WORLD TRADE ORGANIZATION

WT/CTE/W/100
8 January 1999

(99-0051)

Committee on Trade and Environment Original: English

ENVIRONMENTAL EFFECTS OF TRADE LIBERALIZATION IN THE AGRICULTURAL SECTOR

Submission by Norway

Summary

1. This paper reviews the impact on the environment of agricultural trade liberalization. Allocative efficiency is a central objective in economic policy and provides a fundament for the multilateral trading system. Trade liberalization is not an end in itself, but is generally a means to improve efficiency and increase welfare. However, the market alone cannot lead to optimal resource allocation if prices do not fully reflect all costs and benefits relating to the product. And allocative efficiency cannot be achieved if preferences for *public goods* are not taken into account.

2. The environmental costs related to agricultural production are taken into account through the *Polluter-Pays-Principle* (PPP). Concerning public goods, a way of reasoning could be what we have suggested to call the *Provider-Gets-Principle* (PGP). According to this principle, those who provide benefits, *inter alia* in the environmental area, above a certain reference level and which are demanded by the public, should if necessary be paid for them.

3. An analysis of public goods provided by the agricultural sector in Norway shows firstly that the agricultural landscape is the most obvious environmental benefit or public good produced jointly with agricultural production. Arable land amounts to only 3 per cent of the total land area of Norway; because of this scarcity extensive measures have been necessary to ensure its protection, including both general policies and specific measures.

4. Secondly, agriculture contributes to the conservation of biological diversity. In Norway, the agricultural landscape is the only habitat of around 10-20 per cent of the threatened species. Conserving biodiversity is therefore closely related to protection of the agricultural landscape. Moreover, increased trade in agricultural products increases the risk of alien species being introduced. Thirdly, agriculture in Norway contributes to good phytosanitary, zoosanitary and public health. Under considerably increased trade, control measures may not fully offset the increased risk related to the introduction of contagious substances and diseases.

5. Negative environmental effects have been considered in a global perspective in order to examine the validity of the hypothesis put forward in the CTE that the environmental costs of the agricultural sector are lower in low-support countries than in high-support countries. The analysis is based on nationally aggregated data for the OECD area, and it seems to indicate that animal densities and the use per unit area of pesticides and N and P fertiliser are only moderately correlated with support levels. Moreover, high-support countries seem to have reduced fertiliser and pesticide use more than low-support countries. More importantly, low animal densities at national levels mask higher concentrations at local level, and these have a negative impact on the environment; for instance, high levels of nitrate have been found in groundwater samples in both high - and low - support countries.

6. The production shift projected to follow from further trade liberalization may also have a detrimental impact on biodiversity in low-support countries where agriculture is projected to expand. Several low-support countries with extremely high levels of biodiversity have already experienced loss of biodiversity due to agricultural expansion.

7. To conclude, the extent of the environmental problems relating to the agricultural sector varies above all according to natural conditions, farming methods, and national legislation and policy measures, including input-output price relationships. All in all, the analysis does *not* seem to indicate that the shift in production from high- to low-support countries that is projected to result from further trade liberalization would lead to an overall reduction in environmental degradation.

I. INTRODUCTION

8. During the March meeting of the WTO Committee on Trade and Environment (CTE), countries that suggested that trade liberalization could lead to *adverse* environmental effects were invited to contribute examples from their own experience. Norway is pleased to accept this invitation. This paper presents a review of the agricultural sector.

9. In the Preamble to the *Marrakesh Agreement Establishing the World Trade Organization* , the Parties recognize that their relations in the field of trade and economic relations should allow for "*optimal use of the world's resources in accordance with the objective of sustainable development*".

10. The Ministerial Decision on Trade and Environment adopted by ministers in Marrakesh in April 1994 states that the WTO Committee on Trade and Environment should address a number of issues, including market access, "*with the aim of making international trade and environmental policies mutually supportive*". According to the Agreement on Agriculture, non-trade concerns, such as the need to protect the environment, should be taken into account in the agricultural reform process.

11. This paper examines from a welfare economics perspective how environment and trade policies in the agricultural sector could be made mutually supportive. Section Two explores the relationship between allocative efficiency and welfare maximization as policy objectives and agricultural trade and trade liberalization as means of achieving such objectives.

12. Sections Three and Four examine the extent to which production externalities exist in the agricultural sector, focusing only on environmental issues. Important non-environmental public goods and non-trade concerns such as food security and rural viability, which would be included in an overall cost-benefit analysis of the agricultural sector, are therefore not examined in this paper. Section Three discusses public goods in the Norwegian agricultural sector. No attempt is made to analyse environmental benefits relating to agriculture in other countries.

13. Section Four deals with *negative* production externalities. Here, a global approach is taken in order to examine the validity of the hypothesis put forward in the CTE that the environmental costs of the agricultural sector are lower in low-support countries than in high-support countries.

14. Section Five explores the environmental effects related to the *transport* involved in agricultural trade.

15. Based on the analysis and with relevance to further agricultural policy reform, Section Six makes some concluding remarks on the positive and negative environmental effects in the agricultural sector.

16. The analysis is by no means exhaustive, and further research is needed. We are looking forward to an open dialogue and a constructive discussion on these issues in the Committee.

II. ALLOCATIVE EFFICIENCY

17. *Allocative efficiency* is a central objective in economic policy and provides a fundament for the multilateral trading system. Trade liberalization is not an end in itself, but is generally a means to improve efficiency and increase welfare.[1] However, the market alone cannot lead to optimal resource allocation as long as market failures exist, i.e. if prices do not fully reflect all costs and benefits relating to the product. Also, allocative efficiency cannot be achieved if preferences for *public goods* are not taken into account. In contrast to private goods, public goods have no functioning markets, and it is generally accepted that governments use various types of public intervention, where necessary, to ensure the provision of these goods.

18. The allocative efficiency of Norwegian agriculture depends to a large extent on two important policy principles. The first relates to negative production externalities and is called the *Polluter-Pays-Principle* (PPP). This well-known and widely accepted principle, states that the costs of a negative externality (e.g. pollution) should be borne by its originator, and reflected in the price of the product. Through the application of the PPP, a certain reference level of environmental quality would be achieved in accordance with the definition of good agricultural practices.

