NuRa - Importance of Grass Production in North Savo in Relation to Climate Change

Panu Korhonen
Natural Resources Institute Finland (Luke)

INTERNATIONAL CHALLENGES OF DIGITALISATION AND EDUCATION
Theme session *AgriFuture*
Savonia University of Applied Sciences, Iisalmi
1 Dec 2016

The European Agricultural Fund for Rural Development: Europe investing in rural areas

Forage grasses and Finnish agriculture

- Cultivated field area in Finland is 1 969 000 ha (2015), of which forages cover ~33% (652 500 ha). More than 75% of this area is used for silage production.
- Milk and beef production account for ~50% of the agricultural gross return in Finland, and ~70% in North Savo region.
- More than 50% of livestock farm's total costs are from forage production - in dairy production silage is the largest single cost factor
  - Higher yield usually decreases forage production cost
  - Currently only 50% of yield potential is used (Virkajärvi et al. 2015)

Characteristics of forage production that are not included in most arable cropping systems

- Perenniality → requirement for overwintering
  - swards are usually cultivated for ~4 years
- Plants need to recover from repeated defoliation during one growing season (in North Savo grasslands are usually harvested for silage 2-3 times during growing season)
- Usually cultivated as species mixtures - species composition changes temporally
- Interaction between animals and vegetation is an important aspect of grasslands (nutrient recycling)
- Silage is not widely available on markets and it cannot be stored in large quantities to buffer storages → production must succeed regionally every year

Climate change in North Savo shortly

Precipitation and temperature increases clearly more during winter than during summer

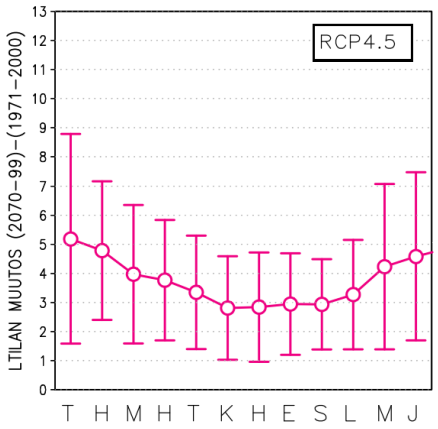
Thermic growing seasons will lengthen - mostly in the autumn (Ruosteenoja et al. 2011):

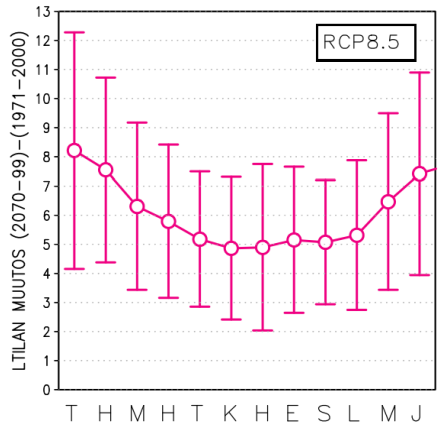
- High emission scenario: appr. +45 days in inland regions of Finland
- Low emission scenario: generally no more than +30 days

The effective temperature sum will increase ~1.4-fold (1971-2000 → 2040-2069) (Ruosteenoja et al. 2011)

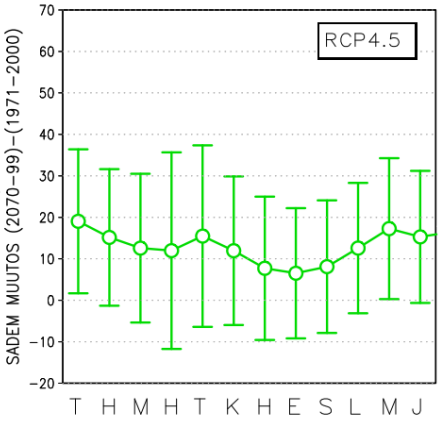
Predictions for change with low (left) and high (right) emission scenarios between periods 1971-2000 → 2070-2099

