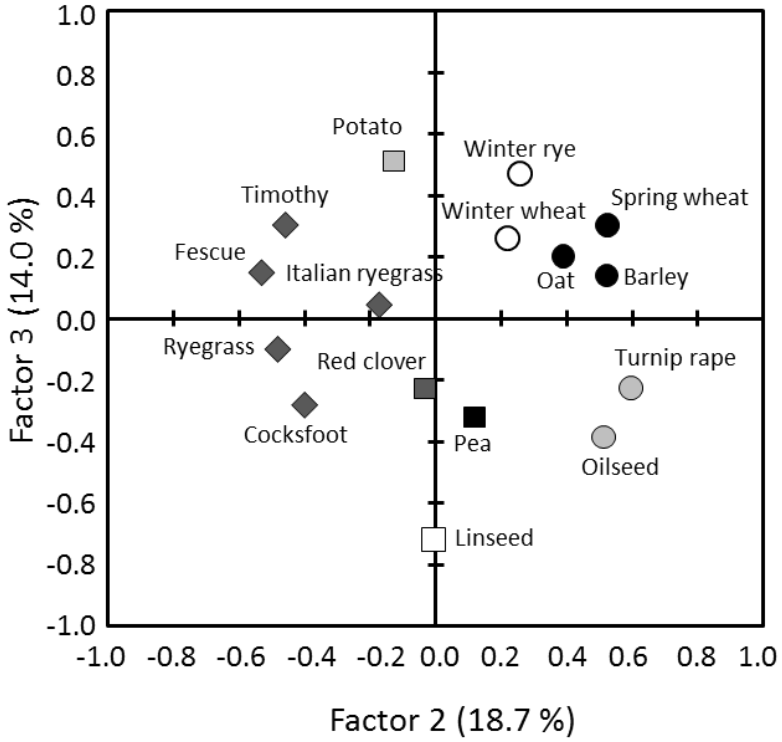
PLOS ONE

RESEARCH ARTICLE

Land Use, Yield and Quality Changes of Minor Field Crops: Is There Superseded Potential to Be Reinvented in Northern Europe?

Pirjo Peltonen-Sainio[1]*, Lauri Jauhiainen[1], Heikki Lehtonen[2]





The closer the crops are, more similarly they respond to constraints that cause variation in yield

