Modelling European Agriculture with Climate Change for Food Security

WIFO ÖSTERREICHISCHES INSTITUT FÜR WIRTSCHAFTSFORSCHUNG AUSTRIAN INSTITUTE OF ECONOMIC RESEARCH

Regional Pilot Case Study Mostviertel - AT

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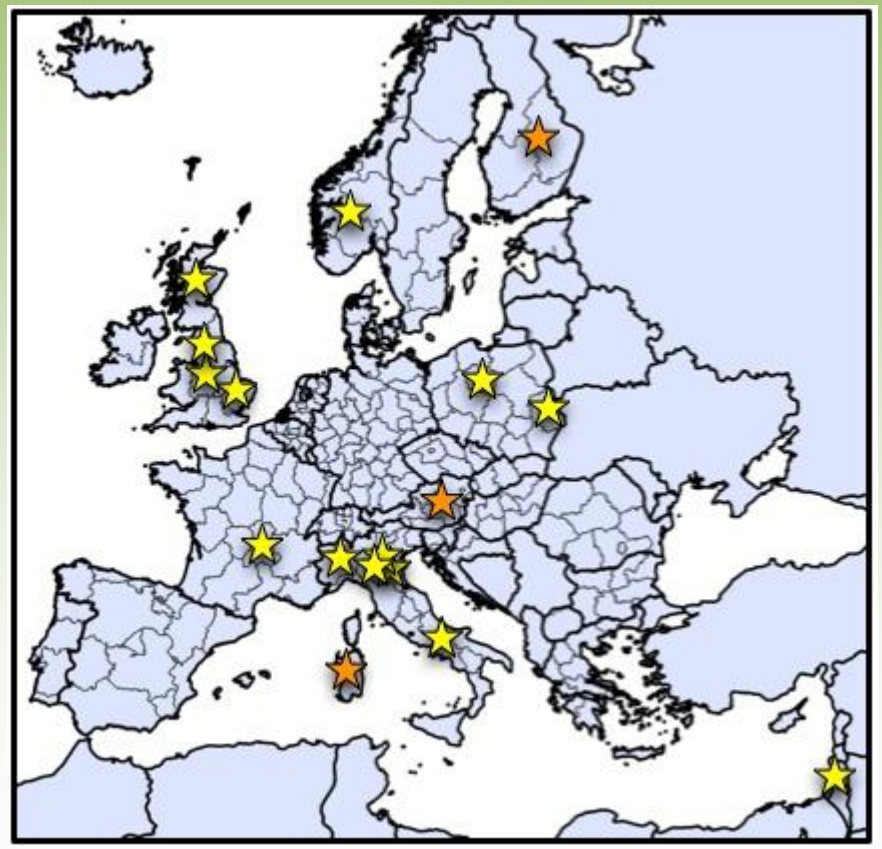
FACCE MACSUR Conference, Sassari

1st April 2014

Mostviertel region



One of three MACSUR
Pilot Case Study Regions

Two landscapes, 1,500 ha each
231 farms

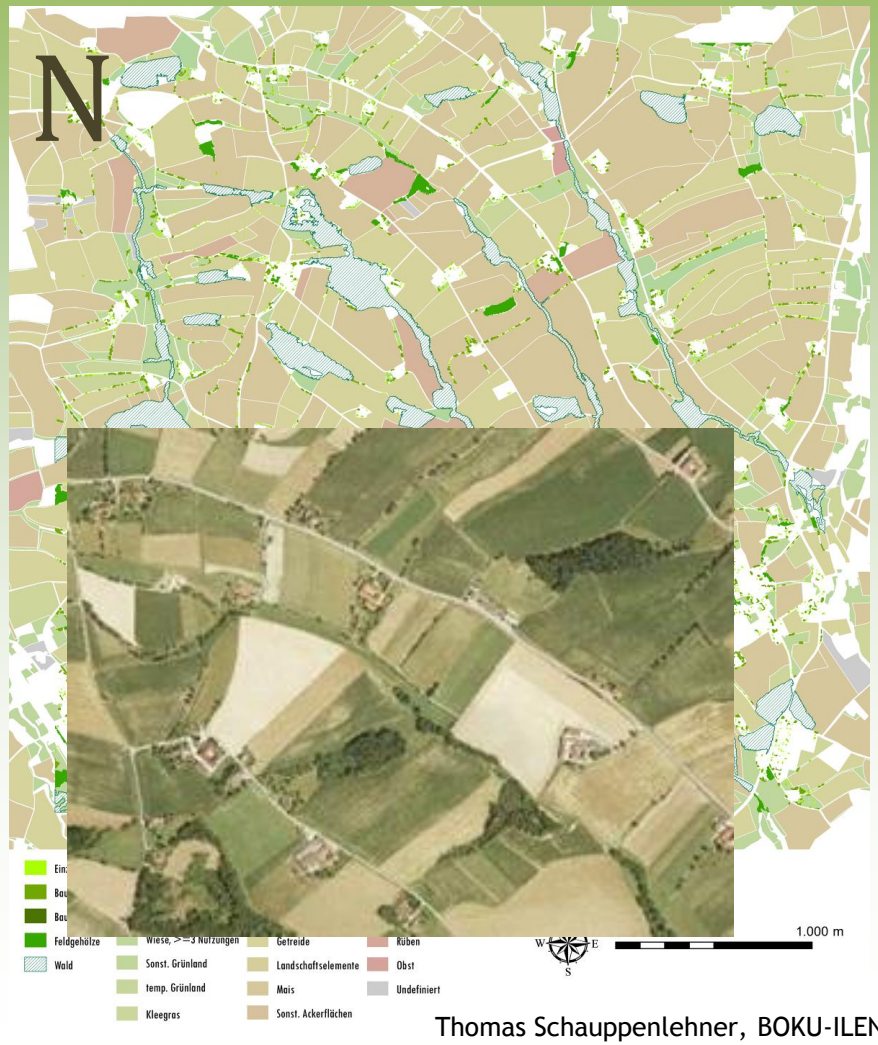
www.macsur.eu/index.php/regional-case-studies/

