ENVIRONMENTAL EFFECTS OF AGRICULTURAL TRADE LIBERALIZATION AND DOMESTIC AGRICULTURAL POLICY REFORMS

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The paper reviews existing studies on linkages between agricultural policies, trade liberalization and the environment. Since the price and production changes induced by the Uruguay Round Agreement on Agriculture seem likely to be quite modest for most countries, this partial trade liberalization 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 liberalization, partial or complete, can 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, for example, agro-environmental programmes.

INTRODUCTION

A. Background

Governments have intervened in the production, trade and consumption of agricultural products in almost all countries. There is a general tendency to protect and subsidize farmers in developed countries and to tax and discriminate against farmers in developing countries.

The main objectives of agricultural policies in many developed countries have usually been food security and the income level of farmers. The objective of self-sufficiency in food has been exceeded in many countries and consequently overproduction of agricultural products has become a problem in those countries whose production is not cost-competitive. Thus, domestic surpluses have been exported to world markets by using export subsidies, which has depressed world market prices. Overproduction has been tried to be solved through production control measures like production quotas, which have created market distortions and economic efficiency losses. Market price support has been used extensively to support farm incomes. However, market price support has contributed to the intensification and specialization of agriculture, which are the main causes of direct pollution due to agricultural production.

In developing countries agriculture is taxed, directly or indirectly, to generate revenue for industrial expansion, and agricultural prices have been held below world market prices in order to secure low retail prices for urban consumers. Low and taxed producer prices and ill-defined property rights have prevented farmers from adopting environmentally benign production techniques and resource conservation practices. In addition, fertilizer and pesticide subsidies are sometimes paid to offset the disincentive effects of low producer prices. However, the low application efficiency of subsidized inputs has resulted in environmental pollution.

Hence, both protection and discrimination of agriculture distort the intersectoral allocation of resources and consequently impose "deadweight" losses on society. The causal chain from agricultural protection and discrimination to environmental degradation is straightforward, since environmental degradation is partly due to distortions in resource allocation.

The objectives of agricultural policies are not a problem *per se* but the agricultural policy instruments used to achieve these objectives may be. If agricultural support were provided through lump sum transfers, the economic costs relating to support would be minimized. Hence, a re-instrumentation of domestic agricultural policies is needed to alleviate both economic and environmental costs relating to current agricultural policies. The increased demand for domestic agricultural policy reforms has evolved both domestically and internationally.

The linkages between agriculture, trade and the environment have emerged in the context of multilateral trade liberalization in agriculture. 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 examining the environmental impacts of specific agricultural policy instruments. In addition, while a large number of theoretical studies dealing with agricultural trade liberalization have been undertaken, only modest attention has been paid to the likely environmental impacts. 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 by trade liberalization or domestic policy reforms. This has to do with the fact that increased trade flows owing to agricultural trade liberalization 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 affected by domestic agricultural policies. Thus, the environmental effects of agricultural trade liberalization are channelled through domestic agricultural policies and their impact on production patterns and via these on the environment. Hence, the integration of environmental considerations into domestic agricultural policies may play an important role when realizing full environmental and economic benefits from agricultural trade liberalization.

However, current agricultural policies and production patterns and their environmental impacts form the baseline against which changes in environmental quality due to trade liberalization and

domestic policy reforms can be assessed. Since the Uruguay Round Agreement on Agriculture as well as domestic policy reforms are quite recent, and many environmental impacts become evident only in the longer term, qualitative elements play a major role in this analysis.

B. Objective of the paper

The objective of this paper is to synthesize existing studies on linkages between agricultural policies, trade liberalization and the environment. It will not directly provide new empirical evidence. However, the hypotheses provided by earlier studies will be compared to the latest information on, for example, world market prices, production changes, market access, etc. Issues to be addressed include: (i) the environmental implications of domestic agricultural policy instruments; (ii) the environmental effects of overall changes in agricultural policies, i.e. domestic agricultural policy reforms; (iii) the environmental effects of agricultural trade liberalization in developed and developing countries.

C. Structure of the paper

The paper is structured as follows. First, 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 examined in chapter I. This is followed in chapter II by a description of the main elements of domestic agricultural policy reforms and the analysis of the likely environmental impacts of these reforms. The main elements and some viewpoints on the implementation of the Uruguay Round Agreement on Agriculture, as well as the likely environmental impacts of agricultural trade liberalization are then examined in chapter III, which is the main part of the paper. Finally, conclusions and policy implications are provided in chapter IV.

