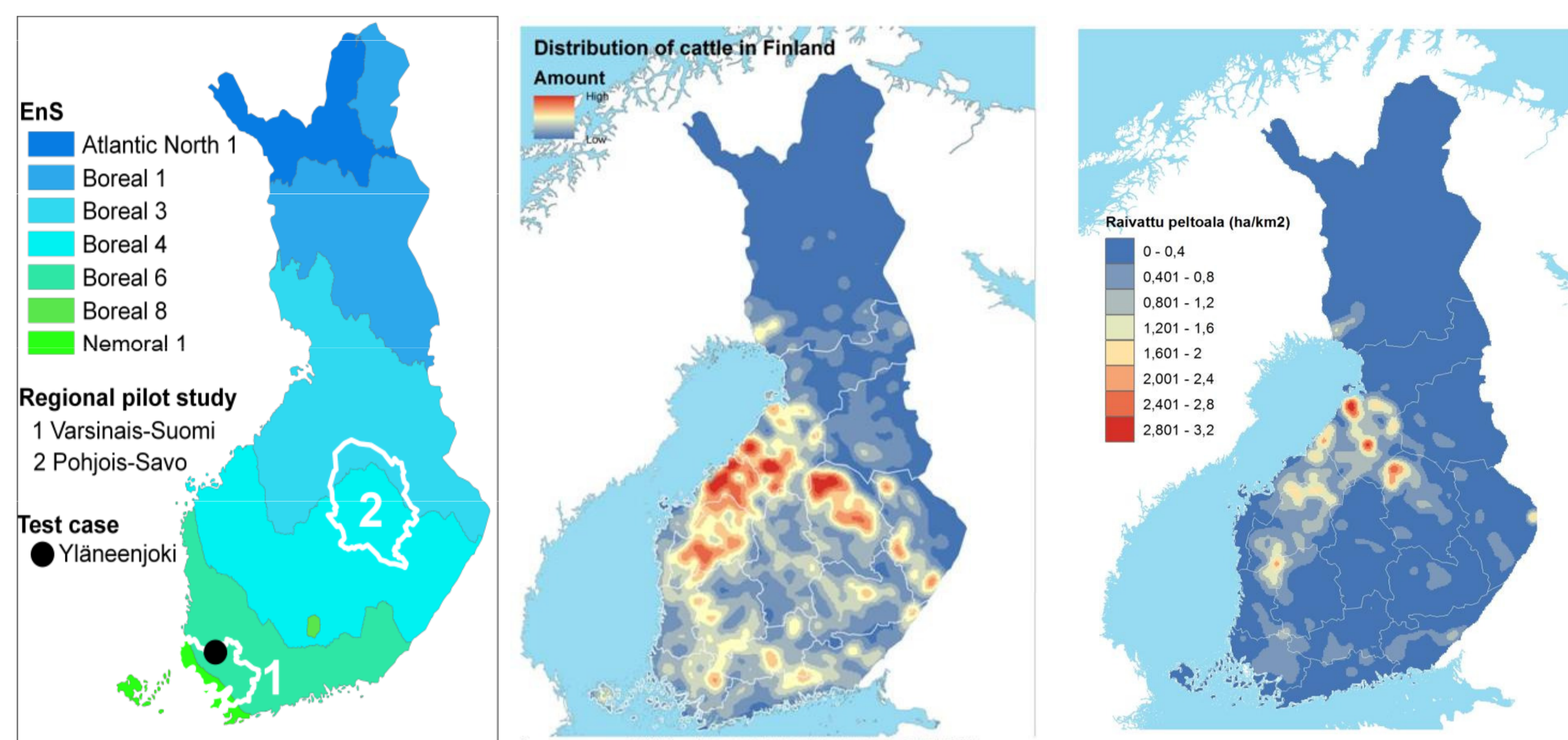


Problems and opportunities of climate change adaptation in North Savo region



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.

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		Hardening period, start		Snow days, > 10 cm	
	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: Kässä, 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.

