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NEXUS OF AGRICULTURE, TRADE AND THE ENVIRONMENT : A REVIEW

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I. Introduction

Agriculture today is riding on two powerful trends–trade liberalization and environmental protection. The recent Uruguay Round Agreement on Agriculture underlined that the agricultural sector is no longer free from making great strides for open markets. For nearly 50 years, GATT has played a unique and vital role in shaping an open and fair trading system in a global scale. This spirit for market access has been passed down to WTO, encompassing expanded issues in a broader context.[1] Free trade is further nourished in the regional level by economic integration. Such trading blocks as APEC, NAFTA and EU reflect growing demands for regional development and economic as well as political interests within the region.

At the same time, the notion of ecological interdependence of the planet has emerged to the international political scene and then is attracting public interest. Harmful effects by global environmental problems such as deforestation, loss of biodiversity, climate change, ozone layer depletion, etc. are valid not only within national boundaries but also across the boundaries and over the whole planet. As the number of global environmental issues has multiplied, multilateral environment agreements(MEAs) have proliferated to protect the ever-rising environmental degradation of the earth.

A potential conflict between the multilateral trading system

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[1] Unlike GATT, WTO accounts for Trade-Related Aspects of Intellectual Property Rights(TRIPs), Trade-Related Investment Measures(TRIMs) and Trade in Services(GATS).

(MTS) and MEAs arises from the fact that MEAs allow to excercise trade measures for the purposes of environmental protection. Despite advocates for the two lines mutually recognize the common goal of environmental protection, their means to accomplish the goal do not work in tandem. The GATT advocates or free traders have faith in the positive correlation between trade, economic growth and the availability of resources to invest in environmental protection(GATT, 1992). In contrast, environmentalists or some eco-economists observe that the economic growth by pro-trade may cause environmental damages, generating the unsustainable consumption of natural resources. This clash of economic and ecological paradigms is thus marked as one of the most complex, subtle and difficult challenges that WTO and other international organizations are currently faced with.

The purpose of this paper is to identify the relationship among agriculture, trade and the environment with a recognition of environmental effects from agriculture and from agricultural trade liberalization. An emphasis is made on the environmental benefits from agriculture and the environmental harms from free trade with some Korean cases, since they have been largely less mentioned in literature. Then, it suggests a few ideas how to approach this complex issue.

II. Nexus of Agriculture to the Environment

Agricultural production requiring large land and water supplies makes it differ from other industry. Mingled with natural resources and environmental conditions, agricultural production weaves a set in which people get staple commodities and essential services including social and environmental amenities. In this sense, agriculture has a direct link to natural resources and the environment.

(Table 1) summarizes various type of environmental consequences due to agricultural activities. On one hand, improper or excessive application of agricultural inputs such as fertilizers, pesticides, and energy brings about environmental risks by contaminating water, air, land and thus food. On the other hand, agricultural production renders an array of positive environmental contributions, offsetting the

TABLE 1 Environmental Effects of Agriculture

Negative Effects	Positive Effects
· eutrophication · water, air, and food contamination · waterlogging · salinization · water and nutrients depletion · compaction of land · soil structure deterioration and erosion · biodiversity loss · carbon sink loss · loss of wilderness and native habitats · emissions of carbon dioxide, methane, ammonia, and nitrous oxides	· provision of landscape · water clarification · water resources fostering · flood control · soil erosion control · atmosphere purification · air cooling(temperature control) · carbon sink · biodiversity gain · wildlife habitats preservation

environmental harms. Both spill-over effects are called as agricultural externalities.[2]

