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Promoting clover-grass: Implications for agricultural land use in Finland

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ABSTRACT

Clovers, such as red clover (Trifolium pratens), are often cultivated with grass in Northern Europe. Clover forages are suitable for sustainable low-input or organic dairying, since they require less nitrogen fertilization, while providing higher protein content in feed, than pure hay grasses. A partial equilibrium, economic sector model was used in analyzing land use and production effects of measures promoting clover-grasses, in forage production, in Finland. Reduced costs, higher clover-grass yield levels, premium payments for clover-grasses, and fertilizer taxes could increase clover-grass areas and feed use. The results suggest that premium payments for clover-grass areas or reduced costs may have little effect, while fertilizer taxes and higher yield levels of clover are more likely to result in significantly increased clover-grass production. We also found that the effectiveness of clover-grass promotion measures is highly dependent on crop and livestock product prices, as well as fertilizer prices. However, the potential for increasing clover-grass is limited due to, e.g., manure spreading requirements. It was found that it is hard to increase clover-grass area above 30%, from the current 15%, of overall grassland area in Finland.

1. Introduction

Large changes in European dairy production supply management, such as abolition of production quotas, may increase volatility in dairy markets. Prices of agricultural inputs have increased rapidly, 50–60%, since 2005. Adopting low-input legume-based grassland in dairy production may lead to significant environmental benefits (Lüscher et al., 2014; Soussana et al., 2010) and offer farmers an option for increasing resilience to market changes, by reducing production costs. Low-input dairy systems are primarily understood to differ from high-input dairying in terms of feed ration composition and feed production. However, decreasing input use in Northern European forage production has not been considered a very attractive option, as high capital production costs require high animal productivity (Virkajärvi et al., 2015). Reduced feed quantity and quality, or larger forage areas, due to decreased use of inputs, could jeopardize productivity and economic viability of dairy production. Over the last 10 years, increasing dairy production in Europe is often coupled with larger farm size, more intensive land use and feed production, and increased use of feed protein purchased outside the farm. Nevertheless, legume based grasslands are considered promising since they reduce the need for nitrogen (N) fertilization, production costs and increase protein content of feed (Lüscher et al., 2014). In this study, we evaluate the feasibility and effectiveness of different measures promoting clover-grass cultivation in Finland. Forage legumes are known for providing a greater intake potential and better animal performance than grassland species in animal nutrition (Dewhurst et al., 2003). The most important Finnish forage production species are timothy (*Phleum pratense* L.) and meadow fescue (*Festuca pratensis* Huds.). These are preferred because of their combination of good winter tolerance, reasonably high yield capacity and high nutritive value, under Finnish conditions and management practices (Virkajärvi et al., 2015). The most important forage legume is Red clover (*Trifolium pratens*), which, along with other legumes, is commonly cultivated in Northern Europe as well as in the United States and Canada (Kuoppala et al., 2009). As a legume, red clover offers biological nitrogen (N) fixation, which reduces the need for N fertilization. These benefits are realized, in the context of Finland, if sufficiently low (N) fertilization, e.g., 50 kg of soluble N per ha, is applied. This would maintain a clover biomass comparable to the hay biomass in the vegetation, while higher N fertilization leads to deterioration of clover and intensive growth of grassland species (Mela, 2003; Nykänen, 2008). Thus, clover-grass, in this paper, refers to low N fertilization and an intended 50–50 mix of clover and grassland species, where clover has remained in the sward with a 25% or

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higher proportion of the total dry matter yield. However, high N fertilization is often the only possibility at farms with high livestock density, due to manure spreading obligations. There is often too little or too expensive additional land available for manure spreading. It is difficult to significantly increase clover-grass area, under such circumstances. Some increase of clover-grass (with little spreading of manure N) is possible, however, if manure spreading on other crops can be increased. Low levels of manure spreading on clover-grass is possible, if livestock density is not too high. According to Finnish FADN (Farm Accountancy Data Network) results, the average livestock density is still relatively low (0.80 livestock units (LU) per ha 2006 and 0.82 LU/ha 2014) on Finnish dairy farms (Luke, 2015a). Such livestock densities typically imply 50–100 kg manure N per ha, on average, depending on the productivity levels of a farm (Kokkonen et al., 2014). Hence, increasing clover-grass, overall, is possible in Finland, if properly incentivized.

