Dairy sector adaptations to climate and global change in North-East Europe

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Heikki Lehtonen, Xavier Irz, Helena Kahiluoto, Csaba Jansik, Pellervo Kässi, Hannu Känkänen, Olli Niskanen, Karoliina Rimhanen, Hanna Mäkinen, Miia Kuisma
MTT Agrifood Research, Finland

Vladimir Surovtsev, Mikhail Ponomarev, Yulia Nikulina, Elena Chastikova, Evgeny Schedrin
Northwest Research Institute of Agricultural Economics and Organisation of the Russian Academy of Agricultural Sciences, Pushkin, Russia
Agenda

- Research objectives and aims
- Climate change impacts on Northern European dairy farms
- Global change impacts on dairy farms and dairy sector
- Solutions to adaptation challenges and their implementation
- Conclusion
We focus on dairy regions in Finland and Leningrad region in Russia

Finland: province 10 (decreasing production), provinces 11,17 (increasing production)

Leningrad region
Key Industries
Food and beverages, forestry, timber, pulp and paper, fuel, energy.

The oblast has an area of 84,500 km², population of 1,716,868 (2010).

The crop production accounts for 16% the commodity composition of output, and the animal industry for 74%, milk production 27%, egg production 22%. Main crops: potatoes, vegetables, feed crops.
Research objectives and aims

(1) Compare means for increasing sustainability and adaptive capacity of food production
• in Finnish case study regions
• in a Russian case study region Leningrad Oblast, through enhancing the region-specific adaptive capacity by analyzing how adopting new technologies and incentive systems affect the socio-ecological development of these case regions

(2) Identify indicators for adaptive capacity, to predict and assess socio-economic impacts of climatic change, taking into account the changing production organisation and management at farms and other parts of the food chain
Development of milk production in different provinces in Finland, 2001/2002 = 1
Source: www.mmmtike.fi

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### Total milk production, 1000 tons

<table>
<thead>
<tr>
<th>Years</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>567.9</td>
<td>544.3</td>
<td>555.4</td>
<td>557.3</td>
<td>547.2</td>
<td>559</td>
<td>569.7</td>
<td>554</td>
</tr>
</tbody>
</table>

### Number of dairy cows, 1000 heads

<table>
<thead>
<tr>
<th>Years</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>86.6</td>
<td>85</td>
<td>84.4</td>
<td>84.7</td>
<td>83.7</td>
<td>83</td>
<td>80.3</td>
<td>76.6</td>
</tr>
</tbody>
</table>

### Consumption per person, kg

- **Leningrad region**: 261, 272, 273, 290, 296, 295, 294, 293
- **Saint-Petersburg**: 312, 312, 303, 318, 320, 332, 317, 315

### Milk production per person, kg/cap

- **2006**: 91
- **2007**: 89
- **2008**: 90
- **2009**: 83
- **2010**: 84
- **2011**: 85
- **2012**: 82

### Share of Leningrad region production, out of total consumption

- **2006**: 29
- **2007**: 29
- **2008**: 30
- **2009**: 28
- **2010**: 26
- **2011**: 26
- **2012**: 27
- **2013**: 26

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115 agricultural enterprises in Leningrad region, with developed dairy farming, accounted for 92% of total milk production (The Committee for Agro-industrial complex of Leningrad region, 2013)

Basic indicators of agro-industrial and fishery complex of the Leningrad region in 2006-2011. Source: Northwest Research Institute of Agricultural Economics and Organisation of the Russian Academy of Agricultural Sciences, Pushkin, Russia

Is big beautiful in dairy production?

Large farms (common in Denmark, Netherlands, France, Germany, Russia) produce **high milk output per hour of labor** but are vulnerable to feed and milk prices (below, dropping profitability at 2009 milk crisis. Source: FADN)

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### Grouping of dairy specialization in net profit in the Leningrad region in 2013.

<table>
<thead>
<tr>
<th>Net profit, million rub. annually</th>
<th>Number of companies</th>
<th>Average herd size, head</th>
<th>Production of cows, kg</th>
<th>Net income per cow, thousand rub</th>
<th>Share in the total number of cows, %</th>
<th>The rate of growth / decrease the number of cows, %</th>
<th>Share in the gross production of milk, %</th>
<th>The rate of growth / decline in gross production of milk, %</th>
<th>The ratio of subsidies to the state of emergency, times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Losses</td>
<td>17</td>
<td>288</td>
<td>6025</td>
<td>-147</td>
<td>7,5</td>
<td>-32,4</td>
<td>6,2</td>
<td>-24,4</td>
<td>-0,09</td>
</tr>
<tr>
<td>from 0 to 10 Mrub</td>
<td>28</td>
<td>483</td>
<td>6433</td>
<td>6</td>
<td>20,6</td>
<td>-1,5</td>
<td>18,2</td>
<td>2,3</td>
<td>4,55</td>
</tr>
<tr>
<td>from 10 to 30 Mrub</td>
<td>29</td>
<td>1279</td>
<td>7407</td>
<td>24</td>
<td>35,1</td>
<td>1,6</td>
<td>35,7</td>
<td>-0,1</td>
<td>1,57</td>
</tr>
<tr>
<td>from 30 and higher Mrub</td>
<td>24</td>
<td>1006</td>
<td>7882</td>
<td>68</td>
<td>36,8</td>
<td>2,2</td>
<td>39,9</td>
<td>3,3</td>
<td>0,71</td>
</tr>
</tbody>
</table>