However, a standard approach in the environmental economics literature tends to internalize only pollution factor as a public "bads" that results from "waste discharges" in agricultural production. According to Cropper and Oates(1992), the basic relationships can be formed as:

$$U = U(X,Q) \quad (1)$$
$$X = X(L,E,Q) \quad (2)$$
$$Q = Q(E) \quad (3)$$

where U is the utility function of a representative consumer, X

[2] According to the theory of externalities, externalities occur when some of the benefits or costs of an activity are external to the decision maker, involved in the decision-making process(Randall, 1981). They are attributed to the structural characteristics of products, market failures, or government policies. The exact calculus of externalities is almost impossible in the context of scientific, social, and political criteria unless production costs and consumption benefits are evaluated at social prices and values, respectively. Thus, externalities are in general subject to a spectrum of uncertainties and structural problems outside the markets.

is a vector of consumed goods, Q is the level of pollution, L is a vector of conventional inputs, and E represents waste emissions. The assumed signs of the partial derivatives are $U_X>0$, $U_Q<0$, $X_L>0$, $X_E>0$, $X_Q<0$, and $Q_E>0$. Note that the public "bads", pollution is assumed to have negative effects on the utility of a representative consumer in equation (1) and the production level (2). In fact, environmental gains generated by the production process are not reflected at all in this popularly accepted stylized model.

A key point is that the recognition of environmental benefits linked with agricultural production is as much important as that of its environmental risks. Environmental outcomes of agriculture production and farm management should encompass both positive and negative effects. A valid argument here is to identify what the respective magnitudes of environmental gain and loss are, and to draw out the net environmental effects in evaluating the relationship between agricultural production and the environment. Otherwise, simply imputing environmental damages to agriculture can be a fallacy.

There are a few empirical studies that actually estimate the values of public "goods" resulting from agriculture. Brunstad et al.(1995) described agriculture as a provider of public goods in a case study for Norway. Using a numerical model, they estimated agriculture's contribution to public goods as food security, landscape preservation, and maintenance of population in remote areas. Eom et al.(1993) and Oh et al.(1995) have identified a number of positive externalities arising from paddy land farming in Korea. They include: floods control, underground water buildup, soil protection against washing away by waves, air, water and wastes purification, mitigation of soil acidification, alleviation of the consecutive planting damages, subsidence of ground prevention, landscape and bio-diversity preservation, provision for recreational space, maintenance of local culture and communities, etc. The public benefits amount to enormous monetary values(Table 2).[3]

The empirical results can shed some light on the validity for agricultural support since subsidies are remedies for market failures.

[3] Since this study did not account for the negative side effects of rice production, the net consequence of rice farming is uncertain from an environmental perspective.

TABLE 2 Estimation of Environmental Benefits from Paddy Cultivation

Unit: million dollars

Major Effects	Estimated Benefits	
	Eom et al.(1993)	Oh et al.(1995)
Flood control	133 ~ 1,082	1,978
Water resources fostering	735 ~ 1,230	-
Water clarification	623 ~ 1,540	7452
Soil erosion control	66 ~ 124	83 ~ 258
Waste disposal	49	-
Atmosphere purification*	2,327 ~ 4,642	3,497 ~ 7,109
Total Monetary Value	3,933 ~ 9,806	13,011 ~ 16,796

* It accounts for CO_2 removal and O_2 emission.
Source: Oh et al.(1995)

Market failures occur if the social value of a commodity does not equal to the sum of its private value and externalities. In order to remedy the market failures, policy makers may want to use such policy tools as taxes, subsidies, and command-and-control. In case of Korean rice, if the relative magnitude of positive externalities exceeds that of negative externalities and farmers are not appropriately compensated for their contributions to net public benefits, the market price of rice happens to be lower than social equilibrium price. Then, government may provide farmers with subsidies to remedy the market failures(McCalla and Josling, 1985). In line with this, the subsidies toward rice farms in Korea can be understood in part as some compensation for their provision of net public benefits.