I. ENVIRONMENTAL EFFECTS OF CURRENT AGRICULTURAL POLICIES

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, 1994d). However, agricultural production subsidies have an impact on environment via altering incentives for farmers. By creating economic and market distortions, these subsidies may produce adverse environmental impacts. Short-run effects of agricultural support policies on the environment are often connected to their influence on levels of

variable input use like fertilizer and pesticide use. Market price support and deficiency payments as well as other policies that increase unit revenues to producers stimulate production, and hence the use of variable inputs, creating more pressure on the environment than would otherwise have arisen (OECD, 1994d; OECD, 1995c).

A. Major domestic agricultural policy instruments

Following the OECD (1994b), the four major agricultural policy instruments used to support cereal and dairy producers in OECD countries are market price support, deficiency payments, production quotas, and direct income support.

In the **market price support** system the domestic market price is fixed at a level higher than the equivalent world market price. For a traded commodity, market price support requires the use of border measures to provide import protection, and if domestic surpluses are generated, the use of export subsidies. Market price support raises domestic producer and consumer prices, thus increasing production and decreasing consumption, implying a transfer from consumers to producers. Hence, the market price support system distorts both production and consumption decisions.

Deficiency payments guarantee producers a per unit payment on output equal to the difference between the market price and an administrative target price. This policy instrument raises the effective producer price through direct payments by taxpayers rather than transfers from consumers, as consumers pay the lower market price.

Under the **production quota** system the government sets a support price and restricts production to a level below that which would otherwise occur at the support price. Production quotas are usually used in combination with support price or deficiency payments. According to OECD (1996a), the main quantitative restrictions in OECD countries include quotas on output (e.g. the EU quotas for milk and sugar) and set-aside of agricultural land, and it is increasingly the case that farmers receiving market price support or direct payments must comply with specific input or output constraints. Quantitative restrictions lead to economic efficiency losses, can create significant market distortions for the commodity controlled and have negative "spillover" effects on competing products or on factors of production. In addition, the long term supply controls may reduce the competitiveness of controlled sector by slowing structural change and technological innovation.

The term **direct income payment/support** refers to transfers that are financed by budgets and paid directly to farmers, and are independent of current and future production levels, whereas the term **direct payments** refers to budgetary measures with no judgement as to their linkage with production or factors of production. The latter category includes a wide range of different types of payments, such as deficiency payments, area and headage payments. These payments may be based on past farm or

regional production data, and can generate economic distortions to varying degrees (OECD, 1994a; OECD, 1994b).

B. The measurement of agricultural support

The *Producer Subsidy Equivalent* (PSE) is the level of subsidy that would be necessary to compensate producers, in terms of income, for the removal of government programmes affecting a particular commodity. PSE calculations include all the transfers that specifically result from agricultural policies. Thus, the PSE can include the transfer effects of any policy that can be linked directly to farm incomes, including trade restrictions, market price supports, direct transfers, input- and factor-market policies (OECD, 1995a; Tangermann, *et al.*, 1987).

The percentage PSE for the OECD as a whole has fluctuated around 40 per cent since 1988 (table 1). There is, however, a wide range of percentage PSEs among the OECD member countries. The lowest estimates have usually been for Australia and New Zealand and the highest have been for Japan and former EFTA countries. It is important to note that PSEs for developing countries between the years 1979-1989 were usually low or negative, for example, -38 per cent for Argentina, -4 per cent for Thailand and -2 per cent for India (Anderson, 1991).

Table 1

Trends in producer subsidy equivalents in selected OECD countries

Percentage producer subsidy equivalents

	1979-81	*1986-88*	*1989-91*	*1992*	*1993*[e]	*1994*[p]
European Union	36	48	45	47	49	50
Australia	8	10	10	11	9	10
Japan	60	73	66	73	73	74
USA	15	30	22	22	23	21
OECD	29	45	40	42	43	43

Source: OECD (1995a).
Notes: e = estimate.
p = provisional.

The variation in percentage PSEs across commodities is wide as well. For the commodities covered by the PSE calculations, the OECD PSEs in 1995 were highest for rice (93 per cent), milk (60 per cent) and sugar (50 per cent). The lowest estimates were for wool (7 per cent), poultry (13 per cent), eggs (14 per cent) and pork (16 per cent). PSEs declined by 10 percentage points to 47 per cent for the crop sector as a whole from 1986-1988 to 1995, while for livestock products they remained at 38 per cent (OECD, 1996a).

C. Environmental effects of specific agricultural policy instruments

Although a number of indicators like 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 so account for less than full effects of those policies on social welfare. The same agricultural policies that have distorted production decisions and trade have also reinforced environmental damages in agriculture. Following 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 simultaneously.

