

**APEC TASK FORCE ON FOOD**

**CO-CHAIRS' 1997 PROGRESS REPORT**

**AND**

**REPORTS ON 1997 ANALYTICAL WORK**



**APEC Economic Committee**  
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## Foreword

Since its establishment by APEC Ministers in Jakarta, November 1994, the Economic Committee has undertaken a broad range of research and analysis in support of APEC's work both on trade and investment liberalization and facilitation and on economic and technical cooperation.

One of the most important tasks that have been assigned to the Committee is the APEC Economic Leaders' initiative on *The Impact of Expanding Population and Economic Growth on Food, Energy and the Environment* (FEEEP). At Osaka in 1995, Leaders agreed on the need to put this issue on APEC's long-term agenda and to consult further on ways to initiate joint action to ensure that the region's economic prosperity is sustainable.

To address the aspects of the FEEEP issue centered on food and the linkages between food and the other issue areas, the Task Force on Food (TFF) was established under the Economic Committee. The TFF, under the leadership of its co-chairs, Australia and Japan, developed a comprehensive analytical program to address this most complex of issues which was carried out with the strong support of many participating economies over the past two years.

While the main conclusions from this research and analysis have been summarized in the TFF reports through the Economic Committee to Senior Officials, Ministers and Leaders, the very substantial work that has been carried out will undoubtedly be of considerable interest to the research community and others interested in the analysis that underpinned the TFF's policy-oriented recommendations that will be conveyed to Economic Leaders this year and, more generally, on the issues related to the region's capacity to meet its food needs both quantitatively and qualitatively over the coming decades as population and incomes expand. This volume fulfills these purposes.

John M. Curtis

Chair  
APEC Economic Committee  
Ottawa, August 1998



## Preface

The Osaka Leaders' Declaration of 1995 noted that the Asia-Pacific region's population and rapid economic growth are forecast to increase sharply the demand for food and energy and the pressures on the environment. Leaders agreed on the need to put these inter-related, wide ranging issues on their long-term agenda and to consult further on ways to initiate joint actions so as to ensure the region's economic prosperity is sustainable.

Responding to the Osaka Declaration, the Task Force on Food (TFF), chaired jointly by Australia and Japan, was established in May 1996 to examine the impact of population and rapid economic growth on the demand and supply (production, trade flows and stocks) of food in the region, processing and distribution, as well as agriculture-related environmental issues, and to explore possible options for initiating joint actions to deal with regional food challenges that could arise in the future.

The terms of reference of the TFF were as follows:

### 1) Objectives

- Initially, to examine regional food issues in order to promote region-wide understanding within APEC of these issues, as highlighted by Leaders;
- Thereafter, explore possible options for initiating joint actions to deal with regional food challenges that could arise in the future;

### 2) Scope of Activity

- Undertake analysis of the impact of expanding population and economic growth on food supply and demand in the region (production, technology changes, trade flows, stocks, processing and distribution);
- Undertake analysis of food-related environmental issues;
- Exchange information, views and analysis relevant to the region;
- Conduct econometrics methods and specific case studies on key member economies including appropriate regional linkages and collect existing data;
- Draw as appropriate on regional expertise, including the work of other regional organisations and multilateral institutions and on private sector and academic research and analysis;
- On completion of necessary analytical work, explore possible options for initiating joint actions.

The initial analytical work of the TFF which was conducted in 1996 and 1997 was divided into four areas and advanced under a shepherd system. The Areas and lead shepherds were:

Area 1	(Food Supply and Demand)	Korea and Australia
Area 2	(Food Processing and Distribution)	Philippines, Indonesia, Canada
Area 3	(Correlation between Food and Environment)	Chinese Taipei and New Zealand
Area 4	(Future Trends)	Japan and United States

In October 1997 the Co-Chairs submitted a Progress Report to the Economic Committee. The Progress Report, together with the four Area Reports, are reproduced in this report.

The Co-chairs are to forward their Final Report to Leaders, incorporating their recommendations on possible options for joint action, at the end of 1998.



# CO-CHAIRS' PROGRESS REPORT FOR 1997

## I. INTRODUCTION

1. The Osaka Leaders' Declaration noted that the Asia-Pacific region's population and rapid economic growth are forecast to increase sharply the demand for food and energy and the pressures on the environment. Leaders agreed on the need to put these inter-related, wide ranging issues on their long-term agenda and to consult further on ways to initiate joint actions so as to ensure the region's economic prosperity is sustainable. Responding to the Osaka Declaration, the Task Force on Food (TFF) was created to examine the impact of population and rapid economic growth on the demand and supply (production, trade flows and stocks) of food in the region, processing and distribution, as well as agriculture-related environmental issues. The TFF is chaired jointly by Australia and Japan.

2. The TFF faces a particularly challenging task. The APEC member economies represent a wide range of economic and demographic characteristics. There are also wide variations in rates of economic growth, income levels and distribution within and among the member economies. Dietary patterns vary greatly. Many are experiencing profound changes in food consumption patterns as incomes rise. Their agricultural and food sectors also have divergent characteristics. Some economies are net food exporters and some are net food importers. Furthermore, issues of food production and consumption cannot be considered independently of global trends. Therefore, food issues will be analysed in a wide ranging and comprehensive manner, including by means of supply and demand projections.

3. The TFF has met six times to examine regional food issues in order to promote and deepen the analysis and understanding of issues surrounding food demand and supply in the region. The work of the TFF was divided into four areas and advanced under a "Shepherd System". The areas and lead shepherds were:

- Area 1: Supply and Demand (Australia, Republic of Korea)
- Area 2: Processing and Distribution (Canada, Indonesia, Philippines)
- Area 3: Correlation between Food and the Environment (NZ, Chinese Taipei)
- Area 4: Future Trends in Food Supply and Demand (Japan, US).

4. In assessing future trends in food supply and demand in the APEC region in the medium and longer term, both quantitative and qualitative procedures were used to develop a more comprehensive and complete view of the future opportunities and challenges facing APEC.

5. This report consists of the Co-Chairs' summary and synthesis of the work covering the above four areas. It was jointly drafted by the Co-Chairs, based on the reports of the co-shepherds. It has been discussed in draft at the St. John's TFF Meeting and finalised by the Co-Chairs in light of discussions at St. John's.