Increasing farm size, which decreases the unit cost of production and is needed for maintaining economic viability of dairy production in Finland (Luke, 2015a), often leads to higher livestock densities and higher (manure) N fertilization. Such developments may challenge the promotion of low-input forage options, such as clover-grasses. Some technologies are available and expected to improve manure logistics and the efficient use of nutrients. Biogas processing of manure, separates solid organic N and manure phosphorous (P), from soluble N (in liquid fraction of digestate material). Organic N and P could be transported out of the farm and, thus, reduce the need of manure spreading on a farm. This could, in principle, still maintain N fertilization at sufficiently low levels and ensure the feasibility of clover-grass, despite increasing the livestock density of dairy farms. However, biogas processing, which requires significant capital investments and is still rare on dairy farms in Finland, maintains total manure N and increases soluble N at a farm, if not transported out of the farm (Luostarinen et al., 2011, 2016; Haverinen 2014). Manure P and organic matter are most likely needed on a dairy farm, since there is, typically, relatively little excess manure P on Finnish dairy farms (Luostarinen et al., 2011). Hence, biogas, or other manure processing, may not reduce N fertilization on dairy farms, in the context of Finland. Thus, one cannot rely on the possibilities of manure processing as a means of maintaining sufficiently low N fertilization and clover-grass, as a forage option. How to promote clover-grass as a low-input forage feed option is still a relevant question.

Organic dairy farms already find clover-grasses a feasible option, as they are incentivized by higher milk prices and higher area-based subsidies granted for organic production. However, the market demand for organic milk products has developed very slowly in Finland (1.8% of all milk received and processed in dairies was organic in Finland, in 2013). Some organically produced milk has been sold as conventional milk, as well, due to weak demand (Suomen Kuvalehti, 2008; Pro Luomu 2013). Thus, increasing the currently small organic dairy production and accompanying clover-grass area is fully dependent on market demand developments.

Increasing clover-grasses on conventional dairy farms could provide a significantly greater potential for clover-grass area expansion; however, it is also presents challenges. Conventional dairy and cattle farms can purchase protein feeds, relatively inexpensively, on the market, but future market prices for livestock and crop products, as well as fertilization prices, are unknown. Farms must also comply with manure spreading obligations and restrictions, which apply to both N and P (Niemi and Ahlstedt, 2012). Clover-grasses may not provide sufficient cost savings for purchased feeds and inorganic fertilizers, when compared to the increased costs due to additional land needed for feed production and manure spreading, as well as increased labor costs. This study focuses on these factors, which all affect clover-grass production in Finland and summarizes the challenges in a way that could be useful, beyond Northern Europe. The most important issues are related to the feasibility and economic viability of required land use changes, the feed use of dairy cows, manure spreading restrictions, and the resulting production reorganization and land use at the farm and regional (national) levels.

The objective of this study is to evaluate: (1) How cultivation and use of clover-grasses as a feed can be promoted?; (2) How much more land area could be allocated to clover-grass, if clover-grass premiums, reduced cost levels, a fertilizer tax, or increased clover-grass yield levels were implemented?; (3) What kind of land use change is implied, i.e., which crops are reduced in land area if the area under clover-grass is increased?; (4) How much clover-grasses can be increased by, using reasonably inexpensive policies and other measures, without increasing the overall budget of agricultural support payments, and still keep dairy and cattle production economically viable?

Current clover-grass cultivation is further modeled in a partial equilibrium, economic sector model. The DREMFIA model (Dynamic Multiregional Model of Finnish Agriculture) (Lehtonen, 2001, 2015) is built to capture the most important farm and sector level land use effects, under different European prices or agricultural policies. The model, simulating competitive markets and rational economic behaviors of consumers and producers, primarily allocates land to crops providing the most economic value for the food chains. Increasing the area of low-input use forage (here, clover-grass mix) means a reduced area under some other forage or other crops. It is important to evaluate what kind of land use change would be implied by increasing clover-grass cultivation, and to what extent such changes are feasible and economically viable.

This paper proceeds as follows. First, we briefly present the agricultural sector model simulating competitive markets, based on price and policy scenarios, up to 2030. We also estimate the current clover-grass area, based on available data. Second, we present our main price scenarios, i.e., two baselines, under which the effectiveness of specific measures of promoting clover-grasses is evaluated using the sector model. Third, we present the main results of the effect of the measures on land use and dairy production, as well as farm income. We discuss the main findings and conclude on the effectiveness of the different promotional measures for clover-grasses.

2. Methodology

2.1. Economic agricultural sector model DREMFIA

The DREMFIA model simulates production, demand and foreign trade of the main agricultural commodities produced in Finland, as well as land use (areas under crops and set aside) and production intensity (fertilization, manure use) annually, from 1995 until 2020; and produces a steady state static equilibrium for 2030, 2040 and 2050. The model assumes rational economic behavior and competitive markets, replicates realized production and land use from 1995 to 2014, and produces consistent future agriculture development paths.

The model includes supply and demand of main agricultural commodities produced in Finland, such as, 11 crops and 4 types of forage crops, beef, pork and poultry meat. Dairy milk is used in the processing activities of 18 different dairy products. Demand and foreign trade is determined at the level of four main regions: Southern Finland, Central Finland, Ostrobothnia and Northern Finland. The products move between the main regions to cover the demand of each main region, at a certain transportation cost. Since the model is very exacting in terms of agricultural policy, the main regions are further divided into sub-regions, according to