It can be argued that agricultural production subsidies have increased incentives that have lead, for instance, to water and soil pollution. Market price support has an effect on the price-ratio between a product and a production input like fertilizer or pesticide. Market price support increases the producer prices, which in turn increases the economically optimal rate of input use. Farmers try to apply fertilizers at the economically optimal rate in order to maximize profits. This economically optimal level of fertilization, however, may exceed the rate that is optimal for crop growth (depending, for example, on weather conditions), thus exceeding also the environmentally optimal rate. Excessive use of fertilizers has led to eutrophication in surface waters and nitrate accumulation in ground waters; agriculture has indeed been the main source of both nitrogen and phosphorus leakages into surface waters in many countries. In other words, the growth in fertilizer intensity has resulted in external costs. These external costs can be internalized through appropriate environmental policy instruments. However, monitoring and controlling agricultural pollution encounters enormous problems owing to the characteristics of nonpoint source pollution (Lankoski, 1996). According to Runge (1993), 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.

Because commodity-specific policies alter the relative prices of crops that can be grown in rotation, they lead to an increased use of fertilizers to maintain soil productivity. These policies have encouraged the intensive cultivation of "programme" 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 programme 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 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 where imported feeds are cheaper due to lower transportation costs. As a result, the volume of manure produced in areas where livestock production is concentrated has exceeded the area of cropland available on which to apply manure. Thus, manure surpluses and nutrient pollution of surface 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 a set-aside of arable land. While the purpose of set-aside programmes is to limit the output-increasing effects of price supports, the reduction of available arable land can induce input intensification on lands remaining on cultivation. The environmental effects of set-aside as a supply control measure are, however, complex depending on the way the set-aside programme is implemented (e.g. plant cover) and input use intensity on the remaining production base (OECD, 1995c).

According to Arnold and Villain (1990), the concentration of farms, land and livestock, the specialization in a narrow range of products and the intensification of the use of fertilizers, pesticides, feedstuffs and energy have been responsible for the greatest environmental damage due to agricultural production in EU. These factors have composed part of an adjustment process to technological and economic developments which has been reinforced by agricultural policies. However, the most important effects on environment have resulted from distorted prices and cost structures. These distorted price relationships exist between the EU market and the world market, between output and input, between domestic and imported products, and between products with market regulation and those without intervention.

Subsidies for the purchase of fertilizers 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 (OECD, 1995c).

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

II. ENVIRONMENTAL EFFECTS OF DOMESTIC AGRICULTURAL POLICY REFORMS

The OECD countries are responding to the environmental impacts of agriculture partly through agricultural and trade policy reform, and partly through specific environmental policy instruments. The starting point should, however, always be the reform of agricultural policies in order to reduce the production distortions associated with many forms of agricultural support. Progress in the movement towards increased market orientation through re-instrumentation of domestic support measures, that is from market price support to direct income support, will reduce distortions in production decisions and hence lead to environmental benefits due to a shift to more sustainable farm management practices, a more optimal use of farm chemicals and a change in the composition and location of production (OECD, 1995a).

Some of the environmental policy instruments implemented in the OECD area have been payments based on estimates of costs to farmers producing environmental benefits. However, a number of these instruments have been implemented in a context of high agricultural support, which has contributed in the first place to the environmental damage they have been designed to mitigate. Environmental policy instruments like *cross-compliance measures* link eligibility for farm income support to environmental benefits. For example, the EU has implemented set-aside requirements as a prerequisite for receiving support payments for cereals, oilseed and leguminous crops. Given that these measures are designed

to target both environmental and farm income objectives, it is not clear whether they fulfil the cost efficiency criterion. With direct payments to farmers increasingly linked to environmental benefits, there is also concern that some of these payments can distort production decisions, allocation of resources and agricultural trade (OECD, 1995a).

A. Domestic agricultural policy reforms: the role of direct income payments

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). Quantification of the progress towards agricultural policy reform through PSEs is a central focus of the annual monitoring process of OECD (*Monitoring and Outlook* reports).

Thus, agricultural policy reform involves strengthening the role of market signals, which reduces economic distortions, and decreasing total support to production. Direct income payments have a potential role to play here for two reasons: first, direct payments can be designed to transfer income to producers without imposing distortions on either market prices or production and consumption decisions, and, secondly, they allow a reduced level of total assistance to be used more effectively, since the direct payments can be designed to transfer support more directly to target groups (OECD, 1994a). Moreover, they can be used to alter the distribution of income and to promote efficiency in cases where the absence of a market for certain inputs and outputs leads to a misallocation of resources, i.e. to compensate for market failures. It should be noted, however, that regardless of their objective, direct income payments are never wholly free of economic costs imposed on other sectors. Even a decoupled, flat rate payment that has no distortionary effect on production decisions would involve transaction costs due to raising taxes (OECD, 1994a). Another problem related to direct income payments is that they may render farmers passive and lead to "sluggish" farming.