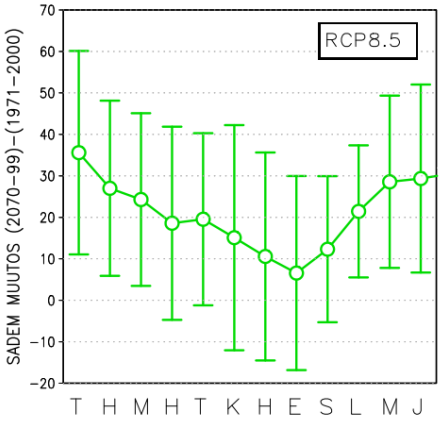
change in monthly temperature (°C)





change in monthly precipitation (%)





month

month

Figures: Ruosteenoja, SETUKLIM (ilmatieteenlaitos.fi/setuklim)

Luke NATURAL RESOURCES INSTITUTE FINLAND

Prolonged growing seasons

- **Thermic growing seasons have been predicted to lengthen** by 40-50 days in inland regions of Finland and by 50-90 days in coastal regions with high emission scenarios by the end of this century. With low emission scenarios the prolongation is generally no more than 1 month. (Ruosteenoja ym. 2011)
  - however, most of the lengthening will take place in autumn (especially in Southern Finland) when amount of solar radiation is lower
- The effective temperature sum during growing seasons is predicted to increase 2-fold in northern finland and 1.5-fold in southern finland
- Changes in harvest strategies
  - three cut system becoming more popular
  - harvests will take place earlier
  - time window for harvests will become smaller when temperatures increase