19. The second principle, which deals with the provision of public goods (e.g. agricultural landscapes), we have suggested could be called the *Provider-Gets-Principle* (PGP). This principle relates to public demand for, *inter alia*, environmental qualities *beyond* the reference level, according to an established environmental target. As the production of such goods commonly depend on privately owned production factors, and since private property rights are recognized, application of the PGP means that, *if necessary*, payments must be made to the provider of such goods in order to achieve the desired resource allocation.

20. It is important to bear in mind that in order to ensure the quality of the public goods provided, a range of other policy measures, including legislative and administrative measures, voluntary agreements, training and information may be indispensable. However, in Norway, provision of public goods such as agricultural landscape and biological diversity by the agriculture sector, is contingent on relatively high levels of public payments.

21. Both principles are reflected in Norwegian agricultural policy. This policy is based on a number of objectives related to non-trade concerns such as environmental protection, food security and the viability of rural areas. The overall level of support to the Norwegian agricultural sector reflects the political valuation of the public goods provided by agriculture, as well as the generally high costs involved in the provision of those goods in Norway. To the extent that taxes and restrictions limit negative effects and a certain level of agricultural support is necessary in order to ensure a balance between the supply and demand of certain public goods, current agricultural policy in practise obeys the Provider-Gets and Polluter-Pays-Principles.

---

[1] By trade liberalization we understand reductions in border protection, domestic support and export subsidies, as provided for in the WTO Agreement on Agriculture.

III. PUBLIC GOODS IN THE AGRICULTURAL SECTOR: THE CASE OF NORWAY

A. AGRICULTURAL LANDSCAPE

22. The agricultural landscape is generally defined as landscape created or modified by agricultural activity. In Norway, as in many other countries, this landscape is the result of thousands of years of farming, and it varies according to natural conditions and farming practices. The value attached to the agricultural landscape relates to (i) its contribution to human health and welfare (the recreational value); (ii) its aesthetic, cultural and historical qualities; and (iii) its biological and ecological characteristics (covered in more detail in the next sub-section).

23. The agricultural landscape generally includes elements such as farmland, meadows, pastures, dry stone walls, farm roads, waterways, animals and farm buildings. However, the concept of agricultural landscape goes beyond the sum of the single elements. More importantly, the value of the agricultural landscape is related to its genuine farming origin. Just as natural wilderness cannot be man-made, but derives its value from the fact that it is native to the area and untouched by man, the agricultural landscape is by definition closely related to agriculture's primary function of producing food and fibre, from which it cannot be detached. Therefore, the agricultural landscape is not only decorative scenery; its aesthetic and recreational value is closely contingent on the authenticity of its food-producing role. Thus, this public good is a joint product of the agricultural production.

24. The agricultural landscape is the result of a continuous history of agriculture over several thousand years and is a central part of our cultural heritage. The difficult natural conditions under which Norwegian agriculture operates, have resulted in a variety of local adaptations. Thus, the agricultural landscape and the living traditions connected with farming and the management of buildings and farmland are vital both to our identity and as a source of knowledge on the relationship between man and the natural environment. The conservation of our cultural heritage, and the understanding of the sustainable agriculture on which it is based, therefore depend on the continued viability of rural areas and their agricultural activities.

25. Around 80 per cent of the Norwegian population take part in outdoor recreational activities. Based on ancient traditions and regulated by law, every citizen has, under certain conditions, free access to uncultivated or cultivated land, regardless of whether this land is privately - or publicly - owned.[2] In addition to the practical problems and limited usefulness of fencing off pieces of agricultural land in order to commercialize agricultural landscape as private goods, this would therefore be incompatible with Norwegian culture and traditions.

26. In Norway, the total arable land amounts to approximately 1 million ha, accounting for only 3 per cent of the total area of Norway excluding Svalbard (as against e.g. 27 per cent in the EU, 21 per cent in the US and 12 per cent in New Zealand).[3] Productive forests cover around 22 per cent of the land area, and the remaining 75 per cent consists of mountains, lakes and man-made infrastructure. The scarcity of agricultural landscape has meant that extensive measures have been necessary to ensure its protection.

27. Agricultural landscapes vary according to farming methods and location. Thus, preserving different types of landscape requires the maintenance of agricultural production in all parts of the country, even in marginal areas. It is therefore a national objective in Norway, as in many other countries, to safeguard rural agriculture and the viability of rural areas. High production costs and low population densities often threaten the viability of the rural agricultural economy. As remote

[2] Free access to agricultural fields is only permitted during the frost period or from 15 October to 1 May.

[3] Source: FAOSTAT. Permanent pasture is not included in the definition of arable land.

rural areas often have above-average production costs, rural agriculture frequently requires substantial support, to certain extent linked to production. Moreover, in Norway, due to regional development concerns, budgetary support is strongly modulated, in order to allocate higher support per area or livestock unit to smaller farms, and is also differentiated according to the region's suitability for agricultural production. Such differentiation favours rural areas.[4]

28. A number of policy measures are designed to meet specific environmental objectives, including the protection of the agricultural landscape. The Acreage and Agricultural Landscape Scheme, which accounts for roughly 28% of budgetary outlays, aims in particular at the protection of the agricultural landscape. The scheme imposes several environmental conditions on farming, such as:

- maintenance of open waterways;
- protection of field fringes, including a ban on pesticide use;
- maintenance of dry stone walls and other landscape elements;
- ban on land grading; and
- maintenance of paths.

29. If these rules are violated, payments may be withdrawn for a period of three years.[5] Other policy measures include the Specific Agricultural Landscape Support Scheme[6]; support for amended soil management, along with soil protection and reduction of erosion; and support for mountain farming during the summer period (transhumance).

30. The Ministry of Agriculture and the Ministry of the Environment have developed a monitoring programme in order to collect accurate information on status of the agricultural landscape and any development trends. The programme will provide information on specific issues of interests such as ecosystems, cultural heritage, accessibility for the general public and infringement by urban development.

