# THE IMPACTS OF ALTERNATIVE POLICY SCENARIOS ON MULTIFUNCTIONALITY

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***Paper prepared for presentation at the XIth International Congress of the EAAE***

***(European Association of Agricultural Economists),***

***'The Future of Rural Europe in Global Agri-Food System'***

***Copenhagen, Denmark***

***August 24-27, 2005***

# THE IMPACTS OF ALTERNATIVE POLICY SCENARIOS ON MULTIFUNCTIONALITY

**Abstract.** This paper provides first results of the sector model approach to analyze the effects of alternative policy scenarios on the multifunctional role of Finnish agriculture. In terms of environmental non-commodity outputs we focus on nutrient runoffs, landscape diversity and biodiversity. As regards to socio-economic outputs our focus is on direct and indirect agricultural labour force. The results suggest that while partial de-coupling agricultural supports from production is not likely to result in any drastic decline of agricultural production the amount of green fallow will increase considerably. As a result, the agricultural land will become biologically richer. The agricultural labour force is likely to decrease substantially irrespective of agricultural policy.

**Key words:** agricultural policy, multifunctionality, sector model

**JEL classification:** Q18, Q21

## 1. Introduction

The notion of multifunctional agriculture refers to the fact that agricultural production provides not only food and fibre but also different non-market commodities. These non-commodity outputs include the impacts of agriculture on environmental quality, such as rural landscape, biodiversity and water quality. Often this list includes also socio-economic viability of countryside, food safety, national food security and the welfare of production animals together with cultural and historical heritage. There is no universally accepted definition of multifunctionality, and emphasis given to various types of non-commodities differs. OECD (2001) provides a “working definition” of multifunctionality. This definition gives as the fundamentals of multifunctionality i) the existence of joint production of commodity and non-commodity outputs and ii) the fact that some of the non-commodity outputs exhibit the characteristics of externalities or public goods (OECD, 2001: 13). Both theoretical and applied work has tried to push forward the dimension of this working definition.

Academic research made on multifunctionality has mainly focused on the environmental dimension of multifunctionality. The reason for this is evident: Pareto optimality requires that all positive and negative externalities should be internalized, giving thus a firm theoretical basis to the environmental dimension multifunctionality. Boisvert (2001), Romstad et al. (2000), Guyomard and Levert (2001), Anderson (2002), Paarlberg et al. (2002), Vatn (2002), Peterson et al. (2002), Lankoski and Ollikainen (2003), Guyomard et al. (2004), and Lankoski et al. (2004) focus on the properties and policy design of multifunctional agriculture either in a closed economy or in an international trade framework. All these studies utilise the theory of joint production.

None of previous papers has focused on the non-public good aspects (such as rural viability or food security) of multifunctional agriculture. The decision of whether other aspect than these public goods should be introduced to the social welfare function of agriculture is a complex question. As OECD (2001) observes and, for instance, Anderson (2002) argues, food security and rural viability cannot entirely be subsumed into the category of public goods. Very recently Ollikainen and Lankoski (2004) have enlarged the conventional public goods and bads framework to include non-public good aspects via rural viability. Following OECD (2001) they express rural viability through employment effects of agricultural production. They demonstrate that rural viability moderates policy towards public goods (environmental non-commodity outputs) because society trade-offs public good aspects with viability aspects. Two Norwegian studies (Brunstad et al. 2004 and Prestegard 2004) have employed Norwegian agricultural sector model (Gaasland et al. 2001) to analyse the effects of alternative policy scenarios on food security, landscape and employment.

An important question, so far unfocused in the literature of multifunctional agriculture, is the fact that joint production between commodity and non-commodity outputs naturally differs between alternative production lines. For example, milk production can be considered as truly multifunctional production activity (both in terms of environmental non-commodity outputs as well as rural viability aspects), which however, differs much from multifunctionality associated with crop production. Previous literature has focused on policy packages mainly within crop production (see e.g. Guyomard et al., 2004 and Lankoski et al., 2004), but not in alternative production lines. Hence, an important research question rises: how does multifunctional agricultural policy affect the relative profitability and public goods and viability aspect across alternative production lines within agriculture? The main research question in this paper is how alternative policy scenarios affect the relative profitability of different production lines and how the supply of joint non-commodity outputs change as a result of profitability changes. Moreover, we analyse the merits of environmental cross-compliance schemes to address multifunctionality.

We examine this problem in a dynamic regional sector model of Finnish agriculture (DREMFIA) (for a thorough description of the model see Lehtonen, 2001). This model is employed to assess the effects of alternative policy scenarios on the multifunctional role of Finnish agriculture. The special advantage of the model is that it allows us to explore the nature of the adjustment paths over time as a response to alternative policies. In terms of environmental non-commodity outputs we focus on nutrient runoffs, landscape diversity and biodiversity. We use regional nutrient surpluses (soil surface balance method) for nitrogen and phosphorus as a proxy for nutrient runoffs and resulting surface water quality impairment. For assessing landscape diversity we employ Shannon's diversity index (SHDI) to assess the richness (number of different land-cover classes, that is cultivated crops and bare and green fallow) and evenness (uniformity of distribution between land use types) of agricultural land use under different policy scenarios. The area under different types of wildlife habitats is used as a proxy for biodiversity. We link land areas and biodiversity as follows. We first measure the area under intensively cultivated habitats (e.g. cereals and silage) as well as the area under semi-natural habitats (e.g. field edges, buffer strips, extensive grass land and pasture, low intensity permanent crops etc.). Then we employ relative weights (that is, the quality of each habitat to flora and fauna) for different types of habitats in order to determine the biodiversity implications of different policy scenarios. The relative weights we are using are derived from Finnish field surveys in which the quality of different habitats for butterfly richness and abundance has been estimated (Kuussaari and Heliölä, 2004).