Landscape

Mostviertel
geological transition zone
between flat land (Danube valley, N)
and alpine region (Nördliche Kalkalpen, S)


-70%

Land use - Overview

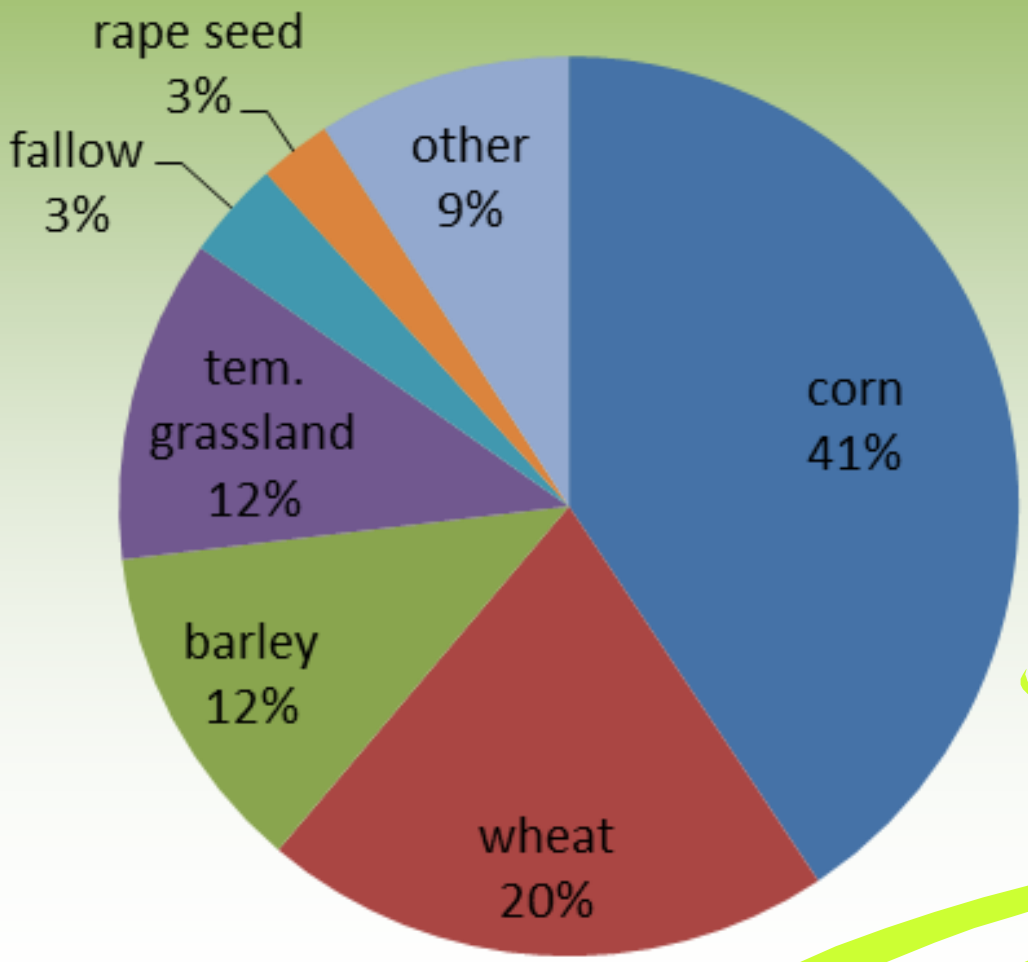


Thomas Schauppenlehner, BOKU-ILEN

Land & Livestock

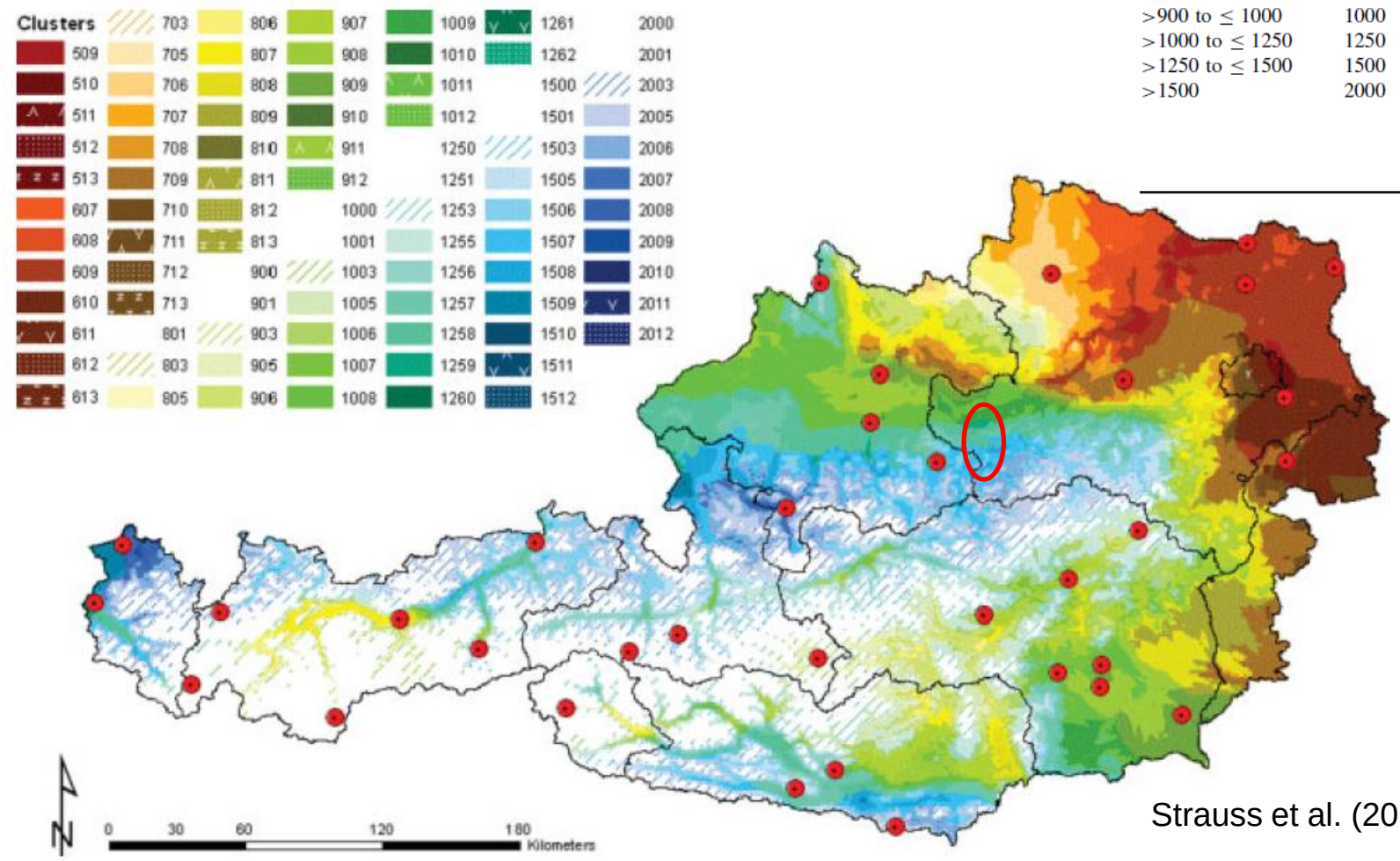
	min	Ø	Max	Number of farms
Farm area (ha)	**1**	**23**	**100**	**231**
Permanent grassland (ha)	1	11	81	224
Cropland (ha)	1	18	67	161
Cows (dairy & suckler, #)	1	38	268	162
Swine (fattening, #)	1	203	2,152	123
Laying hens (#)	1	134	4,990	74