Although there has been an increase in the share of direct payments of total support in the OECD, market price support has remained the dominant form of assistance representing over two-thirds of total agricultural support in 1994. Direct payments represented about 17 per cent of total support (PSE) in OECD countries in that year. The category of direct payments in the PSE calculations, however, includes a wide range of different types of payments which might have rather different effects on the agricultural sector. One third of total OECD direct payments is classified as deficiency payments and another third as acreage and headage payments. Many of them are dependent on the fulfilment of

specific environmental, conservation or production limitation criteria. Most direct payments in the OECD area are, however, either production specific, or related to or based on factors of production, and the more closely they are related to production or factors of production, the more likely they are to be economically distortive (OECD, 1995a).

The OECD (1994a and 1995a) defines the characteristics of such direct income payments that are least production related and 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. Furthermore, payments to facilitate structural adjustment should normally be limited to a transitional period while payments to encourage the provision of environmental public goods in agriculture could be justified as longer-term measures, provided that these payments are targeted to clearly defined and valued environmental outcomes and that the environmental impacts of current agricultural policies and practices are taken into account (OECD, 1996a).

B. Environmental impacts of domestic agricultural policy reforms

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

According to the OECD (1995a), agricultural trade liberalization and domestic agricultural policy reforms can have positive environmental effects. Generally, freer trade that is combined with domestic agricultural policy reform should result in a more efficient use of natural resources and a decrease in global agricultural pollution, although in some areas the environmental stress could augment. The resulting environmental effects will depend, however, on the extent to which relative incentives facing farmers change. It is noteworthy that the analysis of environmental effects due to changes in relative incentives facing farmers (e.g. price effects), is the same regardless of whether those changes arise from domestic policy reforms or from trade liberalization. Hence, it might be difficult to distinguish whether environmental effects are brought by domestic policy reforms or trade liberalization. This is particularly the case if and when the environmental impacts produced by these two sets of policy changes are similar.

However, through re-instrumentation of domestic agricultural policies, that is from commodity-based market price support and input subsidies to decoupled direct payments, 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. It can be argued that the removal, reduction or decoupling of agricultural production subsidies should reduce incentives for fertilizer and pesticide use, conversion of environmentally sensitive lands for production, as well as irrigation water withdrawals (Ervin, 1996).

According to Carr *et al*. (1988; Batie, 1996), agricultural subsidy reduction has three basic types of impacts on agricultural production: (i) output substitution impacts, (ii) output price impacts, and (iii) input substitution impacts. Output substitution impacts would imply, for example, a shift from "programme" crops to "non-programme" crops. Environmental implications of this production shift would depend on whether the latter group of crops are 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 fertilizers, pesticides and land. Thus, these inputs would be used less intensively.

The reform of New Zealand's agricultural policies in the year 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, fertilizer 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 fertilizers and other agricultural chemicals decreased, livestock numbers declined, land conversion on pastoral farms fell, and forestry plantings increased (OECD, 1996b).

The case of Indonesia is a good example of removing input subsidies. Due to a reduction of pesticide subsidies, government savings during 1985-1988 were US$ 150 million annually. Concurrently, new pest-resistant rice varieties became available and farmers adopted the Integrated Pest Management (IPM) approach through the extension network (Lutz and Young, 1992). According to Gupta *et al*. (1995), this kind of policy reform can have favourable impacts on the macroeconomic performance, such as impacts on balance of payments, national output and fiscal balance, especially in the long run. The reduction or removal of subsidies can substantially improve the fiscal balance of a country. As to the case of balance of payments, the removal or reduction of pesticide and fertilizer subsidies can lead to lower import requirements of these inputs themselves, or of the inputs used in their production. On the other hand, the removal of subsidies may imply an increase in food imports, if agricultural production declines due to the removal of subsidies.

Farmers in developing countries face low and taxed producer prices, lowering incentives to produce. These domestic distortions are reinforced by international trade distortions (Runge, 1993). According to Young and Burton (1992), the removal of domestic price distortions in developing countries would lead to increases in commodity prices, which in turn would induce farmers to produce more as well as to change their product mix. This positive supply response may occur through an extension of agricultural margins or an intensification through an application of fertilizer and pesticide inputs, technology, etc. Either way, this may have important environmental implications. When assessing the overall environmental impact of policy reforms, account must be taken of which products are encouraged and which discouraged by the policy reform, since the chosen product mix has important environmental implications, such as input requirements and impacts on soil erosion. The possible adverse environmental impacts could be mitigated to the extent that positive income effects facilitate resource conservation.

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 programmes 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 programmes 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 programme reform took place in a period of record high world prices for corn, wheat and soybeans. Therefore, the plantings of these former programme 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.