As regards to other non-commodity outputs one of our focus is rural socio-economic viability. In line with Ollikainen and Lankoski (2004), we describe the core economic content of rural viability by employment in agriculture and in the rural sectors serving agriculture. We employ an economic sector level model which does not consider explicitly linkages between agriculture and other sectors of national economy. Hence the approach cannot provide final results concerning the employment effects of agricultural policies. However, our approach considers explicitly and in a detailed way the linkages between different production lines in agriculture. Especially the changes in relative profitability in different agricultural activities affect production volumes and land use since land is a limited resource. Agricultural land and production equipment, on the other hand, are of low value in alternative uses in Finland where countryside is relatively sparsely populated. Hence even a partial equilibrium approach is interesting in evaluating socio-economic effects of agricultural policies.

The rest of this paper is organized as follows. The section two presents the agricultural sector model employed by the study as well as the selected multifunctionality indicators used in the calculation. In section three, alternative agricultural policy scenarios are listed and interpreted. The fourth section lays out the indicator results from the sector model. Finally, the results are evaluated and the applicability of the chosen approach is discussed.

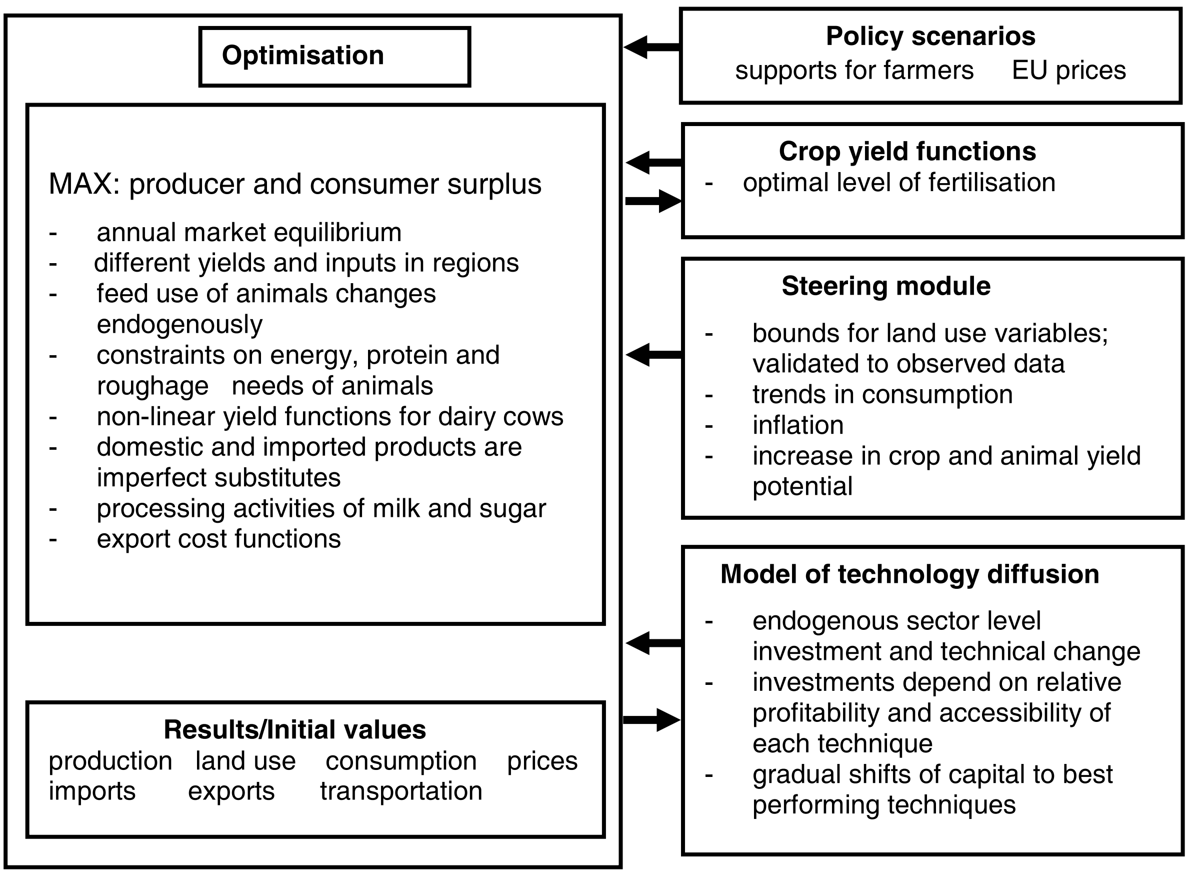
## 2. The model and multifunctionality indicators

### *2.1 The sector model*

DREMFIA is a dynamic recursive model and includes 17 production regions. The model provides effects of various agricultural policies on land use, animal production, farm investments and farmers' income. The model consists of two major parts: (1) a technology diffusion model which determines sector level investments in different production technologies, and (2) an optimisation routine which simulates annual production decisions (within the limits of fixed factors) and price changes, i.e., supply and demand reactions, by maximising producer and consumer surpluses subject to regional product balance and resource (land and capital) constraints (cf. Figure 1).

In the DREMFIA model, annual land use and production decisions from 1995 to 2020 are simulated by an optimisation model which maximises producer and consumer surplus subject to regional product balance and resource (land) constraints. Products and intermediate products may be transported between the regions. The optimisation model is a typical spatial price equilibrium model (see e.g. Cox & Chavas 2001), except that no explicit supply functions are specified (i.e., supply is a primal specification). Furthermore, foreign trade activities are included in DREMFIA. The Armington assumption (Armington 1969), which is a common feature in international agricultural trade models but less common in one-country sector models, is used. Imported and domestic products are imperfect substitutes, i.e., endogenous prices of domestic and imported products are dependent. There are 18 different processed milk products and their regional processing activities in the model.

Figure 1. Basic structure of the DREMFIA model.




Four main areas are included in the model: Southern Finland, Central Finland, Ostrobothnia (the western part of Finland), and Northern Finland (Fig. 2). Production in these areas is further divided into sub-regions on the basis of the support areas. In total, there are 17 different production regions. This allows a regionally disaggregated description of policy measures and production technology. The final and intermediate products move between the main areas at certain transportation costs.

