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Foreword

The negotiation process of the Uruguay Round Agreement on Agriculture (AoA) during the 1986-1994 was the actual starting point for the ongoing agricultural trade liberalisation. Despite the quite different initial views on the free trade of agricultural products, some progress has been made in the international context. Recently, this development has lead to the formation of the World Trade Organisation (WTO), which is the main body responsible for the promotion of free trade. The members of the WTO, including the EU countries, have committed themselves to the negotiations of further reductions on barriers of agricultural trade.

The results achieved in this study serve as a discussion opening in preparing the Finnish position for the next WTO negotiation round, the round which will most likely start at the end of 1999. Although Finland will be part of the delegation of the European Union (EU) and will not have an independent position in the negotiations, it is important that Finland prepares its own standpoints related to the possible environmental and agricultural effects of liberalised trade. EU countries differ considerably from each other in terms of agricultural and environmental characteristics. This means that quantitative as well as qualitative estimates of the effects of liberalised agricultural trade from the Finnish point of view are needed in order to advise the EU representatives participating in the WTO negotiations.

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Helsinki, May 1998

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AGRICULTURAL ECONOMICS RESEARCH INSTITUTE
P.O. Box 3, FIN-00411 HELSINKI, Finland
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AGRICULTURAL TRADE LIBERALISATION AND ENVIRONMENTAL EXTERNALITIES

JUSSI LANKOSKI

Abstract. The paper reviews theoretical and empirical studies on linkages between agricultural policies, international trade, and environmental quality. From the theoretical point of view, further liberalised agricultural trade is welfare improving, provided that appropriate environmental policies are implemented to internalise environmental external costs. According to the reviewed empirical studies, the changes in environmental quality induced by agricultural trade liberalisation may remain relatively small. Since the price and production changes induced by the Uruguay Round Agreement on Agriculture seem likely to be quite moderate for most countries, this partial trade liberalisation may not cause major changes in the environmental impacts of agricultural production. Instead, the environmental impacts of domestic agricultural policy reforms will probably be more significant than impacts induced by the Uruguay Round Agreement on Agriculture. This is largely due to the fact that agricultural trade liberalisation, partial or complete, does alleviate some policy failures which have adverse environmental impacts, but does not correct environmental market failures. By contrast, domestic agricultural policy reforms, while alleviating policy failures, could also tackle environmental market failures through e.g. agri-environmental programs.

Key words: agriculture, international trade, environment, agricultural policies, environmental policies, trade policies

1. Introduction

International trade *per se* is not the main cause of environmental problems which are due to market and policy failures. The rationale for studying the environmental effects of trade liberalisation lies in the fact that environmental externalities influence the ultimate social welfare outcomes of trade liberalisation. The traditional gains from international trade may be reduced or reversed if the increased specialisation in pollution-intensive products leads to environmental degradation. Thus, it is necessary to weigh traditional gains from trade against environmental quality deterioration. While a large number of theoretical studies dealing with agricultural trade liberalisation have been undertaken, only modest attention has been paid to the likely environmental impacts. Hence, there is a need for analytical and empirical work investigating the linkages between agricultural policies, international trade, and environmental quality.

The environmental impacts of agricultural policy and trade reforms are complex and not well understood. This is partly due to the fact that there is only limited empirical research on the environmental impacts of specific agricultural policy instruments. Furthermore, since the commitments in the Uruguay Round Agreement on Agriculture as well as those taken in the context of domestic agricultural policy reforms overlap, it may be difficult to distinguish whether environmental impacts are brought about by trade liberalisation or domestic policy reforms. This has to do with the fact that increased trade flows owing to agricultural trade liberalisation have mainly indirect effects on the environment through complex changes in the location, intensity, product-mix, and technology of agricultural production, factors that are also influenced by domestic agricultural policies. Thus, the environmental effects of agricultural trade liberalisation are partly channelled through domestic agricultural policies and their impact on production patterns and, through these, on the environment. Current agricultural policies, production patterns, and their environmental impacts form the baseline against which changes in environmental quality due to trade liberalisation and domestic policy reforms can be assessed.

The objective of this paper is to provide an overview of the current state of knowledge on linkages between agricultural policies, international trade, and the environment. Issues to be addressed include: (i) alternative modelling approaches when analysing the links between international trade and environmental quality; (ii) the environmental implications of domestic agricultural policies and policy reforms; (iii) the environmental implications of agricultural trade and trade liberalisation.

The paper is structured as follows. Chapter 2 discusses alternative modelling approaches for analysing the relationship between international trade and environmental externalities. In order to provide a basis for a qualitative analysis of the likely environmental impacts of agricultural policy and trade reforms, the environmental effects of current agricultural policies are briefly examined in Chapter 3. This is followed by a description of the main elements of domestic agricultural policy reforms and the analysis of the likely environmental impacts of these reforms in Chapter 4. The potential impact of further liberalised agricultural trade on the environment is then examined in Chapter 5. Finally, conclusions and policy implications are provided in Chapter 6.

2. Modelling approaches in the analysis of trade and the environment

In general, two broad issues can be distinguished in the debate concerning the trade and the environment; the effect of international trade and trade liberalisation on the environment, on the one hand, and the effect of environmental protection on international trade flows and competitiveness, on the other. The latter group of issues is treated in another paper in this volume (see Alanen and Lankoski). As to the first group of issues, the methodological approaches can be divided into standard theoretical trade models (e.g. Heckscher-Ohlin and Ricardian), partial equilibrium models, and general equilibrium models (see van Beers and van den Bergh 1996 for a comprehensive survey of the literature on the topic).

Integration of externalities into international trade models

According to van Beers and van den Bergh (1996), some mix of externality and international trade theories is unavoidable when analysing the linkages between trade and the environment. As the first approach, they propose the extension of traditional trade theories with environmental elements, i.e. the analysis of trade and the environment can focus on environmental quality and policy as the determinants of international trade.

For example, Siebert (1987) incorporated environmental elements in the Heckscher-Ohlin (H-O) two-country model by interpreting environmental scarcity, i.e. the assimilative capacity of the environment, as a production factor that influences the comparative advantage. Thus, a (home) country endowed with environmental resources will be expected to produce and export the relatively pollution-intensive[1] goods. On the other hand, the (foreign) country with limited environmental services produces and exports goods which are relatively less pollution-intensive. As a result of international trade, the home country exploits the comparative advantage in producing pollution-intensive goods, and the environmental quality deteriorates. Environmental degradation in the home country reduces the net gains from trade. If the home country now implements environmental policy (e.g. emission tax), the production costs and the price of the pollution-intensive good will rise and the home country's comparative price advantage declines. As a consequence of the environmental policy intervention, the environmental quality of the home country improves, while that of the foreign country declines due to more production and exports of the pollution-intensive good. Hence, the environmental policy of the home country may have

[1] A large quantity of pollutants per unit of output compared to that of other goods.

an adverse effect on the environmental quality in the foreign country through international specialisation and trade (pollute-thy-neighbour via trade hypothesis).

According to van Beers and van den Bergh (1996), another possibility of incorporating environmental elements in the H-O model is by changing the assumptions of the model. They refer especially to the assumption relating to the absence of technological differences between countries, that is, the production function is the same in all countries. Relaxing this assumption by postulating the existence of technological differences between countries would imply that the environment as a factor of production could be more productive in one country compared to another country. Thus, as a result of technological differences the use of the environmental factor in one country creates more output than in another country, implying a shift in the environmentally more productive country towards pollution-intensive goods.

Partial and general equilibrium models

The second approach for analysing the relationship between international trade and the environment is to use partial or general equilibrium models. Partial equilibrium models are designed for examining the impact of changes in e.g. agricultural and environmental policies regarding specific commodities, while there are no changes in the remaining sectors of the economy. As a result, these models focus on efficiency gains in the sector analysed without exploring the effects on incomes, relative prices, and indirect efficiency effects. This restricts the relevance of the results. By contrast, general equilibrium models examine the economy as a whole, taking into account the inter-linkages between different sectors.

There are a number of issues that cannot be treated by means of partial equilibrium models, including the interactions between sectors and the distributive impacts of policy changes. According to van Beers and van den Bergh (1996), the potential advantage of the general equilibrium approach for international trade and the environment analysis lies in the number of issues which can be dealt with it. These issues include the impact of trade and environmental policies on resource allocation, income distribution and employment, prices of commodities, wages and capital rents, terms of trade and balance of trade, substitution between goods and factors, and public finance. According to Anderson and Strutt (1996), the use of multi-sectoral CGE (computable general equilibrium) models would have an advantage over the partial equilibrium models by allowing the offsetting impacts when analysing the impact of large trade reforms, such as the Uruguay Round. For example, positive effects on non-agricultural sectors could offset the negative impacts of the agricultural trade reform on the environment.

The partial equilibrium approach, however, is suitable for clarifying analytical issues relating to the effects of environmental policies and agricultural trade liberalisation on the environment and social welfare of a country. Comparative-static analysis (assuming perfect competition) of trade liberalisation and the environment in a partial equilibrium setting is used here to demonstrate the opening up of a small economy to trade in a product with pollution-intensive production process (e.g. barley)[2], following Anderson (1992).

The small country assumption implies that the production and consumption of the economy do not affect world the market prices and the rest of the world. Let us also assume that the production of barley leads to nutrient leakages into surface waters, which results in eutrophication. Eutrophication is a negative externality, which is not internalised into the production costs of farmers but the society as a whole bears this external cost. Hence, there is a difference between the private and social costs of barley production. This difference is reflected in Figure 1. in the divergence between the marginal private cost (MPC) and marginal social cost (MSC) curves, where the latter is obtained by adding up the private and external costs of production. The marginal private benefits (MPB) of consuming barley are represented by the demand curve D. The price axis refers to the price of barley relative to all other prices in the economy, which will remain constant throughout the analysis.

In this case, OQ would be the level of barley production without international trade (i.e. autarchy) and without environmental policy intervention such as a pollution tax to internalise the external costs associated with barley production[3]. This level of production yields net social welfare equal to the sum of producer (PS) and consumer surplus (CS) less the social cost of the negative externality, i.e. *abe-ade*.

When trade is opened (i.e. from autarchy to free trade) and P_0 is the border price (world market price), as in Figure 1., production falls to OQ_m, consumption increases to OC_m, and Q_mC_m units of barley would be imported. The net social welfare would in this case be *abfg-ahg*, yielding *defgh* as the welfare gain from opening up to trade. This welfare gain (*defgh*) can be decomposed into two effects. First, *degh* represents the gain from reducing the negative externality through decreasing the production of barley (externality effect). Second, *gef* represents the gain from importing the barley at a lower price than the country

2 This approach is based on Anderson (1992). The regular assumptions of a partial comparative-static analysis are adopted, i.e. there are no changes in tastes and technology, and no international factor mobility, etc.

3 One of the most appropriate means for aligning the private and social costs of negative externalities is through a *tax* or *charge* on the polluter based on the cost of damage caused by pollution. Imposing this tax provides an incentive to reduce pollution to the socially optimal level.

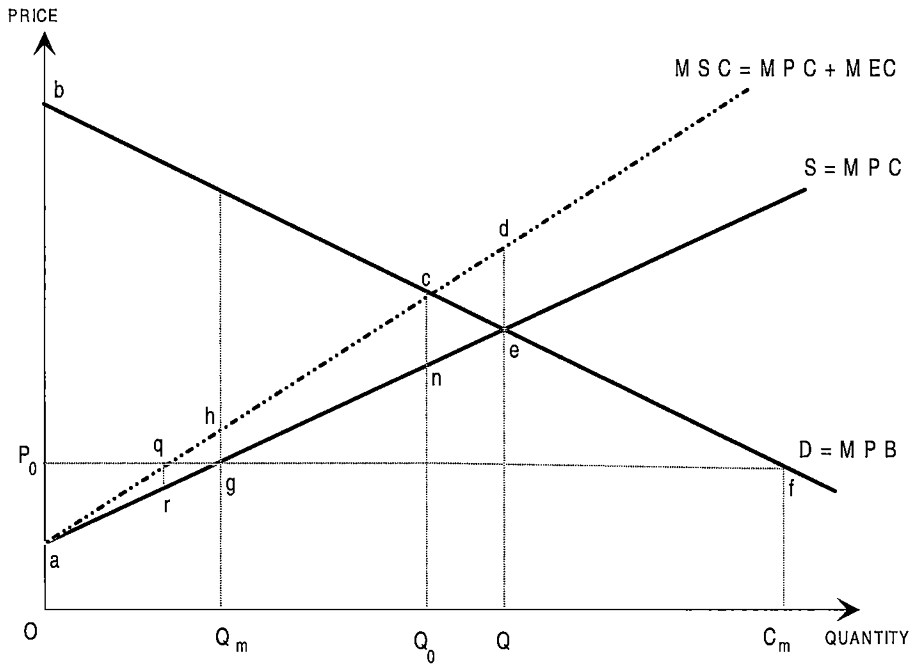

Figure 1. Effects of opening up a small economy to trade in a product with pollution- intensive production process; the case of importable (Anderson 1992).

can produce it (efficiency effect). Hence, the gain from opening up to trade in a product with a polluting production process is positive. Furthermore, the welfare gain is greater than it would have been in the absence of a negative externality (area *degh*).

Let us now assume that the country is implementing an optimal environmental policy to internalise the external costs relating to barley production before and after the trade is opened. The full internalisation of external costs through environmental policy intervention implies that the marginal social cost (MSC) of barley production equals the marginal social benefits (MSB) accruing from the production. In the case of autarchy a production tax equal to *cn* decreases the production from OQ to OQ_0 , resulting in a welfare gain (*cde*) from the environmental policy intervention. In the case of free trade, the optimal tax would be *qr* if the border price is P_0, resulting in a welfare gain *qcf*. This welfare gain can also be decomposed into two effects: the trade liberalisation efficiency effect *gef* and the externality effect *qceg*.

The proposition arising from this analysis is that liberalising trade in a good with polluting production process improves the environmental quality and welfare of a small country if the good is imported after the trade policy change. However, if the country exports the good, environmental degradation reduces the welfare gains from trade, resulting in an ambiguous welfare effect of the liberalised trade (not shown in Figure 1.). Consumption externalities can be analysed in a similar manner as production externalities. Liberalising the trade in a good with consumption externality improves the environment and welfare if the country exports this good, but should this good be imported, the environment may be worsened and welfare reduced unless a pollution tax to internalise the consumption externality is used (Anderson 1992).

One example of theoretical general equilibrium models combining international trade and pollution can be found in Chichilnisky (1994). She analyses the interactions between property rights and international trade. Her model considers the North-South trade in a world where the North has better-defined property rights for environmental resources (private property) than the South (common property). A completely symmetric case is considered first, i.e. a world economy consisting of two identical countries, both with same inputs and outputs, with the same endowments, technologies, and preferences. These two countries engage in free trade on unregulated and competitive world markets. Trade is not necessary for efficiency when two countries are identical. However, differences in property right regimes create a motive for trade among otherwise identical regions. Trade with a region with well-defined property rights transmits and enlarges the problem of the commons in the South, while the North overconsumes underpriced resource-incentive products imported from the South. Moreover, the apparent comparative advantages may derive from historical and institutional factors, i.e. the lack of property-rights for a common-property resource. Thus, the South exports environmentally intensive goods to a greater degree than is efficient, and at prices that are below the social costs (Chichilnisky 1994).

Anderson and Strutt (1996) discuss alternative modelling approaches for analysing environmental implications of agricultural trade policy reforms. The use of global trade models to provide estimated impacts of trade reforms on agricultural production in different countries would be a good starting point for countries which are concerned about the national environmental impacts of international trade reforms. These estimated production changes could then be plugged into environmental models that relate production changes to input changes and, through these, to the changes in environmental quality. As a more sophisticated approach they propose the use of an existing multi-commodity model of food markets and explicit incorporation of input markets, environmental damage functions, and shadow prices for environmental damages. One of the advantages of this approach is the possibility of economic welfare evaluation of environmental effects alongside the conventional economic welfare measures of trade reform.

Anderson and Strutt (1996) go on to propose three steps to be taken in order to improve the modelling of environmental effects of agricultural trade liberalisation. The first step would be to use the existing economic models for the estimation of production and input use changes and infer the potential environmental impacts qualitatively from these changes. The second step is then to estimate physical damage functions and to incorporate them into economic models in order to quantify environmental effects. The third step would be the valuation of these quantitative effects by using shadow prices or Hicksian estimates.

3. Environmental implications of current agricultural policies

Although a number of indicators like the Producer Subsidy Equivalents (PSEs) have been developed for measuring economic distortions arising from agricultural policies, these indicators do not reveal the effects of agricultural policies on the environment, and thus fail to account for all effects of these policies on social welfare. According to Runge (1993), the same agricultural policies that have distorted production decisions and trade have also reinforced environmental damages in agriculture. Moreover, the dilemma faced by the agricultural sector is that the policy failures due to government intervention in agricultural markets tend to reinforce rather than mitigate market failures in agriculture.

Environmental effects of different agricultural policy instruments are not always apparent, which makes their assessment complex. Moreover, there is only limited empirical and quantitative research that examines the relationships between the level of support, the specific policy instruments implemented, intensity of input use, and environmental impacts (OECD 1994b). However, it can be argued that market price support and deficiency payments as well as other policies that increase unit revenues to producers, implying higher effective producer prices, stimulate production and the use of variable inputs like fertilisers and pesticides. It is noteworthy, at this point, that an increase in fertiliser (or pesticide) use does not necessarily imply more pollution. The pollution resulting from agricultural production is dependent on factors that are endogenous (level of fertilisation) or exogenous (soil characteristics), as well as on stochastic variables, such as weather conditions. This leads to the inability to infer ambient pollution levels from observable use of inputs like fertilisers and pesticides (Braden and Segerson 1993). In other words, since the agricultural production process is stochastic in nature, it is difficult to predict the ambient pollution resulting from agricultural production with certainty. Thus, a lot of uncertainty is involved when analysing the impact of agricultural policies on agricultural production patterns and, through these, on the environmental quality.