III. ENVIRONMENTAL EFFECTS OF AGRICULTURAL TRADE LIBERALIZATION

Multilateral trade liberalization 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 liberalization 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 environment would fall in the former, but would rise with prices in the latter (Runge, 1993). Following Anderson (1994), while the environmental effects of trade liberalization are critical for all countries, the may be particularly important in developing countries, since these countries often have large agricultural sectors, and trade liberalization can lead to relatively large changes in trade, production, and economic growth, and possibly large coincident environmental impacts.

It is important to note that agricultural policy reform and trade liberalization are a necessary but not sufficient condition for sustainable development in agriculture, and they must be accompanied by appropriate environmental policies. This is valid even for countries where environmental benefits are expected to arise as a result of policy reforms and trade liberalization. In other words, agricultural policy reform and trade liberalization do correct some policy failures. However, some market failures still exist and can be corrected through environmental policy instruments.

Thus, trade liberalization and optimal environmental policy interventions are both needed to achieve economic efficiency. A gradual liberalization of trade due to adverse environmental impacts would be an inefficient way to alleviate environmental problems, since this kind of intervention is not targeted to the main cause, the environmental externality. The rationale for trade liberalization lies in reasons other than environmental protection, since environmental quality improvements can be achieved with lower costs through specific environmental policy instruments. Neither should trade liberalization be resisted for environmental reasons - provided that appropriate environmental policies are in place to address environmental market failures. This is not to suggest that trade policy goals would be superior to environmental policy goals, but to ensure that specific policy instruments are used to address each policy objective in order to fulfil the cost efficiency criterion.

A. Agricultural trade liberalization: the Uruguay Round Agreement on Agriculture

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 summarized below.

1. Commitments on domestic support, market access and export subsidies

A major achievement of the AoA is that agriculture is now subject to WTO disciplines, whereas previously agricultural protection had either been accorded "special treatment" (e.g. permitting the use of export subsidies under Article XVI and the use of import quotas under Article XI) or had not been explicitly covered by GATT provisions (e.g. domestic subsidies and variable import levies). The AoA appears to close these loopholes (Ingersent *et al.*, 1995). Aggregate domestic support will be reduced from US$ 198 billion to US$ 162 billion and export subsidies will be cut from US$ 21.3 billion to US$ 13.8 billion.

2. Domestic support commitments

A 20 per cent reduction in total Aggregate Measurement of Support (AMS) in six years (1986-1988 base period) has been committed to. For developing countries, the reduction is 13.3 per cent in ten years. 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. The GATT *Aggregate Measurement of Support* (AMS) is defined as "the annual level of support, expressed in monetary terms, provided for an agricultural product in favour of the producers of the basic agricultural product or non-product-specific support provided in favour of agricultural producers in general". The AMS is, however, subject to a set of exemptions and exclusions in order to ensure that reductions apply to those policy measures which distort trade and production. While OECD's PSE tries to reflect the full range of economic distortion arising from agricultural policies, the GATT AMS measure, by comparison, tries to reflect only those policies which are trade distorting (OECD, 1995b).

According to Tangermann (1996), one of the most important implementation problems of 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, green box policies have to fulfil a number of specific criteria in order to be exempted from AMS calculation. However, a number of policies which meet the respective policy-specific criteria may cause larger than minimal distortion on production and trade, thus violating the general criteria.

According to Tangermann (1996), commitments on domestic support (AMS) do not appear to constrain agricultural policies very much for the immediate future. For example, the EU, Japan and the USA had already fulfilled their AMS commitments before the implementation period for the Agreement on Agriculture began. As to the case of the EU, the current AMS has already fallen below the commitment. This has to do with the reduction of price support due to the CAP reform and the fact that EU compensation payments are exempted from the AMS commitment. However, the PSE for the EU has not followed the downward trend of the AMS measure, mainly owing to the fact that it includes the compensation payments. Existing AMS commitments, however, prevent countries from sliding back to the type and level of support they used to administer.

3. 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 for developed countries with a minimum of 15 per cent reduction in each tariff line, and 24 per cent in ten years in the case of developing countries with a minimum of 10 per cent reduction in each tariff line. Minimum access provision is 3 per cent and will rise to 5 per cent of base period domestic consumption. The tariffication process is likely to result in the establishment of tariff rates which may prove to be as prohibitive as the NTBs they replaced. This has to do with loose guidelines for the determination of base period tariff equivalents of former NTBs prescribed by the agreement (Ingersent *et al.*, 1995). Following Tangermann (1996), 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 which will not bind current agricultural policies such as support prices for some time. Moreover, there are cases where domestic producer prices have been reduced since the base period, and world market prices have increased, so that a tariff lower than the one bound would be enough to protect domestic producer price.

