

Combining stakeholder views and simulations to boost sustainable intensification of cereal production in North Savo

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Introduction

Sustainable intensification is needed to cope with the challenges agriculture faces with respect to climate change and increasing food demand. Northern cropping systems may benefit from longer and warmer growing seasons, but the sustainability of production will be challenged due to increased production risks. Farmers and other agricultural stakeholders need information and improved skills to effectively respond to these risks (Lehtonen et al. 2018).

Material and Methods

This study combined stakeholder knowledge and simulation modelling in order to find and assess means for sustainable intensification of cereal production in the North Savo region in Finland under current and future climatic conditions. North Savo was one of the selected case studies in MACSUR and SUSTAg projects to perform integrated modelling and assessment studies on climate change adaptation and sustainable intensification. Stakeholder workshop discussions were used to identify promising intensification measures for cropping systems in the region. Different options and their combinations, altogether 19 technology packages, were assessed using the APSIM cropping system model (Holzworth et al., 2014). The model was used to assess cereal yields, grain nitrogen (N) content, nitrate leaching and water productivity for a historical baseline (1981-2010) and mid-century conditions (2041-2070) as projected by five General Circulation Models for different emissions scenarios. Management options simulated included improved cultivars with later maturing characteristics, improved heat-drought resistance and nitrogen-use efficiency, increased N fertilisation levels, improved crop rotations together with improved soils as well as supplementary and full irrigation. The model results were presented to the stakeholders and their comments, reflections and complementary views were gathered.

Results and Discussion

The simulation results indicated that although a warming climate in conjunction with elevated atmospheric CO₂ concentrations generally increases yield levels, N uptake and water productivity, risk associated with higher N leaching due to increased precipitation is a challenge for sustainability of crop production in the region (Table 1). There seems to be, however, a large potential for sustainably intensifying crop production in northern conditions as the sustainability indicators studied were more affected by different SI options than future projected climate. Combining several intensification measures at a time showed large potential. Among a wide set of SI options tested for their sustainability impacts, improved crop cultivars, particularly with some increase in N fertilisation, showed the firmest positive impacts. This was supported by the views of agricultural stakeholders in the region.

Agricultural stakeholder's suggestions for alternative SI options challenged the simulation approach to some extent. For example, grass mixtures, i.e. use of forage crop seed mixes tailored for farm conditions, that were seen important by local stakeholders could not be assessed, because the methodology for modelling the crop mixtures is not yet mature enough for this type of analysis. Simulations results still provided robust information for comparing the sustainability impacts of alternative measures and supported local discussions on how to sustainably improve currently low profitability of cereal production in the region and prepare for changing climate conditions.

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Management option	Baseline	RCP2.6	RCP4.5	RCP8.5	Baseline	RCP2.6	RCP4.5	RCP8.5
	Barley yields				Grain N			
Current management	0	0	+	+	0	+	+	+
Improved cultivar	++	++	++	+++	+	+	+	+
Increased fertilisation level	0	0	+	++	+	+	++	++
Soil improvements	0	0	+	++	0	0	0	0
Supplementary irrigation	+	+	++	++	0	+	+	+
	Nitrate leaching				Water productivity			
Current management	0	+	++	+++	0	+	+	++
Improved cultivar	-	0	+	++	+	+	++	++
Increased fertilisation level	+	++	+++	+++	0	+	+	++
Soil improvements	-	+	++	++	+	+	++	++
Supplementary irrigation	+	++	+++	+++	0	+	+	++

Table 1. Effects of selected management options on simulated sustainability indicators under baseline (1980-2009) and future (2040-2069) climate conditions. The notations depict average changes in comparison to the results for current management under baseline conditions.

Keywords: barley, climate impacts, scenarios, stakeholder interaction, wheat.

References:

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