# Problems and opportunities of climate change adaptation in North Savo region

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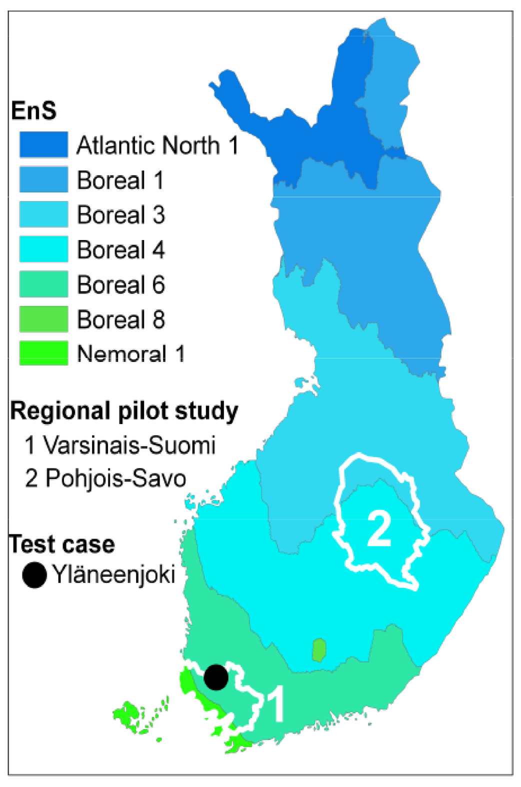
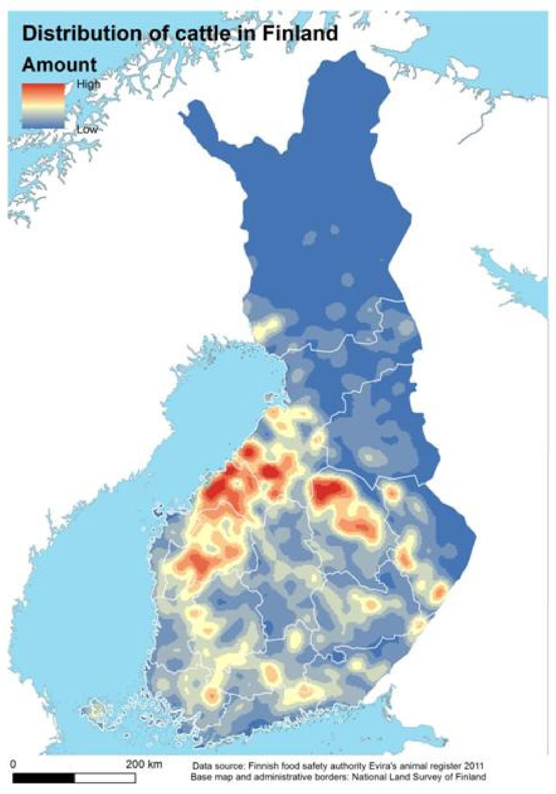
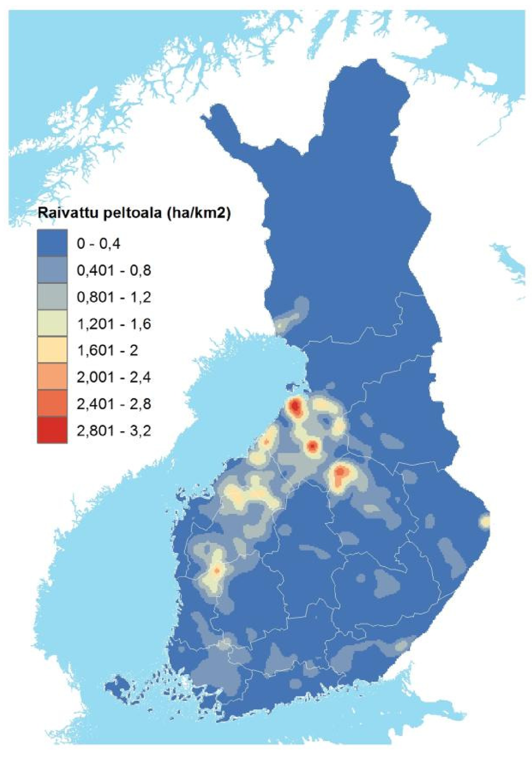