Cropland use



Observed regional climate in Austria

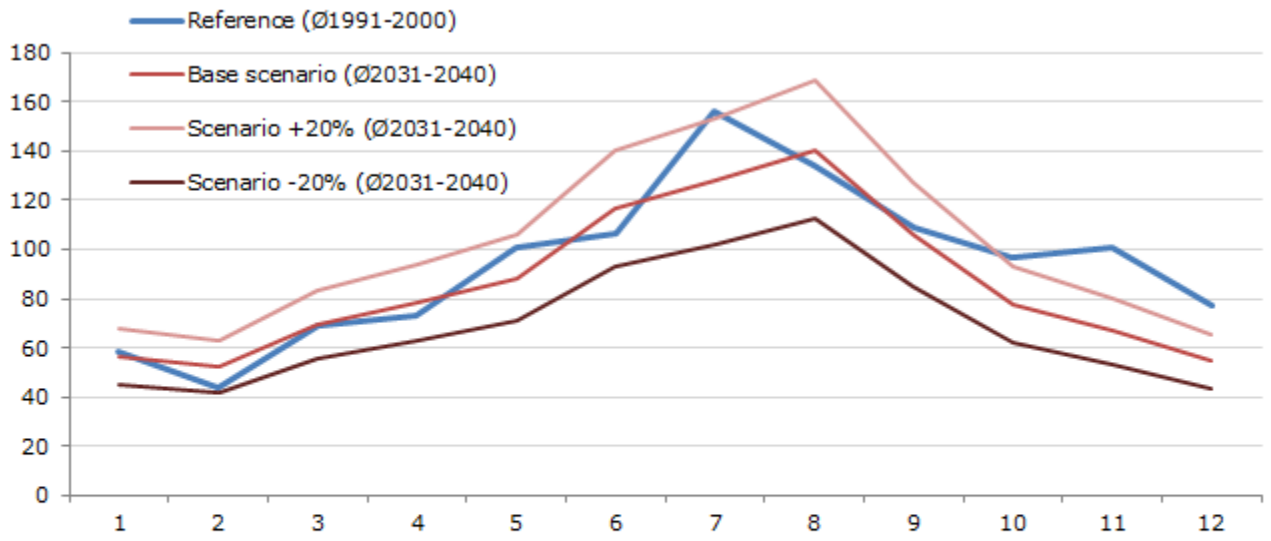
Precipitation (mm)	Class	Temperature (° C)	Class[a]
≤ 500	500	≤ 0	0
>500 to ≤ 600	600	>0 to ≤ 2.5	1
>600 to ≤ 700	700	>2.5 to ≤ 4.5	3
>700 to ≤ 800	800	>4.5 to ≤ 5.5	5
>800 to ≤ 900	900	>5.5 to ≤ 6.5	6
>900 to ≤ 1000	1000	>6.5 to ≤ 7.5	7
>1000 to ≤ 1250	1250	>7.5 to ≤ 8.5	8
>1250 to ≤ 1500	1500	>8.5 to ≤ 9.5	9
>1500	2000	>9.5 to ≤ 10.5	10
		>10.5 to ≤ 11.5	11*
		>11.5 to ≤ 12.5	12*
		>12.5	13*



Strauss et al. (2013)

Projected climate change*

Monthly precipitation sum [mm]



Precipitation [mm]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Year**
Reference (Ø1991-2000)	58.3	43.4	68.9	72.7	100.6	106.8	156.2	133.9	109.2	96.6	100.8	76.9	**1124.4**
Base scenario (Ø2031-2040)	56.4	52.5	69.1	78.2	88.4	116.6	127.7	140.5	106.1	77.4	66.8	54.5	**1034.2**
Scenario +20% (Ø2031-2040)	67.7	63.0	83.0	93.8	106.0	139.9	153.2	168.6	127.4	92.9	80.1	65.4	**1241.0**
Scenario -20% (Ø2031-2040)	45.1	42.0	55.3	62.6	70.7	93.3	102.1	112.4	84.9	61.9	53.4	43.6	**827.4**

Strauss et al., www.landnutzung.at

*Statistical climate change model, municipality Seitenstetten






Perceived changes in weather and climate

Table 2 Perceived changes in weather and climate, regional vulnerabilities, and potential adaptation options

Perceived changes in weather and climate	Perceived regional vulnerabilities and chances	Potential regional adaptation options
Increase in mean annual temperature	Prolonged growing season	Changes in sowing and harvesting dates
		Introduction of new cultivars
	Desertification of porous soils	Irrigation (only relevant to a minority of rather specialised farmers)
	Higher infestation pressure of pests and diseases	Changes in pesticide and insecticide use
	Harder conditions for extensive orcharding	Changes in varieties
Prolonged hot and dry periods and increase in maximum daily temperature in summer	Decreases in crop yield/forage yield	Introduction of new cultivarsChanges in fertilizer and pesticide use
	Heat stress in livestock and thus decrease in meat and milk yield	Air conditioning of livestock houses
	Lack of drinking water supply in mountainous regions	No suggestions made
Shift in the seasonal precipitation distribution from the winter to the summer	Decreases in crop yield/forage yield	Replacement of winter with spring planting cereals
Increase in number and intensity of heavy precipitation events	Increases in run-off and thus soil water erosion leading to crop yield losses and soil fertility declines	Conservation tillageAdaptation of crop rotations
	Increasing number of flood events	No suggestions made

The results are from the interviews and stakeholder workshops

Mitter et al., 2014. Reg Environ Change 14, 385–400

Case study research questions

- **Impacts of climate change**, agricultural commodity price development and CAP reform on farm mitigation and adaptation?
- **Effects of land use policies** on climate change adaptation and mitigation?
- Potential of policies to minimize trade-offs between **farm production**, **biodiversity** conservation, **landscape** element preservation, and **nutrient** emissions?
- Impacts of climate change and CAP reform - accounting for adaptation responses - on regional production and **rural development**?