## II. OVERVIEW

6. Over the past thirty years, the APEC region has been distinguished by some of the most rapid economic growth in the world economy. It has been sustained for longer and affected more people than any such previous burst of economic activity in world history. While growth and its benefits and costs have been spread unevenly throughout the region, nowhere has been entirely untouched by this new prosperity. And nowhere have the changes been more pronounced than in the East Asia part of APEC.

7. Rapid economic growth, rising per capita real incomes and population change have had a big impact on APEC's agricultural sector. These have increased the demand for food in total, with marked differences in growth in demand within the food group and between members of the region. Economic growth, mainly in the form of rapid industrialisation, has also affected the region's capacity to meet changes in demand.

8. On one hand it has helped supply to expand through more manufactured inputs, better technology and more sophisticated methods for managing diseases and pests. It has also increased rapidly capital that could be available for investment in agriculture, but at the same time increased the competition for that capital from other sectors of the region's economies. In some members this has contributed to a decline in rural infrastructure, such as vital irrigation systems. Industrialisation and its associated urbanisation have encroached on farm land, and pollution and land degradation have further reduced the arable area of some economies. But in others, substantial areas of potential cropping land remains available to be brought into production. Even in member economies with low population densities, land degradation has been evident and a serious problem for some. At the same time, transport, storage, and processing infrastructure have been extended and developed through increased investment and technological change, but in some members not rapidly enough to keep up with changes in the geographical distribution of production and changes in where people live.

9. APEC's food outlook and challenges are also a major part of the world's and accordingly need to be considered in a global context. Trade has played an increasingly important role in helping the region meet its food requirements and will continue to do so. Increased trade flows will further change the geographical distribution of production. This can lead to more efficient patterns of resource allocation within the region. In turn, this can help to sustain high rates of economic growth and generate the income needed to raise nutritional levels.

10. With ever increasing trade in agricultural products and a shift away from supply management policies in key exporting economies, however, comes concern about the future stability of world food markets. Over time, the trend for food stocks to decline as well as for exports to come from fewer economies have, for some, more strongly focused these concerns. On the other hand, the long-term trend in world grain prices has been downward in real terms, more smoothly operating markets may be better able to adjust to unexpected short-term fluctuations in supply, and product mix is also likely to be more diversified thereby spreading the risks of supply variability.

11. While there is much debate about the relative importance and, especially, the policy implications of the many developments affecting agriculture in the region, some common points of reference have emerged.

12. Significantly, the region has not experienced a peace-time famine or critical food shortage in the past thirty years. It has, therefore, been able to meet the food challenges of one of the most extraordinary periods of rapid economic growth in world history.

13. When considering the future, however, the optimism that may be engendered by past experience needs to be tempered by consideration of a number of factors, including: increasing environmental pressures; the pivotal challenge of raising yields when the benefits of earlier massive investment in rural R&D seems to be levelling off; and the need to keep incomes rising for the region's poor so that their nutritional needs can be turned into effective demand. The inevitable pressures of structural adjustment on the rural sectors of the region, especially those that are associated with more traditional patterns of rural life, raises particular policy challenges for individual member economies to manage.

14. Meanwhile, population growth rates globally and in the APEC region are declining, reflecting higher incomes and lower fertility from changing age structures. And while malnutrition remains a problem in parts of the region, and beyond, the number of people estimated to be suffering from undernutrition continues to fall. Economic growth continues to create major challenges for meeting food demand at reasonable prices. However, the factors that promote economic growth are nevertheless a key part of the solution.

15. Whether the past successes in meeting the region's food challenges can be confidently projected into the future remains contentious. But the experience to date within APEC in meeting its food requirements and raising nutritional levels is noteworthy. It also provides something of an exemplar to other parts of the world where undernutrition remains a far more challenging issue than in the APEC region.

### **III. ANALYSIS**

#### ***i) Demand Issues***

16. Demand has risen greatly in the APEC region over the past thirty years driven by population growth and rising per capita incomes. Average food consumption levels have risen both globally and in APEC as world food production has increased more rapidly than population. Population growth rates globally and in most APEC members are now declining, easing some pressure from this source on demand for food.

17. On the demand side, the analysis has identified two important trends in the APEC region. Both of these are related mainly to rising real per capita incomes driven by high rates of economic growth. One is for the importance of cereals in diets to decline relative to other products in higher income economies. The other is for the demand for cereals to rise in some lower income economies.

18. From this, three important conclusions emerge. One is that rising per capita incomes affect the demand for both staples and non-staples. The second is that there are big differences in these effects across the region reflecting differences in average per capita incomes and size of population. The third is that there is a trend towards more diversified diets across the region as incomes rise over time, though the balance of specific elements in diets is likely to differ from society to society depending on factors such as culture and historical experience.

*ii) Supply Issues*

19. Supply consists of domestic production, stocks and imports. As a generally open region that trades widely with the rest of the world in all types of goods and services, APEC's sources of food imports must be thought of as global and not just confined to APEC members.

20. Food production has continued to rise globally and in APEC, but the rate of increase is declining. Imports of grain are expanding in the APEC region and other food imports are rising as well. Many APEC members also export a wide range of foodstuffs to each other and other parts of the world. But food imports are constituting an increasing proportion of food supplies in the face of rising demand and limited land. This is particularly the case for high income members of the region, such as Japan, Republic of Korea and Chinese Taipei and the rapidly growing South-East Asian economies. Food imports, however, continue to be a small proportion of total food supplies, but this could change over time.

21. The capacity for individual members of the region to expand domestic production is mixed and in some cases quite uncertain. Strong debate exists over the extent to which current technologies are being fully exploited; the capacity to push the technological frontier outwards and the time it would take for that to be achieved; and the impact of urbanisation, pollution and land degradation on the availability of arable land within the region.

22. A number of these constraints on expanding supply from domestic production apply very unevenly across the region and globally. Even the technological constraints are quite different in different parts of APEC and globally.

23. The issue of the capacity to raise yields in agriculture is particularly vexed. Two important issues need to be resolved. One is whether the region and indeed world agriculture is uniformly at world best-practice or, in other words, at the technological frontier. While many producers, including those in the region, may well be at the current technological forefront in some products, many if not most would not have reached that point.

Nevertheless, there is general agreement that the rate of growth in yields in a number of important product areas has generally levelled off, suggesting that gains from existing technology could be diminishing, or are about to diminish.