According to Just and Antle (1990), agricultural policies are composed of a complex set of measures that interact with one another in determining farmers' decisions on the extensive and intensive margins. Lewandrowski et al. (1997) have analysed the aggregate linkages between agricultural support and environmental damages. Agricultural intensification (measured by fertiliser use per hectare) and extensification (agricultural land expansion) were used as indicators for environmental impacts. They found that agricultural support has a positive and significant effect on fertiliser use per hectare, but the impact of support on cultivated area was negative in industrialised countries and neutral in low-income countries, thus providing empirical support for agricultural intensification, but not for the extensification.

Because commodity-specific policies alter the relative prices of crops that can be grown in rotation, they lead to increased use of fertilisers to maintain soil productivity. These policies have encouraged the intensive cultivation of "program" crops and reduced rotation (Runge 1993). The chosen crop mix has important implications for environmental quality as some crops are more pollution-intensive than others. Adverse environmental impacts are reinforced if program crops are highly polluting. Tobey (1991) has analysed the pollution intensity of different crops using data from the United States. The rankings of different crops were mainly based on chemical input requirements and the rate of soil erosion. The most pollution-intensive grains were (in descending order) corn, rice, wheat, oats, and barley.

Moreover, differential support levels distort the relative crop and livestock prices and may produce environmental strain through reduced production diversity. The pattern of relative production subsidies also encourages higher spatial concentration of specific production lines. For example, intensive pig and poultry production is often located in geographically concentrated areas near EU ports, resulting in a significant surplus of manure produced in relation to the area of cropland available for manure spreading. Thus, manure surpluses and nutrient pollution of surface water and groundwaters have increased (OECD 1995c; OECD 1993).

Price support policies are usually combined with other measures like supply controls, and their environmental impacts depend on the form of these combinations. Open-ended price support will result in more input use than price support that is supplemented by quotas. Another combination is price support that is supplemented by restrictions on input use, like set-aside of arable land. While the purpose of short-term set-aside program is to limit the output-increasing effects of price supports, the reduction of available arable land can induce input intensification on land remaining in cultivation. The environmental effects of set-aside as a supply control measure are, however, complex, depending on the way the set-aside program is implemented (e.g. plant cover) and input use intensity on the remaining production base (OECD 1995c).

According to OECD (1995c), subsidies for the purchase of fertilisers and pesticides, as well as supply of natural resources below their marginal cost (e.g. irrigation water) distort the real price of these inputs and encourage their enhanced use due to lower effective prices. Subsidies may contribute to over-application of these inputs, thus increasing pollution. Furthermore, these subsidies also discourage farmers to practise soil conservation and use organic manure more efficiently. Lower production input costs also induce greater overall production on the natural resource base. Correspondingly, interest subsidies provide incentive to invest in farm capital, which encourages a shift to capital and stock-intensive farming practises.

In developing countries, as a partial compensation for policies that usually tax agricultural production, the use of fertilisers and pesticides has often been subsidised by governments. Sometimes fertiliser subsidies are justified in order to maintain soil fertility, and they may play an important role in combating soil erosion and deforestation. However, e.g. pesticide subsidies also contribute to the low application efficiency, probably under 50 per cent, in these countries, thus resulting in environmental pollution (Desai 1990; Repetto 1987; Runge 1993). By contrast, fertiliser and pesticide subsidies have not been so common in OECD countries. However, irrigation water is commonly subsidised, and where soils are saline, this tends to exacerbate salinity problems. Some Latin American countries have subsidised livestock production on large estates through tax incentives, thus increasing the clearing of tropical forests for grazing purposes (Lutz and Young 1992).

It is important to note that environmental degradation can also occur without agricultural support if agricultural product prices do not fully reflect the external costs of agricultural production. Thus, free trade prices are not a remedy for environmental degradation since these prices do not internalise environmental costs (Anderson 1994).

4. Domestic agricultural policy reforms and the environment

The 1987 Ministerial Council of the OECD drew up a set of principles for reforming agricultural policy. The key objectives in the reform of domestic agricultural policies were to increase the influence of market signals on agricultural production and consumption decisions through progressive and concerted reductions in support; to implement measures which will prevent an increase in excess supply; and to provide farm income support through direct income payments rather than through price guarantees or other measures linked to production or to factors of production (OECD 1995b).

The OECD (1994a; 1995a) defines the characteristics of such direct income payments that are the least production related and the least economically distortive as follows: participation in direct payment programmes should be voluntary; the size of payments should either be fixed or, if variable, should be related to a factor which is outside the farmer's control; the size of the payment should not be determined by current or future levels of production or input use; and payments should be targeted to particular policy objectives rather than attempt to achieve multiple objectives.

According to Ervin (1997), through reinstrumentation of domestic agricultural policies, i.e. from commodity based market price support and input subsidies to decoupled direct payments, domestic agricultural policy reform can contribute to environmental quality by reducing the negative environmental effects associated with the increased level and intensity of agricultural production induced by former agricultural policies. Thus, the removal, reduction, or decoupling of agricultural production subsidies should reduce incentives for fertiliser and pesticide use, conversion of environmentally sensitive lands for production, as well as irrigation water withdrawals.

According to Carr *et al.* (1988, *ref.* Batie 1996), agricultural subsidy reduction has three basic types of impacts on agricultural production: (1) output substitution impacts, (2) output price impacts, and (3) input substitution impacts. Output substitution impacts would imply e.g. a shift from "program" crops to "non-program" crops. Environmental implications of this production shift would depend on whether the latter group of crops is relatively more or less pollution-intensive than the former group of crops. Output price effects due to policy reform, e.g. removal of market price support, would imply lower effective producer prices. As a consequence, farmers would cultivate less intensively in response to lower prices, thus relieving environmental pressure. Input substitution impacts due to subsidy reduction and consequent lower producer prices would reduce the marginal product gained by the use of inputs like fertilisers, pesticides, and land. Thus, these inputs would be used less intensively.

The reform of New Zealand's agricultural policies in 1984 is a concrete example of eliminating almost all subsidies relating to agricultural production and input use. This policy reform included the removal of price support, fertiliser and other input subsidies, investment and land development concessions, and tax concessions to farmers. In addition, some macroeconomic circumstances (e.g. high interest rates and an appreciated exchange rate) tended to lower agricultural returns and increased the costs of adjustment. The removal of agricultural subsidies contributed to a number of changes with positive environmental implications: the use of fertilisers and other agricultural chemicals decreased, livestock numbers declined, land conversion on pastoral farms fell, and forestry plantings increased (OECD 1996).

Because some adverse environmental impacts of agriculture in developing countries are linked to agricultural income problems that arise from both domestic policy and international trade distortions, Runge (1993) proposes three types of policy reforms to resolve these interrelated dilemmas: first, the reform of domestic policies in developing countries that tax farmers, and hence lower incentives to produce; second, the reform of agricultural trade policies in developed countries (e.g. the reduction and removal of trade barriers and export subsidies); and third, given that the first two reforms would lead to higher prices and expanded trade, thus resulting in income growth, developing countries could implement environmental policies to address environmental impacts of agriculture.

Lojenga (1995) has analysed the environmental impacts of structural adjustment programs in Costa Rica. Environmental impacts in the grain sector were ambiguous, but on balance there was increased soil erosion and increased use of agrochemicals. The shift from livestock and grain production towards the production of export crops (banana, oranges, melon, pineapple, etc.) reduced soil erosion and soil compaction, while the use of agrochemicals and loss of biodiversity increased. The study concludes that the overall environmental impact of structural adjustment programs in agricultural sector were a reallocation of environmental degradation from soil erosion to pollution stemming from the use of agrochemicals.

According to Batie (1996), the environmental impacts of agricultural policy and trade reform can be overwhelmed by non-policy related events. For example, the US 1996 farm program reform took place in a period of record high world prices for corn, wheat, and soybeans. Therefore, the plantings of these former program crops increased, instead of decreasing as was expected. The high price of e.g. corn may cause farmers to reduce their use of conservation practices such as filter strips, as well as encourage the removal of fencerows. The environmental impacts of increased plantings depend on the quality of the land coming into production and the environmental impacts of production that the new plantings replace.

5. The potential impact of further liberalised agricultural trade on the environment

Increased trade flows owing to agricultural trade liberalisation have mainly indirect effects on the environment through complex changes in the location, intensity, product-mix, and technology of agricultural production. Direct negative environmental impacts of expanded agricultural trade relate to the pollution caused by the transportation of agricultural products and to the potential migration of harmful species of plants, insects, and animals to new areas where they do not have natural enemies.

5.1. Overview of linkages between agricultural trade liberalisation and the environment

Multilateral trade liberalisation in agriculture is commonly expected to produce environmental benefits in developed countries due to reduced production intensity. By contrast, environmental effects may be negative in developing countries due to increased production intensity and area expansion. It has been assumed that if the liberalisation lowered the relative prices received by farmers in developed countries as a result of expanded access to their markets and reduced subsidies and raised relative prices in developing countries, the pressure on the environment would fall in the former, but would rise together with prices in the latter (Runge 1993).

A large number of theoretical and empirical studies dealing with agricultural trade liberalisation have been undertaken, but only a few have considered the effects on the environment. However, some studies have used the results of the economic models for agricultural trade liberalisation as a starting point for the assessment of the likely environmental effects of production and price changes (see e.g. Anderson 1991; 1992; Anderson and Strutt 1996). Reductions in agricultural support and increased market access in developed countries would cause a partial shift of agricultural production to developing countries. This relocation of production would bring economic benefits to both groups of countries, with the gains being even larger if there were also policy reforms in the countries whose policies tax or discriminate against their farmers (Anderson 1991). The removal of subsidies in developed countries has an effect on their own resource use and environment, but through relocation of production on the environment and resource base of developing countries as well. By increasing world market prices, the removal of subsidies would provide an incentive for developing country producers to increase their level of output by intensifying production. This effect could be felt in the short term in the use of intermediate inputs like fertilisers and pesticides, in the long term in primary factors of production like capital, labour and land use, and, through these, in the environment (Lutz 1992). Chemical fertiliser and pesticide applications are strongly correlated with producer price incentives, whereas the primary factors of production are less responsive for changes in producer prices (Anderson 1991).

According to Anderson (1991), globally speaking, it is presumed that international relocation of agricultural production from countries with high producer prices to countries with lower producer prices would substantially reduce the use of chemicals in world food production. Increased chemical use in countries with relatively low producer prices would be more than offset by lower chemical application that results from production declines in countries with high producer prices. In addition, the international relocation of meat and milk production from intensive production units in developed countries to extensive pasture-based farms in developing countries would reduce air, soil, and water pollution. However, welfare estimates for quantified environmental impacts of such changes have not been made (Anderson 1991).

As it was already noted, the direct impact of increased agricultural trade on the environment mainly relates to the pollution stemming from the transportation of agricultural products and the potential migration of non-indigenous pests and diseases. Growth in agricultural trade results in higher volumes and longer distances of transportation, with potential increases in pollution relating to transportation. According to Ervin (1997), the introduction of harmful non-indigenous animal, insect, and plant species (HNIS) through new trade routes is one of the most important environmental risks relating to agricultural trade liberalisation.

5.2. Environmental impacts through changes in Gross Domestic Product

A number of studies have dealt with agricultural trade liberalisation, including the reduction or removal of subsidies. For example, the World Bank/OECD (Goldin *et al.* 1993) has estimated the global annual income gains from full agricultural trade liberalisation as around US$ 430 billion (i.e. 1.5 per cent of base GDP). According to Harrison *et al.* (1995), the Uruguay Round would yield annually US$ 53 billion worth of economic benefits in the short run, but could yield US$ 188 billion (of which US$ 74 billion from agricultural reforms) in the long run after capital stocks have optimally adjusted. Some recent studies (e.g. Francois *et al.* 1995; Harrison *et al.* 1995) have estimated that the Uruguay Round will increase global economic growth by 0.2 per cent of GDP, which is well below one year's growth in world income. It is important to note that the results from different models are sometimes diverse (e.g. depending on the base period chosen, elasticities, etc.) and should not be taken as estimates of specific changes, but rather as indications of the magnitude and direction of changes.

Agricultural trade liberalisation can bring along environmental benefits through the income effect. Liberalised trade should increase growth, economic diversification and development, thus generating the funds available for environmental protection. The demand for environmental quality has a high income elasticity, and higher per capita income thus induces demand for more stringent environmental standards. The assumed relationship between per capita income and environmental quality is often referred to as an "Environmental Kuznets Curve". This curve estimates the relationship between per capita income and environmental quality, which is measured by e.g. air or water pollution, or deforestation. The form of this relationship has been argued to be an inverted U-shape, i.e. the level of pollution rises at the early stage of growth, reaches a maximum at middle income levels, and eventually decreases at higher income levels. According to Anderson (1994), this is usually the case for air pollution and other forms of pollution with no stock feedback effects; however, this may not be the case in sectors that rely on resource stocks (water, forests, soil depth, etc.), as economic growth and increased production may deplete the quantity and quality of a resource stock beyond its assimilative capacity and regenerative ability.

Several studies have identified inverted U-shape relationships between per capita income and the level of pollution. For example, Grossman and Krueger (1991) studied the relationship between economic growth and urban air quality by comparing cross-country panels of data on concentrations of two pollutants, namely sulphur dioxide and smoke emissions, and average incomes in 42 countries. They found that once per capita GDP reaches US$ 5000, the concentrations of these pollutants peak, and as income continues to rise, the concentrations of these pollutants decline significantly. Selden and Song (1994) used aggregate emissions data and found, similarly, that per capita emissions of four pollutants (suspended particulate matter, sulphur dioxide, oxides of nitrogen, and carbon monoxide) exhibited inverted U-shape relationships with per capita GDP. However, "turning points" were somewhat higher in their study, exceeding US$ 8,000. It is important to note, however, that the potential existence of an environmental Kuznets curve for one form of environmental degradation does not imply that the relationship would hold for all forms of environmental degradation. For example, some pollutants, such as carbon dioxide, appear to rise monotonically with the level of income (World Bank 1994). Moreover, the empirical studies have mainly concentrated on the correlation between income and ambient emissions, but the correlation between income and resource degradation is less quantifiable and clear (Anderson 1994).

The role of income growth due to agricultural trade liberalisation may thus not be sufficient to ensure environmental quality improvements in agriculture. Moreover, since some environmental damages of agricultural production, such as soil erosion, desertification, and groundwater pollution, can be considered irreversible, it may be the case that soil and water resources are already depleted before the income effect improves the resource conservation practices. Hence, in the absence of appropriate environmental and resource conservation policies, income growth alone may not suffice to ensure that environmental quality targets are achieved both in developed and developing countries. However, income growth due to trade liberalisation can enhance the implementation of effective environmental policies in the agricultural sector.

5.3. Environmental impacts through changes in world market prices

The price effects of agricultural trade liberalisation have important environmental implications through changes in the intensity and location of production as well as through product mix incentives. It has been expected that world market prices for most agricultural products would increase due to trade liberalisation. On the one hand, in countries where domestic prices were equal to or below world market levels prior to trade liberalisation, this price increase raises production incentives, and while increasing production, may also increase any environmental damage associated with production. This production increase can occur at the intensive or extensive margin of agricultural production; both may have adverse environmental impacts. On the other hand, in countries where domestic prices were higher than world market prices prior to trade liberalisation, the reduction in relative producer prices would decrease production and any associated environmental damage, even when increased world market prices would partly offset the decline in domestic prices. Environmental effects of these price and production changes will, in the short run, depend on the level of fertiliser, pesticide, and irrigation use. In the long run, the environmental effects also depend on changes in land use and production technologies in response to changes in prices and revenues.

As already noted, fertiliser and pesticide applications are highly correlated with producer price incentives. Hence, given the increases in world market prices due to trade liberalisation, it has been expected that the use of these production inputs would decrease in developed countries because of the reduction in relative producer prices, and increase in developing countries. As a result, the environmental degradation resulting from the use of these inputs would decrease in the developed countries but increase in developing countries. However, before drawing any final conclusions, the current level of fertiliser use in different groups of countries should be examined. For example, it may be the case in some developing countries that mineral balances are negative, i.e. the amount of nutrients removed by crops exceeds the amount applied in fertilisers, implying that fertiliser applications should be increased in order to maintain soil fertility and to combat soil erosion and deforestation. Thus, a certain increase in fertiliser use would bring about environmental benefits in these countries. By contrast, in many OECD countries mineral balances are clearly positive, implying that the amount of nutrients applied exceeds the amount removed by crops, leading to nutrient surpluses, which in turn may lead to nutrient leakages into surface water and groundwaters. Thus, a decrease in the use of fertilisers in these countries would bring along environmental benefits.

Eiteljörge and Shiells (1995) have analysed three recent studies (Page and Davenport (1994); FAO (1995a); and Goldin and van der Mensbrugghe (1995)), that have provided estimates of the world market price changes resulting from the Uruguay Round Agreement on Agriculture. The study by Page and Davenport (1994) is based on the RUNS model (the Rural-Urban-North-South model), which is a general equilibrium model of the OECD Development Centre. This study predicts quite modest increases in world market prices. Unweighted average price increase was 2.3 per cent for the commodities studied. The price increase is less than 1 per cent e.g. for rice, coarse grains, and oils, from 1 to 3 per cent for wheat and beef, and exceeds 5 per cent for dairy products (6.2 per cent) and sugar (5.2 per cent). The study by FAO (1995a) is based on the World Food Model, which is a dynamic partial equilibrium model. This study shows that projected price increases due to the Uruguay Round Agreement for various types of cereals are in the range of 4 to 7 per cent, and for meat (bovine, pig and, sheep) from 8 to 10 per cent. The study by Goldin and van der Mensbrugghe (1995) was also based on the RUNS model. This study projects very modest price declines for most commodities, the largest increase being in wheat prices (1.2 per cent) under scenario I. Under scenario II, which presumes larger tariff reductions in comparison to baseline tariff level than scenario I, price changes are in the range of -1.5 per cent to 3.8 per cent.