B. CONSERVATION OF AGROBIOLOGICAL DIVERSITY

31. Environmental protection in the agricultural sector also raises important issues concerning biological diversity, which includes both diversity in ecosystems and habitats, species diversity and genetic diversity. The objective of the 1992 Rio Convention on Biological Diversity is to ensure the conservation of biological diversity. In Norway, the agricultural landscape is the only habitat of around of 10-20 per cent of the threatened species.[7] Conserving biodiversity is therefore closely related to the protection of the agricultural landscape.

32. In the agricultural sector, two processes have to a large extent had adverse effects on biodiversity in Norway. The first relates to more intensive use of the arable land. The second process consists of land abandonment, often in marginal and less-favoured areas. Both processes may have a negative impact on the agricultural landscape and, thereby, on biodiversity. Therefore, it appears that

---

[4] For more information about this modulation and differentiation, see Norwegian Ministry of Agriculture, 1998. Non-trade concerns in a multifunctional agriculture. Implications for agricultural policy design and the multilateral trading system. Oslo, 16 pp.

[5] Additional legal requirements have to be met through e.g. the Land Act, the Cultural Heritage Act, the Nature Conservation Act and the Pollution Control Act. A minimum outdoor grazing period of 8 weeks for cattle is also required.

[6] The scheme involves grants for restoring valuable buildings and promotion of alternative types of production in grain-producing areas vulnerable to erosion.

[7] According to the Norwegian Directorate for Nature Management.

biodiversity would in most cases benefit from policy measures aiming at the conservation of the mosaic pattern of the agricultural landscape.[8]

33. Increased trade in agricultural products also increases the risk of alien species being introduced. According to Article 8(h) of the Convention on Biological Diversity, "*each Contracting Party shall, as far as possible and as appropriate … prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species*". According to the Norwegian Directorate for Nature Management, around 10 alien insect species are introduced to Norway every year, partly as a result of agricultural trade. Around 1 per cent of these introductions constitute a possible ecological threat with potentially far-reaching implications.

C. Good Phytosanitary and Zoosanitary Standards and Public Health

34. Another ecological and health issue involves the increased risk of spreading pests and diseases. With the considerable increase in agricultural trade, control measures may be very costly and are unlikely to fully offset the increased risks related to the introduction of contagious substances and diseases, even if we have access to the most modern and efficient measures available. Further research is needed in order to assess the implications of increased animal and food trade for the transmission of microbes and infectious animal, plant and human diseases, and in order to develop efficient ways of dealing with these challenges.

IV. NEGATIVE PRODUCTION EXTERNALITIES IN AGRICULTURE

35. This section examines negative environmental production externalities commonly associated with agriculture, concentrating mainly on pesticide use, water pollution as result of nitrogen and phosphorus overloads, and loss of biological diversity. Both national and transboundary environmental effects are analysed. In particular we examine the hypothesis that environmental problems are less pronounced in countries with low agricultural support levels than in countries with high levels of support.

36. Unfortunately, the analysis is restricted by lack of data for a number of environmental indicators. Comparative statistics are to a large extent only available for the OECD countries.[9] The analysis therefore focuses mainly on the OECD area. While some country cases are included in the analysis, these are by no means exhaustive or comprehensive.

A. Environmental Risks Related to Pesticide Use

37. Ideally, the environmental risks related to pesticide use should be measured by sampling pesticide residues in the biological environment, e.g. in water or animal tissue, and comparing them with an established threshold level. However, as comparative data are not available, pesticide *use* is commonly used as a proxy indicator. Table 1 presents all available data on average pesticides use per square km arable land and on producer subsidy equivalents (PSE) for the OECD countries. The table seems to indicate that pesticide consumption is moderately correlated ($r = 0.49$) with support, measured as PSE.[10] Moreover, while all countries for which data are available have reduced their pesticide use, reductions, in absolute figures, have generally been higher in high-support countries.

---

[8] Policy measures specifically aimed at protecting the agricultural landscape are described in Section 3.1.

[9] OECD has developed a number of agri-environmental indicators, and a recent OECD workshop was held on these issues in York, UK, on 22-25 September 1998. This paper draws to some extent on this work.

[10] However, the sample is small, thereby reducing the reliability of the correlation coefficient. Although no data on support levels are available for a wider range of countries, significantly increasing use of pesticides has recently been reported in some major low support exporting countries (not included in Table 1),

Table 1

Pesticide use per arable land for the OECD countries in 1994/95

Country	Producer Subsidy Equivalents (PSE) 1994/95 (%)	Pesticide use per arable land and land under permanent crops 1985/86 kg/km2	1994/95 kg/km2	----Change 1985/86-94/95---- kg/km2	in per cent
Australia	10	n.a.	260	n.a.	n.a.
Canada	24	72	64	-7	-10,4
EU	49	594	475	-118	-19,9
Hungary	25	543	172	-370	-68,3
Japan	76	1703	1438	-265	-15,6
New Zealand	3	n.a.	430	n.a.	n.a.
Norway	73	177	93	-84	-47,5
Poland	21	91	49	-41	-45,8
Switzerland	80	596	439	-157	-26,3
Turkey	28	138	114	-24	-17,3
USA	16	201	200	-1	-0,6
PSE Correlation			0,49	-0,34	-0,04

Source: FAOSTAT (http://apps.fao.org/cgi-bin/nph-db.pl?subset=agriculture) and OECD (1996a, 1997b, 1998b and 1998e).

Notes: PSE as a percentage of the value of agricultural production. Arable land includes land under permanent crops, but excludes permanent pasture. Generally, pesticide data are from 1994/95 (or the most recent year available prior to 94/95), as more recent data were not available.

38. The pesticide use and trends observed in Table 1 are related to a number of factors, such as the input-output price relationship between pesticides and the corresponding agricultural produce, legislative or administrative restrictions on pesticide use, climate and natural conditions and cropping techniques and intensity. One possible explanation for the pesticide use observed in the table may be that the input-output price ratio is lower in high-support countries, than in those with lower support levels, which acts as an economic incentive for pesticide use. However, the table also suggests that changing policies in high-support countries, partly through increased input-output price ratios and stricter environmental policies, have resulted in a reduction in pesticide use.