Technical change and investments, which imply evolution of farm size distribution, are modelled as a process of technology diffusion. Investments are dependent on economic conditions such as interest rates, prices, support, production quotas and other policy measures and regulations. The model of technology diffusion follows the main lines of Soete & Turner (1984). Two crucial aspects about diffusion and adaptation behaviour are included: first, the profitability of a new technique, and second, the risk and uncertainty involved in adopting a new technique. The information about and likelihood of adoption of a new technique will increase as its use becomes widespread (Lehtonen, 2001).

Use of variable inputs, such as fertilisers and feed stuffs, are dependent on agricultural product prices and input prices through production functions. The economic model explicitly takes into account nutrients from animal manure. Feeding of animals may change in the short-term within certain bounds imposed by fixed production factors and animal biology, provided that nutrition requirements are fulfilled. Specific production functions are used to model the dependency between the average milk yield of dairy cows and the amount of the grain based feed stuffs used in feeding. The yield of dairy cows responds to price changes of milk and feed stuffs. Time series of the model outputs include number of animals, areas of different crops and feeding of animals.

Milk quotas, which constrain milk production at farm and country level, are traded within three separate areas in the model. Within each quota trade area, the sum of bought quotas must equal the sum of sold quotas. The price of the quota is the weighted sum of the shadow values of an explicit quota constraint.

A detailed presentation of the model and its parameters can be found in Lehtonen (2001, 2004). The overall model replicates very closely the ex post production in 1995-2003.


Figure 2. Main regions in the dynamic regional sector model of Finnish agriculture (DREMFIA).

### *2.2. Multifunctionality indicators*

Most of the indicators presented in this paper, like production volumes, hectares of crops, nutrient balances and incomes, as well as direct agricultural employment, are calculated directly using the DREMFIA sector model. Indirect agricultural employment was calculated using regional input-output –tables which take into account both upstream and downstream indirect employment (Knuuttila 2004).

Shannon's diversity index (SHDI) was applied in the land-cover diversity calculations (McGarigal and Marks 1995). The index is based on information theory (Shannon 1948) and it is frequently used in diversity quantifications (cf. Di Falco and Perrings 2003, Hietala-Koivu et al. 2004). The values of SHDI were calculated according to the formula:

$$SHDI = -\sum_{i=1}^{m} \left(P_i \times \ln P_i\right),$$

where m is the number of land-cover classes, $P_i$ measures the proportion of area covered by land-cover type i and ln denotes natural logarithm. SHDI is equal to zero when the agricultural area contains only one land-cover class (i.e. no patch diversity). The value of Shannon's diversity index increases as the number of different land-cover classes increases and/or the proportional distribution of the area among land-cover classes becomes more equitable. Hence, for a given number of land-cover classes, SHDI reaches its maximum when the proportions of land-cover classes are uniform, i.e. $P_1 = P_2 = \ldots = P_m = 1/m$ (McGarigal and Marks 1995).

In addition to diversity in agricultural land use, we also discuss the potential biodiversity effects of policy scenarios. According to Duelli (1997), biodiversity evaluation at regional level can be based on landscape parameters. Even though landscape diversity indicators give an overview of biological diversity, there are no general models which relate overall species diversity to landscape diversity (Jeanneret et al. 2003). The relationship depends thus strongly on the organism examined.

The aggregate soil surface balances (surplus/deficit) for nitrogen and phosphorus per cultivated area, excluding set-aside, were calculated by adding the nutrient content of fertilisers, organic manure, and nitrogen depositions, and by subtracting the nutrient content of the harvest and losses to the atmosphere. The calculated net nutrient surplus (kg/ha) provides an indicator of the production intensity, and of the potential nutrient losses and environmental damage to surface and ground waters.

The amount of pesticide application area was also reported. Chemical pesticides enhance agricultural productivity but also pose potential risks to human health and the environment. They may, for example, cause contamination of surface water.

Habitat index was calculated on the basis of a large scale dataset of empirical observations concerning butterfly numbers on lands of different crops (Kuussaari & Heliölä 2004). The butterfly was selected as an indicator species by environmental scientists. It was observed that green set-aside was 6 times more valuable habitat for butterflies than grain fields, whereas field edges provided more than 7 times more valuable habitats, and natural meadows provided almost 10 times more valuable habitats for butterflies than grain fields. These relative weights were used directly when calculating a habitat index as a linear vector, divided by overall hectares of agricultural lands. Hence the resulting index represents average biodiversity value of all agricultural land, in comparison with natural meadows. In 1995-2004 the calculated habitat index is valued between 20-25. The index would be 100 if all agricultural lands were changed to natural meadows.

## 3. Alternative agricultural policy scenarios

Based on the current multilateral trade negotiations and the most recent indications of negotiation positions from various WTO members, there are a number of interesting policy scenarios that could be analysed. In response to the WTO framework' agreement approved in Geneva on July 2004 and the possible conclusion of the Doha round, a following set of scenario are formulated:

### *3.1. The baseline scenario (BASE)*

The baseline scenario BASE corresponds to the continuation of the Agenda 2000 agricultural policy (agreed in Berlin 1999) over the medium term. The purpose of the baseline is not as a forecast of the future but to establish a yardstick against which policy simulations can be judged. The baseline simulation is a view of the world where policies remain unchanged. The impact of EU enlargement has not been incorporated into the baseline. However, it is important to remember that the baseline scenario includes the reductions in intervention support prices and future increases in quotas in the dairy sector that were already politically agreed in Berlin 1999. Therefore, it is assumed that producer price of milk would fall by 12% in the EU and in Finland until 2008 from the average producer price of 1999-2001.