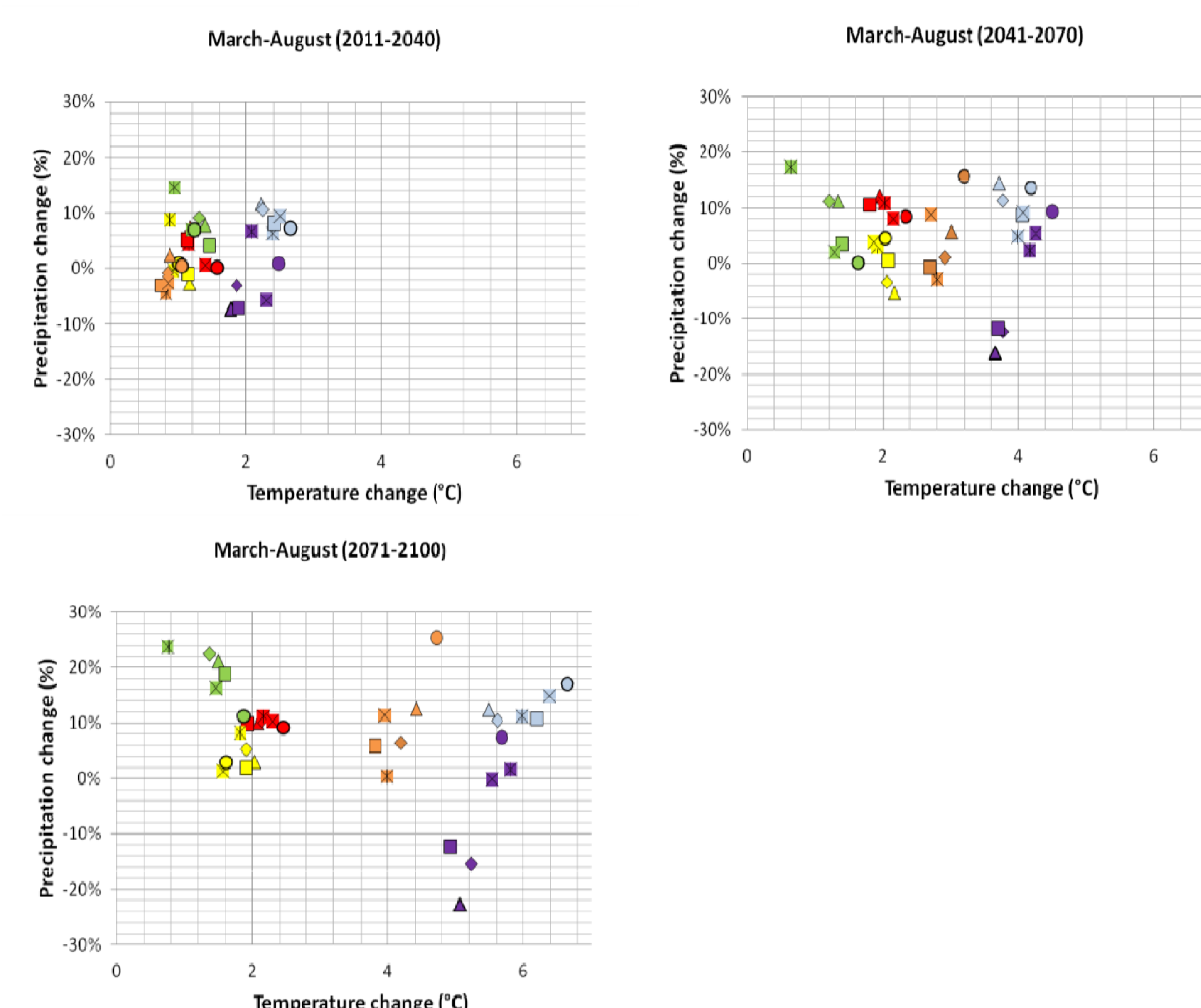
(Right) Source: R. P. Rötter, J. G. Höhn & S. Fronzek (2012) Projections of climate change impacts on crop production: A global and a Nordic perspective, *Acta Agriculturae Scandinavica, Section A – Animal Science*, 62:4, 166-180, DOI: 10.1080/09064702.2013.793735

Heikki Lehtonen^{a)}, Taru Palosuo^{b)}, Reimund Rötter^{c)}, Pellervo Kässä^{a)}, Olli Niskanen^{a)}, Panu Korhonen^{d)}, Perttu Virkajärvi^{d)}, Xing Liu^{a)}, Tuomo Puroola^{a)}

- MTT Agrifood Research Finland / Economic Research, Latokartanonkaari 9, FI-00790 Helsinki, Finland
- MTT Agrifood Research, Plant Production Research, Latokartanonkaari 9, 00790 Helsinki, Finland
- MTT Agrifood Research, Plant Production Research, Lönnrotinkatu 5, 50100 Mikkeli, Finland
- MTT Agrifood Research Finland, Animal Production Research, Halolantie 31a FI-71750 Maaninka, Finland

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

Indicator	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

Indicator	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

Adaptation challenges:

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

Digestibility 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 (fungus) 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