Effects of climate change on grassland production

R.P. Kipling et al. / Science of the Total Environment 566–567 (2016) 851–864

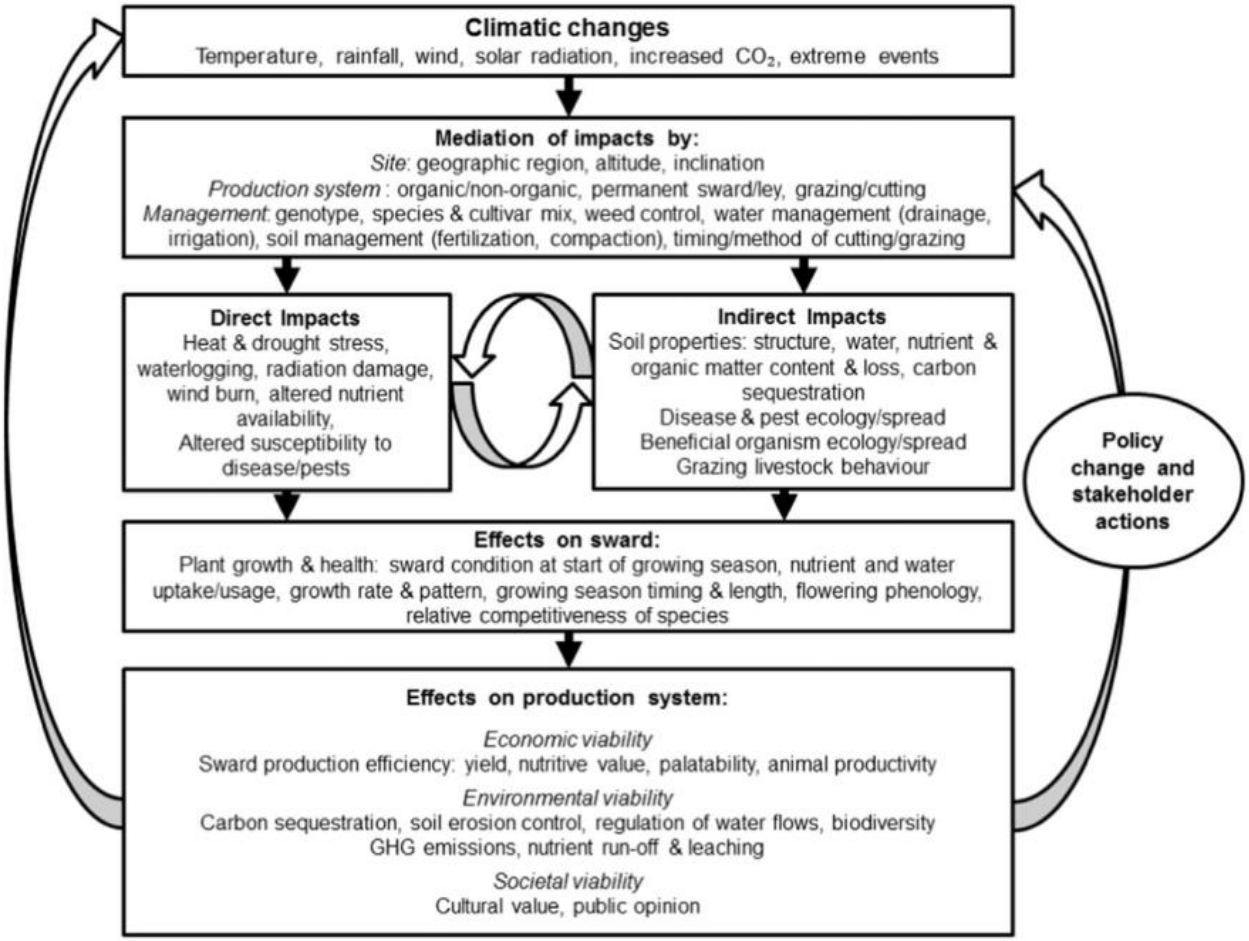


Fig. 1. Map of impacts of climate change on grassland systems, including feedbacks.

The European Agricultural Fund for Rural Development: Europe investing in rural areas

NuRa -project: 07/2015-12/2018

The project investigates the methods that have potential to maintain or improve the viability and competitiveness of forage production that is challenged by climate change and changing markets.

7 research themes

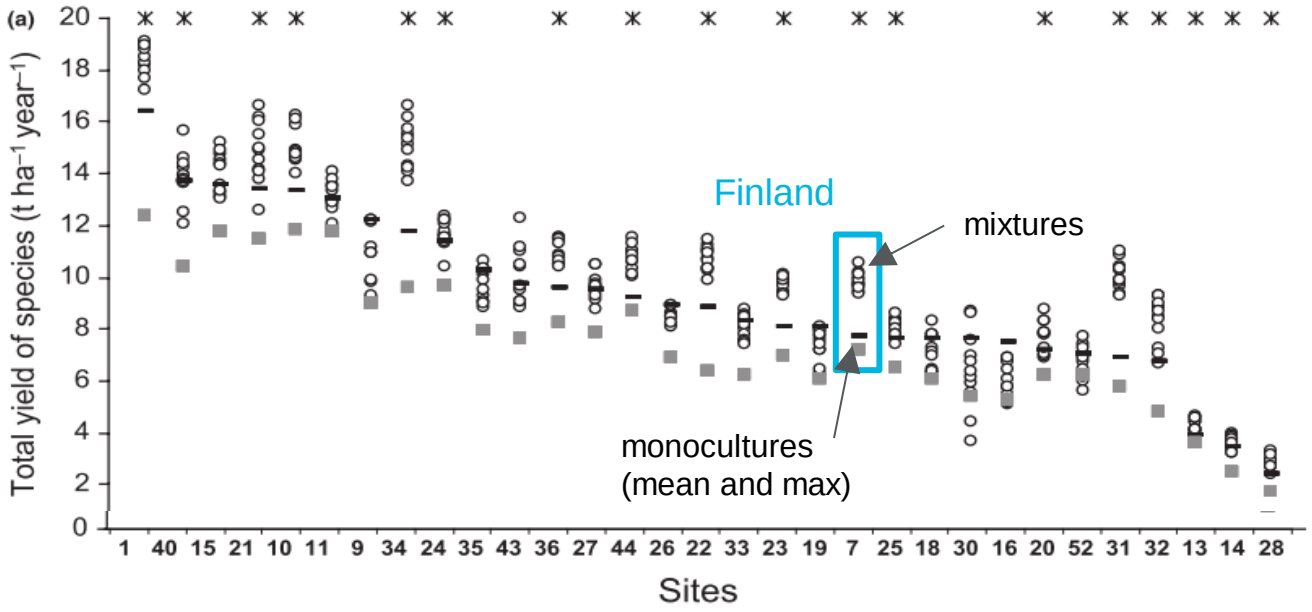
1. Harvesting strategies and milk production effect of regrowth
2. **Species- and cultivar mixtures**
3. **Oversowing**
4. Legumes as a source of protein
5. Cation-anion difference of silage
6. **Crop models for forage grass production**
7. **Feed logistics and farm scale models**

Theme 2:
Species- and cultivar mixtures

Why use mixtures?