### *3.2. CAP reform scenario (REF)*

The on-going CAP reform scenario (from now on REF scenario) followed the CAP reform agreement made in June 2003, according to which most direct CAP subsidies will be decoupled from production and paid in a single, lump-sum farm payment based on 2000-2002 historical production levels (CEC 2003). All CAP arable area payments will be decoupled from production in 2006 and a regionalised flat-rate payment will be paid for all farms and all crops (including set-aside, but excluding some permanent crops). Also decoupled CAP animal support, based on 2000-2002 production, will be paid for individual farms. However 69% of bull premia and 100% of suckler cow premium will remain coupled to production, i.e. paid per animal. The sum of coupled bull and suckler cow premia will not exceed 75% of the bull premia paid in the reference period 2000-2002. Overall, 85% of CAP support will be de-coupled. The farm-specific payments of decoupled animal support will be later included in the flat-rate payment (MAF 2005).

Receiving decoupled CAP support will not require any agricultural commodity production. However, farmland has to be kept in good agricultural and environmental condition and this means in practice that land has to be either cultivated or kept as set-aside land. In the REF scenario, no change in the EU level cereal prices is assumed. The intervention price for butter is reduced 25 percent (-7 percent in 2004, 2005, 2006, and -4 percent in 2007), which is 10 percent more than agreed in Agenda 2000. For skimmed milk powder (SMP) prices will be cut by 15 percent as agreed in Agenda 2000 (but in 5 percent steps over three years from 2004 to 2006). In 2007, it is assumed that the overall decrease in the average producer price of milk at the EU level will be 16% down from the 2003 price level, i.e. 4 percentage points more relative to the baseline. The price cuts will be compensated by a direct payment of €35.50 per ton of milk quota. This payment becomes fully decoupled in 2007. Furthermore, 5% of all direct EU payments will be cut (modulated) from 2007.

As regards to multifunctionality issues and indicators, the question here is to evaluate to what extent the 2003 CAP reform, notably the decoupling of agricultural income support direct aids is likely to have positive or negative impacts of multifunctionality indicators.

### *3.3. Environmental Cross Compliance (ECC)*

'Environmental cross compliance' scenario ECC is identical to REF scenario, except that one assumes that each member state chooses the full decoupling option, and that field edges have to be expanded by 300%, i.e. from 0.5 meter to 2 meter wide. The idea of this scenario is to test the field edges' contribution to habitat index and possible effects on production.

### *3.4. Attack on domestic support scenario (RED)*

The 'Attack on domestic support' scenario RED assumes, in addition to scenario ECC, that the EU (and Finland) is forced to agree a 20% cut in existing decoupled payments by 2013. By comparing RED and ECC, one should be able to say something on the "relative" efficiency of decoupling as regards to multifunctionality.

## 4. Indicator results from the model

### *4.1. Continuation of Agenda 2000*

The base run of the agricultural sector model indicated with certain exceptions that if the Agenda 2000 policy continued, there would be no substantial changes in production volumes. For example, dairy production would stay almost unchanged in all regions. However, the total amount of cultivated area, including fallow and cultivated grassland, would decrease significantly. The most important change therefore concerns the amount of marginal farming land taken out of production, the area of which would increase up to 10-15% of all agricultural land. Such a change results mainly from investments in larger dairy facilities which, in turn, lead to a regional concentration of agricultural commodity production within each individual region studied. Consequently, the demand for feed (grain and grass) decreases in many areas. This weakens endogenous market prices and the profitability of grain production. Because also pork and poultry production continue to concentrate into large production units, some agricultural land is left idle in relatively less favourable agricultural areas. The relative increase in the uncultivated land area will be largest in northern Finland, but the absolute changes are largest in southern and central Finland. Soil quality is highly heterogenous even in Southern Finland. This heterogeneity is partly taken into account since there are 18 production regions in the DREMFIA model. However, soil quality is considered homogenous inside each region.

### *4.2. Agenda 2000 vs. the on-going reform of Common Agricultural Policy*

In base scenario the milk production remains relatively stable in all regions since milk payments compensating the price reductions of butter and skimmed milk powder are tied to milk quotas. In CAP reform the linkage between milk payments and milk quotas is removed. According to the model results, CAP reform is not likely to result in any drastic decline of agricultural production in Finland, on the aggregate. However, milk production may reduce substantially in Northern Finland where dairy is the dominant line of production. Some decline of production may also take in Central Finland but the decline of production on these areas will be partly compensated by an increase in production in Ostrobothnia region which may benefit from the decreasing values of milk quotas in CAP reform. Hence some milk quotas from Central Finland shift to Ostrobothnia. Since milk quotas cannot be sold from Southern Finland to Ostrobothnia (the movement of milk quotas has been restricted in three major quota trading areas where the number of sold quotas must equal to the number of purchased quotas), the decreased value of milk quotas in Southern Finland will facilitate a recovery of milk production from 2010. In northern Finland, which constitutes a third quota trade area, however, not even the reduced milk quota values are sufficient to later recovery of milk production volume.

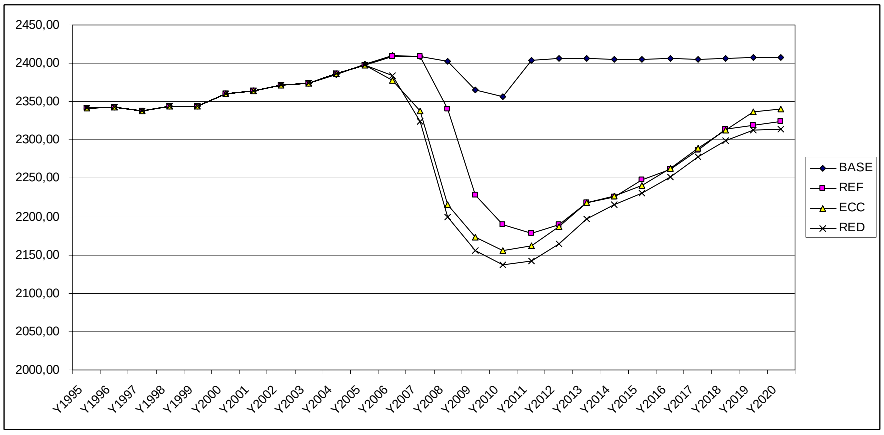



Figure 3. Total milk production volume (million litres) in Finland. Abbreviations: BASE = Agenda 2000; REF= Luxembourg 2003 reform with national adaptations; ECC= Environmental Cross Compliance; RED = Reduction of CAP payments by 20% until 2013.