4. Export subsidy reduction commitments

Subsidized export expenditure is to be reduced by 36 per cent and subsidized export volume by 21 per cent over six years (base period 1986-1990 average). For developing countries, the reduction will be two-thirds of these figures over a ten-year period. However, the agreement states that where export levels, defined as the average of subsidized exports for 1991-1992, exceed average exports for the base

period 1986-1990, the former may be used as a starting point provided the same reduction level is attained (front loading).

According to Tangermann (1996), the constraints on the quantities of subsidized 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 subsidized exports had increased between the base and the implementation period, thus making reductions in quantities rather 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 in order to reduce quantities of subsidized exports, countries have to adjust their agricultural policies.

B. Environmental impacts of agricultural trade liberalization

Increased trade flows owing to agricultural trade liberalization 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.

1. Overview of agricultural trade liberalization and environment linkages

OECD (1994c) has identified five main categories of trade-related environmental effects: scale effects, structural effects, product effects, technology effects, and regulatory effects. For example, agricultural trade liberalization can have positive or negative effects on the environment by changing the product composition of trade (product effect); by increasing economic growth and generating the funds available for environmental protection (scale effect); and by altering the location, product-mix and intensity of production through the removal of trade distortive and environmentally harmful subsidies (structural effect).

Current agricultural policies and production patterns and their environmental impacts form the baseline against which changes in environmental quality due to trade liberalization can be assessed. At the first stage, one would need to observe how world market prices would change after trade liberalization (macro level). In order to find out the environmental effects one would then need to go to the farm level and see how farmers respond to the changes in relative prices (micro level); particularly whether supply responses occur at the extensive or intensive margin of agricultural production.

A large number of theoretical and empirical studies dealing with agricultural trade liberalization have been undertaken but only a few have considered the effects on the environment. However, some studies have used the results of economic models of agricultural trade liberalization as a starting point for the assessment of the likely environmental effects of production and price changes (Anderson, 1991 and 1992). 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 also on the environment and resource base of developing countries. 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 on the use of intermediate inputs like fertilizers and pesticides, in the long term on primary factors of production like capital, labour and land use, and via these on the environment (Lutz, 1992).

Following Anderson (1991), a good starting point towards understanding the likely environmental effects of agricultural trade liberalization is to look how the global volume and international distribution of agricultural production changes with liberalization of agricultural trade. It is estimated that total world food production would hardly change as a result of agricultural trade reform. If developed countries reduce their agricultural protection the reduction in their food production would be offset by increased output in developing countries.

Environmental effects of these production changes will depend on adjustments in fertilizer and pesticide use as well as in irrigation in the short run, and in the longer run on adjustments in capital and land use in agriculture. Chemical fertilizer 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).

A consensus view has emerged that the environment in the developed countries would benefit from agricultural policy reforms due to reduced intensification of agriculture. By contrast, developing countries may face negative environmental impacts due to the intensification of agriculture in those countries. It has been argued, however, that some or all of the negative environmental effects in developing countries could be offset via the income effect of higher prices. Higher world market prices for agricultural commodities facilitate environmental cost internalization by permitting farmers to use more environmentally friendly production techniques and to make conservation-type investments that increase long-term productivity (Lutz, 1992).

Following 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. The global reduction in chemical use would occur all the more so because most of the countries where production expansion would be concentrated tend to be relatively sparsely populated; the consequent lower price of land in these countries is believed to result in less use of farm chemicals per unit of output than in more densely populated countries at identical farm product 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 do not exist (Anderson, 1991).

2. Environmental impacts through changes in GDP

Numerous empirical models are available for estimating the economic effects on developed and developing countries of reducing subsidies and liberalizing agricultural trade. These models provide forecasts of effects of trade liberalization on prices, production, consumption and economic welfare. Most of the models are partial equilibrium models, i.e. they are designed for examining the impact of changes in agricultural policies regarding specific agricultural commodities with the remaining sectors of the economy not changing. 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. By contrast, general equilibrium models examine the economy as a whole, including macroeconomic determinants like savings, employment and income, as well as interlinkages between sectors (Goldin and Knudsen, 1990).

A number of studies have dealt with the issue of agricultural trade liberalization, including the reduction or removal of subsidies. For example, Anderson and Tyers (1991) used a dynamic, multi-commodity simulation model of the world markets to calculate the effects of liberalizing agricultural trade. In general, a significant reduction in the level of subsidies in developed countries would lead to lower farm gate prices, reduced output and exports, and increased price variability in those countries. The global economic benefits from such a policy reform in developed countries are estimated at US$ 62 billion per year, of which US$ 17 billion for developing countries (Anderson and Tyers, 1991). The benefits for developing countries would include improved market access, higher and more stable world market prices and expanded export opportunities. However, developing countries that are net importers of agricultural products might lose if world market prices increased. Economic welfare could improve

also for net importers of agricultural products if they switch to net exporter status or if they respond by reducing their own distortive food policies (Anderson, 1991).