Hence, the impact of the Uruguay Round Agreement on Agriculture on world market prices seems likely to be modest compared to e.g. the impact of temporary supply factors; this may also imply only modest environmental impacts through price changes due to the Agreement. For example, the world prices for corn and wheat in 1995 were, respectively, 39 and 54 per cent higher than in the previous year, as the robust demand and small harvest led to low stock levels and consequent high prices. Thus, when assessing the environmental impacts of changes in world market prices and consequent production responses due to trade liberalisation, it is noteworthy that short-run supply shocks can surpass trade policy effects.

5.4. Environmental impacts through changes in agricultural production and trade patterns

The environmental impacts of expanded trade owing to trade liberalisation depend on complex changes in the location, scale, product-mix, and technology of agricultural production. For example, the degree of pollution intensity varies within crops and between livestock and cereal production. In addition, the assimilative capacity of the environment varies between regions, complicating the analysis of likely environmental impacts. Thus, only rough indications of likely environmental impacts can be inferred from estimated changes in agricultural production due to complete or partial liberalisation of agricultural trade.

According to Anderson and Strutt (1996), the effect of complete liberalisation of agricultural trade on the relocation of world food production between developed and developing countries would still be quite modest. For example, grain and meat production would be 5 to 6 per cent lower in developed countries and 3 to 8 per cent higher in developing countries. However, regional differences would be higher. For example, the declines from baseline production of meat and grains would be from 15 to 50 per cent in Western Europe and Japan.

By contrast, the production would increase from 5 to 20 per cent in Africa, North America, Oceania, and Latin America. Since the contracting regions are relatively densely populated compared to the areas where production is expanding, the use of chemicals and intensive livestock methods in world agricultural production is expected to decline substantially.

Global environmental effects of this relocation of production can be positive or negative, depending on the use of chemicals and land induced by the production shift. For example, it can be expected that the overall use of chemicals would decrease in Japan and Western Europe, implying positive environmental impacts e.g. in terms of reduced nutrient leakages. However, production decline in these regions may also result in the removal of agricultural land from production and land abandonment, thus leading to potential reductions in biodiversity and amenity values of the landscape. Hence, trade liberalisation can reduce adverse environmental impacts of agricultural production in these regions. However, it may not sufficiently induce farmers to provide environmental benefits, such as the provision of positive environmental public goods. The provision of these environmental benefits can be enhanced e.g. through agri-environmental programs, currently implemented in many OECD countries.

The environmental impacts in countries and regions where production is expected to increase (e.g. Latin America, North America, and Oceania) will depend on whether production increases are brought about through intensification of production, or by bringing additional land into cultivation, on the environmental endowments of these regions, as well as on whether appropriate environmental policies are implemented. For example, soil erosion has been a significant problem in some areas within these regions. Whether increased grain production contributes to soil erosion in these regions depends on soil conservation practices undertaken at the time of liberalisation. However, many countries in these regions have already begun to address the problems relating to soil erosion.

Anderson (1994) has analysed the likely impact of the North American Free Trade Agreement (NAFTA) on environmental quality in Mexican agriculture. The increased fruit and vegetable production may have adverse environmental impacts through increased use of chemicals and irrigation, but a decline in grain production may partly offset this increase. Thus, the total use of chemicals in Mexican agriculture may not change. NAFTA-induced increases in livestock production may not result in deforestation, since some of the land under grain production will be converted to pasture, thus reducing the rate of reforestation for pasture land. Hence, it is unlikely that NAFTA will significantly improve or worsen the environmental quality in Mexican agriculture compared to what would be expected without a trade reform (Anderson 1994).

Beghin et al. (1997) have analysed the linkages between growth, trade, and the environment in Mexican agriculture by means of an empirical economywide model. The analysis includes three alternative policy reforms. First, environmental taxes are examined alone, followed by the analysis of trade liberalisation alone. In the last scenario, environmental and trade policies are combined to show how they interact. The joint trade and environmental policy reforms combine the best of both worlds, that is, efficiency gains from free trade and environmental protection through taxes. More liberal trade combined with environmental policy interventions can achieve notable mitigation of environmental degradation and efficiency gains, but with the implication of contraction of aggregate agricultural output.

Figueroa et al. (1996) have analysed the environmental effects in Chile of a complete agricultural trade liberalisation in the OECD countries based on a SWOPSIM model (Krissof et al. 1990). They assumed that trade liberalisation in the OECD countries would increase prices for all major commodities produced in Chile and that production responses to higher prices would take the form of improved management and increases in variable input use rather than major land use changes. It was assumed that higher prices for dairy products would improve pasture management through better grass varieties and legumes as well as fertilisation, thus reducing soil erosion. However, higher wheat prices may induce the conversion of marginal lands to cultivation. Hence, neutral effects on soil erosion are expected from trade liberalisation. Higher prices are also likely to increase fertiliser use for almost all the crops. Nevertheless, potential nutrient leakages into surface water and groundwaters are expected to be small due to the low precipitation in Chile. The expected increase in pesticide use and water withdrawals for irrigation may have some adverse effects on the environment. However, the study concludes that the overall environmental effects of agricultural trade liberalisation are relatively small.

Figueroa et al. (1996) have also analysed the environmental effects of production shifts due to Chile's potential accession to NAFTA. This case is different from multilateral trade liberalisation in the sense that the protection for traditional commodities would be removed without any expectation of increases in the world market prices for these commodities. The study found out that the land use shift from corn, wheat, and dairy production towards fruit and vegetables in Chile would continue and possibly be reinforced due to NAFTA. This production shift would be beneficial in reducing soil erosion. In addition, increased forestry plantings were expected to reduce soil erosion. Implications for water quality were more ambiguous, since reduced fertiliser use in grain production would be offset by increased use in fruit production. Some adverse effects on the environment and human health were possible due to increased fruit production, since more pesticides would be used in fruit production than grain production.

FAO (1995a; 1995b) has analysed the impact of the Uruguay Round on selected agricultural commodities and regions using the World Food Model.

This study shows the impact of the Uruguay Round on world agricultural production to be negligible. The aggregate output of agricultural commodities is projected to grow 1.6 per cent annually from 1987-89 to 2000 compared to 2.2 per cent in the 1980s, even when the effects of the Uruguay Round are taken into account. Hence, the overall growth of agricultural production is projected to decrease slightly. Decrease in the growth rates is the greatest for rice, meat (other than bovine), dairy products, coffee, and cocoa. The Uruguay Round is estimated to have a positive effect on the value of trade since the small boost to volumes is coupled with some increases in the prices. The global value of agricultural exports is projected to rise by US$ 85 billion between 1987-89 and 2000, and US$ 25 billion of this can be attributed to the Uruguay Round. Among the developed countries, Western Europe and Japan would increase their imports of principal commodities. By contrast, North America and Oceania are expected to have large export gains. North America and Oceania would gain from higher exports of cereals, fats and oils, meat, and milk. Among the developing countries, net exports are expected to increase in Latin America, the Caribbean region and in the Far East. Argentina, Brasil, and Uruguay would gain from higher exports of grains, oilseeds, oilmeals, and some livestock products. Overall, there would be a small decline in the production of temperate zone products in developed countries, and a fractional rise in the production of these products in developing countries (FAO 1995b).

Since the production changes induced by the Uruguay Round Agreement on Agriculture seem to be quite modest in most countries, it is unlikely that this partial trade liberalisation would cause major changes, positive or negative, in environmental quality, at least in the short run. It may be the case that the environmental impacts of domestic agricultural policy reforms are more significant. For example, the use of decoupled income payments and implementation of agri-environmental programs will reduce adverse environmental impacts of agriculture and may also enhance the provision of environmental public goods. However, the succesful implementation of agri-environmental programs from the environmental point of view is dependent on the incentive structure of these programs. Thus, compensation payments for environmental improvements should be decoupled from production and should not be greater than cost increases or income losses that accrue when applying measures creating environmental benefits (e.g. reduction in fertiliser use, maintenance of plant cover, use of buffer strips, etc.). This is to ensure that agri-environmental programs are the least production and trade distortive and hence cost-effective in the long run.

It is important to note that the Uruguay Round Agreement on Agriculture also affects the environment through these domestic agricultural policy reforms, which may be required or stimulated by the agreement. Hence, trade liberalisation together with domestic policy reforms would probably reduce global environmental pressure from agriculture. However, the environmental effects of agricultural policy reforms and trade liberalisation are likely to be neither universally negative nor positive, but they are likely to differ by region, country, and commodity in question, as well as in the short and long run.

6. Conclusions and policy implications

The rationale for studying the environmental effects of trade liberalisation lies in the fact that environmental externalities influence the social welfare outcomes of trade liberalisation. The economic benefits of liberalised trade are reduced or reversed if negative environmental externalities are left uncontrolled, but should appropriate environmental policies be used to internalise negative externalities, a net welfare gain from trade liberalisation could be expected.

Domestic agricultural policy instruments have led to economic welfare losses and environmental degradation, and they have thus been welfare decreasing for the society as a whole. Hence, the reinstrumentation of domestic agricultural policies from market price support and input subsidies to decoupled direct income support should be the first step when alleviating both economic welfare losses and environmental degradation relating to current agricultural policies. The existence of environmental market failures implies that the removal of agricultural support policies alone would not suffice to achieve environmental quality targets.

Agricultural policy reform in developing countries should include the reduction of agricultural taxation in order to draw resources into the agricultural sector, where many countries enjoy a comparative advantage, the allowance of world market price increases to domestic market in order to give incentives to produce, the establishment of well-defined and secure property rights to induce resource conservation practices, and the removal of environmentally harmful input subsidies.

In developed countries, the use of decoupled income support and the implementation of agri-environmental programs can reduce adverse environmental impacts of agriculture and may also enhance the provision of environmental benefits. This is because the use of decoupled income support is capable of correcting some policy failures relating to current agricultural policies, and a targeted use of agri-environmental programs could tackle environmental market failures relating to agricultural production.

Since the price and production changes induced by the Uruguay Round Agreement on Agriculture seem likely to be quite modest in most countries, this partial trade liberalisation may not cause major changes, positive or negative, in the environmental impacts of agricultural production. Instead, the environmental impacts of domestic agricultural policy reforms will probably be more significant than impacts induced by the Uruguay Round Agreement on Agriculture. This is largely due to the fact that agricultural trade liberalisation, partial or complete, does alleviate some policy failures, which have adverse environmental impacts, but does not correct environmental market failures. By contrast, domestic agricultural policy reforms, while alleviating policy failures, could also tackle environmental market failures through e.g. agri-environmental programs. It is noteworthy that these domestic policy reforms may be required or stimulated by the Agreement on Agriculture.

To conclude, the environmental impacts of the Uruguay Round Agreement on Agriculture will be small compared with the effects that domestic agricultural policy reforms can have on the environment. Hence, integrating environmental considerations into domestic agricultural policies and implementing agri-environmental programs should ensure that global environmental pressure from agriculture would decrease. However, the environmental effects of agricultural policy reforms and trade liberalisation are likely to be neither universally negative nor positive, but they are likely to differ by region, country, and commodity in question. Hence, there is a need for country and region specific analysis.

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AGRICULTURAL ECONOMICS RESEARCH INSTITUTE
P.O. Box 3, FIN-00411 HELSINKI, Finland
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AGRICULTURAL POLICY REFORMS AND ENVIRONMENTAL QUALITY IN FINLAND: A SECTOR MODEL APPLICATION

JUSSI LANKOSKI AND HEIKKI LEHTONEN

Abstract. The potential impacts of the Agenda 2000 and further liberalised agricultural trade on the environmental quality in Finland are examined in this paper. An agricultural sector model is used to simulate the changes in production allocation, land use, and input use and, through these, the impacts on environmental quality resulting from the given policy changes. Environmental indicators such as regional nutrient balances and stocking densities are incorporated into the sector model. On average, the nutrient surpluses are lower in the Agenda 2000 scenario than the base scenario due to reduced production intensity in 2005. The Agenda 2000 and the decoupling scenarios result in lower nitrogen and higher phosphorus surpluses than the reference scenario in 2011. The decoupling scenario results in a higher level of nitrogen and phosphorus surpluses and higher stocking densities in the southern part of Finland (areas A and B) than Agenda 2000 and the base scenario. The sector model allocates the livestock production into Southern Finland, where the cost competitiveness of production is higher than in other areas in Finland. Import of feed grains increases rapidly in the decoupling scenario, which decreases the cultivated area (even in Southern Finland). Consequently, nitrogen surpluses are greater in the decoupling scenario than in the Agenda 2000 or base scenario in 2011.

Key words: agricultural policy reforms, sector model, production allocation, nutrient balances

1. Introduction

The Uruguay Round Agreement on Agriculture (AoA) established new international rules on agricultural trade and imposed constraints on domestic support, border protection, and export subsidies. The European Union has committed to a 20 per cent reduction in the domestic support by the year 2000. All existing non-tariff barriers will be converted into a tariff equivalent (tariffication) and reduced by 36 per cent. Subsidised export expenditure is to be reduced by 36 per cent and subsidised export volume by 21 per cent. The World Trade Organisation (WTO) members have committed themselves to further liberalisation of agricultural trade, and it is expected that the critical linkages between environmental protection and international trade regime will be high on the agenda of the next negotiation round in the WTO starting in 1999. Further reductions in tariffs and the commitments concerning domestic support and export subsidies may lead to adjustments and policy reforms in the Common Agricultural Policy of the EU (CAP). Thus, Finland could also face the prospect of additional policy changes.

The potential environmental impacts of the CAP reform proposal (Agenda 2000 scenario) and further liberalised agricultural trade (decoupling scenario) in Finland are examined in this paper. An agricultural sector model (described in more detail in Lehtonen 1998) is used to simulate the changes in production allocation, land use, and input use and, through these, the impacts on environmental quality caused by the given policy changes. Environmental indicators such as regional nutrient balances and livestock densities are incorporated into the sector model.

The starting point for our analysis is that the CAP reform package, which is part of the Agenda 2000, is set to enhance the European Union's negotiating stance in the new round of multilateral trade negotiations starting in 1999. Thus, further liberalised agricultural trade will lead to policy adjustments in the CAP, which in turn have environmental implications through changes in agricultural production patterns. In addition to the Agenda 2000 scenario, the scenario of further decoupling of agricultural support is analysed. The decoupling scenario is also called the trade policy reform.

The paper is organised as follows. First, the main elements of the Uruguay Round Agreement on Agriculture are shortly reviewed and prospects for further reductions in agricultural trade barriers are discussed in Chapter 2. This is followed by a description of the structure of the sector model in Chapter 3. Alternative policy scenarios and the application of the model are presented in Chapter 4. Finally, conclusions are provided in Chapter 5.

2. The Uruguay Round and prospects for further reductions in agricultural trade barriers

The Uruguay Round Agreement on Agriculture (AoA) established new international rules and imposed constraints on domestic support, border protection, and export subsidies. The main elements of the AoA are briefly summarised below.

Domestic support commitments

A commitment has been made to reduce the total Aggregate Measurement of Support (AMS) by 20 per cent in six years (1986-88 base period). The required 20 per cent reduction is not commodity-specific. Thus, the support of individual commodities may be cut more or less than 20 per cent, even not at all.

According to Tangermann (1996), one of the most important implementation problems related to the domestic support commitments may arise from the classification of policies into categories which are exempt from reduction commitments or are not included in the calculation of AMS. These include "green box" policies (policies that do not distort production and trade) in the case of reduction commitments and "blue box" policies (payments under production-limiting programmes) in the case of AMS calculation. For example, the AMS of the EU has already fallen below the commitment owing to the reduction of price support due to the CAP reform 1992 and the fact that CAP reform compensation payments are exempted from the AMS commitment. The PSE for the EU, however, has not followed the downward trend of the AMS measure, mainly owing to the fact that it includes the compensation payments. Thus, it may be the case that commitments concerning the domestic support (AMS) do not appear to constrain agricultural policies very much for the immediate future (Tangermann 1996).

Market access commitments

All existing non-tariff barriers will be converted into a *tariff equivalent* (tariffication) and reduced by 36 per cent in six years. Minimum access provision is 3 per cent, and it will rise to 5 per cent of the base period domestic consumption. According to Ingersent et al. (1995), the tariffication process is likely to result in the establishment of tariff rates, which may prove to be as prohibitive as the NTBs (non-tariff barriers) they replaced. This has to do with loose guidelines for the determination of base period tariff equivalents of former NTBs prescribed by the agreement. The combination of "dirty tariffication" and the high price gap between domestic and world market prices in the base period has resulted in high tariff levels that will not bind current agricultural policies, such as support prices, for some time (Tangermann 1996).

Export subsidy reduction commitments

Subsidised export expenditure is to be reduced by 36 per cent and subsidised export volume by 21 per cent over six years (average of the base period 1986-90). According to Tangermann (1996), the constraints on the quantities of subsidised exports are likely to be the most binding elements of the AoA. As to the constraints on budgetary outlays for export subsidies, they may generally be less binding than the quantity constraints in spite of the fact that the percentage reduction is higher for the budgetary outlays. This is because the volume of subsidised exports had increased between the base and the implementation period, thus making reductions in quantities quite significant in a number of cases, and because reduced domestic prices and increased world market prices have tended to reduce the subsidy required per tonne. Hence, the export subsidy commitments may effectively constrain agricultural policies, since the countries have to adjust their agricultural policies in order to reduce the quantities of subsidised exports (Tangermann 1996).