39. It should also be noted that the use of pesticides may vary substantially according to the type of crops. Further research should be undertaken in order to examine the extent to which the aggregated data presented in Table 1 mask production-specific differences between countries.[11]

40. Moreover, legislative restrictions relating to pesticide use and enforcement capacity vary substantially between countries. Analysis undertaken by the FAO seems to indicate that on average, from an environmental and health point of view, pesticide restrictions may generally be more

for which the initial pesticide use was at relatively low levels. The pesticide use per km2 arable land and land under permanent crops in Argentina, Brazil and Thailand is 201 kg (1996), 68 kg (1995) and 118 kg (1995), respectively. In these countries, use per unit arable land has increased by 108%, 95% and 28%, respectively, since 1993.

[11] Preliminary analysis seems to indicate that these production-specific variations are not systematically correlated with support levels (OECD, 1998b).

stringent, and enforcement capacity more developed, in high-support countries than in low-support countries.[12]

B. NITROGEN AND PHOSPHORUS POLLUTION IN WATER

41. Nitrogen (N) and phosphorus (P) may result in the eutrophication of lakes, rivers and marine waters. Nitrogen, in the form of nitrate, may also contaminate drinking water. The agricultural sector is reported by the OECD to be a major source of N and P water pollution in most OECD countries through run-off and leaching, regardless of support levels. According to the OECD environmental policy reviews, these problems, and agriculture's contribution to them, do not seem to be less severe in low-support countries than in high-support countries.

42. Various indicators are commonly used to measure the risk of water contamination. The OECD uses emission indicators, such as national nutrient balances based on total nutrient input and output. Indicators relating to agricultural practices, such as fertiliser use and livestock density, point to the risk of nitrogen leaching and phosphorus losses. Table 2 gives all available data on national livestock densities and fertiliser use for the OECD area. The table suggests that while animal density and phosphate fertiliser use are only weakly correlated with support levels (r equal to 0.24 and 0.34, respectively), nitrogen fertiliser use seems to be strongly correlated with support levels (r = 0.87). However, the table also seems to indicate that high-support countries have generally reduced nitrogen and phosphate fertiliser use more than low-support countries.[13]

Table 2

Animal manure units (AMU) and nitrogen and phosphate fertiliser use per unit of arable land for OECD countries in 1994/96 (average) and percentage changes compared to 1984/86

	PSE (%)	**--- AMU/km^2 ---**		**--- Nitrogen (mt/km^2) ---**		**--- Phosphate (mt/km^2) ---**	
Country	1994/96	1994/96	% change	1994/96	% change	1994/96	% change
Australia	9	74	-5	1,36	87	1,92	23
Canada	23	24	15	3,35	28	1,40	-6
EU	47	186	-1	14,83	-14	4,55	-31
Hungary	22	33	-46	5,71	-49	1,06	-85
Japan	74	133	9	12,34	-15	14,80	-7
Mexico	14	108	-10	3,72	-27	0,90	-43
New Zealand	3	416	-5	4,29	355	12,16	45
Norway	72	121	-8	11,43	-11	3,25	-48
Poland	21	57	-27	6,04	-32	2,05	-67
Switzerland	79	357	-12	14,22	-18	5,16	-49

[12] This is evidenced by the analysis of government responses to FAO's second questionnaire on the state of implementation of the *International Code of Conduct on the Distribution and Use of Pesticides* (see http://www.fao.org/ag/agp/agpp/pesticid/manage/quest2/2qfrt.htm).

[13] Interestingly, New Zealand, which has substantially reduced its support levels during the second half of the 1980s and now ranks as the least-supported country in the OECD, has substantially increased phosphate use (by 45 per cent) and nitrogen use (by remarkably 355 per cent) between 1984/86 and 94/96. It should also be noted that Switzerland adopted stricter environmental policies, relating to water pollution in environmentally vulnerable areas in 1997 and in its new agricultural act in 1998. These policies are expected to further reduce fertiliser and pesticide use below the levels reported in Tables 1 and 2.

Country	PSE (%) 1994/96	--- AMU/km² --- 1994/96	% change	--- Nitrogen (mt/km²) --- 1994/96	% change	--- Phosphate (mt/km²) --- 1994/96	% change
Turkey	27	56	13	3,92	14	1,96	4
USA	16	48	3	6,14	20	2,41	18
PSE Correlation		0,24	0,16	0,87	-0,44	0,34	-0,36

Source: FAOSTAT (and OECD (1997b and 1998e))

Notes: PSE as a percentage of the value of the agricultural production. Arable land includes land under permanent crops, but excludes permanent pasture. One AMU is defined to equal 1.5 cattle; or 7 sheep; or 7 goats; or 2 horses; or 7 pigs; or 300 chickens; or 180 turkeys; or 250 ducks; or 150 geese. Given the small sample, the reliability of the correlation coefficients is relatively low.

43. As with pesticide use, fertiliser use and trends observed in Table 2 are related to a number of factors, including the input-output price relationship and environmental restrictions. In the case of nitrogen fertiliser, one possible explanation for the strong relationship between N fertiliser use and support levels may be that the input-output price ratio is lower in high-support countries, than in those with lower support levels. However, the table also suggests that changing policies in high support countries, again partly through increased input-output price ratios and stricter environmental policies, have resulted in a reduction in fertiliser use.

44. The actual price-elasticity of nitrogen demand has been subject to research. Recent modelling of the cereal production function in Norway seems to indicate that N fertiliser use is only weakly affected by changes in the input-output price ratio, and only modest reductions in N leaching (12-15 per cent, depending on local conditions) were predicted as a result of a 100 per cent N tax or a 33 per cent reduction in cereal prices.[14]

45. The data presented in Table 2 should be interpreted with considerable caution. Firstly, the number of countries in the sample is limited, reducing the reliability of the computed correlation coefficients. Secondly, the definition of arable land may vary between countries. Thirdly, permanent pasture has not been included in the calculations. Although these shortcomings are expected to have a considerable affect on the reliability of the figures, the effect may not be systematic.