Table 1. Percentage changes in milk production by 2015 in different scenarios compared to the baseline. Abbreviations: BASE = Agenda 2000; REF= Luxembourg 2003 reform with national adaptations; ECC= Environmental Cross Compliance; RED = Reduction of CAP payments by 20% until 2013.

| | REF | | | ECC | | | RED | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2020 | 2010 | 2015 | 2020 | 2010 | 2015 | 2020 |
| Southern Finland | -11.1 | -9.3 | -0.9% | -14.8 | -9.2 | +1.0% | -14.4 | -8.5 | +0.5 |
| Ostrobotnia | -4.0 | +3.4 | +3.7 | -2.2 | +3.6 | +4.9 | -3.3 | +3.3 | +6.1 |
| Central Finland | -5.9 | -11.3 | -8.9 | -9.1 | -13.4 | -11.8 | -9.3 | -14.7 | -11.7 |
| Northern Finland | -7.4 | -18.6 | -22.2 | -6.5 | -16.5 | -17.5 | -9.1 | -20.5 | -25,0 |
| Whole country | -7.1 | -6.6 | -3.4 | -8.5 | -6.9 | -2.8 | -9.3 | -7.3 | -3.9 |

This difference is due to cuts in milk price and decoupled CAP payments which considerably reduce incentives to invest in milk production in the REF scenario. Since many farms are small and production costs are high, most dairy farmers who exit milk production make only the minimum effort to receive the CAP payments, i.e., they leave their land as set-aside. The reduction in overall production volume, on the other hand provides opportunities for expanding dairy farms.

Decreasing number of dairy cows and the partial or full de-coupling of CAP headage payments will gradually result in decreasing beef production and grass area in all parts of Finland. Effects of CAP reform on pork and poultry production will be minor, however.

When comparing the agricultural land use predictions of the on-going CAP reform scenario to the corresponding results of the extended Agenda 2000 scenario, we found that the REF scenario resulted in an almost four times larger green fallow area than the BASE scenario. Correspondingly the areas devoted to barley, oats and grass will be significantly smaller under the REF scenario. Only the most feasible areas of earlier grasslands will be used for grain production. In relative terms, the difference in the green set-aside area between the two scenarios was largest in northern and central Finland. In both regions, green set-aside area will increase significantly as a result of the REF scenario.

Table 2. Percentage changes in land use (1000 ha) by 2015 in different scenarios compared to the baseline. Abbreviations: BASE = Agenda 2000; REF= Luxembourg 2003 reform with national adaptations; ECC= Environmental Cross Compliance; RED = Reduction of CAP payments by 20% until 2013.

| | Cereals area | | | Grass area | | | Green set-aside | | |
|---|---|---|---|---|---|---|---|---|---|
| | REF | ECC | RED | REF | ECC | RED | REF | ECC | RED |
| Southern Finland | -12.8 | -13.1 | -11.9 | -20.4 | -23.2 | -20.1 | +350 | +231 | +341 |
| Ostrobotnia | -23.2 | -25.6 | -23.9 | -5.2 | -2.7 | -0.0 | +156 | +78.7 | +143 |
| Central Finland | -45.5 | -48.3 | -46.8 | -11.2 | -12.8 | -12.6 | +440 | +357 | +450 |
| Northern Finland | +150 | +191 | +166 | -9.7 | -13.3 | -13.1 | +1073 | +705 | +1089 |
| Whole country | -19.2 | -20.2 | -18.9 | -11.8 | -12.3 | -11.1 | +305 | +206 | +299 |

Compared to the base scenario, decoupling of CAP support from production (in REF scenario 85% of CAP supports are de-coupled, and in ECC and RED scenarios 100% of CAP supports are de-coupled) slightly decrease the area under cereals in southern Finland. The changes in dairy sector are clearly seen in the proportion of grassland area, which will be appr. 20% smaller in 2015 as a result of the REF scenario. Instead, the fallow area may be over three times larger than under Agenda 2000. These changes in grassland and fallow areas are also significant in absolute terms, since over a half of total agricultural area is located in southern Finland.

Ostrobothnia is the second largest agricultural area. If CAP supports are decoupled from production, the area under cereals in 2015 will be over 20% smaller than as a result of the base scenario. Fallow area, in turn, will be almost 2.5 times bigger. If CAP support is disconnected from production, cereals area will decrease relatively most in central Finland. In 2015 it will be close to 50% smaller than as a result of Agenda 2000 policy. The grassland area in turn will be over 10% smaller, but the fallow area may be almost times larger.

The share of agricultural land under grain was appr. 9%, and the share of set-aside was appr. 4% in northern Finland in 2003. In base scenario the share of grain reduces further to 3% until 2015. Opposite to the other regions, the on-going CAP reform will not decrease the cereals area of northern Finland. Instead the grain area remains close to 2003 level, i.e. grass lands, but not grain areas, are converted to set-aside areas. When many northern dairy farmers exit unprofitable dairy production, this not only adds set-aside areas, but may also lead to an increase in grain areas on those former grasslands where the costs of feed grain cultivation can be covered. The greatest increase is, however, in the fallow area, which will be over 10 times larger as a result of the REF scenario. The area under grass, which already covers close to 90% of agricultural land in northern Finland, will be approximately 10% smaller compared to the base scenario. While dairy production reduces by 15-20%, this means that dairy production becomes relatively more extensive

The decreasing cereals area also means decreasing area under pesticide application. Everywhere except in northern Finland, the chemical pesticide application area is smaller under CAP reform scenarios than as a result of the base scenario, since cereal areas will decrease if direct aid payments are decoupled from production. If we examine the land-use results at the whole country level, the pesticide application areas will be largest as a result of the base scenario and smallest as a result of the

RED scenario. This will benefit, for example, farmland birds since reduced use of pesticides may increase the amount of insect prey.