The prospect for further reductions in the next round of the negotiations

According to Josling and Tangermann (1997) and Meilke et al. (1996), the next round of multilateral trade negotiations could start from the disciplines agreed in the Uruguay Round by strengthening the rules and imposing further reductions relating to export subsidies, market access, and domestic support. The rates of reductions should be at least as high as those agreed in the Uruguay Round. According to de Zeeuw (1997), in the view of the Cairns group countries the next negotiation round should concentrate on total elimination of the export subsidies, substantial reduction in tariffs, substantial increase of minimum access, a limited and possibly totally de-coupled Green Box income support, and the elimination of the Blue Box. Thus, although a complete liberalisation of agricultural trade is not likely to happen in the near future, a gradual liberalisation, which is based on the framework provided by the Uruguay Round, is feasible.

3. Structure of the sector model

There is an ongoing research project at the Finnish Agricultural Economics Research Institute in which an extensive, dynamic regional model of Finnish agriculture (DREMFIA) has been constructed (Lehtonen 1998). The model concerns the so-called basic agriculture (excluding e.g. organic production), i.e. all the most important production lines. The production, costs, consumption, foreign trade, and price formation as well as the support system of agriculture have been modelled in detail. No explicit connections to the other sectors of the national economy are made. However, the connections to the national economy can be described implicitly by means of the total of the national agricultural support and e.g. the consumption trends, price elasticities of the demand, the price of an hour of labour, and inflation.

In the first version of the model the development of the agricultural sector is simulated from 1995 till 2005, but in this study the time span is extended up to the year 2011. The model includes four main areas, Southern Finland, Central Finland, Ostrobothnia, and Northern Finland, and the production of these is further divided into sub-regions on the basis of the support zones. The consumption is determined according to the main areas. The final and intermediate products move between the main areas. There is foreign trade from each main area at fixed average EU prices.

The model comprises the most important production lines of agriculture, like crop production, dairy production, production of beef, pigmeat and poultry meat, as well as egg production. The arable crops include barley, oats, malting barley, mixed cereals, rye, wheat, oil-seed plants, sugar beets, potatoes for human consumption, starch potatoes, silage, green fodder, dry hay, and peas. The open and green set-aside areas are also included in the model. In the processing of sugar and milk, fixed margins in FIM are used between the raw material and the final product. Other products are priced at the producer price level. Livestock includes dairy cows, suckler cows, dairy and suckler cow heifers, slaughter heifers from milk production and specialised beef production separately and, correspondingly, bulls of over one year and over 15 months, as well as sows and fattening pigs, laying hens, and other poultry.

The known support for the different years and the anticipated support for the future years (the effects of which are being examined) are determined by means of a separate policy section (Figure 1). Together with the support policy, a scenario of the price level on the single market of the EU is also formulated. In a specific steering module, development factors that are partly independent of the policy are directed by means of their own scenario parameters, which include, among others, the maximum allowable annual limits for change of the production in the different production lines, long-term development trends, and allowable range of the consumption.

The basic structure of the sector model is presented in Figure 1. The core of the model is an optimisation model simulating the markets, which provides the annual market balance using the outcome of the previous year as the initial value. However, restrictions are imposed on the production variables based on the production of the previous year. The restrictions represent short-term technical and biological constraints in each production line. Thus, the calculated market balance should be interpreted as an annual short-term disequilibrium, which represents reactions towards equilibrium, rather than a static long-term equilibrium state. The DREMFIA model computes a sequence of spatial disequilibria, which converge into the long-term equilibrium. Even if the changes are restricted in the short term, long-term changes may be considerable, if the price relations and policy causing the change prevail long enough. The development paths obtained from the model are dependent on the given limits for change, which are partly based on the largest changes in the production in the time series and partly on the production-specific time lags and technical and biological constraints of each production line.

Each static optimisation model simulates efficient markets by maximising the total of the producer and consumer surpluses within the framework of the market balance and resource constraints. The objective function is of the second degree, i.e. price is an endogenous variable that sets the demand and supply into balance. The hypothesis is that efficient markets operate in an optimal way in terms of the consumer and producer surplus. As the final outcome of the optimisation model we obtain the production and consumption in each region as well as the movements of products between the main areas under the assumption of free competition. Thus the task of the optimisation is to simulate the market (Hazell and Norton 1986 pp. 160-162, 167-168). The basic mathematical form of the objective function and constraints can be found in Hazell and Norton 1986 and Apland and Jonasson 1992, for example. The specific form of the objective function used in the DREMFIA model can be found in Lehtonen (1998).

The constraints of the optimisation are the conditions concerning the market balance (demand-supply), production capacity, quotas, crop rotation, feed use,

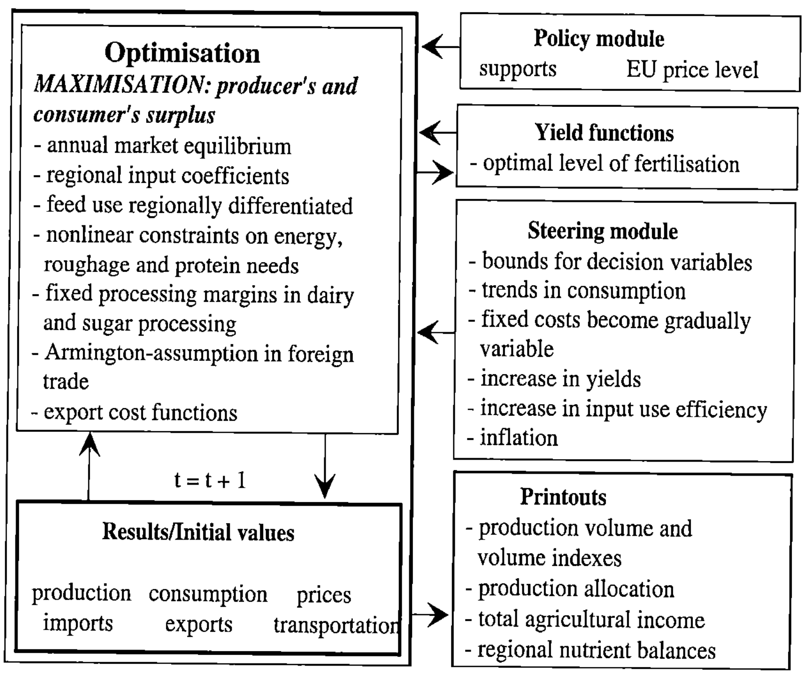

Figure 1. Basic structure of the sector model.

and other restrictions. In general, there are certain fixed inputs and outputs corresponding to each production activity (Leontief technology). In livestock sector, however, there are non-linear constraints relative to feed use. The required energy, roughage, and protein need of animals could be fulfilled in different ways. The use of each fodder, however, is allowed to change only 5-10 percent annually due to fixed production factors in feed production. This means that feeding may change only gradually because of the fixed factors.

All foreign trade flows are assumed to and from the EU. It is assumed that Finland cannot influence the EU price level. For the part of imports, the domestic and the corresponding foreign product are defined as different products which may substitute for each other (Armington assumption). The demand functions of the domestic and foreign product influence each other through the elasticity of substitution (Dixit 1988, Sheldon 1992 p. 116). Using this specification, consumers are assumed to prefer domestic meat and to be willing to pay 2-7 percent more for domestic meat products (Lehtonen 1998).

The export products are still homogeneous with the domestic products. The export costs (transportation and marketing costs) have been defined as linearly increasing in relation to the export quantities of the preceding year. Exports cannot grow too rapidly in the short term without considerable additional costs. Thus, large short-term fluctuations in exports are avoided.

Fixed costs are sunk in the short term, but in the long term they are variable costs. There are no explicit investments in the model. The production path given by the model is adjusted to match the observed production pattern in the early years of simulation by defining some fixed costs as sunk. The fixed costs become gradually variable until 2006, when all costs are taken into account in the optimisation. It is impossible to obtain any accurate empirical information on the schedule of the change of the fixed production factors into variable ones in each production line. Consequently, this is one reason why the model should be used for a comparative analysis of different policy alternatives, not to give accurate forecasts of the future agricultural production.

The crop level of the different crops is determined separately for each year and for the 14 production regions. The crop levels are obtained by determining the optimum fertilisation level by means of the market prices of the preceding year or the intervention prices of the current year, as well as the fertiliser prices and fertilisation response function. The response function is obtained by adjusting the known empirical response functions to the known fertiliser and yield levels in each of the 14 production regions. Independent of the fertilisation level, the response function will rise linearly by an amount that is 1 % of the current crop level according to the trend.

The animal yields grow linearly in time independent of the changes in the feed use. Certain energy, roughage, and protein needs have to be fulfilled. The same yield may be achieved by means of several different feeding alternatives.

In general the increase in the cost efficiency of Finnish agriculture is expected to accelerate from the long-term trend value as a result of the pressures caused by the EU membership. Thus, it can be expected that the efficiency in the use of both variable and fixed production inputs is going to increase. In the model it is possible to define the target levels for certain production inputs by 2005 and 2011. The target levels are set as ratios in relation to the use of inputs in 1995 (Figure 2). The target levels are set to keep the animal production volumes near the current levels in 2005 in reference scenario, when no changes in agricultural policy occur after 2000 (no Agenda 2000 or trade liberalisation).

The long-term consumption trends caused by the consumer habits concerning the most important foodstuffs are taken into account in the model. This concerns in the first place changes in the consumption of meat and dairy products. In the model a decreasing trend at the rate of 1% a year is assumed for beef consumption, pigmeat consumption is assumed to stay at the present level, and the consumption of poultry meat is assumed to grow 2% a year. However, the meat consumption is allowed to vary 2% of this trend value annually due to price changes. Consequently, for the part of meat the consumer surplus is maximised within a range of only 2% annually. The above-mentioned consumption trends, allowable ranges, and other parameters have been defined in the same way separately for each dairy product. Thus, the optimisation is mainly done for production and its allocation, and the maximisation of consumer surplus has less weight in the model.

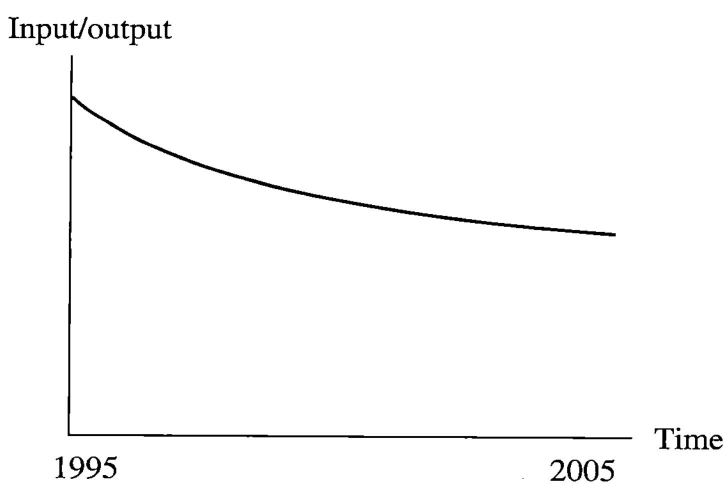

Figure 2. Increase in the efficiency of the input use as a function of time

4. Alternative policy scenarios and the application of the model

An analysis made by means of a multi-period model is based on comparisons between the results of the so-called reference scenario and alternative scenarios. The reference scenario or base scenario provides a kind of basic forecast of the development path of agriculture, subject to the assumption that there will be no significant policy reform. By comparing other policy scenarios with the reference scenario we obtain a picture of the direction and magnitude of the changes in e.g. production allocation and nutrient balances.

4.1. Reference scenario and policy reform scenarios

The reference scenario must be in accordance with the known production quantities, production costs, and incomes of the known years, i.e. 1995 and 1996. This makes it possible to change and validate the model, but it is not possible or in all cases even sensible to obtain results that would correspond exactly to the known years. Various kinds of random factors like weather conditions may cause deviations from the economically optimal equilibrium.

Consequently, in certain respects the reference scenario is a subjective picture of the development, because the above-mentioned development factors cannot be defined in a reliable way. Thus there is no secure basis for the evaluation of the reference scenario, except for the part of the known initial years. In the case of the following years the reliability of the reference scenario must be evaluated subjectively in relation to the current future prospects of each production line. Because of this the reference scenario is not a forecast for the future, but, rather, the basis for the alternative scenarios.

Reference scenario

In the *reference scenario*, the support system (including both the EU and national support measures) of the year 2000 is assumed to remain constant till 2005. The price level of the EU is assumed to be constant between 1995-2005. The annual rate of inflation is 2.3% implying that the prices of production inputs are increasing, on average, 2.3% a year and altogether 28.4% between 1995-2005. Total inflation is less than 20%, however since fertiliser prices are assumed to be constant and the prices of industrially produced feeding stuffs are increasing 1% a year. The cost efficiency in the *crop sector* is assumed to increase over 20% from 1995 to 2005. This cost efficiency gain comes from a 10% yield growth, 15% increase in the efficiency of using variable inputs, and 10% increase in the use of fixed inputs. This cost efficiency increase will partly compensate the reduction in the support levels. Since fertiliser prices are constant through the time span 1995-2005, the overall cost increase in the crop sector remains below 20%. Assumptions concerning the *dairy sector* are as follows. Other than feed costs are decreasing approximately 25% per kilogram of produced milk until 2005. Since the prices of industrially produced feeding stuffs are increasing only 1% a year, the overall cost increase in dairy production will be below 25%. Thus, the cost efficiency increase will partly compensate the reduction in the support levels. The cost efficiency in pork production is assumed to increase substantially due to a 40% reduction in the production costs (other than feeding stuffs). The cost efficiency also increases in poultry and egg production due to a 40% decrease in the production costs until 2005 (other than feeding stuffs).

The Agenda 2000 scenario

The *Agenda 2000 scenario* includes The Commission proposal for a CAP reform. The CAP reform package includes a cut in the grain intervention prices by 20% (from 119 to 95 ECU/t), which is compensated by a partial increase in the compensatory payments from 54 to 66 ECU/t. Beef prices are to be cut by 30% over the years 2000-2002, which is compensated by special beef and suckler cow premiums. Dairy prices are cut by 15% over the years 2000-2003, and this is compensated by a new dairy cow premium. Milk quotas are increased by 8.4% in all regions over the years 200-2003. There is no set-aside obligation.

Decoupling scenario

The *decoupling scenario*, which is a general trade liberalisation scenario, includes a percentage reduction of the aggregate level of domestic support. Domestic support (including both the EU and national support schemes) is to be reduced by 40% from its 1996 level by the end of 2010. All the domestic support is paid either as a direct payment based on arable land (acreage payments) including set-aside or a direct payment based on livestock units (headage payments). These direct payments are decoupled from production in the sense that the payments are equal for all crops as well as for all livestock units. Moreover, no regional differentiation is made, i.e. the payments are the same throughout the country. There is no set-aside obligation. The upper limit for the area under set-aside is 50% of the total cultivated land area.

4.2. Calculation of nutrient balances

The nutrient balance (or surplus) provides an indicator of the potential nutrient losses from a farm to the surrounding area. The basic idea behind nutrient balances is to calculate nitrogen (N) and phosphorus (P) flows at specific observation points on the farm. The two methods of nutrient balancing are *farm gate balance* and *surface balance*. In this study the surface balance method was adopted for regional nutrient balance calculations. In the case of nitrogen both *gross* and *net*[1] balances were calculated. Surface balance is calculated by measuring the nutrient content of fertilisers, organic manure, and nitrogen depositions, and subtracting the mineral content of the harvest and losses to the atmosphere. Standard coefficients were used to calculate the mineral content of organic manure and harvested crops (see e.g. Lankoski 1996 for more information on the calculation of nutrient balances). Regional nutrient balances are calculated and reported per cultivated area (kg/ha).

It should be noted that the nutrient balances are calculated as regional aggregates as a result of regional cropping patterns and livestock quantities, and they do not correspond to nutrient balances at the farm level. The manure is spread to all fodder crop area in the model, because farms with and without livestock and their cultivated area are not modelled separately. The basic units in the model are hectares and heads of animals only. For this reason, the actual nutrient balances presented are regional aggregates. What really matter are the differences in regional aggregate nutrient balances in different policy scenarios. However, the differences in regional nutrient balances may be due to (1) differences in the regional product mix, which concerns both crop production and livestock production, and (2) due to the differences in the production intensity and input use.

4.3. Impact of Agenda 2000 on regional nutrient balances and livestock densities

The effect of the CAP reform proposal, i.e. Agenda 2000, on regional nitrogen balances is shown in Table 1. Balances are reported for four main regions (R1, R2, R3, and R4), Southern Finland, Central Finland, Ostrobothnia, and Northern Finland, and for sub-regions (A, B, C1, C2, C2P, C3 and C4) on the basis of the support areas.

The model results show that the net balance of nitrogen decreases in most regions, but increases in some regions due to changes in the production allocation. One reason for the decrease in the nitrogen balance in most regions is the increase in the yields (10% from 1995 to 2005). Animal yields increase also in time which decrease the nitrogen balance since more is produced with the same feed input. For example, the milk yield of dairy cows increases 18% from 1995 to 2005. In area A (also area BS), the southernmost part of Finland, the net

[1] Net balance = gross balance - 30% reduction of the nutrient content of manure due to nitrogen losses in manure handling.

Table 1. Impact of different policy scenarios on regional gross and net nitrogen balances (kg/cultivated ha) in 2005.