46. More importantly, aggregated figures for national stocking densities may mask higher densities at regional, local and farm level. This is the case in both high - and low - support countries. Preliminary data from major livestock-producing low-support countries such as USA, Argentina and Australia suggest that stocking densities in some of their production regions are substantially above the national average rates. It is reported that "*livestock agriculture (e.g. dairy, beef, pork, poultry) in the USA is tending rapidly toward operations where a large number of animals are concentrated in a relatively small area*".[15]

47. These regional variations are emphasized by the OECD: "*Regional data suggest that in certain areas of those countries where the national nitrogen surplus is relatively low,…, they are experiencing both the effects of nitrate pollution (e.g. the Brittany area of France, and some regions of Canada and the United States), and soil nutrient depletion from crop production (e.g. certain regions in Australia, Canada and United States)*".[16]

48. The actual environmental and health effects of livestock production and fertiliser use, as well as pesticide use, depend on a range of factors that are independent of support levels, such as soil and

[14] See Vatn et al. (1996).
[15] Cressie and Majure, 1997.
[16] OECD, 1997a.

climate conditions, cropping techniques and the absorptive capacity of the recipient. This capacity is also determined by the ratio of agricultural land to other land in the recipient area.

49. Empirical evidence relating to the health and environmental impact of livestock production and fertiliser use is found in for instance in the level of nitrate (NO3) in drinking water in agricultural areas. Generally speaking, the OECD reports that, for most OECD countries, agriculture is a "*major contributor [to N and P emissions], accounting for around two-thirds of nitrogen emission into surface and marine waters and about one-third for phosphates*.[17] Certain high-support countries including large parts of the EU have reported high nitrate levels in their water resources. In Austria, 15 per cent of 18 277 ground-water samples were above the threshold limit of 50 mg NO3/litre. In Denmark, which has very high animal densities, as many as 25 per cent of the samples exceeded this level.[18] According to national reviews, no freshwater samples, including ground-water, are reported to exceed this guideline in Norway.

50. However, nitrate problems are also widespread in several low support countries. In US, nitrate concentrations in 21 per cent of groundwater samples collected beneath agricultural land exceeded the maximum contamination level of 10 mg N/litre set by the US Environmental Protection Agency.[19]

51. In Canada, "*agriculture makes a significant contribution to the diffuse source contamination of surface and groundwater resources, particularly contributing to the NO3-contamination of groundwater. … The rural groundwater quality in Ontario, Canada, was evaluated with respect to common contaminants including NO3. Approximately 1300 domestic farm wells were sampled, and wells were drilled in some fields of farms involved in the study. NO3 was present at concentrations above the maximum acceptable for drinking water (10 mg N/litre) in 14 per cent of wells, including 7 per cent of wells that also had unacceptable concentrations of coliform bacteria. Significant levels of NO3-contamination were observed under most agricultural land use practices investigated.*[20] In intensive dairy areas in New Zealand, nitrate concentrations in the domestic water supply have been shown to exceed the 50 mg NO3/litre recommended limit in 5 per cent of the affected area.[21]

52. The environmental impact of fertiliser use and livestock production is also indicated by the degree of *eutrophication* of lakes and rivers. In New Zealand, the OECD reports that "m*any streams in intensive dairy areas suffer from excessive levels of dissolved inorganic nitrogen, dissolved reactive phosphate, suspended sediment concentrations, turbid base flows and faecal contamination. Small watercourses that receive animal waste from multiple rural point sources are not safe for contact recreation much of the time, and some are not even safe for water supply of stock".*[22]

53. In the USA, "*the economies of scale are counterbalanced by the dangers of pollution from inadequate treatment of animal waste. Traditional methods of treatment involve lagoon retention and subsequent spreading on fields, but the sheer volume of production seems to be outstripping these and other technologies. Surface-water runoff finds its way into streams and rivers, ultimately polluting all downstream segments of the watershed".*[23] Eutrophication is also increasing in Australia: "*In the Murray-Darling Basin region of Australia, which accounts for over 40 per cent of the nation's*

[17] OECD, 1997a.

[18] See European Commission, 1998.

[19] Mueller et al. (1995), based on 2012 ground-water samples from agricultural land. In a similar study for Nebraska, which is characterized by intensive agriculture, about 20 per cent of a total of 5826 groundwater samples had nitrate concentrations exceeding the maximum recommended contamination level (Lakshminarayan et al., 1996). It should be noted that 10 mg N is equivalent to around 44 mg NO_3.

[20] Goss et al. 1995.

[21] OECD, 1996a

[22] OECD, 1996a.

[23] Cressie and Majure, 1997.

agriculture production, soil eutrophication of surface water bodies is becoming increasingly common".[24] However, once again, these problems are widespread in most of the OECD area, including in high support-countries.

C. LOSS OF BIOLOGICAL DIVERSITY

54. Biological diversity is commonly defined as the variability among living organisms and includes diversity within species, between species and of ecosystems.[25] The existing endowment of biodiversity is fundamentally a non-renewable resource that we are unable to duplicate or substitute by technological innovation.[26] Today, biological diversity is being depleted at alarming rates, and this is widely attributed to the spread of unsustainable human development. More specifically, it is caused by habitat loss and fragmentation; the introduction of species; overexploitation of plant and animal species; pollution of soil, water and atmosphere; and global climate change.[27]

55. Agriculture is both a major threat to biodiversity and a key to its survival. As pointed out in Section 3, traditional agriculture can play a major role in the conservation of biodiversity. Some agricultural land use systems maintain surprisingly high levels of biodiversity.[28] Nevertheless, agriculture is arguably the principal cause of habitat destruction and biodiversity loss around the world. Such loss generally results from the expansion of the agricultural sector, the conversion of natural land into farmland or the intensified use of existing farmland in ways that negatively affect the biodiversity of the current agricultural landscape.[29] The shift in production projected to result from further trade liberalization may therefore have a negative impact on biodiversity both where agriculture is contracting (as described in Section 3) and where it is expanding.

56. A very small number of countries, 17 in all, defined as *megadiversity* countries, account for some 60-70 per cent of total global biodiversity, see Table 3. All megadiversity countries are low-support countries where the agricultural sectors are expected to expand, as a result of trade liberalization. Table 4 gives the total number of species and the number of threatened species in selected high - and low-support countries.