The REF scenario will result in lower nitrogen and phosphorus surpluses only temporarily in all regions. Regional concentration of dairy and beef production is stronger in REF scenario compared to base –scenario. This, in turn, will drive up the nutrient balances again. The same kind of development takes place in REF scenario. Significant regional concentration of dairy production and larger farms imply more intensive grassland management, despite lower milk prices due to CAP reform. For this reason nutrient balance increases even in central Finland where dairy production volume decreases slightly. The high increases of average nutrient balances in central Finland are partly due to drastically diminishing grain area, and partly because of more intensive dairy production. In central Finland the there will be some scarcity of land available for large dairy farms which drive up the nutrient balances. The nitrogen and phosphorous balances remain below base scenario levels in southern Finland and also in northern Finland, where the overall milk production volume will decrease considerably, and there are less pressures for intensive dairy production.

Table 3. Percentage changes in aggregate nitrogen and phophorus balance (kg/ha) by 2015 in different scenarios compared to the baseline. Abbreviations: BASE = Agenda 2000; REF= Luxembourg 2003 reform with national adaptations; ECC= Environmental Cross Compliance; RED = Reduction of CAP payments by 20% until 2013.

| | Aggregate nitrogen balance | | | Aggregate phosphorus balance | | |
|---|---|---|---|---|---|---|
| | REF | ECC | RED | REF | ECC | RED |
| Southern Finland | -17.8 | -18.2 | -18.5 | -2.2 | -3.5 | -2.3 |
| Ostrobotnia | -7.2 | -2.5 | -0.0 | +5.8 | +11.2 | +8.1 |
| Central Finland | +10.1 | +10.2 | +11.1 | +19.7 | +20.1 | +18.7 |
| Northern Finland | -0.1 | -6.0 | -1.8 | -6.9 | -7.5 | -6.5 |

The above-mentioned changes in land allocation lead to a bit more uneven aggregate land-cover class distribution in southern and central Finland and in Ostrobothnia (c.f. Shannon’s diversity index in Table 4). Instead, in northern Finland, the value of SHDI will slightly increase in CAP reform scenarios along with the higher cereals area and uncultivated agricultural area. Increased uncultivated area results increased Shannon index values in CAP support reduction (RED) scenario. Expanded field edges in ECC scenario provide further increase of diversity of land use. On the other hand, reduction of CAP supports do not lead to decrease in Shannon index, compared to REF scenario.

Table 4. Percentage changes in Shannon’s diversity index and habitat index by 2015 in different scenarios compared to the baseline. Abbreviations: BASE = Agenda 2000; REF= Luxembourg 2003 reform with national adaptations; ECC= Environmental Cross Compliance; RE = Reduction of CAP payments by 20% until 2013.

| | Shannon’s diversity index | | | Habitat index | | |
|---|---|---|---|---|---|---|
| | REF | ECC | RED | REF | ECC | RED |
| Southern Finland | -13.7 | -6.0 | -8.8 | +53.7 | +30.8 | +52.2 |
| Ostrobotnia | -5.6 | -2.1 | -4.4 | +30.0 | +12.4 | +29.6 |
| Central Finland | -17.7 | -7.5 | -17.7 | +69.5 | +52.2 | +70.3 |
| Northern Finland | +20.0 | +36.4 | +24.4 | +46.6 | +27.2 | +43.3 |

In order to evaluate changes in biodiversity a habitat index has been calculated. While the base scenario shows gradually decreasing levels of habitat index on agricultural lands (grass area decreases), the rapid expansion of green set-aside in all other scenarios results in a significant increase in habitat index. This is because green set-aside is considered almost 5 times more valuable living environment for certain indicator species (in this case, butterfly) than grain crops. However, if large areas will be idled and gradually converted to forest, this will decrease the biodiversity value of agricultural lands. The actual effect on biodiversity in the overall ecosystem (comprising agricultural land, forests, ponds, lakes etc.), however, is uncertain farmlands are idled. Hence the habitat index calculated only shows the value of different uses of agricultural land.

According to the model results, agricultural income, as well as agricultural income per labour hour, is higher in CAP reform scenarios. In the case of partial or full de-coupling a farmer may reduce relatively less profitable activities without loosing all support. This is a commonly perceived effect of CAP reform and one motivation of it. However, according to the model results, aggregate agricultural income will decrease in northern Finland due to diminishing dairy production. This is understandable since in the north there are few alternatives for dairy and beef.

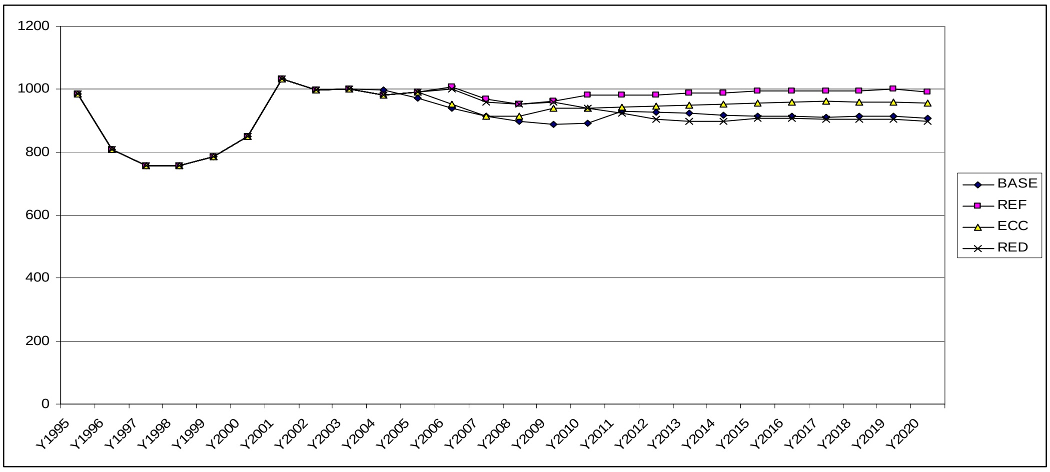



Figure 4. Agricultural income (1000 euros) in Finland. Abbreviations: BASE = Agenda 2000; REF= Luxembourg 2003 reform with national adaptations; ECC= Environmental Cross Compliance; RED = Reduction of CAP payments by 20% until 2013.