The World Bank/OECD (Goldin *et al*., 1993) has estimated the global annual income gains from full agricultural trade liberalization 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 (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 liberalization can bring environmental benefits through the income effect. Liberalized trade should increase growth, economic diversification and development, thus generating the funds available for environmental protection. The demand for environmental quality has 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, for example, by 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 instance, 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$ 8000. 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 polutants such as carbon dioxide appear to rise monotonically with the level of income (World Bank, 1994). Moreover, the empirical studies have mainly concentrated on correlations 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 liberalization 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 as irreversible, it may be the case that soil and water resources are already depleted before the income effect improves 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 liberalization can enhance the implementation of effective environmental policies in the agricultural sector.

3. Environmental impacts through changes in world market prices

The price effects of agricultural trade liberalization 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 liberalization. On the one hand, in countries where domestic prices were equal to or below world market levels prior to trade liberalization, 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 liberalization, 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 fertilizer, pesticide and irrigation use. In the long run, the environmental effects depend also on changes in land use and production technologies in response to changes in prices and revenues.

As already noted, fertilizer and pesticide applications are highly correlated with producer price incentives. Hence, given the increases in world market prices due to trade liberalization, 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, one needs to examine the current level of fertilizer use in different groups of countries. For example, it may be the case in some developing countries that mineral balances are negative, that is the amount of nutrients removed by crops exceeds the amount applied in fertilizers, thereby implying that fertilizer applications should be increased in order to maintain soil fertility and to combat soil erosion and deforestation. Thus, a certain increase in fertilizer use would bring 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 and groundwaters. Thus, a decrease in the use of fertilizers in these countries would bring environmental benefits.

It is noteworthy, at this point, that an increase in fertilizer (or pesticide) use does not necessarily imply more pollution. The pollution resulting from agricultural production is dependent on factors that are endogenous (level of fertilization) 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 fertilizers and pesticides. 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.

The stochasticity of the production process also has important implications for so called "win-win" situations. For example, the reduction of excessive fertilizer use may result in cost savings and reduced nutrient leakages, provided that weather conditions are favourable and yield level is high, implying a win-win outcome. However, the same level of fertilizer use next year may result in lost profit and increased nutrient leakages if weather conditions are poor and the yield level is low.

When agricultural trade liberalization lowers relative producer prices, it could also be considered as an environmental policy instrument, similar to an *output tax*. However, output taxes suffer from several drawbacks due to their failure to address negative externalities such as nutrient and pesticide pollution directly. Several studies (Sumelius, 1994; Miettinen, 1993) indicate that output taxes are a far more costly way to reduce, for example, nutrient pollution than other second best instruments like fertilizer taxes. Following Miettinen (1993), the low efficiency of output taxes as environmental policy measures can be partly explained by the shape of the production function, since the economically optimal level of fertilization remains quite high, despite the reduction in profitability. Moreover, the price ratio between fertilizer and product also influences the efficiency of output taxes, since fertilizer can be seen as a relatively low cost production input, particularly in developed countries with high

producer prices. Hence, the specific environmental policy instruments are far more cost efficient than a general agricultural policy instrument in reducing agricultural pollution, implying that reasons for agricultural policy reform and trade liberalization lie elsewhere than in environmental protection.

There seems to be an interesting dilemma between producer prices and environmental degradation. On the one hand, it has been argued that too high producer prices in developed countries have lead to an intensification of production and resulting environmental degradation. On the other hand, it has been argued that too low producer prices in developing countries have lead farmers to continue cultivation in marginal lands again leading to environmental degradation. In addition, world market prices may not be a good indicator of the marginal social value of agricultural production, since these prices do not internalize external environmental costs relating to agricultural production.

Eiteljörge and Shiells (1995) have analysed three recent studies (namely, 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, for example, 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 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 a robust demand and a small harvest lead 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 liberalization, it is noteworthy that short-run supply shocks can overwhelm trade policy effects.

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

The environmental impacts of expanded trade owing to trade liberalization 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. However, rough indications of likely environmental impacts can be inferred from estimated changes in agricultural production due to complete or partial liberalization of agricultural trade.

Following Anderson and Strutt (1996; Ervin, 1996), the effect of complete liberalization 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.

Global environmental effects of this relocation of production can be positive or negative depending on chemical and land use induced by the production shift. For example, it can be expected that overall chemical use would decrease in Japan and Western Europe, implying positive environmental impacts, for instance in terms of reduced nutrient leakages. However, production decline in these regions may also result in the removal of agricultural land from production, thus reducing some amenity values of landscape. Hence, trade liberalization 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 through agro-environmental programmes, currently implemented in many OECD countries.