Species- and cultivar mixtures can yield higher than what is expected based on monoculture yields (**overyielding**)

- Reasons for higher yields can be e.g. increased resource use efficiency, increased competition against weeds, positive effects between species
- also yield variation between cuts can decrease (Ergon et al. 2016)



Finn *et al.* 2013

Luke
NATURAL RESOURCES
INSTITUTE FINLAND

Theme 2:
Species- and cultivar mixtures

Timothy
(*Phleum pratense* L.)

Meadow fescue
(*Festuca pratensis* Huds.)

Forage grasses are usually cultivated as mixtures. Common mixture in North Savo region contains 70+% timothy and ~30% meadow fescue.

Other possible species:
tall fescue (*Festuca arundinacea* Schreb.)
perennial ryegrass (*Lolium perenne* L.)
festulolium (*Festuca* sp. x *Lolium* sp.)
red clover (*Trifolium pratense* L.)
(white clover, alsike clover, orchard grass, Italian ryegrass, alfalfa...)

Selection of optimal mixture in the future:
Species and cultivars can be grouped by their environmental responses into clusters which can be used to select mixtures with high response diversity.

Luke
NATURAL RESOURCES INSTITUTE FINLAND

Theme 2:
Species- and cultivar mixtures: field experiments

In NuRa we designed a field experiment to test how different species compositions in mixtures affect yield development

Experiments will be established in 2017 using two different harvest strategies:

- **2 cut system:** 5 different forage grass and legume mixtures (3-7 different species per mixture)
- **3 cut system:** 4 different forage grass species and cultivar mixtures (2-5 different species/cultivars per mixture)

Goal of the experiments is to quantify the effects of different mixtures on yield and its nutritive quality

In terms of climate change, we hope to give answers to how much we could improve resilience of production by using mixtures and what is the potential of mixtures for sustainable intensification of production

Theme 3:
Oversowing

Oversowing is a technique of sowing grass/forage legume seeds into existing sward

Usually used to increase the productive age of the sward

The economic viability of oversowing is not easy to determine because it is affected by changes in

- environmental conditions (spring temperatures, soil moisture etc.)
- patchiness and density of sward
- timing and method of oversowing

Theme 3:
Oversowing: field experiments

Field experiments were established to quantify the effects of oversowing on yield and nutritive quality on uneven patchy swards.

Climate change affects overwintering conditions → oversowing is one way to improve production security by making winter damages manageable

Empty patches were created using glyphosate

Luke
NATURAL RESOURCES INSTITUTE FINLAND

Theme 6:
Models for forage grass production

Climate change will affect grassland growth in multiple ways

- **Process based dynamic crop models** can be used to assess the effects of environmental changes as a part of the whole system
- In NuRa-project a crop model is modified to work in Finnish conditions for timothy and meadow fescue swards using new suitable data from field trials
- Developed model can be used to assess:
  - effects of environmental changes on grassland growth
  - optimal features of future cultivars
  - optimal timing of management practices (e.g. time of harvest)
- Crop model development is carried out as a part of international model developer network MACSUR (see macsur.eu)

Theme 6:
Models for forage grass production

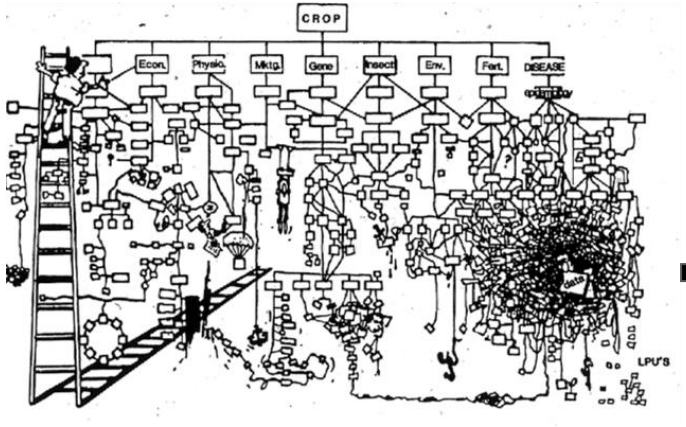
Weather

Crop parameters

Soil properties

Information on crop and soil management

Crop model



In NuRa-project we use timothy growth model called CATIMO modified to work in Finnish conditions