	Gross balance					Net balance				
Area	1996[1]	Base 2005	Change %	Agenda 2005	Change %	1996	Base 2005	Change %	Agenda 2005	Change %
(R1) A	42	57	36	52	22	36	46	30	39	10
(R1) B	51	36	-29	29	-44	40	26	-35	18	-56
(R2) B	43	21	-51	10	-76	33	15	-56	4	-89
(R1) BS	50	98	95	77	54	41	68	66	49	20
(R1) C1	58	69	19	55	-5	45	44	-2	30	-33
(R2) C1	55	49	-12	34	-39	40	29	-26	15	-63
(R3) C1	45	46	1	32	-28	35	31	-10	19	-46
(R1) C2	61	56	-8	40	-34	47	44	-7	28	-41
(R2) C2	66	65	-1	47	-29	50	44	-12	27	-46
(R3) C2	66	67	1	52	-22	51	46	-9	31	-40
(R2) C2P	64	68	6	48	-25	48	41	-14	23	-53
(R4) C2P	88	91	3	71	-19	71	70	-2	51	-29
(R4) C3	102	111	9	89	-13	86	89	3	68	-21
(R4) C4	108	95	-11	88	-19	90	79	-12	68	-25

Reported absolute figures have been rounded. Change percentages were calculated before the rounding.

[1] The high nitrogen surplus in region 4 is due to a relatively high fertilisation recommendation for silage in that region.

nitrogen balance increases 30% in the base scenario and 10% in Agenda 2000-scenario. This is due to lower production intensity in Agenda 2000. Most of the wheat and rye in Finland is already cultivated in area A, and the decrease in the profitability of bread grains results in significant decreases in the cultivated area in area A in both scenarios. This reduces the total cultivated area in area A. On the other hand, livestock production increases slightly in area A. Consequently, the nutrient balances in area A increase and are higher than in the other parts of the country. The percentage changes in nitrogen balances are small in Northern Finland, especially in the base scenario.

The price relations in both scenarios encourage farmers to use more grain in feeds, and this result in a smaller grass area. The lower nitrogen balance in Agenda 2000 compared to that of the base scenario is due to reduced intensity in the crop production. The fertilisation levels of grains decrease 2-3% due to lower producer prices in Agenda 2000, and this in turn lowers the yields 2-5%. For grass, both the fertiliser and yield levels decrease by 10%, which lowers the nitrogen and phosphorous balance. Thus, the 20% reduction of grain prices results in extensive farming in areas B and C. Feed grain cultivation concentrates to area B, particularly in Agenda 2000 scenario. Consequently, manure is spread to a larger area in area B and to smaller area in area C. For this reason the nitrogen balance decreases in area B from 1996 to 2005. The decrease is dramatic in Agenda 2000 scenario. The nitrogen balance in area C decreases only slightly in the base scenario, but in Agenda 2000 the decrease is significant (20-60%).

Nevertheless, only fertiliser use could be adjusted to the changed price relations in the model. In reality, the lower prices may lead to lower application of some other inputs, like pesticides and labour. This is especially true if the prices do not cover even the variable costs of the production, as appears to be the case on many farms in Finland if the grain prices were cut by 20%. Thus, the assumption of linearly increasing yields as a function of time in the model may become problematic, since farmers have no or small incentive to develop their production. On the other hand, large areas of less favourable land will go out of production in the model, which may increase the average yields. However, the assumption of a slight linear increase of the yields does not dominate the results. The changes in the production allocation and fertilisation levels are the main factors that affect the regional nutrient balances.

The effect of the CAP reform proposal on regional phosphorus surpluses is shown in Table 2. Surpluses are reported for four main regions (R1, R2, R3, and R4), Southern Finland, Central Finland, Ostrobothnia, and Northern Finland and for sub-regions (A, B, C1, C2, C2P, C3 and C4) on the basis of the support areas. Phosphorous balances increase significantly in area A, (R2)B, and BS. Phosphorus balances also increase somewhat in areas C1, C2, C2P and C3 in both scenarios (although there are some exceptions like area (R1) C2. The increase in the phosphorus balance, like the increase of the nitrogen balance in area A, is a result of the reduced cultivated area due to unprofitable crop production. At the same time, the livestock production does not decrease or decreases only slightly in those regions. Thus, the phosphorus surplus as a regional aggregate increases. In area B and some parts of C1 and C2 the phosphorus surpluses decrease. These regions are able to maintain or increase their share (not the production as absolute terms) of the national crop production, but there is some decreases in livestock production. The phosphorus balances are, on average, lower in the Agenda 2000 scenario than in the base scenario, even if the cultivated area decreases in some regions. This has to do with lower milk production and fertiliser use in Agenda 2000 relative to the base scenario.

The effect of the CAP reform proposal on regional livestock densities is shown in Table 3. Livestock densities, which are calculated per fodder area, increase significantly in areas A, BS, C1, and C2P. The increase in stocking density, like the increase of the nitrogen and phosphorus balances in area A, is a result of the reduced cultivated area due to unprofitable crop production. Agenda

Table 2. Impact of different policy scenarios on regional phosphorus balances (kg/cultivated ha) in 2005.

	Regional phosphorus balances				
Area	1996	Base 2005	Change %	Agenda 2005	Change %
(R1) A	6	10	59	10	65
(R1) B	9	6	-33	6	-30
(R2) B	8	3	-58	3	-68
(R1) BS	10	26	149	23	127
(R1) C1	11	17	58	13	19
(R2) C1	12	14	10	13	4
(R3) C1	9	9	8	8	-6
(R1) C2	11	8	-26	8	-25
(R2) C2	13	16	17	14	8
(R3) C2	13	16	27	16	25
(R2) C2P	14	20	43	18	33
(R4) C2P	15	17	14	16	5
(R4) C3	16	19	23	17	12
(R4) C4	16	15	-10	17	4

Reported absolute figures have been rounded. Change percentages were calculated before the rounding.

Table 3. Impact of different policy scenarios on regional livestock densities (livestock units per hectare) in 2005.

	Regional livestock densities				
Area	1996	Base 2005	Change %	Agenda 2005	Change %
(R1) A	0.75	1.24	65	1.31	75
(R1) B	0.73	0.60	-18	0.69	-5
(R2) B	0.55	0.49	-11	0.52	-5
(R1) BS	0.84	2.12	152	1.94	131
(R1) C1	0.60	1.25	108	1.14	90
(R2) C1	0.68	0.89	31	0.86	26
(R3) C1	0.58	0.83	43	0.80	38
(R1) C2	0.66	0.60	-9	0.63	-5
(R2) C2	0.67	0.92	37	0.87	30
(R3) C2	0.66	0.95	44	0.96	45
(R2) C2P	0.69	1.15	67	1.10	59
(R4) C2P	0.70	0.91	30	0.85	21
(R4) C3	0.67	0.89	33	0.83	24
(R4) C4	0.67	0.61	-9	0.76	13

2000 leads to somewhat higher livestock densities than the base scenario in the southern part of Finland.

To conclude, the model results show that regional nitrogen surpluses decrease in both the base and Agenda 2000 scenarios in most regions compared to the base year 1996. The phosphorus surplus, however, increases in many regions, mainly due to reductions in the cultivated area in crop production, while livestock production does not decrease or decreases only slightly in those regions. The Agenda 2000 scenario leads to lower nitrogen surpluses in all regions compared to the base scenario. In the case of phosphorus, however, there are some regions where Agenda 2000 results in higher surpluses than the base scenario, namely areas A and B. The Agenda 2000 scenario also results in slightly higher livestock densities in areas A and B. On average, nutrient surpluses are lower in Agenda 2000 than in the base scenario due to reduced intensity in crop production, i.e. lower fertiliser use.

4.4. Impact of decoupled agricultural support on regional nutrient balances and livestock densities

The effect of alternative policy scenarios: reference scenario, Agenda 2000, and further de-coupled agricultural support on regional gross nitrogen balances in year 2011 is shown in Table 4.

The scenario of further decoupling of agricultural support leads to a higher level of nitrogen surpluses in the southern part of Finland (areas A and B) than in the two other policy scenarios. The decrease in the profitability of grain production results in significant decreases in the cultivated area in area A. This reduces the total cultivated area and, consequently, the nutrient balances in area A are higher than in the other parts of the country. In most other regions, however, the Agenda 2000 and decoupling scenarios lead to more extensive farming in terms of nitrogen surpluses than the reference scenario (see also Figure 3).

The effect of alternative policy scenarios on regional phosphorus balances in the year 2011 is shown in Table 5. The results show that the decoupling scenario leads to a higher level of phosphorus surpluses in the southern part of Finland (areas A and B (R1)) than in the two other policy scenarios. However, on average, the Agenda 2000 and decoupling scenario lead to somewhat higher phosphorus surpluses than the reference scenario. This is mainly due to the fact that the share of manure relative to artificial fertilisers increases in the former scenarios.

Table 4. Impact of different policy scenarios on regional gross nitrogen balances (kg/cultivated ha) in 2011.

				Gross nitrogen balances			
Area	1996[1)]	Base 2011	Change %	Agenda 2011	Change %	Decoupling 2011	Change %
(R1) A	42	73	72	88	109	98	132
(R1) B	51	39	-25	32	-37	47	-9
(R2) B	43	12	-71	4	-90	17	-59
(R1) BS	50	177	254	133	166	111	122
(R1) C1	58	83	44	81	40	79	37
(R2) C1	55	50	-9	37	-34	39	-29
(R3) C1	45	33	-26	35	-22	38	-15
(R1) C2	61	54	-12	40	-35	43	-29
(R2) C2	66	63	-4	49	-25	54	-17
(R3) C2	66	69	5	54	-18	50	-24
(R2) C2P	64	68	5	54	-17	53	-17
(R4) C2P	88	92	4	72	-18	73	-18
(R4) C3	102	112	9	88	-14	89	-13
(R4) C4	108	85	-21	70	-35	93	-14

Reported absolute figures have been rounded. Change percentages were calculated before the rounding.

1) The high nitrogen surplus in region 4 is due to a relatively high fertilisation recommendation for silage in that region.

Table 5. Impact of different policy scenarios on regional phosphorus balances (kg/cultivated ha) in 2011.

				Phosphorus balances			
Area	1996	Base 2011	Change %	Agenda 2011	Change %	De-coupling 2011	Change %
(R1) A	6	14	114	19	198	21	235
(R1) B	9	7	-24	7	-19	11	19
(R2) B	8	1	-83	1	-86	6	-21
(R1) BS	10	49	375	43	313	30	188
(R1) C1	11	22	107	26	138	25	135
(R2) C1	12	17	40	16	28	16	29
(R3) C1	9	7	-23	10	11	10	18
(R1) C2	11	7	-37	7	-32	13	25
(R2) C2	13	18	34	17	29	20	47
(R3) C2	13	20	56	19	52	19	51
(R2) C2P	14	23	71	22	63	22	59
(R4) C2P	15	19	27	17	18	17	17
(R4) C3	16	21	35	19	21	19	20
(R4) C4	16	13	-20	13	-18	20	22

Reported absolute figures have been rounded. Change percentages were calculated before the rounding.

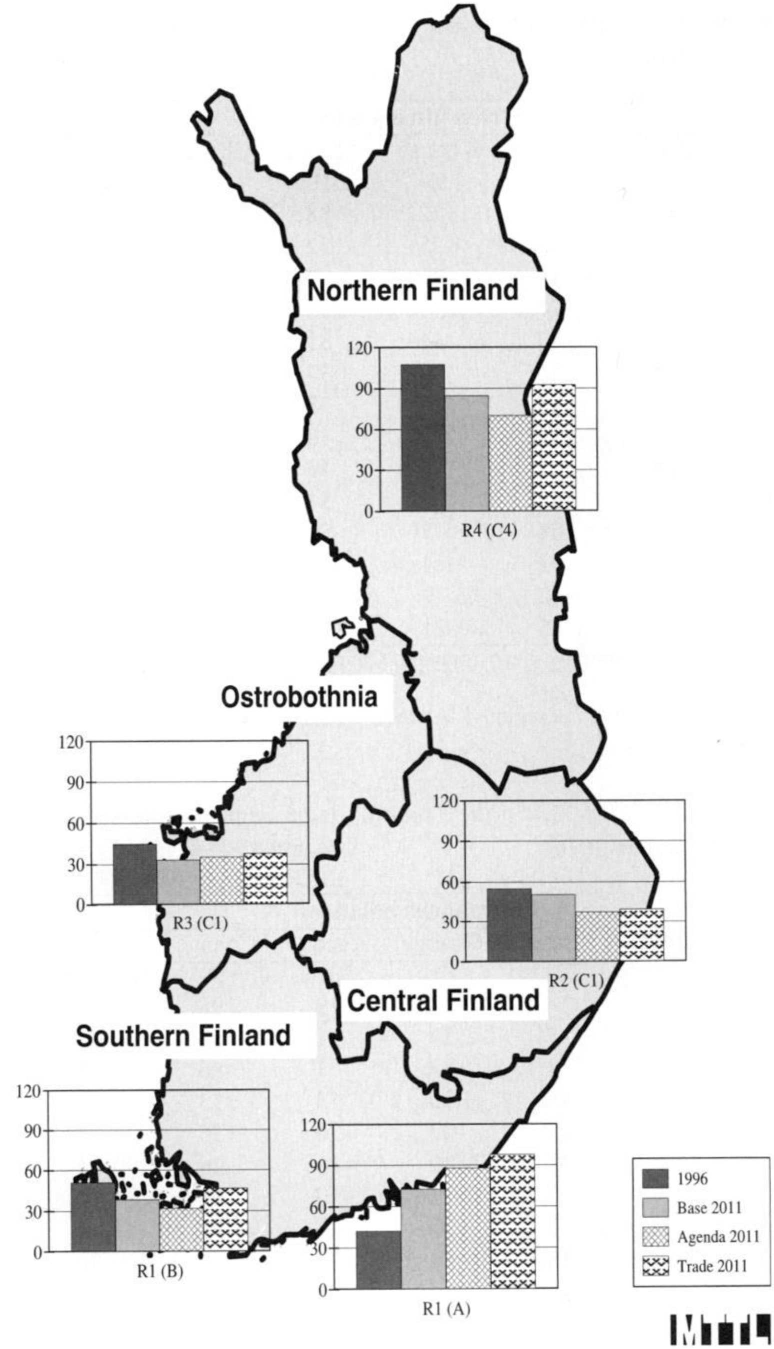

Figure 3. Nitrogen surpluses (kg/ha) in selected areas in different scenarios in 2011.

The impact of alternative policy scenarios on regional livestock densities in the year 2011 is shown in Table 6. Agenda 2000 and decoupling scenarios lead to clearly higher stocking densities than the reference scenario due to the fact that the cultivated area decreases clearly under these scenarios compared to that of the reference scenario. The changes in stocking densities are of the same magnitude for the Agenda and decoupling scenario in all regions except (R1) C2. Reason for this difference is that the cultivated area in region (R1) C2 decreases drastically in the case of decoupling scenario due to low crop yield, while livestock production does not decrease.

The impact of alternative policy scenarios on regional aggregate nitrogen surpluses in the year 2011 is shown in Table 7. Aggregate surpluses decrease significantly in all scenarios, but in the Agenda 2000 and decoupling scenarios they decrease more than in the reference scenario. Agenda 2000 results in slightly lower nitrogen surpluses in Southern Finland, whereas the decoupling scenario leads to slightly lower nitrogen surpluses in Northern Finland. This is due to the changes in the production allocation in the decoupling scenario. The sector model allocates the production to the most competitive regions, determined by production costs, yield levels, and subsidies. Since Southern Finland is the most cost competitive region in Finland and agricultural subsidies are equal throughout the country, the higher share of the production is allocated to Southern Finland in the decoupling scenario than in Agenda 2000. This results

Table 6. Impact of different policy scenarios on regional livestock densities (livestock units per hectare) in 2011.

Livestock densities							
Area	1996	Base 2011	Change %	Agenda 2011	Change %	De-coupling 2011	Change %
(R1) A	0.75	1.38	84	2.06	175	2.40	220
(R1) B	0.73	0.76	4	0.85	16	1.09	49
(R2) B	0.55	0.45	-18	0.60	9	0.72	31
(R1) BS	0.84	4.11	389	3.54	321	2.85	239
(R1) C1	0.60	2.15	258	1.97	228	1.87	212
(R2) C1	0.68	1.19	75	1.14	68	1.13	66
(R3) C1	0.58	0.73	26	1.00	72	1.08	86
(R1) C2	0.66	0.69	5	0.74	12	2.01	205
(R2) C2	0.67	1.13	69	1.12	67	1.28	91
(R3) C2	0.66	1.23	86	1.26	91	1.25	89
(R2) C2P	0.69	1.45	110	1.42	106	1.39	101
(R4) C2P	0.70	1.09	56	1.04	49	1.02	46
(R4) C3	0.67	1.02	52	0.96	43	0.98	46
(R4) C4	0.67	0.56	-16	0.60	-10	0.97	45

Table 7. Impact of different policy scenarios on regional aggregate nitrogen surpluses (1000 tons) in 2011.