**Relative cattle density in Finland (ha/km2)**




**New farmland area (ha/km2), cleared after 1995. Source: MTT soil database**

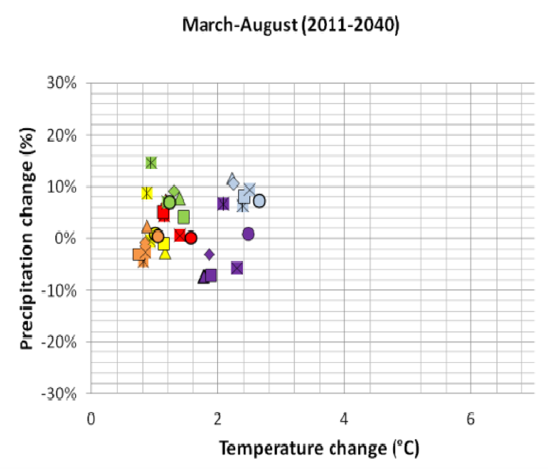
New farmland (ha/km2), and cattle density are correlated. This development is, according to studies conducted in MTT using farm and sector level models, as well as stakeholder dialogues, due to

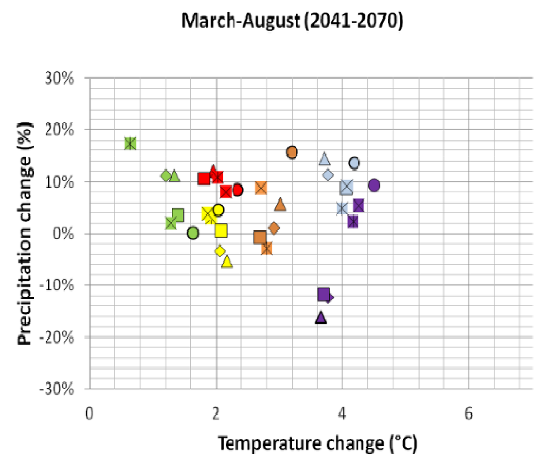
(1) Increasing share of farm subsidies paid per ha of farmland, leading high land rents and prices
(2) Stringent conditions set for environmental permits of new livestock investments as well as phosphorous fertilisation limits in Finnish agri-environmental programme; => increased need for manure spreading area per farm
(3) Expectations of relatively high future cereals and feed prices , already experienced in recent years

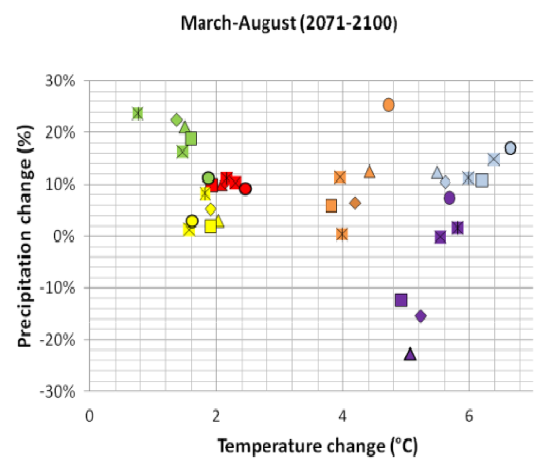
Mitigating land clearance requires more flexible and specific land renting schemes, and more specific contracting and cooperation practices on farmland management, incl .crop rotation and soil improvement arrangements.