Table 3

Megadiversity countries ranked according to level of biodiversity

1. Brazil	7. Venezuela	13. Australia
2. Colombia	8. Ecuador	14. Malaysia
3. Indonesia	9. Peru	15. Madagascar
4. China	10. United States	16. Democratic Republic of the Congo
5. Mexico	11. Papua New Guinea	17. Philippines
6. South Africa	12. India	

Source: Mittermeier et al. (1997), and Conservation International

[24] Commonwealth of Australia, 1995.
[25] See Article 2 of the Convention on Biological Diversity.
[26] Swanson, 1997.
[27] WRI, IUCN, and UNDP 1992.
[28] Smith (1996) reports that in the Yucatán, for example, home gardens contain 387 plant species, and other forms of agroforestry can mimic some of the complexity of rainforests.
[29] It should be noted that not all land converted to farming is natural or has a high level of biodiversity.

57. During the last 15 years, land use has changed considerably, particularly in developing countries where deforestation resulted in a net loss of some 180 million hectares of forests between 1980 and 1995, or an average annual loss of 12 million hectares.[30] Table 5 shows agricultural expansion and annual deforestation for the same countries as those presented in Table 4. Table 5 clearly indicates that deforestation rates are relatively high in several low-support countries. Moreover, while deforestation is caused by several factors, including commercial logging, it often coincides with, and is partly a result of, an expansion in agricultural land.[31] Deforestation often affects virgin forests and thus has a negative impact on biodiversity.[32] It therefore seems that it can be concluded that the expansion of the agricultural sector that is projected to take place in low-support countries as a result of further trade liberalization, will probably have a negative impact on biodiversity.[33]

Table 4

Total numbers of species, and threatened species in selected countries

	Mammals		**Birds**		**Higher plants**		**Sum**	
	In total	Threatened	In total	Threatened	In total	Threatened	In total	Threatened
USA	428	22	768	46	16300	1845	17496	1913
Australia	252	43	751	51	15000	1597	16003	1691
Japan	132	17	583	31	4700	704	5415	752
Canada	193	6	578	5	2920	649	3691	660
Brazil	394	45	1635	103	55000	463	57029	611
Malaysia	286	20	736	31	15000	510	16022	561
Thailand	265	22	915	44	11000	382	12180	448
Indonesia	436	57	1531	104	27500	281	29467	442
New Zealand	10	3	287	45	2160	236	2457	284
Argentina	320	20	976	40	9000	170	10296	230
Norway	54	3	453	3	1650	20	2157	26
Switzerland	75	2	400	3	1650	9	2125	14

Source: World Bank, 1998

[30] World Resources Institute, 1998.

[31] The correlation coefficient between the annual deforestation rate and the expansion in agricultural land is 0.67 (0.69 if forestation is excluded).

[32] In the Brazilian Amazon basin, for example, many of the fires are set to clear old cattle pastures or secondary forest areas. However, about one third of the fires are set to clear virgin forests (World Resources Institute, 1998). Likewise, the net *forestation* that occurs in some of the countries listed in Table 5, results in secondary forests that, generally speaking, are not expected to substantially increase biodiversity.

[33] As an example, in the Pantanal region of Fazenda Rio Negro, Mato Grosso do Sul, a thriving ecosystem, home to a number of endangered species, is under threat from the expansion of soya bean production on the surrounding plateau. The runoff of pesticides and silt harms the rivers and wildlife. At the same time, MERCOSUR wants to build export capacity by dredging and straightening the Rio Negro in order to make it easier to get soya beans to market. This straightening would significantly alter the Pantanal ecosystem. (New York Times, 8 August 1998).

Table 5

Deforestation in selected countries

	Cropland		Perm. pasture		Agricultural land			Forest area	Annual deforestation	
	- - - - - - - - - - - (in per cent of total land) - - - - - - - - - - -						Change	(1000 km^2)	Average 1990-95	
	1980	1995	1980	1995	1980	1995	1980/95	1995	km^2	% change
Japan	13	12	2	2	15	14	-1	251	132	0.1
Norway	3	3	0	0	3	3	0	81	-180	-0.2
Switzerland	10	11	41	29	51	40	-11	11	0	0.0
Argentina	10	10	53	52	63	62	-1	339	894	0.3
Australia	6	6	57	54	63	60	-3	409	-170	0.0
Brazil	6	8	20	22	26	30	4	5511	25544	0.5
Canada	5	5	3	3	8	8	0	2446	-1764	-0.1
Indonesia	14	17	7	7	21	24	3	1098	10844	1.0
Malaysia	15	23	1	1	16	24	8	155	4002	2.4
New Zealand	13	12	53	51	66	63	-3	79	-434	-0.6
Thailand	36	40	2	2	38	42	4	116	3294	2.6
USA	21	21	26	26	47	47	0	2125	-5886	-0.3

Source: World Bank, 1998

D. OTHER NEGATIVE ENVIRONMENTAL EFFECTS

1. Soil erosion

58. Agricultural activity is a major contributor to soil erosion in many areas, including major low-support countries that are exporters of agricultural products. According to the US Department of Agriculture, the annual off-site damage from soil erosion in the United States amounts to more than USD10 billion or around 10 per cent of the total value of US agricultural production.[34] The USA is reported to have one of the world's most comprehensive erosion control programs, and the rate of erosion has been reduced substantially in some regions.

59. According to the OECD, Australia, which makes up 5 per cent of the world's landmass, accounts for an estimated 19 per cent of the world's soil erosion.[35] Around 20 per cent of Australia's soils are considered highly erosion prone with annual rates of loss of 10-50 tonnes/ha. Soil formation generally amounts to less than 1 tonne/ha in the country. In Norway, around 15 per cent of the arable land is considered to be vulnerable to erosion.[36] Erosion rates in Norway have decreased by 30-35 per cent over the last few years.

---

[34] Data from the second half of the 1980s and covering the farm production regions in the USA. Off-site damage is assessed to range from USD 5.8-20.3 billion with a *best estimate,* which is the most likely extent of off-site damage, of 10.1 billion. Source: Steiner, McLaughlin, Faeth and Janke, 1995. *Incorporating Externality Costs into Productivity Measures: A Case Study using US Agriculture.* In Barnett, Payne and Steiner, 1995.