24. The second important issue is the capacity to generate renewed growth through new technologies. While some argue that with the current trend of declining investment in rural R&D there is little prospect of new major breakthroughs in a relevant time period, others point to the fact that the long-term trend to lower grain prices and other food prices in real terms has cut the incentives to invest in rural R&D. If prices were to rise, it is argued, incentives would increase and more would be invested in new R&D. Nevertheless, the speed at which new technologies could be developed is a relevant consideration even if incentives are increased.

25. Overall, environmental pressures, including land degradation, loss of land to urbanisation and pollution factors have the capacity to have an important influence on agriculture production in the region and beyond. The impact of agriculture itself on the environment has also been considered. Here it was found that the environmental effects of agriculture could be both either positive or negative depending on particular circumstances. In evaluating the effects of specific farming practices in particular locations, it is important the net effects are considered.

26. In recent years, world stocks of food have fallen. Debate exists over the meaning and implications of this fall in stocks. Stocks have been falling in the industrialised economies because of the gradual withdrawal of a range of often uneconomic support measures in those economies. The decline of stocks is seen by some as indicating a potential for some instability in world agricultural markets.

27. The issue of stability of world food markets has also been discussed against the background of the possibility that more food will need to be traded and more of the region's food requirements met by imports. Some are concerned if more of the world's food production is concentrated on fewer economies, this may increase the vulnerability of world supplies to climatic shocks and policy changes. Others have pointed out that to the extent to which this trend can in fact be verified, the areas in which food production may become concentrated are in any event very big continental economies, covering a wide range of climatic conditions in both hemispheres. Maintaining competition in the distribution sector, particularly avoiding the concentration of market power in the hands of a few entities, will be a key element in ensuring market stability over the long term.

#### **IV. OUTLOOK**

##### ***i) APEC Outlook***

28. Agricultural economists generally show a guarded optimism about the outlook for the global agriculture and food situation. Their projections, based on quantitative models, show that agricultural production will keep pace with population growth and the increase in demand generated by rising incomes. Food consumption per capita will increase slightly as agricultural production grows at a slightly faster rate than population. As a result, real agricultural prices will fall slightly over the next 10-20 years. Some studies have considered more severe environmental and other restrictions constraining production growth and indicate rising real prices.

29. APEC Asia continues to be the bright spot. Asian diets will continue to diversify, shifting proportionately from grains to meats, fruits, vegetables, and processed foods. Feed grain consumption is forecast to increase rapidly and grain consumption shifts to wheat-based food. With these changes in diet in Asia, agricultural imports rise. This also increases exports of APEC economies with a comparative advantage in agriculture and exportable surpluses.

30. APEC economies have begun to reduce trade barriers and increase their reliance on markets to efficiently allocate resources to meet the increasing demands for a larger variety of food products. Nevertheless, trade barriers remain relatively large in East Asia, particularly in the agriculture and processed food sectors. There are trade liberalization studies on the APEC region that show Asia as the biggest gainer and Asian trade expansion would exceed trade diversion. Asian incomes rise, particularly in China. Reducing domestic support of less-efficient, non-competitive domestic producers lowers the growing budget deficits in many APEC economies. These changes make food more affordable and increasingly available to consumers.

For economies with subsidized consumer food prices, subsidy elimination leads to higher food prices, but, at the same time, a less distorted and more efficient allocation of resources across all sectors. Re-allocating resources to more efficient, competitive industries increases societal incomes and overall economic welfare. Rising incomes allow consumers to purchase even more of the lower priced food (as well as other products), further reducing the remaining food needs deficit. Economies with large impediments to an open global market will face the big changes under liberalization, but will also reap large economic welfare gains.

*ii) Factors to be considered*

31. There are several issues of importance to be considered by policy makers which either arise from the above projection story or are not dealt with in the quantitative models surveyed.

32. Projections show a slow improvement in future food balances, but not all food needs are met. If the state of hunger is to be improved from a humanitarian standpoint, attention will have to be focused on how to fill the gap between food consumption and food need levels. Filling this gap will involve reducing poverty, improving food distribution systems, and increasing food production.

33. Poverty is a major cause of malnutrition and food shortage. Society needs to increase people's ability to translate food needs into effective demand. A key food policy question, therefore, becomes how to alleviate poverty as well as how to increase food production.

34. Although population growth is slowing, it remains an important issue when considering future food demand. Accordingly, in addition to measures to increase food production, governments and national and international organisations need to consider how public policy decisions affect population growth rates.

35. The capacity to expand food production in APEC will vary greatly across the region, but will be constrained in some parts by limited supply of arable land and increased competing demand for land for other uses. Agriculture will be facing stiff competition for land and water resources from industrial and residential uses, further raising agricultural production costs. On the other hand, scope exists in different parts of the region to use available land and water resources more efficiently. The increased negative impact of environmental problems, such as soil degradation and desertification, will also constrain growth in production.

36. The world has not reached biological or physical limits to food production, but the production growth rate has been declining. The growth of grain yields, which has been a major factor in production growth, is also declining, reflecting factors relating to technology, investment, environment and production incentives. Scope also exists to expand the world's arable area in North America, Oceania and elsewhere which helps to ease pressure to raise yields. But with little or no scope to expand arable area in many APEC economies, especially in Asia APEC, tapping the full potential of existing technologies and creating new production technologies will also be a critical factor if output growth is to be sustained in those places. Moreover, there can be a long time lag before investments in technological innovations and in development of land, water and irrigation resources begin to show results. If investment in agricultural research, health, nutrition, education, and extension continues to be reduced, it would adversely affect the future world food situation. Such investment must either come through the public sector, or the public sector must ensure an environment conducive to private investment.

37. The food sector is particularly hard-hit by trade and marketing inefficiencies because many food products are highly perishable. Delays in moving products from producers to consumers not only add to storage costs but lead to spoilage and waste which further increase consumer costs and reduce producer incentives. Distances between consumers and producers are widening due to urbanisation and trade expansion, thereby enhancing the requirement for more efficient systems for food distribution. This in turn calls for higher infrastructure investments in the region, not only to create new facilities but also to rehabilitate the existing infrastructure system in transportation, communication, warehousing, forwarding services and other marketing related services.

38. As the world moves to a more open, global market economy, grain production is expected to shift to more efficient producers who increasingly produce for export. Several of these economies have recently taken steps to cut costs by reducing extremely high stock levels. If production becomes increasingly concentrated in a smaller number of economies, and if future grain stocks remain low, as expected, there could be some concern about the extent to which grain prices might fluctuate.