Finally, it is worth pointing out important implications in the nexus of agriculture to the environment. Firstly, provided that prevalent net positive externalities are not internalized or equivalently understated in the market, the provision of agricultural subsidies for producers can correct the market failures. This support is a double-edged sword in a sense that it can either compensate the understated public goods(correcting the market failures) or encourage the production of the public bads(making the market failures worse by means of intervention failures). Secondly, despite an array of

uncertainties and technical limitations, sound empirical tools based upon objective and scientific criteria can serve as a measuring stick in discerning the characteristics and the relative magnitude of externalities. Finally, it is necessary to recognize the nature of agricultural pollution and to propel the efforts in developing proper methods for the calculus of environmental effects.

III. Nexus of Trade Liberalization to the Environment

A rapid expansion of world trade, especially for agricultural products is primarily attributed to the pursuit of freer trade and the growth of economic interdependence among nations.[4] The conclusion of the UR Agreement was a stimulus for this trend. Meanwhile, as the concept of sustainability prevails, international concerns are being redirected toward the critical linkages between trade liberalization and the environment. The recent establishment of Committee on Trade and Environment(CTE) under WTO signifies its importance.

Trade affects production and consumption of goods that cause environmental results. These are "indirect" effects. "Direct" effects, on the other hand, refer to environmental threats resulted from trading hazardous wastes, chemicals, endangered species, etc. But, the direct effects are known to be small(OECD, 1994).[5] (Table 3) summarizes what OECD characterizes trade effects on the environment–product, scale, structural and regulatory effects. Notice that all the effects embrace both positive and negative environmental outcomes. This explains why there are hot political and economic debates on the relationship between trade liberalization and the environment. It is because trade has no automatic, one-way effects on the environment.

Another argument is that the trade-environment effects are heterogeneous depending on local conditions, assimilative capacity, preferences, natural resource endowment, etc. It implies that a

[4] World exports expanded from $129.7 billion in 1962 to $5.1 trillion in 1995(IMF, 1997). Their share of economic output is continuously increasing. Exports for agricultural products also show a similar pattern that they amounted to $380.4 billion in 1994, a 82 percent increase from the level of 1985(FAO, 1994).

[5] But, OECD laid out the premise that international trade per se is not the root cause of environmental damages but market and government failures are.

"linear" relationship does not hold across regions and countries.[6] In other words, it advocates the environmental effects of trade are local-specific.

If the above arguments are acceptable, it is quite possible to conclude that the trade-environment linkages are subject to empirical researches implemented on the basis of local data and information. Despite relatively little empirical researches are currently available, their results can be of great importance in understanding the critical linkages. The introduction of somewhat exhaustive surveys of literature dealing with the issue in the following is to support previous arguments and to shed some light on the relationship between trade

TABLE 3 Effects of Trade Flows on the Environment

Product Effects	Positive	· Diffusion of goods which contributes to environmental protection or alternatives to environmentally-damaging products · Global spread of environmental technologies and services to address specific ecological problems
	Negative	· International movement and exchange of goods which directly harm ecosystems, such as hazardous wastes, dangerous chemicals and endangered species
Scale Effects	Positive	· Economic growth that provides countries with the financial resources to tackle environmental problems · Raising per capita income that increases national environmental preferences
	Negative	· Market expansion and growth that lead to more degradation and faster depletion of scarce natural resources
Structural Effects	Positive	· Allocating economic activity in accordance with the environmental capacities and conditions of different countries · Promoting the efficient use of resources
	Negative	· Driving production patterns based on large-scale inputs of chemicals, energy and capital rather than on natural environments and sustainable production methods
Regulatory Effects	Positive	· Implications for the level and enforcement of environmental process standards in providing incentives to changes in investment and industry migration. · Strengthening national trade-related commitments under international environmental agreements(IEAs).
	Negative	· Weakening national trade-related commitments under IEAs.

Summarized from OECD(1994).

[6] The term of "linear" may be interchangeable with "constant" or "uniform".

liberalization and the environment.

By analytic welfare comparison, Anderson(1992) argues trade policies are inferior instruments in the preservation of natural environment. He concludes if appropriate domestic environmental polices are in practice, benefits of free trade can be fully realizable.