[35] These estimates relate to total erosion, regardless of cause. However, the agricultural sector is considered to be the largest anthropogenic contributor to soil erosion.

[36] Arable land prone to erosion is defined as having an erosion rate of more than 1.25 mt/ha annually.

2. Water use

60. The OECD lists a number of environmental impacts associated with agricultural water use and withdrawal. These are increased concentrations of pollutants in smaller volumes of water, including salinization; drought and flooding; soil erosion, sedimentation, acidification, leaching, salinization and water logging; wetland loss; loss of rare and valued scenery and of historical, cultural and archaeological sites and changes in microclimate.[37]

61. S*alinization* is a major problem in Australia. OECD reports that "*Australia's soils are naturally saline. Secondary salinization (dryland and irrigation) is a major problem in northern Victoria, central New South Wales, the south-east of South Australia and the south-west of Western Australia. Some 2.5 million hectares are subject to dryland salinization, which can occur when deep-rooted vegetation is replaced by shallow rooted annual crops, causing water tables to rise and bringing dissolved salts to the surface. Some 160 000 hectares are subject to salinization due primarily to rising groundwater tables resulting from irrigation. If present trends continue, 5 million hectares in the Murray-Darling basin alone will be subjected to salinization by 2020".*[38]

3. Energy consumption

62. Fossil energy consumption has environmentally harmful effects through emissions of CO2 and nitrogen and sulphur compounds.[39] Total energy use in agriculture is affected by a number of factors, such as scale, inter-industry transport distances and capital intensity. While further research is needed, a preliminary analysis seems to indicate that total energy use related to agricultural production may be higher in high-support than in to low-support countries. However, tax policies can create incentives for greater energy efficiency.

E. TENTATIVE CONCLUSIONS ON NEGATIVE ENVIRONMENTAL EFFECTS

63. The analysis in Section 4 is preliminary and by no means exhaustive. Comparative data are lacking, and the figures presented are subject to certain methodological shortcomings.

64. The analysis is based on nationally aggregated data of the OECD area, and seems to indicate that while N fertiliser use per unit area is strongly correlated with support levels, the coefficients for animal density and acreage pesticide and P fertiliser use per unit area, show weak to moderate correlation with support levels. However, high-support countries seem for various reasons to have reduced fertiliser and pesticide use more than low-support countries.

65. More importantly, low animal densities at national levels mask higher concentrations at local level, and these have a negative impact on the environment. This may be one of the reasons for the high levels of nitrate that have been found in ground-water samples, in both low- and high-support countries.

66. The production shift projected to follow from further trade liberalization may have a detrimental impact on biodiversity, both in high-support countries where agriculture is projected to contract, and in low-support countries where agriculture is projected to expand. Several low-support countries with extremely high levels of biodiversity have already experienced loss of biodiversity due to agricultural expansion.

---

[37] OECD, 1997a.

[38] OECD, 1998a.

[39] Agriculture acts both as a source and as a sink of greenhouse gases (GHG). The sector is a major source of GHG such as methane and nitrous oxide and a minor source of carbon dioxide. Agriculture's contribution to total emissions seems above all to be related to the level of agricultural activity, regardless of location. However, further research may be needed.

67. Other environmental problems, including erosion, water use, salinization and energy consumption, also need careful consideration and should be included in an environmental review of the agricultural sector.

68. The extent of the environmental problems relating to the agricultural sector varies according to natural conditions, including recipient capacity, farming methods and national legislation and policy measures.

69. The level of coupled support may also, *all things being equal*, have an impact on the level of use of input factors. However, support levels cannot be directly compared across countries as general cost levels vary substantially. Whether economic measures act as an incentive for input use depends first and foremost on the input-output price relationship. Therefore, if some support coupled to agricultural production is needed in order to produce public goods as described in Section 3, it would be possible to avoid or limit any increase in the use of environmentally damaging inputs through targeted taxes and restrictions on input use.

70. To conclude, according to empirical evidence, there does not appear to be a clear relationship between environmental degradation and the level of support in different countries. All in all, the analysis does not seem to indicate that the shift in production from high to low-support countries that is projected to result from further trade liberalization would lead to an overall reduction in environmental degradation.

V. ENVIRONMENTAL EFFECTS OF TRANSPORT IN INTERNATIONAL AGRICULTURAL TRADE

71. According to the FAO, agricultural trade liberalization is expected to result in a shift in production away from countries that currently have high support levels and towards countries where the agricultural sector receives less support and is more competitive. Such a shift in production is likely to affect international transport in three different ways. Firstly, reduced agricultural support is generally expected to lead to higher world prices for agricultural products. In countries that are net importers of food and where little or no support is currently provided for the agricultural sector, such price increases may, if transmitted to domestic markets, result in higher domestic production and import-substitution. Consequently, this effect would lead to *reduced* trade and international transport.

72. Secondly, as a result of trade liberalization, exporting countries with low support levels would tend to replace exporting countries where the agricultural sector currently receives higher support levels. As a result, trade flows would change direction without there necessarily being any change in the total volumes transported or the transport distances. The overall impact of this effect on international transport is therefore difficult to predict. Thirdly, in countries with high support levels, national production would tend to be replaced by imports, which would result in increased international transport.

73. According to projections made by the FAO, the overall impact of further trade liberalization will include an increase in international transport of agricultural goods. This is confirmed by OECD simulations, which estimate that large above average increases in transport would occur, as a result of the Uruguay Round liberalization, in sectors with high pre-UR protection levels.[40] Trade in agricultural products is estimated to increase by 9-14 per cent, followed by corresponding increases in transport of agricultural goods. It is reasonable to assume that further agricultural trade liberalization will be followed by further increases in transport of agricultural goods.

[40] OECD, 1996c.

74. A number of negative environmental effects are related to transport, for instance noise and emissions of CO 2, NOx and SOx. Transport prices generally fail to reflect these negative effects. In Norway, according to the Norwegian Institute of Transport Economics, which has quantified the external costs of different transport categories, air transport seems to be taxed in accordance with the level of external costs, whereas taxes on road transport reflect only 30-70 per cent of external costs. The corresponding figures for rail and marine transport are 9-18 per cent and 5-10 per cent (harbour taxes not included), respectively.[41] Unless these external effects are internalised, trade liberalization is likely to result in sub-optimal market solutions, from a resource allocation and welfare point of view, compared to a situation where all external effects are internalised into the prices of the different transport services.

