Specific problems and solutions in climate change adaptation in the North Savo region

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Abstract— Climate change implies changes in cereals and forage crop yields and nutritive quality. Grass silage, economically the most important crop, because of its importance for dairy producers, in North Savo region is mainly self-produced on farms and most often there is no market for silage. Silage production and use are vulnerable to changes in local climate, because lost yield cannot be easily replaced from market. Risks and costs due to increasing inter-annual yield volatility can be reduced by good management practices, such as crop rotation, plant protection, soil improvements and better crop protection against plant diseases. However the profitability of such measures is dependent on market and policy conditions. Rapid structural change, market and policies affect level and direction of adaptation. The purpose of the North Savo pilot study is to show the value of different adaptation options to the main farm types, the region and the agricultural sector as a whole, under different climate and socio-economic scenarios.

Index terms— Northern agriculture, farm economics, sector level modelling, crop yield variability, drought risk, structural change

1 Introduction

Northern Savo is a province in central parts of Finland with 247 000 inhabitants (2010), 148 000 ha farmland (8.8% of land area) and 4 200 farms. Crop production for feed dominates land use in North Savo. The value of dairy and beef production is appr. 70 % of the total value of agricultural production in the region. While the number of inhabitants in the region is 4.5 % of the population in Finland, there are 38 000 dairy cows in the North Savo region which is more than 10% of the dairy cows in Finland. North Savo is one of the 5 provinces in Finland (out of 15) where milk production quantity has been increasing, while in most other provinces milk production is gradually decreasing. There are significant dairy processing industrial plants in the region.

In northern Europe agricultural practice is challenged by increasingly volatile commodity markets, increasing input prices, climate change and strict environmental constrains. While non-negligible positive impacts of climate change may be anticipated for Northern Europe, increasing climatic variability with higher frequency of extreme events, pest pressure and continuous changes in the markets may present very significant challenges for agriculture in Nordic countries (Hakala et al., 2011). The North Savo

region, where climate change related challenges for agriculture have been studied extensively, is no exception in this. The region is highly depending on dairy production and silage production, while cereals production is also a relevant complement in the farm economy and land use of the region.

2 Main patterns of structural change of agriculture in the region

Farm size of dairy farms at North Savo region has followed the national average, reaching 30 cows per farm in 2013. Appr. 37 % of dairy cows in the North Savo region are kept on farms with more than 50 cows, while 17 % of cows are kept on farms with less than 20 cows. The rate of structural change in dairy farming is, however, rapid since the number of farms has decreased by 50 % in the last 10 years despite a small increase in production. It has been estimated that more than 60 % of dairy cows will be kept on farms with more than 50 cows already in 2020 (Pyykkönen et al. 2010).

The relatively rapid increase in the size of dairy and beef farms (appr. 400 in the North Savo region) has, together with increasing land specific CAP-payments per hectare and increasing cereals prices during the last 10 years, resulted in increasing land prices. This, in turn, has resulted in increasing costs for expanding farms which often face higher logistic costs because of small and spatially fragmented field parcels. While the majority of farms which expand their land area are livestock farms, there are some cereals producing farms, often former livestock farms with no livestock anymore, which increase land area and production. Some crop farms also supply grassland roughage for dairy and beef farms. However, the structural change developments have already led to increasing distances to field parcels, timeliness costs due to short sowing and harvesting periods, uncertainty in land availability due to increased land demand and short land tenure contracts. Expected high/medium crop prices keep the land supply weak. Consequently, farms and especially many livestock farms intensify the crop cultivation, in order to harvest high yields close to the farm. Increasing farm size and intensification of production are considered one of the most important means of maintaining farm viability (Lehtonen et. al. 2013).

3 Implications of climate change in North Savo agriculture

Climate change is expected to increase crop yield variability of both cereals and grasslands in northern latitudes. Average yields for grasslands may increase due to increasing temperature sum if droughts and overwintering problems do not become too frequent and severe. For seed crops (cereals, oilseeds) the effect on yield is uncertain despite increasing length of the growing season and increasing temperature

sum during the growing period. Increasingly volatile markets for crops and other agricultural commodities are not favourable from a point of view of medium- and long- term investments in agricultural productivity and adaptation. For example, it has already been observed that liming and drainage investments are insufficient for the long run, even without climate change considerations. The main expected direct effects of climate change in the North Savo region are various overwintering problems of grasslands, and increased early summer drought, which is harmful especially for cereals, but also for grasslands.