Methods and Data

Input

natural & socio-economic data

CAPRI

- input and output prices
- CAP
- production functions
- farm labor supply
- livestock – herd sizes
- observed land use
- spatially explicit field data
- landscape elements
- climate scenarios
- topography
- soil characteristics

Models

CropRota[1]

EPIC[2]

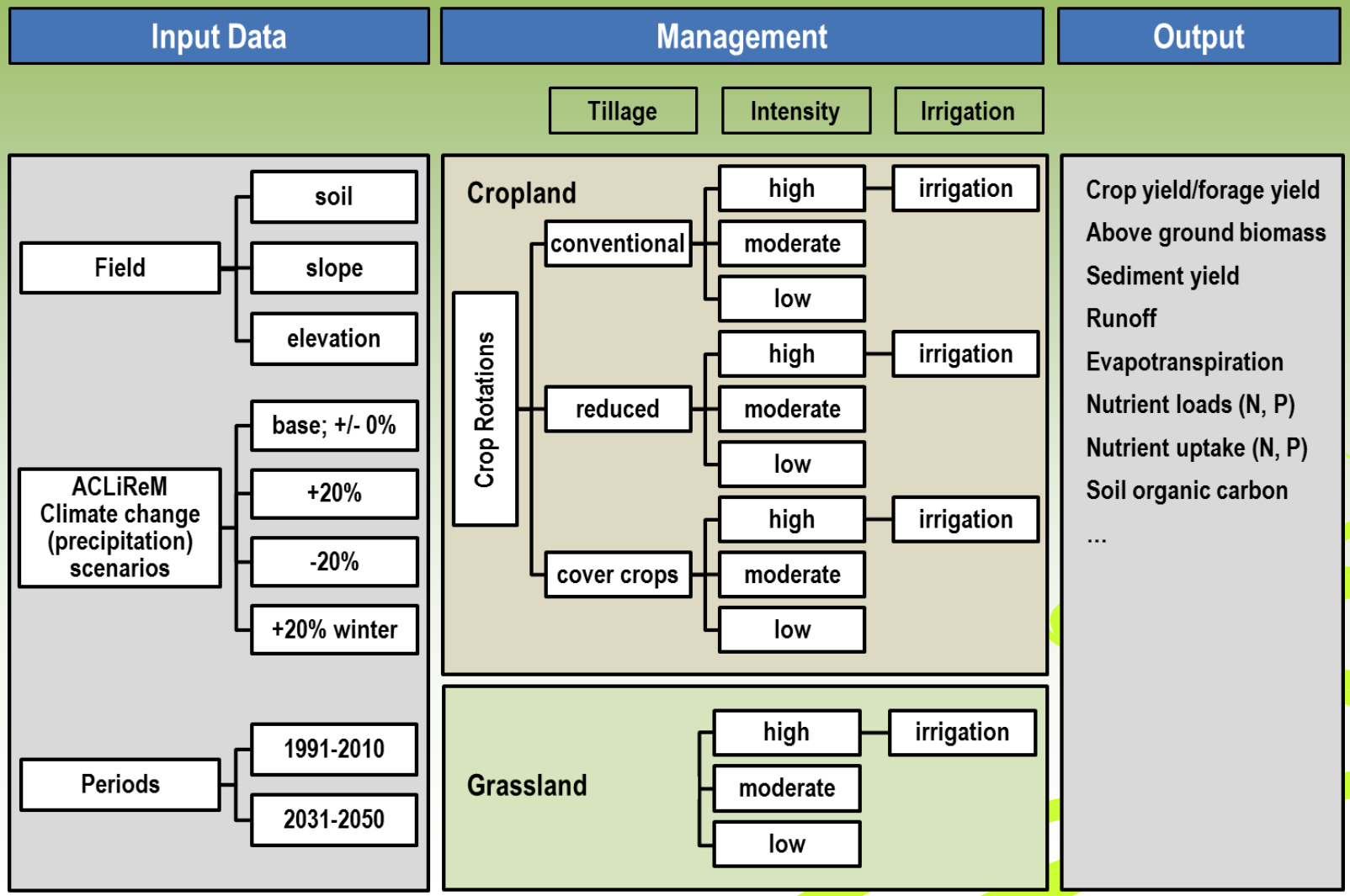
FAMOS[space][3]

Output

- socio-economic & RD indicators
- agri-environmental indicators
- food production indicators

[1]Schönhart et al. (2011). Eur J Agron 34, 263-277.
[2]e.g. Izaurralde et al. (2006). Ecol Modell 192, 362-384.
[3]Schönhart et al. (2011). J Environ Plann Manage 54, 115-143.