Biomass production

Field water balance

Nutrient dynamics

GHG emissions

Harvest dates

Nutritive value

Luke
NATURAL RESOURCES INSTITUTE FINLAND

Theme 6:
Models for forage grass production

Three cut system is becoming more common also in the northern regions of Finland as climate changes

- The development of yield and digestibility at the third harvest is not well understood
  - Empirical models will be updated and developed (e.g. Karpe-calculator) using the new field trial data
- The milk production potential with third harvest yield has been lower than what nutritive value suggests
  - Lypsikki-model for predicting milk production potential will be updated with the new third cut field trial data

Theme 7:
Feed logistics and farm scale models

Silage harvest chains and total logistics of the harvest are important for functionality of the harvest and for cost minimization

Model will be developed for simulation of in-farm logistics that will take into account:

- farm infrastructure
- machinery chains
- workload and work cost
- different forage species
- etc.

With the model unnecessary traffic within the farm can be assessed and hopefully reduces → positive effect on climate change mitigation

Discussion

The NuRa-project aims to

- improve our knowledge on some of the most important (practical) questions related to climate change adaptation and mitigation of grassland production by acquiring information from field trials and modelling
- improve forage related climate change research communication between partner organisations and between partner organisations and stake holders (farmers, policy makers etc.)

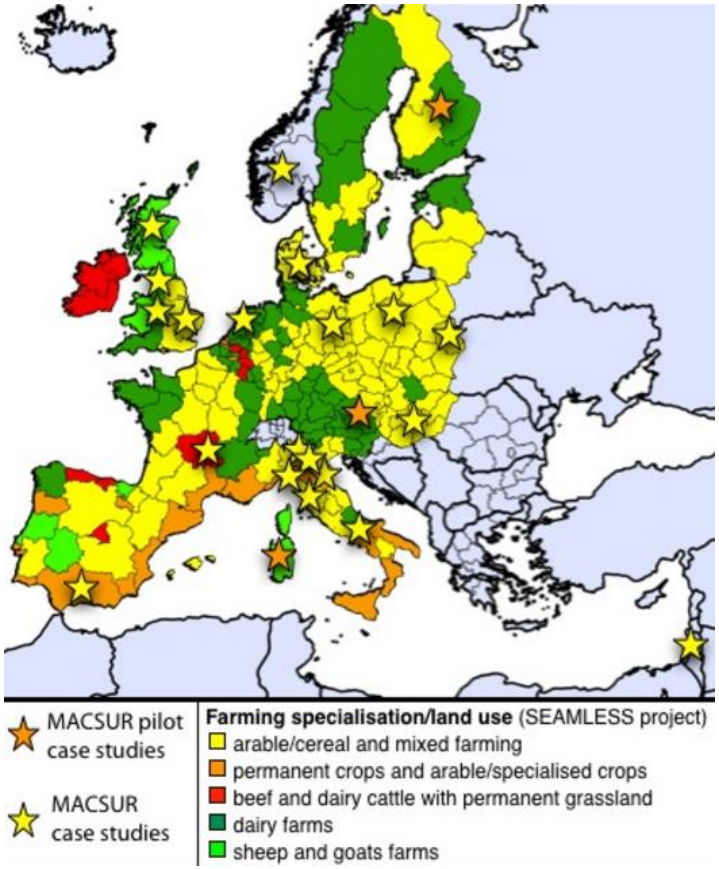
North Savo as a pilot region in other European climate change related projects

MACSUR **(Modelling European Agriculture with Climate Change for Food Security)** **-knowledge hub:** North Savo one of the three European pilot regions. Adaptation and mitigation capacity of farms to climate change is assessed using models.

- Lisätietoja http://macsur.eu/index.php/regional/regional-case-studies/northern-savo

SUSTAg-project: focused on sustainable intensification of agriculture (food production and biogas production). North Savo is one of the three pilot regions and represents a production system "biogas production from manure and non-food crops"

- Lisätietoja http://faccesurplus.org/research-projects/sustag/



Luke NATURAL RESOURCES INSTITUTE FINLAND

Thank you!

Read more about NuRa at
luke.fi/nurmetrahaksi
(in Finnish)

Luke
NATURAL RESOURCES
INSTITUTE FINLAND


Luke
NATURAL RESOURCES
INSTITUTE FINLAND