39. Agriculture has several characteristics in addition to agricultural production. Such external economies and diseconomies in agriculture can lead to desired production, consumption, and trade levels different from levels determined by the market mechanism alone. When externalities generate a desired solution different from a supply-demand market equilibrium, the public sector is frequently expected to play an important role in

assigning costs and allocating benefits. These externalities may reach beyond national borders, and can entail trade-offs between neighbouring economies or trading partners.

40. Population and food production pressures are increasing the strains on the global environment. Individuals, national governments, and national and international organisations need to devise methods to reduce negative environmental impacts on the planet without unduly reducing production or increasing food insecurity. Methods also need to be devised to promote and enhance positive agricultural impacts on the environment. There is also a possibility that, over the very long term, global environmental problems, such as green house effects, will have some impacts on food production. These effects could be positive or negative.

41. For many APEC economies, the structural adjustments in rural communities that accompany economic growth and trade liberalisation involve resource movements out of agriculture. These movements have the potential to disrupt traditional societal norms and create welfare gains and losses for different sectors of the economy. These social and economic opportunity costs must be dealt with through the political process as economic growth continues and as APEC economies become more closely linked in the marketplace. Only when these costs, including all externalities, are incorporated, can the full costs of change in an economy be accurately compared with the benefits received from that change.

30 AUGUST, 1997



# **Report on Area 1**

## **Food Supply and Demand**

### **Republic of Korea and Australia**

## **SUMMARY REPORT**

Australia and the Republic of Korea have prepared a draft report on 'Food Supply and Demand' for submission to the APEC Food Task Force. There is agreement on most of the demand component of the report, while there is much less agreement on the remaining sections. In particular significant differences remain in the approach to the food supply and trade components of the report and in the discussion of factors underlying observed trends. Because of these differences, two separate sets of approaches have been presented for supply, stocks and trade. One is a 'main commodities approach' under which production of key foods is examined and observations about trade in food in aggregate are supplemented by examples for major commodities. The other is an 'aggregated food approach'.

### **AREAS OF AGREEMENT**

- Population growth rates globally and in most countries are declining, with reductions related to increasing incomes and changing age structures which are reducing fertility rates and the number of children per family.
- Although the number of people estimated to be suffering from undernutrition has declined, considerable parts of world population are still malnourished.
- Imports of grains are expanding in the APEC region, but they have been static on a global basis since the early 1980s.
- Food production is rising over time, but the rate of increase is declining, both globally and for the APEC region.
- With rapid economic growth and limited agricultural resources in some APEC members, imports are constituting an increasing proportion of food supplies. This is particularly the case for South East Asian economies, Japan, the Republic of Korea and Chinese Taipei.
- With the rapid increases in agricultural production, environmental problems are being experienced. These are likely to affect the rate of growth in food production

### **AREAS OF DISAGREEMENT**

- Under the 'aggregated food approach', it is indicated that important changes are occurring in the composition of diets in APEC members along with increasing incomes. These include a reduction in the relative importance of starchy staples which as a group includes grains and roots and tubers, and increasing demand for meats, dairy products, vegetables, fruits and vegetable oils. Nevertheless, it is

acknowledged that demand for cereals has still been increasing in many Asian member economies.

- Under the ‘main commodities approach’, the emphasis is on grains and, to a lesser extent meat and other food. This is due largely to the importance of grain in total food consumption and as an input into livestock production as a result of a survey of APEC economies. Considering the problems of calculating a food production index, this has been supplemented by analysing production of individual items including dairy products, vegetable oils and sugar as well as grains and meat. It is concluded that production, not only of grains but also of meat, dairy products, vegetable oil and sugar showed diminishing growth rates. In contrast, under the ‘aggregated food approach’, the emphasis is on food as a whole. The fact that the rate of increase in production is declining is acknowledged in both approaches but differing reasons are advanced. Under the ‘main commodities approach’, food production is approaching technological limits. The ‘aggregated food approach’ emphasises the influence on production of changes in demand as well as technological factors.
- The ‘main commodities approach’ emphasises the principle that yields and production are approaching maximum levels, evidence for which is the declining rate of increase in grain production and yields. Under the ‘aggregated food approach’, the lower rate of growth in grain yields in recent years is attributed to the lack of incentives to produce and for investment in research and development because of low market prices to producers as well as to technological factors.
- The ‘main commodities approach’ on production emphasises the limited or declining land and water resources due to urban expansion, industrialisation and land degradation. Nevertheless, the data provided indicates that 10 per cent of the increase in world grain production since the early 1970s arose from an increase in areas. In the ‘aggregated food approach’, it is indicated that although urbanisation and industrialisation may be encroaching into prime agricultural land in some countries, there are areas of arable land that are currently not cropped in some major agricultural regions, primarily in North and South America, Southern Africa and Oceania. There are also areas in the Former Soviet Union and Eastern Europe which have been withdrawn from production in recent years that could return to cropping.
- Under the ‘main commodities approach’, it is emphasised that only a small proportion of total supplies is traded for most agricultural commodities. The fact that the reason that the quantity traded is small relative to production is attributed to the characteristics of world agricultural production that food has historically and traditionally been produced for self-sufficiency rather than for exports. Also, agricultural markets have usually been unstable since agricultural production as well as trade is strongly affected by natural conditions such as temperatures, rainfall etc. The ‘aggregated food approach’ emphasises that a major reason why trade is small relative to production is the highly protective policies of many importing countries. Those policies force much of the adjustment of agricultural supplies and demand into the relatively small traded sector, thereby making it less stable than if there were fewer barriers to trade and policies were less protective.

- In the ‘main commodities approach’, the conclusion is drawn that the APEC region is now a major net importer of food and that there is a trend towards increasing net imports. This conclusion is based on the fact that agricultural exports of 5 agricultural exporting member economies are much smaller than imports of the other 13 member economies, and also that the gap has been widening. In the ‘aggregated food approach’, FAO data are used to indicate that APEC food imports and exports are in close balance.
- Under the ‘main commodities approach’, trade liberalisation is a major reason for increasing dependence on food imports and as a result, the domestic agriculture of many countries has been adversely affected. Under the ‘aggregated food approach’, the fundamental reasons for increasing food imports by some APEC members are the increase in incomes and population, combined with limited domestic agricultural resources. The degree to which trade has so far been liberalised would have helped to advance the economic well being of the food importing economies.