Empirical outcomes obtained by Anderson and Strutt(1996) indicate that trade liberalization–complete removal of all farmer support policies in all industrial countries and US land set-asides in 1990–would result in negligible impacts on world food output and production relocation. From a North-South perspective, grain and meat production would fall by 5 or 6 percent in developed countries and rise by 3 to 8 percent in developing countries. Japan and Western Europe are likely to experience a huge decline up to 60 percent while North and Latin Americas and Australians fill the gap. As a result, agricultural production would shift from intensive farming regions to less intensive ones by which environmental stresses will be relieved.

Using the regional level data of the potato production system of northern Ecuador, Antle et al.(1996) simulated domestic policy liberalization and its environmental impact, regarding it as the mirror of the effects of free trade on the environment. The liberalized policy represented by an increase in pesticide(an imported good) prices, a potato price increase, and the mix of the two confirmed a negatively sloping transformation frontier. By this, they concluded a tradeoff relationship between environmental(groundwater) quality and agricultural production.

Instead of looking at price effects, a famous study by Grossman and Krueger(1993) focused on scale effects by examining a potential relationship between the fostered income growth by trade expansion and environmental improvement. This study found an inverted U-shaped relationship between the concentrations of sulfur dioxide(environmental quality) and per capita GDP. The benchmark for the turn was around U$ 5,000.

Likewise, Lucas(1996)'s empirical study largely supported the inverted U-shaped pattern, that is, rising income in low-income countries accelerates environmental harm up to a certain point but its trend is tapered off or reversed as moving into higher income ranges. He regressed a wide range of international indices, representing environmental impacts with both macroeconomic indices and

information about the nature of each country. In particular, most of the estimates indicated less environmental harms as export orientation increased, especially among smaller countries.

Inferring from the results, Esty(1994) pointed out that the non-linear relationship between economic growth stimulated by free trade and environmental improvement renders a self-revealing concerns to low-income countries since there might be a potential danger that economic growth does not guarantee higher environmental quality in the short to medium run. He also cast a fundamental doubt on the premise that economic growth entails environmental sustainability in low-income countries, given a relatively poor environmental regime in place, uncertainty and irreversibility of certain environmental harms.

Other studies also suggest indeterminate conclusions. For example, Lutz(1990) has showed that free trade can be a two-edged sword to developing countries, yielding both positive economic effects and negative environmental quality. According to the study, multilateral trade liberalization would reduce the level of production in developed countries by depressing the relative prices. On the contrary, in order to take advantage of relatively higher prices, developing countries would expand their output levels by means of higher utilization of land resources and chemical application that damages the environment. Overall welfare effects of this case then is not conclusive.

Formalizing Lutz's logic into a model, Rauscher(1992) has demonstrated that nations with abundant resources would increase their emissions in response to trade liberalization while resource-poor nations would respond the opposite. Like Lutz, Rauscher has concluded uncertain overall welfare effects of trade liberalization.

General conclusions from these empirical results are as follows. First, the environmental effects of free trade are uncertain. Second, they depend on local-specific conditions. Finally, they are diverse in size and degree. Daly(1995) criticizes the trade analysis because of its tendency to ignore the international factor mobility and imperfect market conditions. OECD(1996) postulates a cautious approach in interpreting the research results since they are usually take the short-run, static view regardless of uncertain paths of policy, institution, market and technology. On the other side, environmentalists claim that as long as production and consumption of agricultural products

are polluting, a global expansion of the outputs can lead to greater environmental risks(Blom 1996).

Environmental risks arising from agricultural trade liberalization can never be negligible and may not be offset by other better-offs.[7] An obvious increase in pollution from increased volume and flows of agricultural products relates to the transport and distribution activities. More long-distance and frequent transport and flows are likely to give a substantial burden on energy-related environmental quality, especially air pollution.