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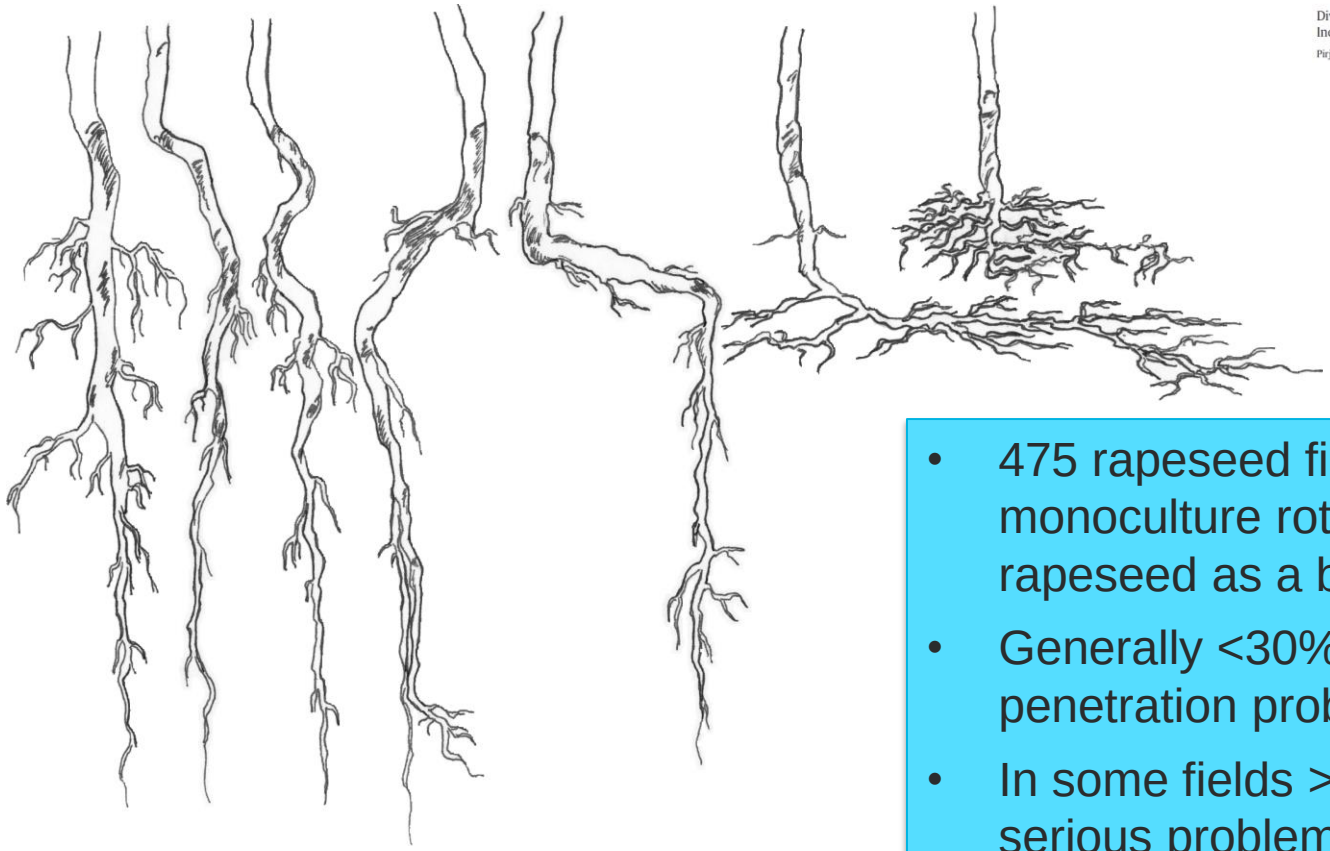
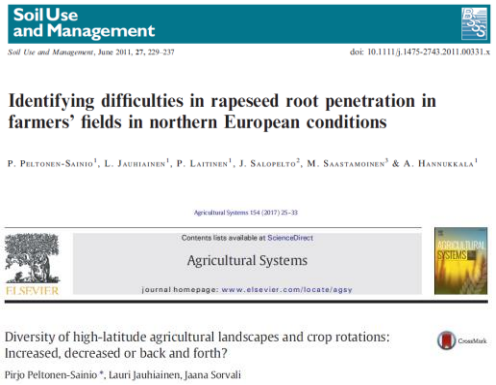
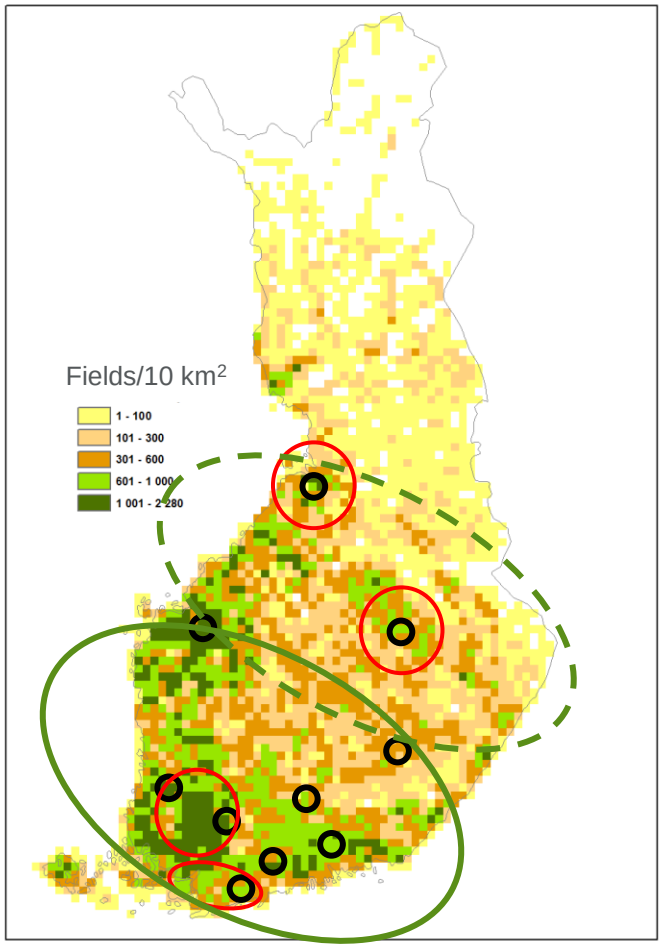
Soil compaction





- 475 rapeseed fields: cereal monoculture rotations with rapeseed as a break crop
- Generally <30% of serious root penetration problems
- In some fields >70% had very serious problems with root growth

Land use optimization



- 10 × 10 km study regions
- Primary study regions with 20 pilot farms
- Crop production region
- Dairy region

We have assessed so far ~500.000 parcels and their land use from 1995 till today

Implementation to whole Finland

In OPAL-Life

- Develop land use optimization tool
- Assess yield gaps at field, farm and regional scale
- Characterize primary reasons for underperforming fields
- Envisage changes needed for input allocation
- Assess biomass enhancement capacity for prime crop and greening areas
- Assess land use change impacts on GHG emissions, biodiversity, resource use efficiency and resilience
- Safeguard socio-economical feasibility of land use optimization

Thank you!

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