More difficult overwintering due to more frequently alternating freezing and thawing cycles in future winters are likely to impose extra costs and work for farmers. For example, winter time ice encasement of grassland may lead to even severe damage for grass vegetation. This implies extra seeding work and fertilization in spring time to avoid weeds, yield losses and reduced quality of feed Since such extra costs and work needed for corrective actions are likely to be realized in peak load periods in spring, the more difficult overwintering may have more impact for farmers than small increments in crop yields over time. Such benefits may, however, be expected because of new crop cultivars suitable for a longer growing period, and because of possible benefits of various adaptation measures, such as fungicide use (crop protection), liming (soil improvement), and improved crop rotation. Higher market prices of agricultural commodities are however required to cover the extra costs of such adaptation measures. Such measures could pay off for some farmers even in near future if market prices remain high. Nevertheless, farmers trying to improve productivity early on may be jeopardized by rapidly increasing prices of agricultural inputs, not only volatile agricultural commodity pricesHence the profitability and viability of farming in the region is highly dependent on global markets, even if effective solutions to local problems will be found.

4 Economic analysis at farm and sector levels

Grass silage, economically the most important crop (because of its importance for dairy producers) is mainly self-produced on farms and most often there is no market for silage. Silage production and use are vulnerable to changes in local climate, because lost yield cannot be easily replaced from market. Risks and costs due to increasing inter-annual yield volatility can be reduced by good management practices, such as crop rotation, plant protection, soil improvements and better crop protection against plant diseases.

It is useful to look at the climate change related challenges at an example farm in the region which has

grown very rapidly during the last 20-30 years. While this specific farm had only 16 dairy cows and 25 hectares of farmland in 1987, it has now 150 cows and 170 hectares farmland. The farm owns 96 hectares and 74 hectares is rented from other land owners. While more than 90% of roughage is still produced on- farm, a fraction of roughage is contract based production on other farms, and some roughage is also purchased from other farms. In fact some crop farms are producing silage and other roughage for large dairy cow farms in the region. The price of grass silage, as well as the price of production contracts, depends on the local land market situation. Anyway such solutions, not only crop specific improvements in productivity, may increase cereals-grassland rotations and land area available for grassland harvest and manure spreading, and thus improve capacity of large dairy farmers to climate change related adverse weather conditions as well. Nevertheless, expensive protein feed has resulted in attempts of some large dairy farms to increase the on-farm production of protein crops (oilseeds, faba bean) which influence land use, costs and crop rotation.

The purpose of the North Savo pilot study is to show the value of different adaptation options to the main farm types, the region and the agricultural sector as a whole, under different climate and socio-economic scenarios. Since farmers in the region seem to respond consistently to past and on-going developments, including agricultural and environmental policies, the most important economic analysis based on crop and livestock research have been carried out in the context of farm economy. The climate change induced problems, which have already attracted attention in the region, as well as hopes on higher crop yields, require careful analysis of adaptations at the level of farms and entire region. The on-going farm level analysis is complemented by sector level economic modeling based on optimization approach and endogenous structural change (Lehtonen 2001, 2004). While important contributions are currently produced at the farm level adaptation analysis, the sector modeling is an important means of showing the sector level repercussions of farm level changes and the value of specific adaptation options in the long run. However the sector level model needs to be sufficiently rich in farm level detail and technological options. Both farm and sector level outcomes are to be discussed and evaluated with local farmers and regional stakeholders.

5 Preliminary results

Our first results of economic analysis, specifically calculated for the North Savo region, show important directions for adaptation and further work. Farms can prepare to exceptional years by adjusting cultivated grass area and having extra storage capacity available. The implied costs of such actions can be

calculated and we have found levels of adaptation where cost of risk is likely to be the lowest (Kässi et al. 2014). We have also derived important results for cereals and crop farms in the region. When crop prices are high, not only are farmers willing to cultivate riskier crops such as wheat and barley to obtain possible high gross margin, but adaptation practices such as rotation, liming and fungicide are likely to be applied at farms as well to reach high yields. Output prices play a key role in providing incentives for farmers to utilize adaptation management. Low prices and restrictive policies lead to cost minimization and decreasing yields. Under sufficient prices, however, yield gap can be narrowed down, or kept almost constant, by combining crop rotation with other management practices, despite increasing plant disease pressure (Lehtonen et al. 2014). Because of considerable climate and socioeconomic uncertainties it is important to find affordable "low regret" adaptations. Both farm and sector level modeling provide important complementary results when evaluating the importance of different kinds of adaptation, e.g. the value of new cultivars better tuned to an increasing length of the growing season and to a possible increased early summer drought in future climate.

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