The increased international exchange of goods and new trade routes can also directly harm environmental resources by the introduction of harmful, nonindigenous plant, animal and insect species–negative product effects(OECD, 1996). Some of examples include African nail frogs(ANFs) imported from Africa into the US in the 1940s and imported bullfrogs and bluegills fishes in Korea. According to OTA(1995), an estimated 50 to 75 percent of major US weeds and 40 percent of the insects pests afflicting agriculture and forestry are nonindigenous, causing extensive damage to lands and agricultural outputs. Ecologists argue that an introduction of foreign species will result in a large disturbance in the ecosystem.

These examples underline ecological side effects due to the introduction of foreign species. Also, they advocate the sensitivity of local, regional, or national environment to external shocks. Even the same environmental risks can result in heterogeneous outcomes. Antle et al.(1996) reinforces this position that trade policy analysis and quantitative modeling are typically conducted at the national level. While this level of aggregation may be useful for general equilibrium analysis, it is not so for analysis of the environmental impacts of these changes. It is because the processes that govern environmental impact are location specific.

It is therefore important to evaluate the environment effects case by case, not in tandem with average expectation nor common standards. In addition, the characteristics of irreversibility embedded in ecosystem highly requires adequate precision in analysis and proper precaution in approach.

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[7] For a detailed review, see OECD(1994; 1996), WTO(1996), OTA(1995) and Krissoff et al.(1996).

IV. A Few Suggestions

The issue on the relationship between agricultural trade liberalization and the environment lacks careful considerations for all its multiplicity of characteristics. To identify and disentangle the complexity, it is necessary to take a well-informed, balanced and multi-dimensional approach, encompassing a wide spectrum of disciplines. Given this framework, a few suggestions can be rendered as follows.

Firstly, identifying the characteristics of environmental risks is a prerequisite for a better approach. A duality condition for pollution indicates that pollution by the haves relates to the level and pattern of production or consumption while pollution by the haves-not comes with the implication for income growth and economic development. A clear distinction of the two different sources of pollution helps control some pollution efficiently without spending much cost of economic development.

Environmental degradation results from a complex array of social and political forces where agricultural production, farm management, and agricultural policies interact with. A claim that farm production much indebted to agricultural policies automatically leads to environmental harms is likely to make a fallacy of generalization problem. As identified earlier, net environment effects are matter.

In addition, the concept of sustainable development can contribute to drive potential solutions for the complicated issues. Since the early 1980s, the definition of sustainable development has evolved steadily. The United Nations Environmental Program(UNEP) defined it as self-reliance, cost-effectiveness, appropriate technology, and people-centered initiatives. More recently, the World Commission on Environment and Development(WCED) adopted a succinct definition as: "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs(WCED, 1987).*"

Popularly accepted by international environmental agencies as a mainstream of sustainable development paradigm, this definition underlines a certain level of ecological and social sustainability to the extent that it accounts for inter-generational choice in resource use. Ecological sustainability refers to preservation of renewable and nonrenewable resources, and environmental process that are crucial to

human life. Social sustainability implies the existence and operation of social and political structures such as infrastructure, services, regulations, and value and belief systems.

An FAO's study proposed alternative definitions of and criteria for sustainability as "*resilience at the agro-system level*", "*maintaining the capital stock*", and "*the implications of entropy and co-evolutionary development*", which can be applied in the analysis of environmental issues. FAO argues for a necessity of integral strategies that serve both development and the environment, paying attention to the vulnerability of the eco-sphere or its capacity to absorb economic activity(FAO, 1996a). As sustainable agricultural and rural development(SARD) is generally perceived as a wider concept, embracing environmental, technological, economic and social dimensions, agricultural production in a country should be also evaluated in such a broader and wider spectrum.

Secondly, it is so important for an independent country, especially a net food importing country to ensure a policy goal of food self-sufficiency or self-reliance. The environment and food self-sufficiency share an implicit linkage under the notion of multi-dimensional facets of agriculture. According to FAO(1996b), food self-sufficiency is to meet food needs from domestic supplies with the minimal level of foreign dependency while food self-reliance is to keep the domestic production level with the possibility of international trade. These are in general nothing but two alternatives achieving food security at the national level.