“Independent agricultural organizations outside the large vertically integrated holdings, adapt production processes to weather and climatic anomalies much faster, which significantly reduces the loss in output, while maintaining financial and economic performance at an acceptable level for the reproduction process.” (Surovtsev VN, Payurova EN, Nikulin Yu, MA Ponomarev. 2014. Adaptation of agricultural production in the North - West of Russia to climate change. SPb., GNU SZNIESKH, 2014. - 176 p. ISBN 978-5-902769-13-2)

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**RISK MANAGEMENT!**

- Production risks, due to price volatility, adverse weather
- Financial risks, debt /assets ratio, liquidity
- The role of purchased feed

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Projected climate change in Finland up to 2100, reference period 1971-2000

Sources: Jylhä et al 2009, Ruosteenoja 2013, results and stakeholder dialogue in ADIOSO

- Annual average temperature +2 - + 6 °C
  - In winter +3-+9 °C
  - In summer +1-+5 °C
- Annual precipitation + 12 - 22%
  - In winter +10 - 40%
  - In summer + 0 - 20%
- Increased evapotranspiration during the growing period – threat of worsening early summer drought, for crops sown in late spring
  - Growing season length +30–45 days until 2100
  - Temperature sum during growing period:
    - Middle Finland 1100 -> 1600 degree days;
    - Southern Finland 1300 -> 1900;
    - Northern Finland 900 -> 1200 degree days
  - Increasing frequency:
    - rainy days, heavy rainfalls, dry spells, increased cloudiness
- Decreased length of thermal winter
- Reduced snow cover and permafrost – impacts on overwintering of Grasslands. Photos: upper (Asko Hannukkala, MTT), lower (Perttu Virkajärvi, MTT)

CONSIDERABLE UNCERTAINTY ON FUTURE CROP YIELDS AND OTHER PRODUCTION CONDITIONS

- Increasing yields? – Only if some problems are solved and solutions implemented
- More frequent wet harvesting conditions? Increased costs due to overwintering?

INDIRECT. GLOBAL EFFECTS: Highly volatile prices of agricultural commodities?
Adaptation solutions, grass

- Three cuts per year
  - Earlier cuts
- New grassland species and cultivars
  - More resistant to heat stress and drought
  - Better nutritive value
  - Sufficient winter hardiness
- Adjusted fertilisation levels
  - Proper timing, according to developmental phases
  - According to yield potential of different crops and cultivars
- Improved weed control needed
  - Considerably increased need for weed control since 2000, according to farmers’ experiences (spontaneous comments from farmers, Nov 2014)
- Prevention of soil compaction
  - Drainage!
  - Development of machinery/use of machinery
  - More frequent wet conditions, weakening soil trafficability – EXTRA COSTS!
- However, severe droughts were considered more threatening than floods
  - This view was expressed in a stakeholder seminar in North Savo region, Nov 2014
Yield gaps and their drivers

<table>
<thead>
<tr>
<th>POTENTIAL</th>
<th>ATTAINABLE</th>
<th>ACTUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gap I (20%) – e.g. water limitations due to soil structure, poor drainage – need for farm investments</td>
<td>Gap II (10%) – e.g. inadequate liming</td>
<td>Gap III (20%) – e.g. inadequate crop protection, fertilisation due to discouraging policies, markets and risks</td>
</tr>
</tbody>
</table>

Gaps 
I+II+III = 50%
Grass yield variation – mainly due to drought - is a core farm management issue

- Cattle’s feeding is based on grass silage in Northern Europe
  - grass growth is highly dependent on weather conditions
- Grass area of a cattle farm is usually determined by the yield variation
- To be adequate in every situation, the lowest expected yield level determines the cultivated area
- To manage the grass yield risk: Increase grass area and silage storage capacity over annual consumption, concentrate feeding
- Variation of grass yield in climate data from years 1961-1990 was compared with 15 different climate scenario models simulating years 2046-2065 in climate scenario A1B
- A farm model was developed for evaluating the risk of silage inadequacy in terms of cultivated area and storing capacity
  - Both imply extra costs!
  - Grass silage is difficult to be compensated entirely with other feeds, but some silage deficit can be compensated with concentrates
Harvested yield determines the cost of drought risk – Cost of drought risk is slightly decreasing in A1B - scenario