EPIC – model run settings





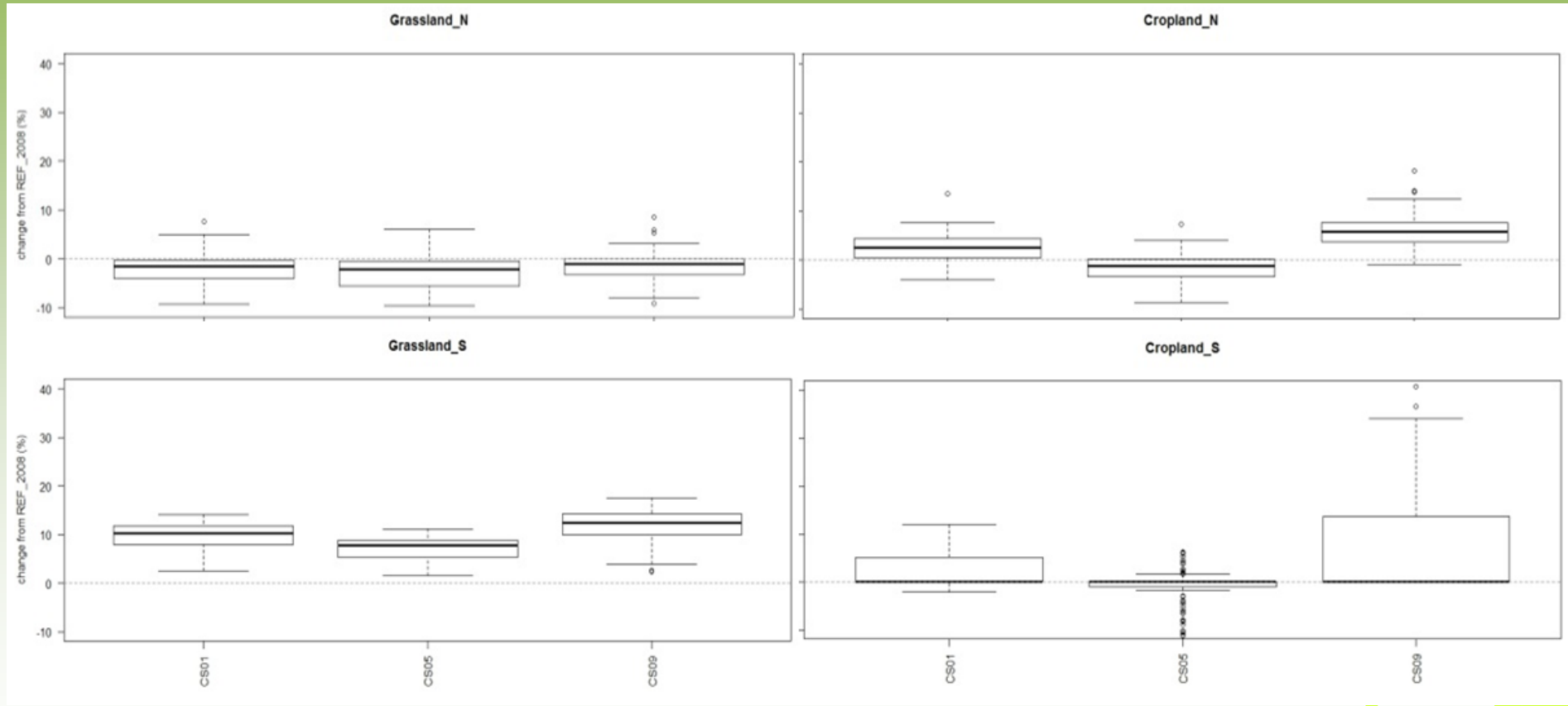



FAMOS[space] scenarios

	AEP	CAP reform	Climate change in 2040	
			Δ temperature (°C)	Δ precipitation (%)
REF_2008	no	no	0.0	0%
BAU_2008	yes	no	0.0	0%
REF_2040	no	yes	0.0	0%
BAU_2040	yes	yes	0.0	0%
CS01	yes	yes	+ 1.6	0%
CS05	yes	yes	+ 1.6	+20%
CS09	yes	yes	+ 1.6	-20%