	Aggregate nitrogen surpluses						
Area	1996	Base 2011	Change %	Agenda 2011	Change %	De-coupling 2011	Change %
(R1) A	12,6	8,5	-33	6,7	-47	7,0	-45
(R1) B	23,0	11,0	-52	6,1	-73	7,7	-67
(R2) B	0,4	0,1	-79	0,0	-105	0,0	-95
(R1) BS	0,2	0,1	-52	0,1	-65	0,1	-43
(R1) C1	1,4	0,6	-59	0,5	-67	0,4	-73
(R2) C1	5,4	1,1	-79	0,5	-91	0,6	-90
(R3) C1	8,4	3,2	-62	1,7	-80	1,6	-81
(R1) C2	1,4	1,4	1	0,9	-37	0,2	-88
(R2) C2	8,5	2,0	-77	1,3	-85	1,1	-87
(R3) C2	13,6	5,3	-61	2,7	-80	2,4	-82
(R2) C2P	1,4	0,4	-71	0,2	-83	0,2	-85
(R4) C2P	1,0	0,3	-73	0,2	-78	0,2	-79
(R4) C3	5,6	2,9	-47	2,5	-55	1,8	-68
(R4) C4	0,8	0,6	-23	0,5	-40	0,3	-60

Reported absolute figures have been rounded. Change percentages were calculated before the rounding.

in higher nutrient surpluses and livestock densities in Southern Finland in the case of the decoupling scenario.

To conclude, on average, the Agenda 2000 and the decoupling scenarios result in lower nitrogen and higher phosphorus surpluses than the reference scenario in 2011. The scenario of further decoupling of agricultural support leads to a higher level of nitrogen and phosphorus surpluses and higher stocking densities in the southern part of Finland (areas A and B) than in the two other policy scenarios. This is due to the fact that the sector model allocates the production to Southern Finland, where the production is more competitive than in other areas in Finland, given the same level of agricultural support in all regions.

5. Conclusions

A sector model of the Finnish agriculture has been used to evaluate the impacts of Agenda 2000 and further decoupled agricultural support on the environmental quality in Finland. Most differences in nutrient balances relative to the year 1996 are due to changes in the regional crop and livestock production and in fertiliser and yield levels due to price reductions. The aggregate regional nitrogen surplus in 2005 decreases in most regions in Finland relative to the base year 1996. This reduction comes from lower grain prices and fertilisation levels due to the Agenda 2000. A slight yield growth in crop and livestock production, which has been set exogenously in the model, is one reason for decreasing nitrogen surpluses. Phosphorus surplus increases in many regions mainly due to the reduction in the cultivated area, while there are relatively smaller reduction in livestock production.

The Agenda 2000 scenario results in lower nitrogen surpluses than the base scenario in all regions, whereas the phosphorus surpluses are higher in areas A and B in the Agenda 2000 than the base scenario. On average, however, the nutrient surpluses are lower in Agenda 2000 due to reduced production intensity. The sector model allocates the production to the most competitive regions, determined by production costs, yield levels, and subsidies. There is already a clear regional specialisation in agricultural production in Finland. However, there are no huge differences in regional production patterns given by the sector model in the base or Agenda 2000 scenarios. Some patterns of regional production specialisation are slightly reinforced and some are slightly reversed in both scenarios, and this affects to some extent both nitrogen and phosphorous balances.

On average, the Agenda 2000 and the decoupling scenarios result in lower nitrogen and higher phosphorus surpluses than the reference scenario in 2011. The decoupling scenario results in a higher level of nitrogen and phosphorus surpluses and higher stocking densities in the southern part of Finland (areas A and B) than Agenda 2000 and the base scenario. This has to do with the fact that the sector model allocates the livestock production to Southern Finland where the production is more competitive in the decoupling scenario than in other areas in Finland. Import of feed grains increases rapidly in the decoupling scenario, which decreases the cultivated area (even in Southern Finland). Consequently, nitrogen surpluses are greater in the decoupling scenario than in the Agenda 2000 or base scenario in 2011.

The regional aggregate nutrient balances given by the sector model should be complemented by farm level analysis in terms of nutrient balances. The regional averages do not tell the whole truth of the environmental quality changes at the farm level. Grain and livestock farms are not examined separately in the model. However, the results of the sector model are the first approximation of the regional level impacts on the environment due to agricultural policy reforms. It takes into account the market behaviour and many dynamic factors that are lacking from static farm level models.

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AGRICULTURAL ECONOMICS RESEARCH INSTITUTE
P.O. Box 3, FIN-00411 HELSINKI, Finland
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IMPACTS OF ENVIRONMENTAL PROTECTION ON AGRICULTURAL TRADE AND COMPETITIVENESS

LEENA ALANEN[1] AND JUSSI LANKOSKI

Abstract. The paper examines the impacts that environmental protection can have on agricultural trade and on the competitiveness of agricultural producers. The objective is to contribute to understanding the general issues at stake, and to identify and systematically review factors that may influence the link between environmental protection and competitiveness. So far the impacts of environmental regulations on agricultural trade flows and competitiveness have been modest due to the subsidy-based approaches implemented. Several influencing factors are reviewed through discussing the case of organic farming in Finland; some of these factors may provide competitive opportunities and others constitute competitive threats.

Key words: agriculture, international trade, environmental protection, competitiveness

1. Introduction

The two other papers in this volume analyse the impact that trade policies can have on the state of the environment. This paper now turns to briefly discussing the other side of the trade and environment link: the impact that environmental protection can have on trade. In this context, environmental policies and their impact on market access, trade flows, and competitiveness are of interest. However, the impacts of environmental protection in general on competitiveness are relevant, regardless of whether environmental protection is motivated by regulations, markets, or other reasons.

Chapter 2 first outlines some literature on the relationship between environmental policies, trade flows, and competitiveness. The chapter touches upon environmental policies as non-tariff barriers to trade and as strategic trade

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instruments, and the relationship between environmental regulations and competitiveness. The purpose of Chapter 2 is to review issues that have surfaced in the debate on the agricultural trade impacts of environmental policies.

Chapter 3 selects one of these issues, namely environmental protection and competitiveness, for closer examination by discussing the case of organic farming in Finland. The purpose of Chapter 3 is to bring up topics that may require systematic consideration in order to understand how the link between environmental protection and agricultural competitiveness may operate. Chapter 4 concludes the paper.

2. The effects of environmental policies on agricultural trade flows and competitiveness

2.1. The issues of environmental protectionism and ecological dumping

As agricultural support policies are now disciplined by the Uruguay Round Agreement on Agriculture, there has been a concern that governments may want to use environmental policies as non-tariff barriers to trade. According to Ervin (1997), the prospects for trade restrictions increase when the definition of the environment is extended to human health and food safety issues. The appropriate use of sanitary and phyto-sanitary standards in a manner that protects human, animal, and plant health from imports but does not constitute unfair trade restrictions thus becomes a central question.

Another concern has been that, in the case of freer trade, governments may want to relax their environmental standards in order to gain a competitive edge over their trading partners (the ecological dumping hypothesis) or to attract investment (the pollution haven hypothesis). Government policy is called "ecological dumping" when the prices of environmental resources are lower in the traded than in the non-traded sector (Rauscher 1994; Schneider and Wellisch 1997). According to Rauscher (1994), through low pollution abatement targets producers obtain hidden subsidies that result in the dumping of products into the world market at prices that do not reflect the social costs of production. Moreover, in contrast to ordinary dumping, ecological dumping is performed by the government, not by an individual firm.

The economically optimal policy response for domestic environmental problems is to use instruments that are the most directly linked to the source of the externality. For example, if production generates pollution, the first best environmental policy response would be a Pigovian tax-cum-subsidy approach, such as a tax on emissions or effluents where the tax rate equals marginal external costs. Trade policy instruments, on the other hand, are usually considered too blunt for correcting domestic environmental problems. The use of trade instruments may result in large economic welfare losses through distorting resource allocation beyond the source of the externality (Beghin et al. 1994). Thus, since the source of the environmental problem is usually production or consumption activity, not international trade per se, trade policy intervention is a poor substitute for the more efficient environmental policy intervention at the source of the problem.

Following Beghin et al. (1994), the political economy of rent seeking provides an explanation for the use of trade policy instruments for addressing environmental externalities. For example, environmental lobbies may find economic welfare losses relating to trade distortions small compared to potential environmental gains resulting from the trade barriers (Hillman and Ursprung 1992). According to Karp et al. (1995), the basis for this belief lies in the notion that the world economy may be closer to free trade than to full internalisation of externalities. In addition, domestic producers may want to level the playing field with foreign competitors in respect of environmental standards and regulations through trade barriers. These overlapping interests may give rise to coalitions between producer and environmental lobbies (Beghin et al. 1994).

Strategic considerations about the competitive position of domestic firms and industries may influence the government's selection of environmental policies. According to Nannerup (1998), a number of examples show that environmental policies, instead of being just regulatory policies, also provide a mechanism for governments to intervene strategically in international trade on behalf of domestic firms. In the case of competitive markets, a small economy with local production externalities cannot increase welfare by choosing its environmental policies strategically. A large economy, however, would have an incentive to do so in the absence of trade policy instruments (Ulph 1996; Krutilla 1991). For example, Krutilla (1991) has analysed the case of a large open economy in which the economy's terms-of-trade can be influenced through environmental policies. In this case the optimal environmental taxes will differ from Pigovian ones due to terms-of-trade effects associated with the tax. Krutilla shows that the optimal production tax will be set above the Pigovian level in the case of a net exporter and below the Pigovian level for a net importer.

Game theory models have been used when the assumed market is imperfect instead of perfectly competitive. The rather sparse literature on the relationship between imperfectly competitive markets and environmental externalities and policies has mainly considered the strategic behaviour of governments and firms when setting pollution standards and taxes. A number of studies (e.g. Conrad 1993; Barrett 1994; Kennedy 1994) have developed adaptations of the Brander and Spencer (1985) model of oligopolistic international markets to embody environmental pollution. Barrett (1994) analyses the case where governments act strategically through setting weak environmental standards on industries that compete in imperfectly competitive international markets. In Kennedy's (1994) analysis imperfect competition creates a strategic interaction between governments that leads to the use of non-optimal levels of pollution taxes. Ulph (1996) concludes that strategic behaviour by governments and producers is greater when governments use emission taxes than in the case of emission standards.

2.2. Environmental regulations and competitiveness

In theory, unilateral environmental protection measures harm the competitiveness of the domestic producers concerned. Some early studies (e.g. Pethig 1976; Siebert et al. 1980; Siebert 1987) on the trade and environment nexus have demonstrated theoretically the potential impact of environmental regulations on the comparative advantage, international trade flows, and competitiveness. It has been expected that if a country imposes more stringent environmental regulations than the competitors, there will be a decline in the comparative advantage of pollution-intensive production resulting in the loss of competitiveness in the case of the domestic firms. This competitiveness loss leads to declining exports and increasing imports of pollution-intensive goods, and a possible migration of pollution-intensive industries into countries with lax environmental standards (the industrial flight hypothesis).

For example, Siebert (1987) shows that, as a result of international trade, a country endowed with environmental resources exploits the comparative advantage in producing and exporting pollution-intensive goods, causing its environmental quality to deteriorate. Environmental degradation in this country reduces the net gains from trade. If the country now implements a unilateral environmental policy (e.g. an emission tax), the production costs and the price of the pollution-intensive good will rise, thus reducing the country's comparative price advantage.

In practice, however, there has been little empirical support for these theoretical results. According to Jaffe et al. (1995), competitiveness indicators can be classified into three broad categories: change in net exports, location of production of pollution-intensive goods, and location of investment. The impact of environmental regulations on output and trade patterns seems to be very small or insignificant, and the evidence also suggests that environmental regulations have not had a contributory role in industrial migration decisions.

For example, Robison (1988) estimated the impact of a one per cent increase in environmental compliance costs on the U.S. trade balance. The results of the study show that the abatement content of U.S. imports rose more than the abatement content of U.S. exports, implying that the comparative advantage of the U.S. shifted away from goods with high abatement costs. However, the effects remained quite small, even though mitigating general equilibrium effects were not taken into account. Tobey (1990) used a Hecksher-Ohlin-Vanek model to test whether environmental regulatory stringency is a determinant of net exports in five pollution-intensive sectors (mining, paper, chemicals, steel, and metals). Consistently with other empirical studies, there was no evidence of a negative impact.

Low and Yeats (1992) studied the patterns of pollution-intensive exports during 1965-1988. They found that dirty industries accounted for a growing share of the exports of certain developing countries. At the same time, the share of pollution-intensive exports declined in developed countries, and the overall share of these products in the world trade fell from 19 to 16 per cent. However, these changes in trade patterns were partly due to the general economic development in developing countries: along with development, the share of manufacturing in the economic activity grows (Jaffe et al. 1995).

Overall evidence on industrial migration to countries with lax environmental regulations seems to be weak. This is because firms base their overseas location decisions on a variety of factors, including infrastructure, labour productivity, and transportation costs. Since abatement costs have so far been modest, the incentive to relocate has also been small (Ervin 1997).

Studies on industrial pollution abatement costs show that these costs comprise only a small fraction of total costs, representing, on average, one to three per cent of production costs (Tobey 1990). Thus, it can be expected that environmental regulations at their present level – which can be assumed not to be a Pareto-optimal full internalisation level – are not a significant determinant of competitiveness in most sectors.

Jaffe et al. (1995) conclude that studies on the impact of environmental regulation on net exports, trade flows, and plant location "have produced estimates that are either small, statistically insignificant, or not robust to tests of model specification". They go on to provide a number of reasons why these effects have been small or difficult to detect. These include data problems concerning the relative stringency of regulations, abatement costs that comprise only a small fraction of total production costs, and small differences in regulatory stringency across competitors. Further reasons for small regulatory impacts may be that environmental regulations encourage firms to discover cost-saving or value-adding innovations that enhance long-run competitiveness (Porter and van der Linde 1995). These will be discussed in more detail in Chapter 3.

In agriculture, the concern of reduced competitiveness due to agri-environmental policies has surfaced only recently (Ervin 1997). This is mainly because these policies have largely used voluntary, subsidy-based approaches with minor effects on production costs and competitiveness, and the application of the polluter-pays-principle has been rare. For example, the compliance costs of the Finnish GAEPS (General Agricultural Environmental Protection Scheme) may in some cases be zero or even negative as the participating farmers have been compensated for the cost increases and income losses.

According to Gardner (1996), the effects of environmental regulations on U.S. agricultural productivity and costs have so far been modest, but environmental regulations have the potential to become a major factor in agricultural trade. Ervin (1997) maintains that the differences in the compliance costs of agri-environmental programs among OECD countries are so small that the policies are likely to exert only a negligible effect on trade between these countries. Blom (1996) also writes that the Uruguay Round Agreement on Agriculture is the most important determinant of the future EU trade, and the impact of environmental policies on agricultural production will be only marginal.

3. Examining competitiveness impacts through the case of organic farming in Finland

In this chapter, the issue of environmental protection and competitiveness is decomposed and examined in more detail to illustrate the diverse aspects that influence this relationship. Even though the focus now shifts from trade flow analysis to more micro level considerations, the fundamental topic remains the same: whether and how the location of production and net exports and imports are affected by environmental protection measures.

As was shown in the preceding review, economic theory would expect improved environmental protection to harm the competitiveness of domestic producers, but such a relationship has not been established in practice. It seems likely that the competitiveness impacts of environmental protection are not systematically negative, nor positive, but depend on many factors and vary between sectors, producers, and circumstances. Thus, for some sectors or producers environmental protection may present a competitive opportunity and for others a competitive threat, while some producers may find their competitive position unaffected by environmental protection.

Even though environmental policies ought to be designed for environmental reasons and not for competitiveness, it is useful to assess their implications in respect of competitiveness. In the following, the case of organic farming in Finland is discussed to shed light on the types of issues to be considered in connection with environmental protection and agricultural competitiveness. The main viewpoint is that of agricultural producers, even though the food industry also needs to be referred to. The example is equally applicable to domestic (import-competing) and export markets; in both cases the competition is assumed to consist of products of conventional agriculture.

3. 1. Dimensions of competitiveness

Competitiveness in this case refers to the ability of Finnish agricultural producers to produce and market their products profitably in open markets (Männistö et al. 1997, p. 9). It can be divided into two dimensions: price (proxied by cost) and differentiation (Porter 1980; Mathur 1988). Differentiation can involve any attribute that may influence the customer's purchasing decision, including the manner in which a product has been produced. Figure 1 illustrates how positioning a product at a certain combination of differentiation and price determines its attractiveness on the market. At the same time, costs are incurred to create differentiation, which in turn relates to the obtainable price. Price and costs together govern the profitability.

Environmental protection can influence both dimensions of competitiveness in both directions. There may be cost increases and decreases, and there may be positive and negative differentiation. Positive differentiation refers to a case where the product's advantages are perceived to increase, and negative differentiation to a case where its disadvantages are perceived to increase, relative to competitors.

Studies on agricultural competitiveness sometimes focus on the cost dimension only. For example, according to Gardner (1996), "the concept of competi-

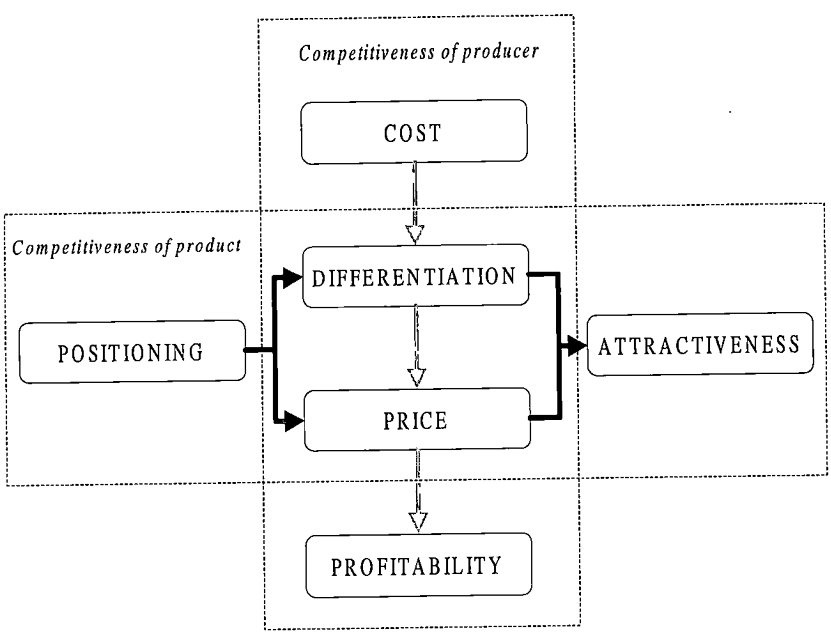

Figure 1. The competitiveness of a product and a producer.

tiveness refers to the domestic cost of production as compared to production costs in other countries." However, here it is considered important to perceive competitiveness as a broader concept that, in addition to cost, covers differentiation as well. It is true that there can be sectors where the cost dimension dominates so heavily in the competition that the differentiation dimension is insignificant. This possibility must not be ruled out, but neither should it be established a priori in the definition of competitiveness.