## KEY CONCLUSIONS

### *Aggregated food perspective*

- World and APEC food production have increased more rapidly than population over the period since 1970 and average consumption levels have risen.
- World market prices at the farm level have trended downward in real terms indicating that growth in demand that farmers face for their products has been insufficient to keep pace with supplies. The incidence of malnutrition is declining in absolute numbers and as a proportion of total population – from 950 million in 1970, or 26 per cent of world population, to 800 million or 14 per cent of world population in the mid 1990s. Nevertheless many people still suffer from malnutrition, especially in Africa and South Asia, primarily as a consequence of poverty and inadequate infrastructure.
- Important changes are occurring in the composition of diets in APEC members along with increasing incomes. These include a reduction in the relative, and in some instances absolute, importance of starchy staples including grains, increasing demand for meats and dairy products and rising demand for other food crops including vegetables, fruits and vegetable oils.
- Imports of grains are expanding in the APEC region, but they have been static on a global basis since the early 1980s.
- There is wide diversity between APEC economies in the extent to which imports have been contributing to growth in food supplies. Imports are becoming proportionately more important in most Asian economies reflecting increasing demand as incomes and population rise and the allocation of an increasing share of resources in these economies to industrial products.

- The situation of stocks in attaining food security globally and in APEC is changing with declining stocks in industrialised countries. Reductions in stocks in those countries have resulted largely from the gradual withdrawal from economically costly, and often ineffective policies that use stock accumulation as a means of supporting domestic producer prices.
- There is substantial scope for increased production, even at the present state of technology. Nevertheless urbanisation and environmental degradation are limiting rates of growth in some APEC economies. Improved technologies are continuing to be developed and significant areas of arable land remain uncultivated, primarily in North America and Oceania.
- Lower population growth rates are creating demand conditions which are being reflected in lower growth rates in supplies over time.

### ***Main Commodities Perspective***

- Although the number of people estimated to be suffering from undernutrition has declined, more than 800 million people or 20 per cent of population in the developing countries are still malnourished.
- Consumption of staple food is generally rising in low income countries and in many Asian member economies.
- Per capita calorie intake has grown at an increasing rate in developing countries while it has decreased in developed countries.
- There are limits to increases in agricultural production because of competition for land and water resources from non-agricultural pursuits, technical limits to yield growth and unsustainable production technologies.
- Per capita production of the world and the APEC region for most foods including grain, dairy products and sugar have already arrived at or are asymptotically approaching their maximum points, showing S-shaped curves.
- There exist inverse relationships between stocks and prices of grains. Prices of grain rise when the level of stocks declines, and vice versa.
- The fundamental problem of food markets is the instability of the market which implies severe fluctuations in food prices. Food supply is unstable due to the facts that trade proportions of food production are so low and that food exporters are geographically concentrated in some specific regions and their shares in world food exports are increasing. In conclusion, food market instability is resulted from supply-side rather than demand-side since food productions are vulnerable to excessive changes while food consumption is relatively stable.

# **FOOD SUPPLY AND DEMAND IN THE APEC REGION**

## **1. INTRODUCTION**

The objectives of this paper are to derive some lessons from past experiences of food supply and demand and indicate the major changes which have been occurring in the balance between supplies and demand for food globally and in the APEC region and to provide an appraisal of the main factors that are contributing to those changes. The period examined is mostly that since the early 1970s, but in some instances longer periods are considered to illustrate particular issues.

The appraisal mainly takes account of social and economic factors, industry and trade policies. Prominent among the social and economic factors considered are income and population growth, income distribution, urbanisation, technological progress, changes in agricultural production and consumption, changes in trade and trade policy, the importance of food stocks and links between all of these variables and international prices.

This paper has been prepared jointly by co-shepherds for Area 1 of the APEC Task Force on Food, the Republic of Korea and Australia. Concerning demand factors, there is general agreement between the co-shepherds about the changes that have been occurring. However, on issues concerning the significance of developments in supply, trade and stocks, the co-shepherds have differing perspectives. Because of this, two approaches are presented. One is a 'main commodities approach' under which production of key foods is examined and observations about trade in food in aggregate are supplemented by examples for major commodities. The other is an 'aggregated food approach'.

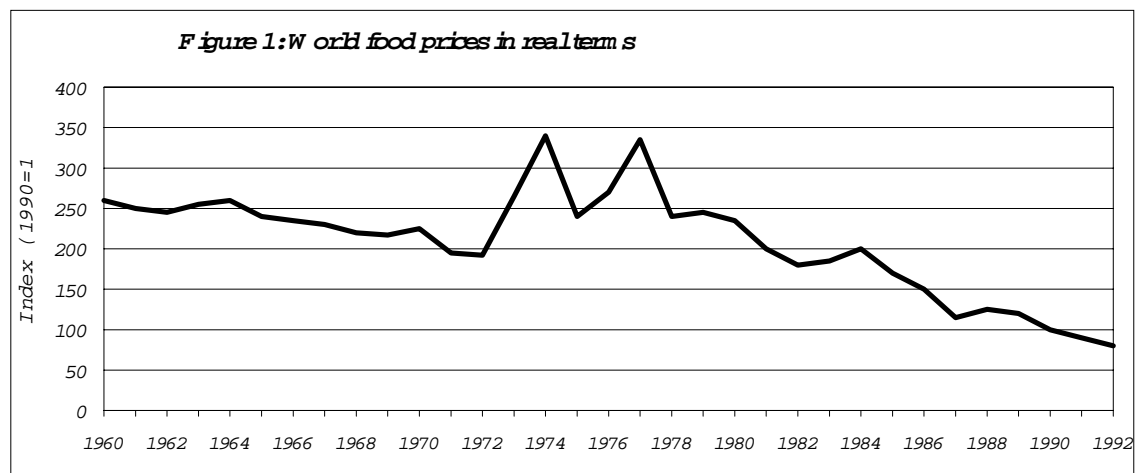
## **2. FOOD DEMAND GLOBALLY AND IN THE APEC REGION**

Levels of effective demand for food change as population, incomes per person, the distribution of incomes in societies and tastes change. Effective food demand refers to the amount of food that consumers are able to purchase given their incomes, the prevailing prices of food and prices and availability of other products. The concept of effective demand has been used extensively in the analysis of food issues because of its role in the determination of market prices for food, an important factor in producers' decisions on how much food to produce.