In respect of sufficient food availability, reliability of import supplies, and price stability, international communities are debating on the pros and cons of counting on international markets for food security. In principle, however, each country's endeavor to ensuring food security at the national level must be respected.

Unlike most industrial commodities, food is an immediate subsistence needs for and a right of human beings to be satisfied with a minimal degree of risk. Food security can be however challenged by external uncertainties sucn as the increasing trends of global climate changes, conflicting political interests and natural disasters, and internal factors reflecting each country's specific conditions. Hence, most countries rank food supplies as a top priority in their policies.

A proper justification for food security requires two binding conditions. One is the discretionary provision of agricultural subsidies and the other is the farming practices, complying with agricultural sustainability. Farm subsidies should not direct or motivate excessive production over the self-sufficiency level that eventually disturbs the international market system. Also, each country should adopt flexible terms of policy instruments, recognizing a diverse nature of agricultural sustainability: heterogeneous socio-economic realities and systems, policy priorities and the degree of environmental degradation, and its absorbing capacity.

Differently endowed realities can lead to a different solution even for the same problem. This opens the possibility that the ways to achieve food security are not necessarily identical across countries. An equilibrium between food production and the environment can be obtained in a full account of national specific conditions.

Finally, if agricultural subsidies can be subsumed under environmental policies correcting market failures, they are subject to territorial sovereignty that covers the sovereignty over the environment and natural resources. This is gaining solid supports from various international organizations. For instance, the UN General Assembly affirmed that governments should exercise their sovereignty over resources in their interests of national development and well-being. Biodiversity Convention in 1992 also declared national sovereignty over their resources. In line with the Stockholm Declaration in 1972, the Principle 2 of the Rio Declaration in 1992 stated that: "*States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and development*···". In this regard, the policy for environmental conservation deserves to be a part of the framework of national security.

Along with the sovereign right, individual country also has a imperative duty to devise and implement environment-friendly, efficient programs in accordance with its endowed environmental capacity and socio-economic condition. As long as net environmental effects are obtainable due to the provision of agricultural subsidies, it is a viable policy tool and should not be excluded from environment-saving instruments.

V. Conclusions

Agriculture, free trade and the environment do not share a monotonic relationship. Instead, the multi-dimensional and complex nature of the linkages calls for a comprehensive approach. Neither freer trade nor protectionism is a universal solution for environmental protection, food security and world-wide hungers. More balanced, nondiscriminatory approaches should be in act in the framework of SARD.

An anthropocentric focus stresses that environmental protection or the conservation of natural resources can not be a goal in itself but rather they should readily available for ensuring higher human well-being. The Principle 1 of the Rio Declaration supports it as: "*Human beings are at the center of concerns for sustainable development*". In line with sustainable development, the Principle 4 of the Rio Declaration states: "*In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it*". These all give a solid support that environmental issues must be dealt within a sustainable development framework.

In order that these approaches reap fruitful and meaningful results in future, it is important to:

- acknowledge diverse structural, technological and cultural characteristics of each country and their interactions with environmental quality and markets and government failures,
- appreciate national sovereignty for policy priorities and relevant instruments even though they may not be identical across countries,
- respect the efforts for ensuring food security, especially in developing countries and net food importing countries,
- understand the embedded limitations on empirical researches which largely ignore a myriad of factors other than economically viable ones,
- develop balanced and nondiscriminatory methodologies for estimating net environmental benefits due to agriculture,
- view the issue of environmental quality in the context of sustainable development, and
- guard against the linear transposition of environmental damages from developed countries to developing countries regardless of their heterogeneous conditions.

REFERENCES

Anderson, Kym. 1992. "Effects on the Environment and Welfare of Liberalizing World Trade: The Cases of Coal and Food." In *The Greening of World Trade Issues*, K. Anderson and R. Blackhurst, eds. New York: Harvester Wheatsheaf.