Both dimensions of competition can be further divided into two subdimensions. Cost competitiveness impacts depend on the magnitude and competitive significance of an environment-related cost change. Differentiation impacts depend on the feasibility of product differentiation as a strategic instrument in the first place, and on how important the environmental aspects are in the differentiation. Several moderating factors influence the two dimensions of competition through the subdimensions. This is summarised in Table 1.

Table 1. Factors that may influence the sectoral link between environmental protection and competitiveness (Alanen 1996).

Dimensions of competition	**Subdimensions**	**Moderating factors**
Cost (proxy for price)	Direction and magnitude of environment-related cost change	Type and extent of environmental externality (e.g. pollution intensity, resource use intensity)
		Technological aspects (e.g. investment cycle, innovation potential)
	Competitive significance of environment-related cost change	Ability to absorb cost (e.g. cost structure, profit margins)
		Ability to pass on cost to customers (e.g. price elasticity of demand, prices of competing products)
Differentiation	Feasibility of competition based on differentiation	Nature of product (e.g. degree of homogeneity, price-based competition)
	Differentiating importance of environmental characteristics	Customers' environmental concern (e.g. direction of sales, sensitivity of issue)

3.2. Direction and magnitude of cost changes

The environmental costs of a sector naturally depend on the environmental impacts that are associated with its products and production processes. The more pollution and resource intensive a sector is, the more likely it is to face significant environment-related costs.

Traditionally, agriculture has not been regarded as a sector with harmful environmental impacts. Instead, regulatory attention focused on easily identifiable polluters, such as industry. Along with notable reductions in point source emissions, however, the share of nonpoint sources of the remaining pollution has become more and more important. For example, the nitrogen and phosphorus load from Finnish agriculture is already greater than that of industry, municipalities, and fish farming combined (Rekolainen 1996).

Eutrophication of waterways that is caused by nutrient runoff may be the most serious environmental impact of Finnish agriculture. Other environmental impacts relate to acidifying ammonium releases into air, pesticide leaching into soil and water and pesticide residues in food, soil erosion, and biodiversity loss. Ethical issues concerning the treatment of animals and genetically modified organisms are also inseparable from the purely environmental issues. However, agriculture also produces positive environmental impacts through biodiversity and landscape creation.

In international comparison, the environmental performance of Finnish agriculture is good in many respects. Due to the hostility of the cold climate to many pests, pesticides are used much less per hectare in Finland and Sweden than in the rest of the EU (Miettinen et al. 1997, p. 29) Further, the intensity of production is relatively low in Finland. For example, in 1993 the use of fertilisers per hectare was clearly less than the OECD average (Miettinen et al. 1997, p. 25). Finland also belongs to the top five countries with the largest share of cultivated area in organic production in the world (Heinonen 1996).

Environment-related costs depend on technology, too. The type and extent of environmental impact determine the amount of externality to be internalised, but technology, in its widest sense, determines how this internalisation translates into costs. "End-of-pipe" type solutions to control pollution that are often found in industry are more difficult to implement in agriculture. Buffer strips could be an example of such a method: they only increase the opportunity costs of capital tied in non-productive land, but do not create value in the product or promote process improvements. Reducing environmental impacts in agriculture largely relates to pollution prevention through reduced use of fertilisers and pesticides. In general, this kind of process changes are considered to represent the most promising environmental solutions in the sense that they may bring about efficiency savings or induce offsetting innovations.

Naturally, decreasing the use of purchased chemical inputs also decreases the input costs. But, due to reduced yields, reduced livestock density, and reduced cultivated area in output production, costs per unit of output usually increase in organic farming, even if total costs decrease as a result of environmental measures. The costs of environmental protection in agriculture are thus largely the opportunity costs of foregone revenue. – There are, of course, also environmental measures that involve direct cost increases: for example, manure storage investments, increased labour requirement especially in vegetable farming, and sometimes investment in different machinery, equipment, and buildings. However, despite being a capital-intensive sector, agriculture may not face particularly high environmental adjustment costs, as has been suggested to happen in the case of capital-intensive sectors (Stevens 1993). This is because in agriculture the same capital can be used in both conventional and organic production.

Environmental protection can also be seen as a means of avoiding risks and the related long-term costs. Agriculture is fundamentally dependent on a clean and productive natural environment. From the agricultural perspective, therefore, environmental quality is not only a public good but partly also a private good. Protecting this private good may reduce the future costs associated with a key input. Furthermore, catastrophic risks (like the case of the BSE disease in Great Britain) may have serious legal and market consequences and involve costs that easily wipe away any savings in environmental protection or animal treatment.

Innovation to develop more efficient production processes may at first seem impossible since in agriculture the "production process" is based on nature and not on a man-made technology, and must deal with stochastic factors such as weather. Many environmental measures in agriculture are aimed at more extensive farming practices and thus switching to *less* efficient production processes. Nevertheless, efficiency-enhancing innovations are not necessarily implausible. It is possible that intensive agricultural methods have masked inefficiencies in farming practices that become visible when shifting to extensive farming. For example, new practices, such as precision farming where each parcel of arable land receives an exactly optimal input combination, are now being developed.

Organic farming, in particular, requires significant experience and knowledge, and yields depend on the professional skills of the farmer. However, efforts to develop organic farming technology have so far been modest and there may thus be many unexplored innovation opportunities (Miettinen et al. 1997, p. 88). For example, varieties that are better suited for organic farming can be cultivated, and pest control can be organised more effectively when there are large open arable land areas in organic production (Miettinen et al. 1997, p. 43). Larger volumes of organic production would also allow more efficient handling in the transportation, processing, and marketing stages.

Evidence of environment-related cost increases in agriculture is mixed (Gardner 1996). Koikkalainen (1996) studied the relative profitability when converting from conventional farming to organic farming in Finland by means of farm models. As farm costs differ between the production lines, he analysed dairy, beef cattle, cereal, pig, and vegetable farms (represented by carrot farming) separately. Table 2 summarises the changes in sales revenue and variable costs found by Koikkalainen. Changes in agricultural support will be examined separately in the next section.

Table 2. Changes in sales revenue and variable costs in representative farms when switching from conventional production to organic production.

	FIM/ha	
Dairy farms		
Change in sales revenue	-1247	
Change in variable costs	- 606	
Net impact on profit		-641
Beef cattle farms		
Change in sales revenue	-1000	
Change in variable costs	- 704	
Net impact on profit		-296
Grain cultivation farms		
Change in sales revenue (green fertilisation yield not sold)	-1213	
Change in sales revenue (green fertilisation yield sold)	- 893	
Change in variable costs	- 619	
Net impact on profit (green fertilisation yield not sold)		-594
Net impact on profit (green fertilisation yield sold)		-274
Pig farms		
Change in sales revenue	-4783	
Change in variable costs	-3957	
Net impact on profit		-826
Vegetable farms (carrot)		
Change in sales revenue	-8080	
Change in variable costs	+1469	
Net impact on profit		-9549

Calculations assume a 30 per cent reduction in yields, except for a 10 per cent reduction in milk yields, and no price premium for organic products, and exclude fixed costs. (Source: Modified from Koikkalainen 1996)

3.3. Significance of cost changes

We have seen that environmental impacts determine the magnitude of the externality to be internalised and that technology determines the associated costs. However, the competitive significance of the cost changes must still be analysed separately. If cost increases can be absorbed by producers or passed on in full to customers, or if all competitors experience similar cost changes, there may be no competitive implications. Gardner (1996) also follows this approach by isolating the magnitude of costs and their incidence on the producers and consumers.

The ability of producers to absorb environment-related cost increases depends on their cost structure. In most sectors environmental costs have to date amounted to only a few per cent of production costs, which dynamic producers have been able to absorb (Sorsa 1994). Another issue to be considered is the profit margin in the sector. If profitability is already weak before the environment-related cost change, even relatively small cost increases are hard to tolerate. In Finland, agricultural profitability has been suggested to decrease in all production lines and all regions during the transitional period following the EU membership. This profitability decrease may be so drastic that most farms will eventually have to discontinue production if no corrective measures are taken (Sipiläinen et al. 1998).

The ability of producers to pass on environment-related cost increases to customers in the form of increased prices depends on the price elasticity of demand. Costs can be passed on more easily in the case of products that have a low price elasticity of demand because the customers of these products are not very sensitive to changes in product price. Due to lack of substitutes, food in general has a low price elasticity of demand. However, there may be substitution between different food items: even if people will always have to eat, they may choose to eat different products. For elasticity estimates on various agricultural and food products, see e.g. Laurila (1994).

The low price elasticity implies that agricultural producers should be able to pass on the costs of environmental protection. According to Gardner (1996), many analysts have found this to take place. Consumers bear the cost increases because of the inelastic demand and an increase in the demand for farmer-owned inputs (land and labour) that may result from restricting the use of purchased chemical inputs. However, Gardner continues to note that the cost incidence differs for the part of goods traded in international markets: prices for such goods are determined by international conditions, and producers must bear the burden if costs increase in one country.

There is evidence of a willingness to pay a price premium for environmentally-friendly agricultural products. (See also the related discussion on product differentiation in the next section.) Consumer surveys in Finland have found an expressed willingness to pay premia of 10 to 30 per cent for organic products, depending on the product group and starting price (Tauriainen and Pohjalainen 1992; Väisänen and Pohjalainen 1995; Tiilikainen 1998). The cost of raw materials at present constitutes roughly one quarter of the price of food. Thus, a 10 per cent increase in consumer prices would allow an increase of as much as 40 per cent in producer prices if the absolute margins of food industry, wholesalers, and retailers were to remain unchanged (Miettinen et al. 1997). Koikkalainen (1996) found that, under the present support system, price premium requirements for organically produced milk, grain, beef, and pork mostly varied between 0 and 9 per cent.

Economic growth decreases the share of food in consumers' budget, and a shift to processed food decreases the share of raw materials in the price of food (Miettinen et al. 1997, p. 95 and 84). These two ongoing trends may further increase the possibility for producers to pass on environmental costs to the prices of agricultural products. At the same time there are pressures in the society to keep food prices low because food constitutes a relatively large expense for poor people.

However, few agricultural products are sold directly to consumers. Most often the purchaser is the food industry or wholesalers. The strength of producers, small identical price takers, towards these companies with oligopsony power is low. It may be more difficult for farmers to obtain a premium from the food industry or wholesalers than it is for the latter to obtain a premium from consumers. Thus, any price premium must flow from consumers to agricultural producers through retailers, wholesalers, and the food industry. If farmers have no market power and no marketing skills, the entire premium or a large part of it may end up in the pockets of retailers, wholesalers, and the food industry and never reach agricultural raw material producers, who are the last ones in the chain.

The ability to pass on environmental costs to prices also depends on the intensity of competition and the price development of competing products. To analyse the price development of competing products one needs to estimate whether competitors would undertake similar environmental measures, and whether the costs of such measures would be comparable. For this purpose it would be interesting to analyse whether the marginal benefit of production intensity is different in Finland than e.g. elsewhere in the EU. Finland cannot probably ever obtain an absolute advantage in agricultural production because of its climatic conditions. However, if the marginal benefit of production intensity were less in Finland than in competitor countries, then Finland could have a comparative advantage in extensive agriculture.

Finally, in the case of agriculture, the competitive significance of environment-related cost changes is crucially determined by the existing support system. If the farmer is compensated for the cost increases and sales revenue losses through the support system, like in the Finnish GAEPS (General Agricultural Environmental Protection Scheme), they do not have any competitive significance on the markets.

Further, the support system determines more generally the profitability of different production lines and production practices. As more than half of farm income may consist of direct support, total farm income is maximised by minimising costs rather than by maximising output (Koikkalainen 1996). This increases the incentive for extensive farming (see e.g. Sipiläinen et al. 1998).

The analysis in Koikkalainen (1996) was broken down at the support area level. Table 3 summarises the profitability changes per hectare from switching from conventional production to organic production, including the impact of agricultural support.

A comparison of Table 3 with Table 2 reveals clearly the major impact that the support system has on the competitive significance of environment-related cost changes. In Table 2, agricultural support was ignored. The net impact on profit from changes in sales revenue and variable costs was negative in each production line when switching to organic production. When agricultural support is included in the calculations, this picture is changed in the case of dairy farms, beef cattle farms, and grain cultivation farms. As long as they enjoy the higher aid of the conversion period, organic production is more profitable than conventional production. When support levels decrease in the fourth year, also profitability decreases. For the part of pig farms and carrot farms organic production remains less profitable than conventional production even when agricultural support is taken into consideration.

3.4. Feasibility of environmental differentiation

It was noted earlier that in some sectors the price or cost dimension might dominate competition at the expense of the differentiation dimension. The nature of the product and its markets determine to what extent differentiation can be an element of competition. This analysis is intimately related to that of the ability to pass on cost increases into prices, since price premia are usually awarded to differentiated products.

Again, the marketing of agricultural products is inseparable from, but also different from, the marketing of the products of the food industry. On the market for agricultural products, sellers are small, identical, anonymous price takers, and the product is often homogeneous. This would suggest that competition would be based, not on differentiation, but on the price and availability after certain minimum quality requirements are met. Indeed, the products are sold at administrative prices, which makes production costs a major issue.

The market where products are sold to the end consumers is quite different. Oligopoly power rests with the sellers. The more processed the products are, the

Table 3. Changes in relative profitability (gross margins) in representative farms when switching from conventional production to organic production.

	FIM/ha				
	1995	**1996**	**1997**	**1998**	**1999**
Dairy farms					
Support area A	673	731	852	-155	-80
Support area B	393	451	572	-235	-160
Support area C	117	175	228	-452	-445
Beef cattle farms					
Support area A	747	1066	1137	99	134
Support area B	357	677	748	-91	-56
Support area C	65	384	378	-338	-381
Grain cultivation farms					
Support area A (green fertilisation yield not sold)	748	758	751	-340	-320
Support area A (green fertilisation yield sold)	1067	1077	1071	-21	0
Support area B (green fertilisation yield not sold)	932	942	865	-82	-129
Support area B (green fertilisation yield sold)	1252	1262	1185	238	191
Support area C (green fertilisation yield not sold	791	801	795	117	140
Support area C (green fertilisation yield sold)	1111	1121	1115	437	460
Pig farms					
Support area A	-755	-359	-53	-807	-542
Support area B	-985	-588	-282	-836	-571
Support area C	-1147	-751	-1113	-2134	-2537
Vegetable farms (carrot)					
Support area A	-7956	-7956	-7956	-9056	-9056
Support area B	-8228	-8228	-8228	-9128	-9128
Support area C	-8249	-8249	-8249	-8949	-8949

The switch is assumed to have taken place in 1995. During the first three years there is higher support for conversion to organic farming and after this lower permanent support for organic production is available. Calculations assume a 30 per cent reduction in yields, except for a 10 per cent reduction in milk yields, and no price premium for organic products, and exclude fixed costs. (Source: Modified from Koikkalainen 1996)

more differentiated they tend to be. Thus, differentiation is a feasible element of competition towards the end consumer. However, agricultural producers can compete based on differentiation towards the intermediate steps in the chain only if the intermediaries require a differentiated input to produce a differentiated output. In organic production this is very much the case. Organic production is covered by regulations stating that a product can be marketed as organic only if a minimum percentage of the agricultural inputs have been organically produced, and if they have been processed according to certain rules. Note also that, because of these very regulations, if the products of organic farming are mixed with those of conventional farming or processed in a conventional way, the differentiating value of the organic input is lost.

The differentiating importance that environmental characteristics can have is closely linked with the concept of environmental competitiveness. Environmental competitiveness can be defined as a product's relative attractiveness to customers that is based on its environmental attributes. It builds on three elements: (1) actual physical environmental performance, i.e. environmental friendliness relative to substitutes; (2) communication of the environmental performance to the markets; and (3) the weight that customers give to the communicated environmental performance in their buying decisions. If any of these elements fails, environmental differentiation as a long-term competitive instrument fails. In the short term, though, it may be possible to maintain environmental competitiveness by means of environmental communication that is unsubstantiated. However, in the case of organic production even this may not be possible because of the strict regulations guiding the production and marketing of organic products.

The relative environmental performance of Finnish agriculture has already been touched upon earlier. More development may be needed especially in the processing and communication stages. In terms of export prospects, the preference for locally produced organic food may reduce the "environmental performance" of Finnish organic agricultural products on export markets. This section, however, discusses the third condition, the weight given by customers to environmental differentiation. This weight can vary between customers, products, and environmental issues.

The demand for a clean environment has been shown to be income-elastic. The wealthier the customers, the more weight they give to environmental issues in their purchasing decisions. Accordingly, the potential for environmental differentiation varies along with the direction of sales, customer segment, and general economic conditions. This is based on differences in the willingness to pay for a clean environment between geographical markets, between wealthy and poor customers within a geographical market, and between the same customers in different time periods.