Table 5. Percentage changes in total agricultural income and income per hour of labour by 2015 in different scenarios compared to the baseline. Abbreviations: BASE = Agenda 2000; REF= Luxembourg 2003 reform with national adaptations; ECC= Environmental Cross Compliance; RED = Reduction of CAP payments by 20% until 2013.

| | Agricultural income (million euros) | | | Agricultural income per hour (euros/hour) | | |
|---|---|---|---|---|---|---|
| | REF | ECC | RED | REF | ECC | RED |
| Southern Finland | +12.6 | +7.9 | +2.1 | +16.8 | +14.5 | +5.4 |
| Ostrobotnia | +6.9 | +3.0 | -2.1 | +10.4 | +7.0 | +0.6 |
| Central Finland | +5.3 | +2.7 | -4.6 | +17.4 | +18.2 | +9.5 |
| Northern Finland | -3.1 | -6.4 | -6.6 | +13.4 | +11.8 | +10.7 |
| Whole country | +8.5 | +4.5 | -0.1 | +14.9 | +12.3 | +4.9 |

In any scenario, also in the base –scenario, the agricultural employment will decline in all parts of Finland. This is because farm size has been relatively low in Finland due to historical reasons, and despite the relatively rapid decline of cattle farms in the last ten years there is still a substantial scope for farm size growth. In future, the decline in agricultural employment is likely to be relatively largest in northern Finland and smallest in southern Finland and Ostrobothnia.

The food industry in Finland has experienced major structural changes as well in the last ten years. These changes are still going on. Hence it is assumed in this study that the indirect employment of agriculture is considered to remain fixed per agricultural labour force. For example, transportation of inputs and outputs will employ less labour as the number of farms decrease. Overall, the efficiency of labour will increase significantly and in the same magnitude in agriculture and in upstream and downstream industries. This means that the average reduction in agricultural employment (-18% in base and -23% in CAP reform scenarios until 2015) is accompanied by the same change in indirect employment. This assumption will be relaxed as soon as new input-output data in each of 20 provinces will be obtained.

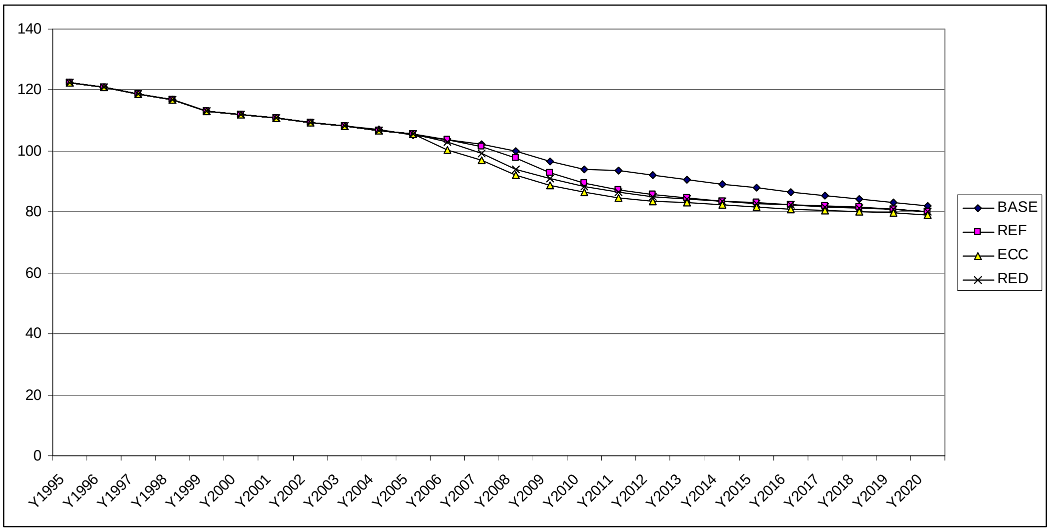


Figure 4. Direct and indirect labour of agriculture (1000 employees) in Finland in BASE scenario.

Table 6. Percentage changes in direct and indirect labour of agriculture (1000 employees) in different scenarios compared to the baseline. Abbreviations: BASE = Agenda 2000; REF= Luxembourg 2003 reform with national adaptations; ECC= Environmental Cross Compliance; RED = Reduction of CAP payments by 20% until 2013.

| | REF | | | ECC | | | RED | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2015 | 2020 | 2010 | 2015 | 2020 | 2010 | 2015 | 2020 |
| Southern Finland | -3.5 | -3.6 | +3.8 | -9.6 | -5.7 | +1.7 | -5.1 | -3.1 | +4.5 |
| Ostrobotnia | -7.2 | -3.1 | -3.0 | -6.4 | -3.7 | -2.8 | -6.5 | -2.7 | -1.1 |
| Central Finland | -3.5 | -10.3 | -8.4 | -8.0 | -13.1 | -11.5 | -7.2 | -12.9 | -12.2 |
| Northern Finland | -3.1 | -14.6 | -20.1 | -5.5 | -14.7 | -17.2 | -5.7 | -15.6 | -21.1 |
| Whole country | -4.6 | -5.6 | -2.4 | -8.1 | -7.3 | -3.7 | -6.0 | -5.9 | -2.4 |

## 5. Discussion and conclusions

The aim of this study was to predict and compare multifunctionality effects of alternative agricultural policy reforms in Finland. Since the multifunctional value of agriculture lies in the joint production process of agricultural and public goods and various externalities, production, biological, and employment effects of different agricultural policies were analysed. The research method applied was agricultural sector modeling which takes into account changes in profitability between different agricultural production lines and the resulting changes in land use and production intensity. Since the model does not explicitly take into account the links between agriculture and national economy, the effects on direct and indirect employment of agriculture are considered external to the model.