Anderson, Kym and Anna Strutt. 1996. On Measuring the Environmental Impact of Agricultural Trade Liberalization. In *Agriculture, Trade, & the Environment: Discovering and Measuring the Critical Linkages*, M.E. Bredahl et. al., ed. Westview Press, Boulder, Colorado.

Antle, M.J., C.C. Crissman, R.J. Wagenet, and J.L. Hutson. 1996. Empirical Foundations for Environment-Trade Linkages: Implications of an Andean Study. In *Agriculture, Trade, & the Environment: Discovering and Measuring the Critical Linkages*, M.E. Bredahl et. al., ed. Westview Press, Boulder, Colorado.

Blom, Jan C. 1996. Environmental Policies in Europe and the Effect on the Balance of Trade. In *Agriculture, Trade, & the Environment: Discovering and Measuring the Critical Linkages*, M.E. Bredahl et. al., ed. Westview Press, Boulder, Colorado.

Cropper, M.L. and W.E. Oates. 1992. "Environmental Economics: A Survey." *Journal of Economic Literature 30*(June 1992): 675-740.

Daly, Herman E. The Perils of Free Trade. In *Green Planet Blues*, K. Conca, M. Alberty, and G.D. Cabelko ed. Westview Press, Boulder, Colorado.

Eom, Ki-Cheol et al. "Public Benefit from Paddy Soil". *Journal of Korean Society of Soil Science and Fertilizer 26*(Dec. 1993): 314-33.

Esty, Daniel C. 1994. *Greening the GATT: Trade, Environment, and the Future.* Institute for International Economics. Washington, DC.

FAO. 1994. Food Statistics.

FAO. 1996a. *Research on Linkages Between Trade, Environment and Sustainable Development.* Rome.

FAO. 1996b. Food and International Trade. Technical Paper 8, April 1996.

GATT. 1992. *Trade and Environment Report.* Geneva.

Grossman, G. and A. Krueger. 1993. Environmental Impacts of a North American Free Trade Agreement. In *The Mexico-US Free Trade Agreement*, P. M. Garber. MIT Press.

IMF. 1997. International Financial Statistics. April 1997.

Krissoff, B., N. Ballenger, J. Dunmore, and D. Gray. 1996. *Exploring Linkages Among Agriculture, Trade and the Environment: Issues for the Next Centry*. ERS/USDA, Agricultural Economic Report No. 738, Washington DC.

Lutz, E. 1990. Agricultural Trade Liberalization: Price Changes and Environmental Effects. *Environment Department Working Paper* No. 16, Washington, DC: World Bank.

McCalla, A.F. and T.E. Josling. 1985. *Agricultural Policies and World Markets*. Macmillan Publishing Co., NY.

OECD. 1996. *Agriculture, Trade and the Environment: Anticipating the Policy Challenges*. Paris.

OECD. 1994. *The Environmental Effects of Trade*. Paris.

Oh, S., E. Kim, and H. Park. 1995. *Evaluation of Non-market Value of Rice Farming*. Research Report R321. Korea Rural Economic Institute, Korea.

OTA. 1995. *Agriculture, Trade, and Environment: Achieving Complementary Policies*. OTA-ENV-617, US Congress, Office of Technology Assessment. Washington, DC.

Randall, Alan. *Resource Economics: An Economic Approach to Natural Resources and Environmental Policy*. Columbus. 1981. page 157.

Rauscher, M. 1992. "International Economic Integration and the Environment: The Case of Europe." In *The Greening of World Trade Issues*, K. Anderson and R. Blackhurst, eds. New York: Harvester Wheatsheaf.

Runge, C. Ford. 1994. The Environmental Effects of Trade in the Agricultural Sector. In *The Environmental Effects of Trade*, OECD. Paris. 1994.

WECD. 1987. *Our Common Future*. Oxford University Press. New York.

WTO. 1996. Report(1996) of the Committee on Trade and Environment. WT/CTE/1.