Not all products are equally prone to environmental differentiation. Product differentiation can be based on content or image differentiation, where content refers to "what the product will do for the customer" and image to "what it will say about him to himself or others" (Mathur 1988). In terms of product content, the quality of organic products may be regarded as superior to conventional products in some respects (purity, taste) and inferior in other respects (size, apperance). In the case of products such as fruit and vegetables the possibility for involuntary negative differentiation may be more substantial than, for example, in that of milk.

Finally, what matters is the environmental issue in question. For some sensitive issues customers show environmental concern and willingness to pay, while for others they do not. In agriculture, issues relating to human health or animal welfare usually arouse strong feelings (see e.g.Tiilikainen 1998). Since environmental and health concerns coincide in agricultural products, the potential for environmental differentation is larger than in many other sectors. Organic products can be considered a bundle containing both private and public goods (Miettinen et al. 1997, p. 97). Even if customers are not willing to pay for the public good, they may be willing to pay for the private, health-related good.

Studies indicate that for Finnish consumers environmental reasons have become a less important argument for buying organic products (Väisänen and Pohjalainen 1995). By contrast, in the other Nordic countries environmental protection is among the most important rationales for such purchasing behaviour (Mathiesson and Schollin 1993; Bugge 1995; ref. Miettinen et al. 1997, p. 56.). The relatively clean reputation of conventional agriculture may serve to reduce the appeal of organic farming for environmental protection reasons in Finland (Miettinen et al. 1997, p. 111). However, it may be questioned whether environmental differentiation that rests on the willingness of customers to purchase the related private goods but not the public goods is a lasting strategy. For example, the Council Regulation 2092/91 of the European Union explicitly forbids marketing claims that would give the impression that organic products have better sensory or nutritive quality or that they are healthier than conventional products. According to Tiilikainen (1998), it is just these three attributes that determine the value that consumers perceive in environmentally friendly food products.

3.5. Summing up competitiveness impacts

The preceding discussion has brought up several factors that may influence the link between environmental protection and agricultural competitiveness, some by providing opportunities and others by constituting threats. The combined impact of these factors on the competitiveness of different production lines can be qualitatively assessed with the help of a matrix illustrated in Figure 2. The overall potential for a negative cost impact arises from the magnitude and significance of environment-related cost changes, discussed in sections 3.2 and 3.3. The potential for a positive differentiation impact was discussed in section 3.4.

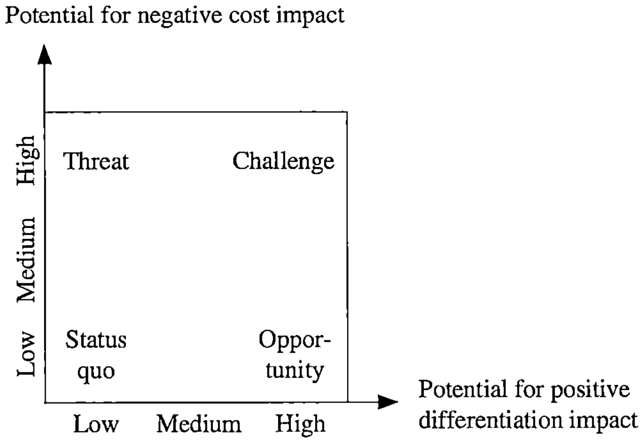

Figure 2. A matrix for assessing overall competitiveness impacts (Alanen 1996).

Four main situations can be identified from the matrix outcomes. A situation where there are neither important cost impacts nor important differentiation opportunities is called the *status quo*. By contrast, where both cost impacts and differentiation opportunities are high, a *challenge* is present as the balance may turn out to be favourable or unfavourable. A *threat* situation is one where cost impacts are significant, but differentiation potential is rare. A pure *opportunity* is available if cost impacts remain low but notable differentiation potential is offered.

4. Conclusions

The paper examines the impacts that environmental protection may have on agricultural trade. Two main groups of issues in this context are environmental policies as non-tariff barriers to trade and the relationship between environmental protection and competitiveness. So far the impacts of environmental regulations on agricultural trade flows and competitiveness have been modest due to the subsidy-based approaches implemented.

In order to understand how environmental protection may affect agricultural competitiveness it is useful to also consider systematically other factors than production costs. Several influencing factors are reviewed in the paper through discussing the case of organic farming in Finland; some of these factors may provide competitive opportunities and others constitute competitive threats.

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SUMMARY

Linkages between agricultural trade and the environment

Jussi Lankoski

The objective of this volume is to provide an overview of the trade and environment debate in the context of agriculture. In general, two broad issues can be distinguished in the debate: the effect of international trade and trade liberalisation on environmental quality, and the effect of environmental protection on international trade flows and competitiveness. The former group of issues is analysed in the first two papers of the volume, whereas the latter group of issues is treated in the third paper of the volume.

The first paper reviews theoretical and empirical studies on linkages between agricultural policies, international trade, and environmental quality. The rationale for studying the environmental effects of agricultural trade liberalisation lies in the fact that environmental externalities influence the ultimate social welfare outcomes of trade liberalisation. Increased trade flows owing to agricultural trade liberalisation have mainly indirect effects on the environment through complex changes in the location, intensity, product-mix, and technology of agricultural production. Direct negative environmental impacts of expanded agricultural trade relate to the pollution caused by the transportation of agricultural products and to the potential migration of harmful species of plants, insects, and animals to new areas where they do not have natural enemies.

From the theoretical point of view, further liberalised agricultural trade is welfare improving, provided that appropriate environmental policies are implemented to internalise environmental external costs. According to the reviewed empirical studies, the changes in environmental quality induced by agricultural trade liberalisation may remain relatively small. Moreover, trade liberalisation may result in a reallocation of environmental degradation. For example, in those countries whose production is not cost competitive, the pollution stemming from the agricultural intensification may decrease (e.g. nutrient pollution), while there is a threat of land abandonment resulting in a loss of agricultural landscape and biodiversity.

Since the price and production changes induced by the Uruguay Round Agreement on Agriculture seem likely to be quite moderate for most countries, this partial trade liberalisation may not cause major changes in the environmental impacts of agricultural production. Instead, the environmental impacts of domestic agricultural policy reforms will probably be more significant than impacts induced by the Uruguay Round Agreement on Agriculture. This is

largely due to the fact that agricultural trade liberalisation, partial or complete, does alleviate some policy failures which have adverse environmental impacts, but does not correct environmental market failures. By contrast, domestic agricultural policy reforms, while alleviating policy failures, could also tackle environmental market failures through e.g. agri-environmental programs.

The potential impacts of the Agenda 2000 and further liberalised agricultural trade on the environmental quality in Finland are examined in the second paper of the volume. An agricultural sector model is used to simulate the changes in production allocation, land use, and input use and, through these, the impacts on environmental quality resulting from the given policy changes. Environmental indicators such as regional nutrient balances and stocking densities are incorporated into the sector model. The starting point for the analysis is that the CAP reform package, which is part of the Agenda 2000, is set to enhance the European Union's negotiating stance in the new round of multilateral trade negotiations starting in 1999. Thus, further liberalised agricultural trade will lead to policy adjustments in the CAP, which in turn have environmental implications through changes in agricultural production patterns. In addition to the Agenda 2000 scenario, the scenario of further decoupling of agricultural support is analysed. The decoupling scenario is also called the trade policy reform scenario.

On average, the nutrient surpluses are lower in the Agenda 2000 scenario than in the base scenario due to reduced production intensity in 2005. The Agenda 2000 and the decoupling scenarios result in lower nitrogen and higher phosphorus surpluses than the reference (= base) scenario in 2011. The decoupling scenario results in a higher level of nitrogen and phosphorus surpluses and higher stocking densities in the southern part of Finland (areas A and B) than Agenda 2000 and the base scenario. The sector model allocates the livestock production into Southern Finland, where the cost competitiveness of production is higher than in other areas in Finland. Import of feed grains increases rapidly in the decoupling scenario, which decreases the cultivated area (even in Southern Finland). Consequently, nitrogen surpluses are greater in the decoupling scenario than in the Agenda 2000 or base scenario in 2011.

The third paper discusses the other side of the trade and environment link: the impact that environmental protection can have on trade. In this context, environmental policies and their impact on market access, trade flows, and competitiveness are of interest. The objective of the third paper is to contribute to understanding the general issues at stake, and to identify and systematically review factors that may influence the link between environmental protection and competitiveness. First, the issues that have surfaced in the debate on the agricultural trade impacts of environmental policies are briefly reviewed. So far the impacts of environmental regulations on agricultural trade flows and competitiveness have been modest due to the subsidy-based approaches implemented.

One of the reviewed issues, namely environmental protection and competitiveness, is then selected for closer examination by discussing the case of organic farming in Finland. The purpose is to bring up factors that may require systematic consideration in order to understand how the link between environmental protection and agricultural competitiveness may operate. Several influencing factors are reviewed; some of these factors may provide competitive opportunities and others constitute competitive threats.

SELOSTUS

Kansainvälisen maatalouskaupan ja ympäristön väliset vuorovaikutussuhteet

Jussi Lankoski

Julkaisun ensisijaisena tavoitteena on luoda katsaus maataloutta koskevaan kansainväliseen kauppa ja ympäristö -keskusteluun. Yleisesti ottaen kauppa ja ympäristö -keskustelussa voidaan erottaa kaksi laajempaa kokonaisuutta. Toisaalta puhutaan siitä, kuinka kansainvälinen kauppa ja kaupan vapautuminen vaikuttaa ympäristön tilaan, ja toisaalta taas siitä, kuinka ympäristöpolitiikka ja ympäristönsuojelu vaikuttavat kansainvälisen kaupan materiaali- ja rahavirtoihin ja yritysten kansainväliseen kilpailukykyyn. Julkaisun kahdessa ensimmäisessä artikkelissa tarkastellaan kansainvälisen kaupan vapautumisen sekä maatalouspolitiikan reformien vaikutuksia ympäristön tilaan, kun taas julkaisun kolmannessa artikkelissa käsitellään ympäristönsuojelun vaikutuksia maatalouden kauppavirtoihin ja kilpailukykyyn.

Ensimmäisessä artikkelissa luodaan katsaus sekä teoreettiseen että empiiriseen kirjallisuuteen maatalouspolitiikan, kansainvälisen kaupan ja ympäristön välisistä vuorovaikutussuhteista. Kansainvälisen kaupan vapautumisen ympäristövaikutuksien tutkiminen on tärkeää, koska ympäristövaikutukset viime kädessä määrittävät valtioiden saaman lopullisen hyödyn kansainvälisestä kaupasta. Maatalouskaupan vapautumisen ympäristövaikutukset ovat pääasiassa epäsuoria ja aiheutuvat muutoksista maataloustuotannon intensiteetissä, tuotannon sijoittumisessa, tuotantoteknologiassa ja tuotevalikoimassa. Suorat ympäristövaikutukset liittyvät pääasiassa lisääntyneiden kuljetusmäärien ja -matkojen aiheuttamiin ympäristöhaittoihin sekä alkuperäiselle lajistolle vieraiden eliöiden leviämiseen alueille, joissa niillä ei ole luontaisia vihollisia.

Talousteorian näkökulmasta tarkasteltuna kaupan vapautuminen lisää hyvinvointia sillä ehdolla, että mahdollisesti syntyvät negatiiviset ulkoisvaikutukset internalisoidaan eli sisällytetään tuotantokustannuksiin. Empiiristen tutkimusten mukaan maataloustuotteiden kaupan vapautumisen ympäristövaikutukset eivät tule olemaan pelkästään positiivisia tai negatiivisia, vaan ne tulevat vaihtelemaan maittain, alueittain ja tuotantosuunnittain. Tämä aiheutuu eroista ympäristön kantokyvyssä, harjoitetussa maatalouspolitiikassa, maatalouden tuotantoteknologiassa ja tuotantotavoissa. Läpikäytyjen tutkimusten valossa maatalouskaupan vapautumisen ympäristövaikutukset ovat melko pieniä. Kuitenkin näyttää siltä, että niissä kehittyneissä teollisuusmaissa, joiden maataloustuotannon kustannuskilpailukyky on heikko, tuotannon intensiteettiin liittyvät ympäristöongelmat kuten ravinnepäästöt saattaisivat vähentyä. Tässä yhteydessä ongelmaksi voi kuitenkin muodostua tuotannossa olevan peltoalan väheneminen, millä on edelleen vaikutuksia maaseutumaisemaan ja maatalouden biodiversiteettiin.

Koska Uruguayn kierroksen maataloussopimuksen vaikutus maailmanmarkkinahintoihin ja maataloustuotannon jakautumiseen eri maiden ja maaryhmien välillä näyttäisi olevan pieni, niin sen vaikutus myös ympäristön laatuun jäänee vähäiseksi. Kotimaiset politiikkareformit sen sijaan saattavat olla merkittäviä ympäristön kannalta, koska ne mahdollistavat ympäristökriteerien huomioon ottamisen uusia maatalouspoliittisia toimenpiteitä suunniteltaessa ja toteutettaessa. Esimerkiksi siirtyminen hintatuesta hehtaari- ja eläinyksikkökohtaisen tuen kautta tuotannosta irrotettavaan suoraan tulotukeen, johon on lisäksi liitetty ympäristökriteerejä kuten suurin sallittu eläintiheys peltohehtaaria kohti, voisi edustaa ympäristön kannalta tehokasta politiikkareformia. On kuitenkin tärkeätä huomata, että kotimaiset politiikkareformit tehdään sekä sisäisten että ulkoisten paineiden johdosta, jolloin mm. Uruguayn kierroksen vaikutus näkyy myös näiden kotimaisten politiikkareformien kautta.

Julkaisun toisessa artikkelissa analysoidaan Agenda 2000:n sekä kauppareformin eli tuen tuotannosta irrottamisen vaikutuksia ympäristön tilaan Suomessa. Vertailun pohjana toimii perusskenaario eli politiikkareformien vaikutuksia verrataan tilanteeseen, jossa jatketaan vallitsevaa maatalouspolitiikkaa ilman muutoksia. Maatalouden taloudellisessa tutkimuslaitoksessa kehitettyä maatalouden sektorimallia hyödynnetään simuloitaessa politiikkareformien vaikutuksia maataloustuotannon alueittaiseen sijoittumiseen, pellonkäyttöön, panoskäyttöön ja näiden kautta ympäristön tilaan. Sektorimalliin liitettiin ympäristöindikaattoreina alueittaiset ravinnetaselaskelmat (maaperätase/peltotase) sekä eläintiheydet hehtaaria kohti. Lähtökohtana tutkimuksessa on, että Agenda 2000 edustaa EU:n näkemystä neuvottelutavoitteista seuraavalla kauppaneuvottelukierroksella. Toisin sanoen kansainvälisen kaupan vapauttamispaineet johtavat EU:ssa politiikkamuutokseen, joka heijastuu tuotantotapojen muutosten kautta ympäristöön. Agenda 2000 -skenaarion lisäksi analysoitiin kauppareformin eli tuotannosta irrotetun tuen vaikutuksia ympäristöön.

Alhaisemmasta tuotannon intensiteetistä johtuen ravinneylijäämät ovat Agenda 2000 -skenaariossa pienemmät kuin perusskenaariossa vuonna 2005. Agenda 2000 ja kauppareformi johtavat alhaisempiin ravinneylijäämiin typen osalta kuin perusskenaario vuonna 2011. Toisaalta fosforiylijäämät ovat pienimmät perusskenaariossa vuonna 2011. Kauppareformi johtaa A- ja B-tukialueilla suurempiin ravinneylijäämiin ja eläintiheyksiin kuin Agenda 2000 ja perusskenaario. Kotieläintuotannon painopiste siirtyy Etelä-Suomeen, missä maatalouden kustannuskilpailukyky on paras. Lisäksi kauppareformiskenaariossa rehuviljan tuonti kasvaa nopeasti, mikä johtaa viljelyksessä olevan kokonaispeltoalan vähenemiseen. Näin ollen kauppareformiskenaario tuottaa suuremman ravinneylijäämän kuin perusskenaario tai Agenda 2000 -skenaario.

Julkaisun kolmannessa artikkelissa käsitellään kauppa ja ympäristö -keskustelun toista pääkysymystä eli ympäristöpoliittisten toimenpiteiden vaikutusta kansainväliseen kauppaan. Artikkelin tarkoituksena on esitellä kysymyskokonaisuutta sekä yleisesti että analysoida yksityiskohtaisemmin tiettyjä asiaan vaikuttavia tekijöitä.

Aluksi tarkastellaan lyhyesti, miten ympäristöpoliittiset toimenpiteet vaikuttavat maataloustuotteiden markkinoillepääsyyn, kauppavirtoihin ja kilpailukykyyn. Nämä aiheet ovat erityisesti korostuneet yleisessä keskustelussa ympäristöpolitiikan vaikutuksista maatalouskauppaan. Toistaiseksi ympäristösäädösten vaikutukset maatalouden kauppavirtoihin ja tuottajien kilpailukykyyn ovat jääneet vähäisiksi, koska säädösten toimeenpanoon on liittynyt kustannusnousujen ja tulonmenetysten korvaaminen tukien avulla.

Ympäristönsuojelun vaikutusta kilpailukykyyn tarkastellaan lähemmin käyttäen esimerkkinä suomalaista luomutuotantoa. Tarkastelun tavoitteena on tuoda esiin sellaisia tekijöitä, jotka saattavat vaikuttaa ympäristönsuojelun ja kilpailukyvyn välisiin yhteyksiin, ja joiden systemaattinen läpikäynti voi edesauttaa tämän yhteyden ymmärtämistä. Artikkelissa esitellään useita vaikuttavia tekijöitä, joista osa voi vähentää ja osa lisätä luomutuotannon kilpailukykyä varteenotettavana tuotantovaihtoehtona.

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