CAP reform, possibly embedded by partial or full-decoupling of CAP payments, is not likely to result in any drastic decline of agricultural production in Finland, on the aggregate. However, the model results suggest that milk production may reduce substantially in Northern Finland where dairy is the dominant line of production. Some decline of production may also take place in Central Finland but the decline of production on these areas will be partly compensated by an increase in production in Ostrobothnia region which may benefit from the decreasing values of milk quotas.

Decreasing number of dairy cows and the partial or full de-coupling of CAP headage payments will gradually result in decreasing beef production and grass area in all parts of Finland. Furthermore, the enlarging size and regional concentration of dairy production is likely to keep up the nutrient balances on agricultural land despite decreasing milk prices which ceteris paribus would reduce the intensity of milk production. The scarcity of land at relatively most competitive areas may even increase the phosphorous balance which is a risk in terms of nutrient runoffs and water quality.

In any scenario (also in the base –scenario) the agricultural employment will decline significantly in all parts of Finland. Agricultural labour force is likely to decrease further substantially irrespective of agricultural policy. According to our results, only significant reduction in agricultural supports would make the decline in agricultural labour any faster in southern Finland and Ostrobothnia. This is because in any scenario overall animal production will stay at the present level or gradually increase on these relatively more competitive regions. However, in northern Finland already the CAP reform will reduce agricultural employment (and related indirect employment) significantly because of the substantial reduction of milk production which is the dominant line of production in northern part of the country. Interestingly, in ECC scenario the reduction of agricultural employment is smaller than under REF. In addition to restrictions in milk quota trading between regions, this result is partly due to enlarged field edges that slow down the concentration of milk production in other areas and also the outflow of milk quotas from northern Finland to some parts of central Finland. Hence the enlarged field edges slightly mitigate the decrease in dairy production and employment in northern Finland. From multifunctionality viewpoint this is interesting since environmental cross-compliance may also enhance socio-economic viability measured by agricultural labour.

When we evaluated the effects of policies on agricultural land use, the main finding was that the amount of fallow land, and especially that of green fallow, will increase considerably if agricultural supports are decoupled from production. Although establishing a green fallow is more expensive than establishing a bare fallow, the maintenance costs of green fallows are lower than the costs of maintaining bare fallows. Based on the farm-level production cost calculations of the Union of Rural Advisory Centres (MKL 1995), this makes green fallows more profitable than bare fallows in a five-year period, and thus the predicted increase in the area of green fallows is justified. However, there is a substantial uncertainty about the level of green fallow areas in the future since the choice of set-aside management also depends on opportunity cost of labour and age of production capital of a farm.

In addition, it should be noted that the above results depend on the environmental cross-compliance requirement of keeping the land in good agricultural condition. Without this requirement, the decoupling of support payments may lead into land abandonment.

Also a significant reduction of agricultural supports may lead to land abandonment. This can be seen in “Attack on domestic support”-scenario where CAP payments were reduced by 20%. As a result, idled land increased up to 25% of the total agricultural land area. Since agricultural land comprises only 8% of all land in Finland, one could argue that any reduction in agricultural land would mean loss in biodiversity or at least diversity at landscape level.

The habitat index calculated does not assign any value for idled or afforested agricultural land but considers agricultural land only. However, the calculated habitat index shows that in any policy scenario the remaining cultivated agricultural land would become biologically richer due to increased green set aside. Expanded field edges, required in cross compliance –scenario, would provide significantly richer habitats for various species, like butterflies. Since the increased set-aside area is a major expected outcome of CAP reform, providing sufficient incentives for green set-aside would make it possible to attain higher level of biodiversity. On the other hand, our results show, that changes in field edges (change from 0.5 m to 2 m wide edges were studied) do not imply any increase on overall habitat value of agricultural lands. On the contrary, the enlarged field edges result in lower level of dairy and beef production which may result in smaller grass areas and higher grain areas which indeed decrease habitat index. Nevertheless, this result, as well as the calculation procedure of the habitat index, needs to be discussed with environmental scientists.

At landscape level, those policy reforms, in which support is decoupled, change land use and decrease diversity of agricultural land-cover classes in almost all parts of the country, except in northern Finland. The effect on the biological diversity, however, may not be equal to changes in Shannon’s diversity index, since at species level, green fallows seem to have some positive effects, especially on the densities and abundance of farmland birds (Haukioja et al. 1985, Helenius et al. 1995, Tiainen and Pakkala 2000, Tiainen and Pakkala 2001). Firbank et al. (2003) concluded that particularly rotational set-aside provides suitable habitats for breeding birds, but the benefits of short-term set-aside for arable plants in England were small. Corbet (1995), on the other hand, considered long-term set-aside as a possibility to establish patches of undisturbed perennial herbaceous vegetation and their associated fauna. Furthermore, Steffan-Dewenter and Tscharntke (1997), Critchley and

Fowbert (2000) and Kuussaari and Heliölä (2004) remarked that green fallows are poorer habitats than meadows when considering species diversity of vascular plants or butterflies and other insects.

This paper provided first results of sector model approach to analyse multifunctionality in MTT Agrifood Research Finland. Further research work and new data is necessary in evaluation of employment effects. Closer co-operation with environmental scientists is needed in the development of habitat index in alternative agricultural policy scenarios, especially when agricultural production techniques (no-till cultivation etc.) are changing.

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