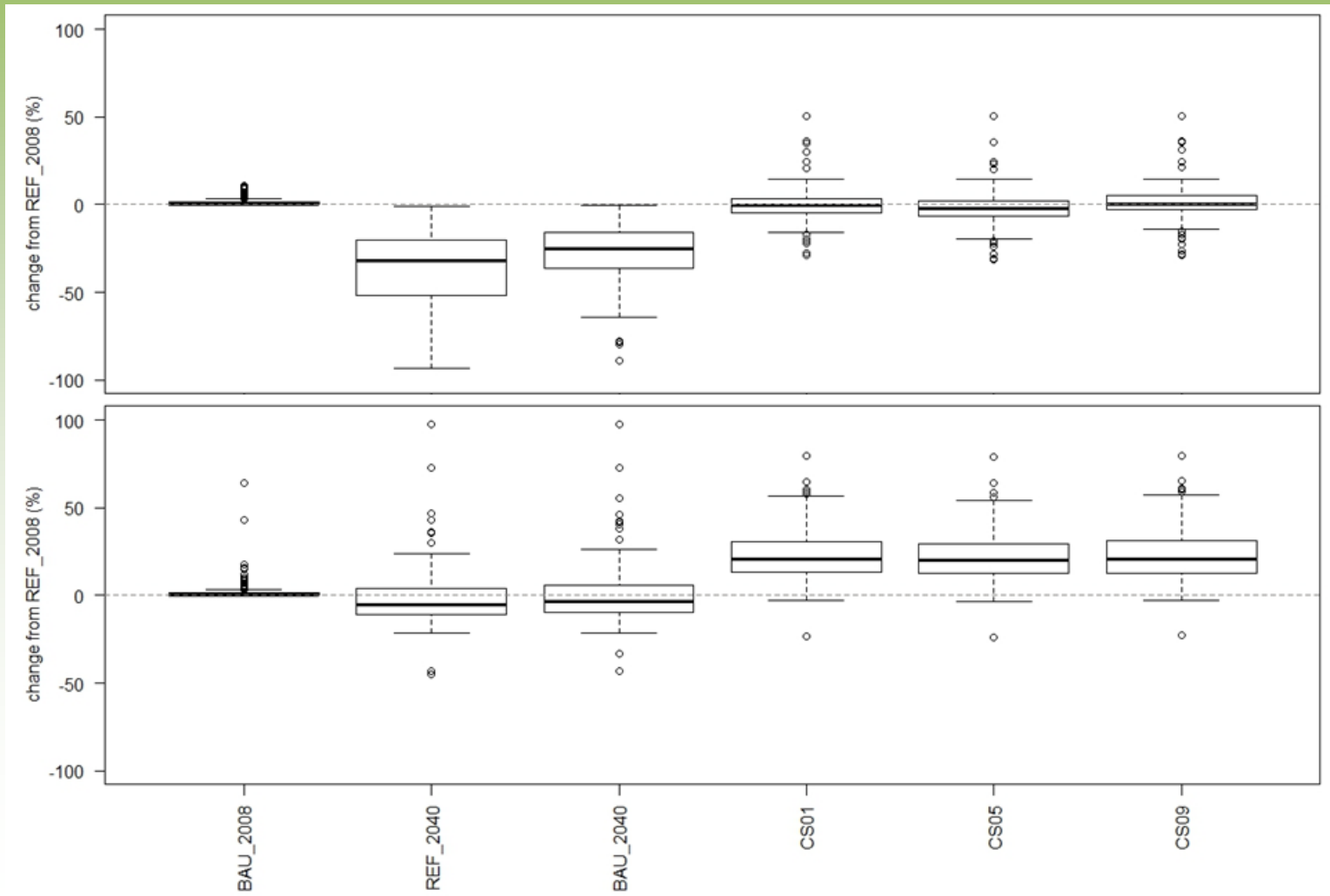
prelim. results – yield changes

1991-2010/2031-2050



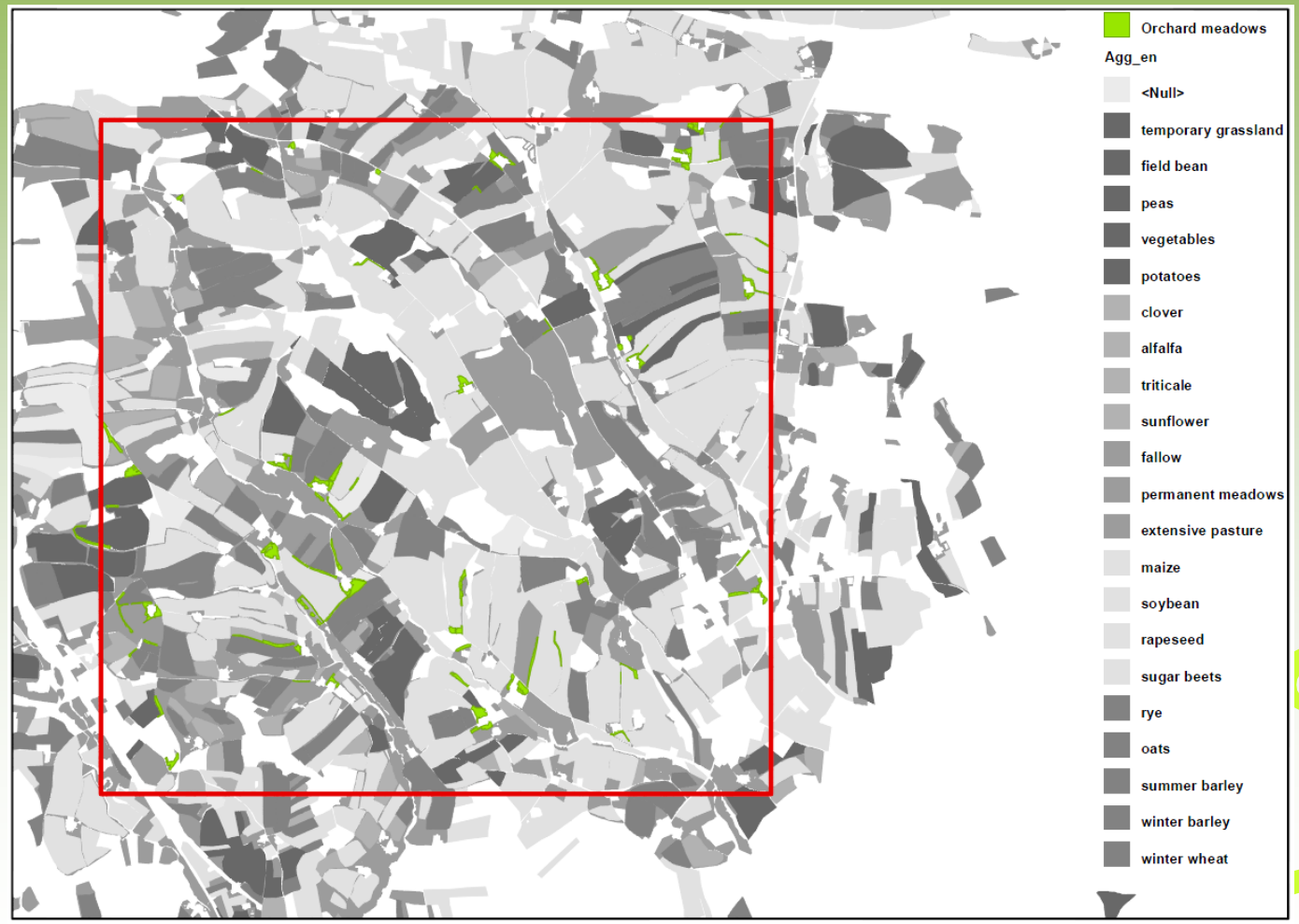
Changes from REF_2008 on the farms (N_{north}=113, N_{south}=118) for grassland (left) and cropland (right) for the northern (N, above) and southern (S, below) case study landscape.