<table>
<thead>
<tr>
<th></th>
<th>Average harvested Yield</th>
<th>Average standard deviation of harvested yield</th>
<th>Harvest cost € / tn dm</th>
<th>Cost of Risk € / tn dm</th>
<th>years of silage deficit (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kuopio</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Baseline</td>
<td>8,11</td>
<td>0,88</td>
<td>-49,17</td>
<td>-53,15</td>
<td>6,00</td>
</tr>
<tr>
<td>GCM:s</td>
<td>8,10</td>
<td>0,62</td>
<td>-49,08</td>
<td>-51,65</td>
<td>4,00</td>
</tr>
<tr>
<td><strong>Jokioinen</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>7,04</td>
<td>1,02</td>
<td>-51,76</td>
<td>-60,13</td>
<td>20,00</td>
</tr>
<tr>
<td>GCM:s</td>
<td>7,11</td>
<td>0,80</td>
<td>-51,42</td>
<td>-56,59</td>
<td>10,20</td>
</tr>
<tr>
<td><strong>St Petersburg</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>8,35</td>
<td>1,06</td>
<td>-48,75</td>
<td>-53,68</td>
<td>14,00</td>
</tr>
<tr>
<td>GCM:s</td>
<td>8,36</td>
<td>0,60</td>
<td>-48,60</td>
<td>-51,04</td>
<td>3,93</td>
</tr>
</tbody>
</table>

These results are from the case where a farm cultivates grass silage at 20% larger area than needed in average yield years, buffer storage for 4 months.

This kind of “down to earth” modeling is useful when discussing the results with farmers and their close regional stakeholders.

Farm level approach to manage grass yield variation in changing climate in Kuopio, Jokioinen and St. Petersburg.
Impacts of CC on clover grass yields

- Based on a relatively large survey of literature and MTT research results on the clover grasses in climate change, one can conclude that clover grasses...
  - Benefit more on warmer springs than hay grasses
  - Benefits more on increased CO2 concentration than hay grasses
  - Are more tolerant to drought than hay grasses
  - Produce lower dry matter yields than hay grasses (-10-20%)
  - Produce higher protein content than hay grasses (+10-15%)
Feasible cultivation area of clover-grass for silage?

- N fertilisation level for clover grasses, max 50 kg soluble N/ha
  - If higher soluble N/ha, then no higher crude protein content is realised
- Maximum 20 kg P/ha in Finland 2007-2014 - restricts the land available for clover grasses
- Average livestock density at Finnish dairy farms is appr. 0.85
- Increasing livestock density leaves little room for clover grasses!
  - ALL LAND is needed for manure spreading => too high soluble N/ha

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Summary of adaptation challenges and opportunities - Case study region of Northern Savo, Finland

- Increasing grass growth benefits dairy and beef
- Inter-annual volatility of grass yield may increase
  - Cost of drought risk decreases in A1B but may increase in high warming scenarios!
- Winter damages, feed quality losses, soil compaction, wet conditions more frequent
- Increase in yield potential of cereals and oilseeds is uncertain, more frequent droughts on sandy soils
- Positive market development + more flexible and encouraging policies needed for adaptation
  - Adaptations require medium/long-term investments - drainage, soil structure, cultivars
  - Winners know all this, are adapting already...
Dairy product demand may expand in Russia, but start gradually declining in high-income EU member states.

**Socio-Economic challenges for CC mitigation**

- **SSP5 Conventional development**
  - "progress with oil and gas, free trade"
- **SSP3 Fragmentation**
  - "regional protectionism"
- **SSP2 Middle of the road**
  - "business as usual", some trade liberalisation
- **SSP4 Inequality**
  - "free trade among rich countries"
- **SSP1 Sustainability**
  - "free trade, regulated by ecologic principles"

**Socio-Economic challenges for adaptation**
Sector level analysis: Key market and policy issues identified

- on the basis of shared MagPie (global model at PIK Potsdam) results on global prices and food diets from SSP1,2,3 - transferred to MTT Dremfia sector model

- Prices are the main drivers:
  - Milk and meat prices with respect to feed prices
  - Other input prices
    - Energy and fertiliser taxes affect agriculture
    - Labour, machinery, construction, affected by public regulations
- Production linked national payments important for milk production
  - 20-30% less milk production if no national payments in Finland
  - Area based subsidies and entitlement conditions maintain land prices
    - Changes may imply significant changes on land markets
- Fertilisation limits, nutrient leaching /GHG abatement policies
  - From restrictive / passive policies to productivity encouraging schemes?
  - Total production is not easily increasing despite increasing productivity
  - => less farmland needed => possibilities for leaching/emission reduction
Conclusions

- Dairy production will most likely continue concentrating on most competitive regions
  - Significant environmental problems possible in areas of intensive production
  - Possibilities for reduced leaching/ emissions where production decreases!
- Large price fluctuations, no increase in real prices of milk
  - Strong demand will maintain prices in the long run, despite decreasing prices in the short run
- High fluctuations of gross margins on large and intensive farms
- Gradually increasing grass growth, if no significant increase in yield volatility, may realise in reduced costs and increased production
- Investments in soil improvements and drainage needed
  - Inhibited by the existing capital needs of structural change, and price volatility
- Russian markets with increasing demand are important both in Finland and Leningrad region
Kiitos!
Thank you!

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