**Right: Changes in temperature and precipitation** for time periods 2011-2040, 2041-2070 and 2071-2100 compared with 1971–2000 for six representative locations relevant for agricultural production in Finland (see Fig.). Six GCMs (CCCMA CGCM 3 1, CSIRO MK 3 5, GISS MODEL E R, IPSL CM4, MIROC 3 2 MEDRES and BCCR BCM 2 0) are presented.

***Source: Rötter et al. in prep***




### Median changes in selected agro-climatic indicators relative to 1971-2000

GISS-ER/B1

| | 2011-2040 | 2041-2070 | 2071-2100 |
|---|---|---|---|
| Sowing date change (nr of days) | -3 | -3 | -4 |
| Proportion of suitable sowing days | 12 | 12 | 16 |
| Date of the last spring frost (days) | -6 | -5 | -7 |
| Effective radiation change (%) | 13 | 9 | 14 |
| Effective growing days (change in days) | 20 | 26 | 41 |
| Rain 3-7 weeks after sowing, change, mm | 1,8 | 1,4 | 10,8 |
| Proportion of dry days in AMJ, change (%) | 0 | 1 | -4 |
| Proportion of dry days in JJA, change (%) | -6 | -4 | -14 |
| Extreme high temp stress, change (days) | 1 | 1 | 1 |
| Temperature sum accumulation during grain filling, change, C | 1,4 | 1,5 | 1 |

IPSL-CM4/A2

| | 2011-2040 | 2041-2070 | 2071-2100 |
|---|---|---|---|
| Sowing date change (nr of days) | -9 | -15 | -17 |
| Proportion of suitable sowing days | 20 | 28 | 32 |
| Date of the last spring frost (days) | -18 | -24 | -24 |
| Effective radiation change (%) | 5 | -3 | -13 |
| Effective growing days (change in days) | 7 | 31 | 52 |
| Rain 3-7 weeks after sowing, change, mm | -6,4 | -9,5 | -12,3 |
| Proportion of dry days in AMJ, change (%) | 2 | 19 | 21 |
| Proportion of dry days in JJA, change (%) | 2 | 13 | 17 |
| Extreme high temp stress, change (days) | 1 | 4 | 6 |
| Temperature sum accumulation during grain filling, change, C | 2,3 | 3,7 | 5,4 |

**(Right)** *Source:* R. P. Rötter , J. G. Höhn & S. Fronzek (2012) Projections of climate change impacts on crop production: A global and a Nordic perspective, Acta Agriculturae Scandinavica, Section A – Animal Science, 62:4, 166-180, DOI: 10.1080/09064702.2013.793735

### Median dates of start of growing and hardening periods, days with simulated snow cover depth > 10 cm Climate scenario A1B, compared to 1971-2000

| | Growing period, start | Growing period, start | Hardenin period, start | Hardenin period, start | Snow days, > 10 cm | Snow days, > 10cm |
|---|---|---|---|---|---|---|
| | Baseline | Ensemble | Baseline | Ensemble | Baseline | Ensemble |
| Kuopio, Pohjois-Savo | May 6 | April 27 | Oct 13 | Oct 27 | 159 | 78 |
| Jokioinen, South-West Finland | May 8 | April 28 | Oct 15 | Oct 31 | 142 | 46 |
| St. Petersburg region, Russia | May 1 | April 16 | Oct 24 | Nov 9 | 131 | 45 |

*Source*: Höglind, M., Thorsen S. M., and Semenov M. A. 2013. Assessing uncertainties in impact of climate change on grass production in Northern Europe using ensembles of global climate models. *Agricultural and Forest Meteorology* 170: 103–113.