The main trends in factors influencing effective demand for food in APEC members have been increasing population, though at a declining rate, increasing incomes per person and changes in tastes related to increased incomes. The growth in demand has been particularly marked in the rapidly industrialising Asian countries which have had both rapidly rising incomes and, in many instances, higher rates of population growth than the APEC or world averages. The extent to which increasing incomes are being distributed throughout societies varies but where income growth has been rapid, it is being

accompanied in most instances by an expanding middle class that is demanding not only increasing quantities of food but also greater variety. There is also a tendency for people to demand increasing quantities of processed and packaged foods as their incomes rise.

These changes increase levels of effective demand for food in total and for a wider variety of foods (Mitchell, Ingco and Duncan 1997). As a result, average calorie intake per person increased (See Table 1), but at the same time, world market prices at the farm level showed a declining trend in real terms (See Figure 1).



Source: Mitchell and Ingco (1993).

The data in Table 1 are expressed in terms of calories per person per day. This is a measure of energy intake which is not fully indicative of total nutritional value of food intake. Nevertheless, it is a very useful indicator of the adequacy of diets in various areas. Generally, countries which have high average levels of calorie intake per person have relatively high incomes and more varied diets than countries with lower average calorie intake per person. In most instances, countries with relatively low calorie intake per person have diets that are highly concentrated in starchy staples which are high in energy but are often deficient in protein, minerals and other nutrients. Consequently, countries where there are higher levels of calorie intake per person generally have higher levels of nutrition than countries with lower levels of calorie intake.

**Table 1: Average Food Consumption Per Person: World, Developing Countries, Developed Countries and Individual APEC Members**

Country or region	1961-63 calories per day	1969-71 calories per day	1979-81 calories per day	1988-90 calories per day	1992 calories per day
World	2288	2434	2579	2697	2719
Developing countries	1945	2122	2327	2474	2542
Developed countries	3032	3195	3287	3404	3304
<i>APEC members</i>					
Australia	3141	3260	3088	3302	3073
Canada	2923	3084	3107	3242	3020
China	1659	1989	2325	2642	2814
Chile	2532	2633	2645	2484	2707
Indonesia	1816	2020	2464	2605	2607
Japan	2514	2693	2764	2921	2883
Republic of Korea	1957	2470	2747	2826	3256
Malaysia	2375	2482	2685	2671	2769
Mexico	2490	2626	3001	3061	3042
New Zealand	3316	3409	3480	3462	3384
Philippines	1722	1738	2201	2343	2335
Thailand	2029	2196	2292	2280	2326
United States	3069	3250	3353	3642	3562

Source: Alexandratos (1995); FAO (1997a).

The dominant trends in APEC economies, and also in most other parts of the world, have been towards increasing effective demand and rising average consumption of food per person. However, there remains much concern about the adequacy of supplies to meet the requirements of many people in places where food supplies are inadequate. Those places are mainly in Africa, parts of South Asia and parts of Latin America. On a world scale, it is estimated that approximately 800 million people, or some 14 per cent of total world population are currently malnourished (Alexandratos 1995). This clearly represents a major challenge for the future. Nevertheless, substantial progress is being made in alleviating this problem. The number of people estimated to be malnourished has declined from 950 million, or 26 per cent of world population 20 years ago (IFPRI 1995).

There has been a focus by some on the concept of food requirements which refers to the amount of food that is necessary to maintain a healthy life (APEC 1997). With this approach, whether the consumer can afford to purchase the necessary amount of food is not the relevant criterion. As a result it does not have any reference to an individual's income or prevailing prices. It is a normative rather than a market based approach.



Whether effective demand or food requirements is the most relevant concept to apply depends on the purpose for which these concepts are to be used. If the objective is to assess the forces that actually affect the demand and supply balances for food, effective demand is the more relevant concept. If some notional idea of what might be required to meet nutritional norms for all people is sought, food requirements might be appropriate. However, even if the norms were met in terms of actual production, it would not mean that all people would be adequately nourished.

The fundamental problem of supplying people with sufficient food has not been the inadequacy of total availability or production of food. It is a problem of poverty which prevents poor people from being able to access food supplies. It is also a problem of the adequacy or otherwise of infrastructure to ensure that supplies can be delivered to inaccessible populations (FAO 1996).

The actual situation in many countries is that food abundance and undernourishment co-exist, as the income distribution within countries results in groups of people who are undernourished because they do not have the means to access the available food. As incomes rise, consumers' purchases generally will rise to satisfy their food requirements, and provided the increases are reflected in higher incomes of poorer groups, the incidence of undernourishment will decline. Given that most of the growth in global incomes is taking place in the APEC region, it is likely that the effective food demand the effective demand for food for a significant number of the poorer consumers in the region would increase to satisfy their nutritional requirements.

### ***The effects of income on food demand***

Three major effects of income on food demand are discussed in this section. The first is on the amount of food that consumers would purchase as their incomes change. The second impact is on the types and quality of food demanded and the third is on the demand for services associated with food.

As consumers' incomes increase, the effective demand for food rises and, provided additional volumes are available, purchases also rise. This relationship between income growth and food demand has been observed in many countries including China, Indonesia and Thailand (Timmer, Falcon and Pearson 1983; Mitchell and Ingco 1993). When incomes increase rapidly from low levels, increases in consumption of food are typically rapid. However, there are limits to food consumption per person which result in the rate of increase declining as income and consumption levels rise. Consequently, in countries which still have relatively low incomes but which also have rapidly increasing incomes, such as Indonesia, food consumption levels are increasing rapidly. In contrast, for countries like Australia where consumption levels are already high and incomes are increasing more slowly, total food consumption per person is relatively static (See Table 1).

The relationship between income growth and food consumption differs at different stages of development. In countries where incomes are initially low and food consumption is mainly of starchy staples such as cereals and root crops, the increases in

income which accompany rapid industrialisation can initially result in increased consumption of these commodities. As incomes increase further, substitution may take place between favoured forms of these staples, and less favoured forms. For example, consumers may initially substitute rice for tubers and later substitute wheat for rice. As incomes increase still further, diets are increasingly diversified to include more animal products such as meat and dairy products and more fruit and vegetables, while consumption levels of starchy staples decline. This does not necessarily mean that demand for cereals in total will decline as the increase in demand for livestock products results in increased demand for feed grains.