prelim. results – changes in total gross margins 1991-2010/2031-2050



Changes in total farm gross margin from REF_2008 for three socio-economic and three climate scenarios (upper graph: N_{north}=113, lower graph: N_{south}=118; scenario)

prelim. results – land use change



Land use resulting from scenarios REF_2008 and CS05 in landscape North

Discussion - Results

- Agri-environmental program (AEP) is effective; slightly increases gross margins, but some farms gain considerably (wind fall profits)
- Regionally diverse climate change impact despite proximity of both landscapes
- Small difference among climate scenario impacts
- Climate change impacts are in the range of CAP reform impacts
- Adaptation moderates climate impacts (compare southern and northern landscape biophysical impacts)
- Increasing productivity on average increases intensification pressures
  - threat for permanent grassland, extensive land use and landscape elements
  - challenges future AEP design






Discussion - Methods

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High spatial resolution of integrated assessment framework

Abiotic and biotic environmental indicators

Rich in crop and livestock management variants

Detailed representation of agricultural policies

Covers two case study landscapes only

No interactions among farms so far

High data and computational demand

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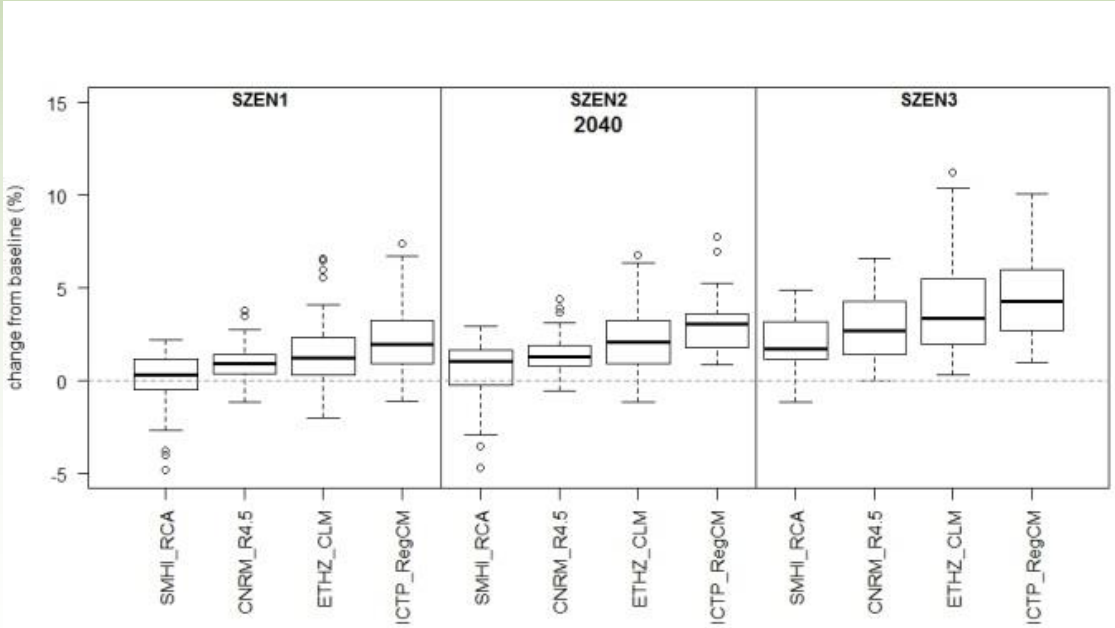
Research to this presentation has been supported by the Austrian Academy of Sciences (ÖAW) and the Federal Ministry of Agriculture, Forestry, Environment and Water Management of Austria.

further ACRP/MACSUR output

Integrated analysis of climate change impacts and adaptation measures in Austrian agriculture

Schönhart, M., Mitter, H., Schmid, E., Heinrich, G., Gobiet, A., German Journal of Agricultural Economics (under review)



Relative changes in aggregated gross margins (incl. subsidies) among Austrian NUTS-3 regions.