### Managing grassland yield variation at the farm level – Cost of drought risk approach

In farms decision making, grass area is usually determined by the variation of yield. To be adequate in every situation, the lowest expected yield level determines the cultivated area. Other way to manage the grass yield risk is to increase silage storage capacity over annual consumption. Variation of grass yield in climate data from years 1961-1990 was compared with 15 different climate scenario models simulating years 2046-2065. A model was developed for evaluating the silage inadequacy risk in terms of cultivated area and storing capacity

| | Baseline | | | Average of all GCM-scenarios | | |
|---|---|---|---|---|---|---|
| | Jokioinen | St. Petersburg | Kuopio, North Savo | Jokioinen | St. Petersburg | **Kuopio, North Savo** |
| Average number of years with grass yield deficit | 16 | 10 | **6** | 8.7 | 2.9 | **3.33** |
| Average yield (ton of DM/ ha) | 8.61 | 10.05 | **9.74** | 9.33 | 11.10 | **12.96** |
| Average standard deviation of yield | 0.25 | 0.18 | **0.189** | 0.24 | 0.19 | **0.2** |
| Average harvest cost, €/ton dm | 52.33 | 49,28 | **49.79** | 52.06 | 49.19 | **49.28** |
| Average harvest and extra concentrate cost, €/ton dm | 58.44 | 51.43 | **53.96** | 55.67 | 50.35 | **52.24** |

Results suggest slowly increasing grassland yields. However there are specific concerns on winter damages and feed quality losses, as well as soil compaction concerns related to heavy axle loads and wet conditions, that need further analysis.

*Source*: Kässi, P. Känkänen, H. & Niskanen, O. 2014.Farm level approach to manage grass yield variation in changing climate in Jokioinen, Kuopio and St. Petersburg. Manuscript, MTT / Economics 2014. Based on GCM Ensemble data derived by Höglind et. al. 2013.

**Adaptation challenges:**

**Overwintering problems** , warmer winters
-Ice encasement and frost damage
-Weakening winter hardiness of grasslands
-Certain types of fungis and other plant diseases, capable of surviving over winter

**Digestability of grass feed** (+/-)
- lignin, cellulosic fibres, dependent on grass cultivars and weather conditions

**Threat of decreased water limited yields** in high end climate scenarios
-Especially harmful for seed crops in the context of high early summer radiation and short yield-determination period

**Crop and animal diseases**
-Plants pests (fungis) favoured by increasing temperatures during growing season, especially in humid conditions
- Insect driven plant productivity decline; invasion of new type of insects, carried by winds from south-east

**Soil compaction**
-due to heavy axle loads at grassland harvest, especially under wet conditions
-Soil compaction expensive to be fixed, especially of compacted bottom soil
-Leads to decreased yields, increased nutrient leaching, and more severe floods, droughts and winter time damages

**Possibilities:**
Crop / cultivar options increase due to increasing temperature sum and length of the growing season
- More feasible options for production and farm management

Crop breeding targets change
- Cultivars better adapted to droughts, more robust to pests and diseases
-Breeding benefits farmers, but also other parts of the food chain
-New grassland species and cultivars, more resistant to heat stress and drought
-Better nutritive value
-Sufficient winter hardiness

Harvesting methods and harvesting strategy change due to increased frequency of droughts and floods

Fertilisation - Crop yield - Nutrient leaching
-Split fertilisation during the growing period improves nitrogen use efficiency and nutrient balances

-Increased plant protection may be in synergy with split fertilisation – use according to the needs

Three cuts of silage grass per year
-Earlier cuts
-Higher mean yields may result in cost savings in feed and manure logistics

**Outcomes:**
Increased liming and drainage investments

Successful adaptation dependent on prices and policies

Good adaptation practices may provide reduced costs and other benefits, exceeding extra work and costs to avoid problems
- example: costs due to droughts, floods and winter time damages for grassland could be mitigated by improved soil structure and grass cultivars of improved feed quality

Changed average (all costs/ quantity produced) and marginal costs (cost of additional 1 unit produced) of production
-Changed marginal costs affects:
(1) Quantity produced;
(2) Use of inputs in production
(3) Regional prices on competitive markets – depending on the supply-demand situation and

After successful adaptation, increased productivity results in decreased prices on competitive markets, depending on competition

Changed competitive advantage between the regions

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