In many APEC members, the demand increasing effect of income growth has been a very important source of the observed increases in food consumption and changes in the composition of diets over the past three decades (See Table 2). For example, the high rates of increase in cereal consumption in Indonesia and Republic of Korea between the early 1960s and the late 1980s reflect the high rates of growth in incomes for those countries. Also, in Indonesia, the substitution of cereals for tubers is apparent, while there were rapid increases in consumption of animal products and vegetables in all of the rapidly expanding economies examined. A study of structural changes in food demand in Taiwan by Huang and Bouis (1996) found that food demand increased by over 60 per cent between 1981 and 1991 due to income growth. Since a number of developing economies in the APEC region are growing at rates similar to that which has been experienced in Taiwan, it can be expected that a high level of growth in food demand in the APEC region would be generated by income growth. However, if the expected increase in incomes is not evenly distributed throughout the communities in these countries, the effects of income growth on consumption levels of various foods and on nutrition would differ from those if income growth were more evenly distributed. If lower income people do not share in the growth to a marked degree, their diets would tend to remain concentrated on starchy staples. Consumption of the items which are associated with higher incomes, notably meats, dairy products, fruits and vegetables, would be likely to remain low for those groups. For the countries as a whole, however, consumption of these higher priced foods would rise, especially if the income growth is reflected in a sizeable, expanding and increasingly affluent middle class.

For developed countries, only limited growth in aggregate food demand can be attributed to income growth, as most consumers have already attained high levels of food intake. However, further income growth in these countries is likely have a pronounced effect on the type, quality and degree of processing and packaging of food being demanded.

**Table 2: GDP and Food Consumption Per Head for Selected APEC Members a**

Country	GDP/head 1989 US\$	b Average growth in In GDP/head		Cereals		Tubers	
		1961–65 to 1985–89 %	1961–65 kg	1985–89 kg	1961–65 kg	1985–89 kg	
Japan	13 698	5.00	142.5	107.4	38.7	27.0	
Malaysia	4 671	4.15	147.5	118.5	11.4	20.7	
Thailand	3 245	4.15	145.0	135.0	12.4	5.5	
China	1 352	4.08	86.4	119.6	97.5	60.3	
Indonesia	1 826	4.43	78.8	151.6	100.2	49.0	
R. Korea	6 090	6.86	116.8	142.8	51.0	12.2	
Philippines	1 734	1.21	99.3	117.9	41.8	40.4	
Chile	4 355	0.76	141.8	136.0	59.4	43.7	
Mexico	5 566	1.35	32.8	45.8	10.9	11.1	

Country	Meat		Dairy Products		Vegetables	
	1961–65 kg	1985–89 kg	1961–65 kg	1985–89 kg	1961–65 kg	1985–89 kg
Japan	9.0	33.8	17.7	41.6	4.4	11.7
Malaysia	14.3	33.2	11.3	12.4	8.1	17.6
Thailand	14.0	19.8	2.2	2.7	1.2	3.8
China	6.4	21.8	2.0	3.6	1.4	4.4
Indonesia	4.2	6.6	2.1	2.8	2.1	4.7
R. Korea	4.6	19.0	3.2	10.3	0.4	7.2
Philippines	14.4	16.3	3.3	2.6	2.9	4.8
Chile	30.7	33.9	49.0	46.9	2.1	8.7
Mexico	26.8	42.6	35.7	55.9	6.2	12.4

Countries shown in this table are the only countries within APEC which were covered in the study by Mitchell, Ingco and Duncan. b In constant 1985 values.  
Sources: NBER (1997); Mitchell, Ingco and Duncan (1997).

Examples of the above mentioned developments in the extent and nature of increases in demand for food as incomes increase in economies at various stages of economic development are provided in a number of studies. Per person consumption of traditional staples, such as rice, in many rapidly developing Asian countries, including China, has been declining along with increasing incomes, while the demand for high valued and highly processed food has been increasing (Timmer, Falcon and Pearson 1983; Ito, Peterson and Grant 1989; Bouis 1991; Mitchell and Ingco 1993). A report by the International Food Policy Research Institute (IFPRI 1995) notes that much of the growth in international demand for livestock products is taking place in China as a result of rising consumer incomes.

In the Republic of Korea, where average incomes are now relatively high and continue to increase, demand has been rising for grain fed beef relative to grass fed beef – tastes are changing towards a high cost, heavily promoted product from a lower cost product (Doyle, Bui-lan, Rodriguez, Benard and Whish-Wilson 1995). The change in orientation of demand towards higher quality, better presented and more convenient products has been apparent in the more developed countries of the APEC region such as the United States, throughout the period examined (Senauer, Asp and Kinsey 1991).

As many economies in the APEC region are experiencing rapid income growth and that growth is expected to continue, demand for starchy staple foods is expected to remain relatively static or decline while, in the long term, most of the growth in food demand will occur in meat, dairy products, seafood and fruits and vegetables. Increasingly, the emphasis is expected to be on higher valued, more value added or processed products.

An important consideration about income growth and food consumption levels is that growth in demand for food slows as incomes approach high levels—there are limits to the quantities of food which individual consumers demand. These developments are evident in the European Union where consumption levels for most major food groups are now relatively static (European Commission 1996). Many APEC members, particularly low income members, are experiencing rapid increases in aggregate demand for food as their incomes are increasing rapidly and they are not yet approaching such limits. However, with continuing rapid increases in income and consumption levels, the rates of increase can be expected to decline. At this point in time, more than three-fourths of total population in APEC member economies still live in low income countries in which demands for food are rapidly increasing.

### ***The effects of population growth on food demand***

Population growth has been identified as the most important factor in determining the growth in food demand (Mitchell and Ingco 1993; Mitchell, Ingco and Duncan 1997). This is because population growth generally has a proportionate effect on food demand while the effects of other factors like prices and incomes are generally less than proportionate. For instance, a doubling of population can be expected to increase food demand twofold, all other things held constant. The same can not be said about the other factors. Thus, in developed countries where food demand per person has not increased significantly, growth in food consumption has been primarily due to population growth (Mitchell and Ingco 1993). The strong growth in food consumption which has been observed in the APEC region is also partly due to population growth.

Given the role of population in food demand, it is important to understand how demographic characteristics have changed in the past and how they are expected to change in the future (Mitchell and Ingco 1993; Duncan 1997; Mitchell, Ingco and Duncan 1997). The reason is that while economic events generally occur quickly, changes in population take time and their effects usually last for many years.