The environmental impacts in countries and regions where production is expected to increase (Latin America, North America and Oceania) will depend on whether production increases are brought through intensification of production, or by bringing additional land into cultivation, environmental endowments of these regions as well as on whether appropriate environmental policies are in place. 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 liberalization. However, many countries in these regions have already began 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 contribute to 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 trade reform (Anderson, 1994).

Figueroa *et al.* (1996) have analysed the environmental effects in Chile of a complete agricultural trade liberalization in OECD countries based on a SWOPSIM model (Krissof *et al.*, 1990). They assumed that trade liberalization in 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 with better grass varieties and legumes as well as through fertilization, 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 liberalization. Higher prices are also likely to increase fertilizer use for almost all the crops. Nevertheless, potential nutrient leakages into surface and groundwaters are expected to be small due to the low precipitation in Chile. Expected increase in pesticide use and water withdrawals for irrigation may have some adverse effects on environment. However, the study concludes that overall environmental effects of agricultural trade liberalization 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 liberalization in the sense that the protection for traditional commodities would be removed without any expectation of increases in world market prices for these commodities. The study found 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 fertilizer use in grain production would be offset by increased use in fruit production. Some adverse effects on environment and human health were possible from increased fruit production, since more pesticides would be used in fruit production than grain production.

FAO (1995a and 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 at 1.6 per cent annually from 1987-1989 to 2000 compared to 2.2 per cent in the 1980s, even with the Uruguay Round. Hence, the overall growth of agricultural production is projected to decrease slightly. Decreases in growth rates are 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 prices. The global value of agricultural exports is projected to rise by US$ 85 billion between the years 1987-1989 and 2000, of which US$ 25 billion 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 for Latin America, the Caribbean region and for the Far East. Argentina, Brazil 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 for most countries, it is unlikely that this partial trade liberalization 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 agro-environmental programmes will reduce adverse environmental impacts of agriculture and may also enhance the provision of environmental public goods. However, the successful implementation of agro-environmental programmes from the environmental point of view is dependent on the incentive structure of these programmes. 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 with environmental benefits (reduction in fertilizer use, maintenance of plant cover, use of buffer strips, etc.). This is to ensure that agro-environmental programmes are 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 affects the environment also through these domestic agricultural policy reforms, which may be required or stimulated by the agreement. Hence, trade liberalization together with domestic policy reforms would probably reduce global environmental pressure from agriculture. However, the environmental effects of agricultural policy reforms and trade liberalization 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.

IV. CONCLUSIONS AND POLICY IMPLICATIONS

Domestic agricultural policy instruments have contributed to economic welfare losses and environmental degradation, and they have thus been welfare decreasing on society as a whole. Hence, the re-instrumentation of domestic agricultural policies, both in developed and developing countries, should be the first step when alleviating both economic welfare losses and environmental degradation relating to current agricultural policies.

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. If these steps together prove insufficient to meet environmental quality targets, specific agro-environmental instruments could be introduced, depending on the institutional capabilities in a given country.

In developed countries, the use of decoupled income support and the implementation of agro-environmental programmes 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 does correct some policy failures relating to current agricultural policies, and a targeted use of agro-environmental programmes could tackle environmental market failures relating to agricultural production. The existence of environmental market failures does imply that the removal of agricultural support policies alone would not suffice to achieve environmental quality targets. This is further complicated by the fact that most agricultural pollution can be classified as nonpoint pollution, which constitutes a complex problem from an agro-environmental policy perspective.

Since the price and production changes induced by the Uruguay Round Agreement on Agriculture seem likely to be quite modest for most countries, this partial trade liberalization 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 liberalization, 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, for example, agro-environmental programmes. It is noteworthy that these domestic policy reforms may be required or stimulated by the Agreement on Agriculture.

Agricultural trade liberalization together with domestic agricultural policy reforms can be expected to reduce environmental pressure from agriculture in the developed countries. In some areas, such as North America and Oceania, where production is expected to increase many of the appropriate environmental and resource conservation policies are already in place to alleviate environmental damage associated with partially liberalized trade. Another question is what will happen in regions like Western Europe and Japan, where a decline in production, while reducing some adverse effects on the environment, may also result in the removal of agricultural land from production and may thus decrease some amenity values relating to agricultural countryside.

The environmental impacts of agricultural trade liberalization and domestic policy reforms in developing countries are more ambiguous. The role of income growth due to agricultural trade liberalization may not be sufficient to ensure environmental quality improvements in agriculture. Increased production may also, either at the intensive or extensive margin of production, imply more pressure on the environment. Thus, integrating environmental considerations into domestic agricultural policies is essential when developing countries begin to exploit their comparative advantage in agricultural production.

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 agro-environmental programmes should ensure that global environmental pressure from agriculture will decrease.

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