75. These issues should be further analysed. In particular, the extent to which further trade liberalization would result in increased transport and how far external costs are not reflected in international transport prices, should be examined. These aspects should be integrated into any environmental impact assessment of trade liberalization in the agricultural sector.

VI. CONCLUDING REMARKS

76. This paper examines environment-related non-trade concerns in the agricultural sector. The analysis is preliminary and by no means exhaustive, and further work on these issues is required. The aim of the paper is to shed light on two issues.

77. Firstly, focusing on negative environmental effects, these are to a greater or lesser extent related to agricultural activity in all countries. According to the empirical evidence reviewed in this paper, there does not appear to be a clear relationship between environmental degradation and the level of support in different countries. Therefore, all in all, the analysis does not seem to indicate that the shift in production from high- to low-support countries, that is projected to flow from further trade liberalization, would lead to an overall reduction in environmental degradation.

78. Secondly, in Norway, a number of positive environmental goods are produced jointly with agricultural products. Thus, a certain level of agricultural production is necessary to produce the positive environmental effects demanded today, beyond the reference level, according to an established environmental target. Given that large disparities exist between countries with respect to agricultural production costs and natural conditions, different levels of support are required to provide the positive environmental effects that are demanded. Therefore, to the extent that a certain level of agricultural support is necessary in order to ensure the balance between supply and demand of certain public goods, such as those described in Section 3.A, 3.B and 3.C, the agricultural policy corresponds in effect to what we have called a Provider-Gets-Principle (PGP).

79. In Norway, for example, agricultural producers face production costs far above the world average. It is evident that production will only take place if production revenues exceed production costs. Thus, the different conditions under which agricultural production takes place should be carefully considered. In Norway, to the extent that public goods are joint products of the agricultural production, a combination of policy measures, including a certain degree of support coupled to the agricultural production, seems to be the most efficient way of ensuring the desired production level of public goods. Based on the analysis in this paper, it seems that further agricultural trade liberalization will have adverse effects on the environment in Norway if it does not allow the desired quantity and quality of environmentally related public goods to be produced.

---

[41] These estimates include external costs such as emissions, noise, accidents, queues and degradation of infrastructure. They are based on Norwegian tax levels, which are assumed to be substantially above world average. For other countries, estimates of the degree of internalization may differ considerably.

References

Barnett, Payne and Steiner, 1995: *Agricultural Sustainability. Economic, Environmental and Statistical Considerations*. Jon Wiley & Sons, Chichester, UK. 266 pp.

Commonwealth of Australia, 1995: *Sustaining the agricultural resource base.* 12th meeting of the Prime Minister's Science and Engineering Council, Office of the Chief Scientist, Department of the Prime Minister and Cabinet, Canberra.

Cressie and Majure, 1997: *Spatio-temporal statistical modelling of livestock waste in streams*. In Journal of Agricultural, Biological and Environmental Statistics, 1997.

European Commission, 1998: *Measures taken pursuant to Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources.* Report of the Commission to the Council and European Parliament. 47pp.

Goss; Goorahoo; Ahmad, 1995: *Nitrate contamination of groundwater: measurement and prediction.* In *Nitrogen economy in tropical soils*. Fertilizer-Research. 1995.

Lakshminarayan, P.G, Babcock, Bruce and Mitchell, Paul, 1996: *A conceptual framework for evaluating agricultural economic and environmental tradeoffs in the Central Nebraska Basins using field-level area study*. Working paper 96-WP 162, CARD, Iowa State University, 16 pp.

Mittermeier, Russell A., Gil, Patricio Robles and Goettsch Mittermeier, Cristina, 1997: *Megadiversity: Earth's Biologically Wealthiest Nations*. CEMEX, 503 pp.

Mueller; Hamilton, Helsel, Hitt and Ruddy, 1995: *Nutrients in Ground Water of the United States. An analysis of data through 1992.* Water Resources Investigations Rep. No. 95-4031. US Geological Survey, Denver Co.

OECD, 1993: *Environmental performance reviews – Norway*.

OECD, 1994: *Environmental performance reviews – Japan*.

OECD, 1995: *Environmental performance reviews – Canada*.

OECD, 1996a: *Environmental performance reviews – New Zealand*.

OECD, 1996b: *Environmental performance reviews – United States*.

OECD, 1996c: *Trade liberalization and changes in international freight movements.* Joint Session of Trade and Environment Experts, Paris, 3-5 June 1996. COM/TD/ENV(96)73. 34 pp.

OECD, 1997a: *Joint working party of the committee for agriculture and the environment policy committee, Agri-environmental indicators: stocktaking report*. COM/AGR/CA/ENV/EPOC(96)149/REV1

OECD, 1997b: *Agricultural policies in OECD countries. Measurement of support and background information – 1997*. Paris. 166 pp.

OECD, 1998a: *Environmental performance reviews – Australia*.

OECD, 1998b: *Joint working party of the committee for agriculture and the environment policy committee, Agri-environmental indicators: stocktaking report*. COM/AGR/CA/ENV/EPOC(98)52

OECD, 1998c: *Economic globalization and the environment*.

OECD, 1998d: *Joint working party of the committee for agriculture and the environment policy committee, CAP reform and the environment*. COM/AGR/CA/ENV/EPOC/RD(98)63.

OECD, 1998e: *Agricultural policies in OECD countries. Measurement of support and background information – 1998*. Paris. 164 pp.

Smith, Nigel, 1996: *Effects of land-use systems on the use and conservation of biodiversity. In Biodiversity and agricultural intensification. Partners for development and conservation*. Environmentally Sustainable Development Studies and Monographs Series No. 11, World Bank, Washington D.C.

Vatn, A., Bakken, L.A., Azzaroli Bleken, M., Botterweg, P., Lundeby, H., Romstad, E., Rørstad, P.K. and Vold, A., 1996: *Policies for reduced nutrient losses and erosion from Norwegian agriculture. Integrating economics and ecology*. In Norwegian Journal of Agricultural Sciences, Supplement No. 23.