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Contribution of High Nature Value farming areas to sustainable livestock production: A pilot case in Finland

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Abstract Animal production, and particularly ruminant livestock, has risen to be among the key issues in the agricultural sustainability discourse. This study addresses the topic through a specific and seldomexplored focus – High Nature Value (HNV) farming systems. These are mainly pastoral systems using semi-natural grasslands in production of high-quality animal-based food. The ongoing study aims to assess the environmental sustainability of production on HNV farms, focusing on greenhouse gas emissions, nitrogen balance and land use. We chose Finland as the pilot study to develop a methodological approach, and aim to extend the analysis to HNV farms within five regions in Europe. We measured the environmental impacts of HNV farms and their alternative states, that is, the same production but without semi-natural grasslands. The HNV farm impacts were comparable to that of the alternative field-based production in terms of their environmental impacts related to production amounts. Using semi-natural grasslands tended to minimize the arable land area, but maximised nitrogen cycling and maintained unique biodiversity.

Keywords: biodiversity, farming systems, livestock, sustainability

Introduction Considerable environmental impacts of livestock production have been well demonstrated. However, livestock are an important part of nutrient cycling in agriculture, as they are able to utilise resources otherwise unsuitable for human consumption and may also support unique biodiversity (Röös et al., 2006). The highest sustainability benefits could be provided by the production systems that have the least overall adverse impact but highest benefits – the lowest possible trade-off situation. This study explores the above through focusing on High Nature Value (HNV) farmlands. These are areas where 'agriculture is a major land user, and where agriculture supports, or is associated with, either a high species and habitat diversity or the presence of species of European conservation concern or both' (Andersen et al., 2003). This has led to the inclusion of HNV farmland indicator as part of the EU sustainability indicator framework. HNV farming systems have so far received only minor research attention in the food system assessments. Most of the Life Cycle Assessment (LCA) studies have been done for intensive animal production systems of limited or no biodiversity, or for other non-material benefits (e.g. pig fattening). In this ongoing project, we collect data from 50 HNV farms across Europe to assess the environmental sustainability of production on HNV farms. We use Finland as the pilot study to test a methodological approach.

Materials and methods We collected data from nine HNV farms in Finland: five beef cattle, two sheep and two sheep and cattle farms. The farms correspond to HNV farming system type 1, that is, farms that utilise seminatural vegetation for grazing and/or haying. We applied the Carbon Calculator (CC) from the Joint Research Centre of the European Commission (Tuomisto et al., 2015). We measured four environmental indicators: greenhouse gas (GHG) emissions and nitrogen balance (from the CC) as well as arable land use and biodiversity value. For each sample farm, we built an alternative state that maintains the production without use of the semi-natural grassland, taking into account the feed demand for the same animal numbers. This resulted mainly in additional area of cultivated grassland and associated inputs. We used the best available national estimations of arable land required by the respective livestock type, and its productivity. There are several approaches for estimating the biodiversity value of a farm for LCA (Winter et al., 2017). In Finland, the semi-natural grasslands represent the single most biodiverse land use on farmland with unique and highly threatened communities (Raatikainen et al., 2017). Therefore, we assumed that the proportion of the managed semi-natural grasslands of a farm indicates presence of such unique biodiversity, while other fields and elements have relatively common farmland species. A farm with no semi-natural grassland thus got 0 value and a farm with half of the land area as semi-natural got 50. We used ANOVA to test the environmental impacts between the HNV farms and their alternative state.

Results and discussion The HNV farms have higher GHG emissions (GHGs) at the product level compared with their alternatives states (Figure 1). When such farms sell only small amounts of animal-derived products, presumably keeping livestock mainly for the agricultural subsidies, their GHGs at the product level are high (160.8 and 193.7 Mg CO_2-eq for two farms with the highest values). HNV farms have lower GHGs at the farm level compared to their alternative states. However, there was no statistically significant difference in GHGs at the farm level ($P=0.1$). The average nitrogen balance value in HNV farms was close to zero. There were no statistically significant differences between the HNV and alternative state farms ($P=0.2$, 0.2 and 0.5 for arable land use, nitrogen balance and GHGs at the product level, respectively). The HNV management options are low or zero applications of external inputs and use of on-farm resources (manure), thus maximizing the nutrient cycling at farm level. HNV farms also use zero-input pastures as potential carbon sinks. We assumed that farming practices of the alternative state farms would remain equivalent to those from HNV farms. Only the allocation of arable land use would change without the access to semi-natural grassland. With an increase of arable land use, the nitrogen inputs also grow. The negative average values for the alternative state farms demonstrate that it is not sufficient to maintain the nitrogen balance through legumes in cultivated grasslands (Karlsson and Röös, 2019). Five out of nine farms would need to increase their arable land or imports of feed in order to maintain their level of production. Since most semi-natural grasslands cannot be used for the arable cropping (due to the environmental constrains such as being on coastal areas or forested land, or legislative ones such as protection under Natura 2000), utilising them in production releases arable land for growing crops for direct human consumption or other uses such as bioenergy production. Biodiversity values of the HNV farms averaged at 52% (range 28-83%). They were assumed zero here for non-HNV farms though such farms can have considerable biodiversity for other reasons (i.e. landscape complexity). Our approach focused specifically at semi-natural grassland while assuming other farm parameters being equal. Our results provide evidence for HNV farming systems being compatible with the mainstream production in terms of their environmental impacts: while producing animal-derived food, they also maintain unique biodiversity, tend to minimise use of arable land area and maximise nutrient cycling. They also illustrate a high trade-off in cases where there is exceptionally low farm productivity: the biodiversity values come at a high environmental cost and small contribution to production. However, reliance on HNV production systems may require changes in the current dietary pattern towards lower levels of animal products. Other plausible benefits of HNV systems –

carbon sequestration on semi-natural grasslands, quality of product in terms of healthy composition and taste – have never been studied in Finland.

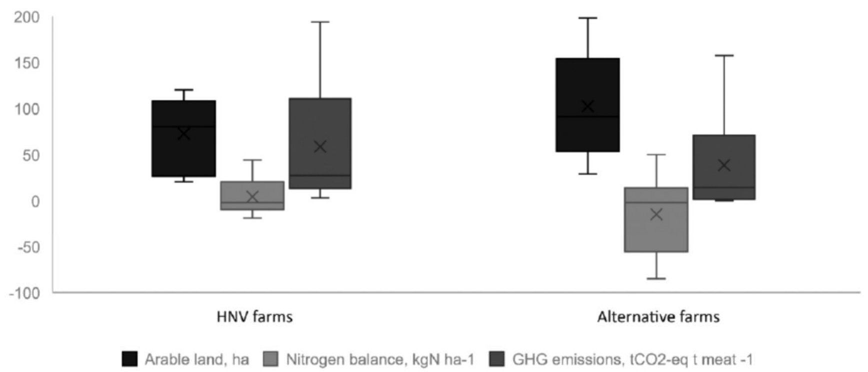

Figure 1. Median, average and quartile values from nine High Nature Value (HNV) farms and their alternative state without semi-natural grasslands (A) for three environmental indicators: arable land, nitrogen balance and GHG emissions at product level.

Conclusions The preliminary results suggest that HNV farming systems in Finland play their role in combining production with maintenance of biodiversity but only when maintaining a certain level of production output. Two issues need to be resolved: methodologically, development of methods dealing with impacts of different nature (e.g. biodiversity vs GHG emissions); and, from the production perspective, how to maintain or increase the capacity of these systems in supplying animal products.

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