This observation is particularly relevant in the APEC region, where the populations of many countries, particularly those developing rapidly, have been undergoing some

important transformations which have influenced food consumption in the recent past and most likely into the future.

On average the APEC rates of population growth have been below the world averages and the rates have declined more rapidly in the APEC members than rates for the world as a whole (See Table 3). Nevertheless, there are some APEC members with rates that exceed the world average, notably Malaysia and Mexico. It is notable that, on average, population growth rates in APEC members have been declining more rapidly than those for the world as a whole since the early 1960s. For Japan, the rates are now extremely low. It is expected that the decline in population growth in the APEC region will continue, with the United Nations (1991) projecting that the average annual growth in population in the APEC region will be below 1 per cent by 2025. One reason why the slow down in the rate of population growth in the APEC region is expected to continue is the effect of income growth on fertility rates.

According to Duncan (1997) an inverse relationship exists between income growth and fertility rates. He argues that as incomes rise, the desire for parents to raise more children to look after them in old age declines as other means of taking care of their needs in old age become available and affordable. Furthermore, the high cost of raising more children becomes a disincentive for parents.

The consequences of this change in family behaviour as incomes rise are declining fertility rates which lead to lower rates of population growth. In addition, the higher education levels and increased availability of information and means of birth control as incomes rise provide greater ability to plan and limit family sizes. As well as these factors, advances in medicine are resulting in increased life expectancy in developed countries well beyond child bearing ages. This is resulting in declining fertility rates while at the same time may raise population growth rates thereby partly slowing the rate of population decline. Fertility rates take time to adjust but Duncan maintains that countries with faster rates of income growth are able to adjust faster to the changing situation. He claims that former developing countries which have had high income growth per person in recent years, as is the case for a number of APEC members like the Republic of Korea and Singapore, have been through the demographic transition and now have lower population growth rates. He concludes that this phenomenon, though not fully appreciated by many, will become very important in the determination of food demand in the future. The more rapid reduction in population growth rates in the APEC region than for the world as a whole is consistent with the principle that population growth rates decline as incomes increase — APEC has experienced more rapid income growth than the rest of the world since the early 1960s.

**Table 3: Population and Population Growth Rates: World and Selected APEC Members**

Country or Region	Population in 1995 million	Average annual growth		
		1970–1980 %	1980–1990 %	1990–1995 %
World	5 687	1.83	1.73	1.46
APEC Members				
Australia	17.9	1.63	1.46	1.15
Canada	29.5	1.20	1.00	1.17
China	1220.2	1.83	1.46	1.12
Chile	14.2	1.56	1.74	1.61
Indonesia	197.5	2.35	1.85	1.57
Japan	125.0	1.14	0.55	0.28
Republic of Korea	44.9	1.79	1.20	0.96
Malaysia	20.1	2.39	2.58	2.09
Mexico	91.1	2.41	2.00	2.09
New Zealand	3.6	1.00	0.77	0.85
Philippines	67.6	2.57	2.44	2.15
Thailand	58.2	2.72	1.89	1.13
United States	267.1	1.06	0.95	1.06

Sources: FAO (1997a); NBER (1997).

### **3A: THE MAIN COMMODITIES APPROACH ON PRODUCTION, STOCKS AND TRADE**

#### ***World food production***

World food production has steadily increased since the early 1960s. During the 1970-1995 period, world grain production increased from 1,079 million tonnes to 1,684 million tonnes, and increase of 56 per cent. Meat production also more than doubled from 67 million tonnes to 152 million tonnes. Dairy products represented by fluid milk increased from 335 million tonnes to 444 million tonnes in 1990 but decreased to 385 million tonnes in 1996.

Peanuts also increased by 38 per cent during 1975-1995 and sugar by 49 per cent during 1975-1996 respectively (See Table 4 and Figure 2).

World grain production is determined by the area cultivated and yield. Therefore, the growth rate of total grain production can be estimated as the sum of the rate of change for yield and that of the area cultivated. We have estimated that 90 per cent of the growth in world grain production can be attributed to an increase in yield, while only 10 per cent is due to the expansion of area under cultivation. In fact, the area under cultivation for

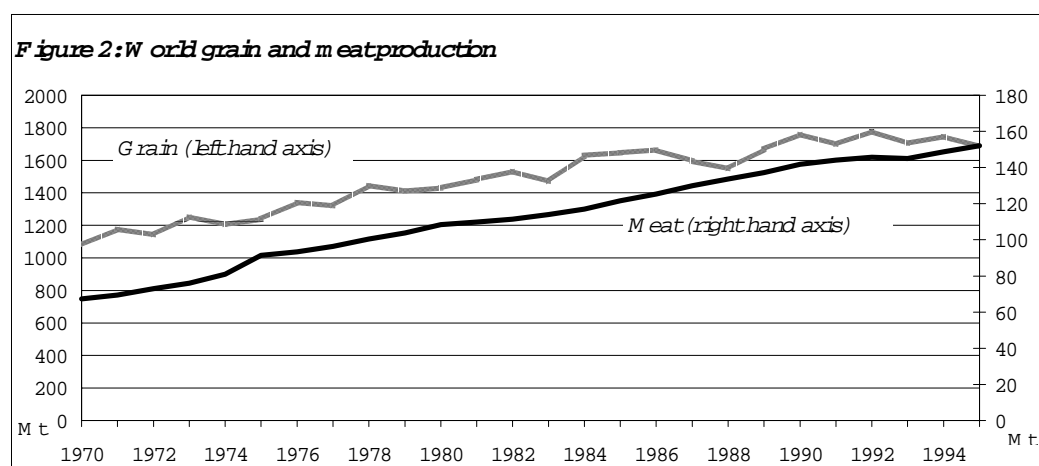
grain in 1995 was not significantly different from the area in 1970. It has actually decreased since 1981. Nevertheless, yields have increased because of technological innovation that have offset the decline in cultivated area.

**Table 4: World Food Production**

Year	Grain kt	Meat kt	Milk kt	Peanuts kt	Sugar kt
1970	1078774	67318	335782	–	–
1975	1236819	91349	360841	18701	78854
1980	1429277	108459	390382	16271	84442
1985	1645717	121627	429524	20022	100078
1990	1759578	141752	444299	22123	109245
1996	1684294 <b>a</b>	152049 <b>a</b>	385120	25936 <b>a</b>	117156

**a Values in 1995**

Source: US Department of Agriculture (1997).



Source: US Department of Agriculture (1997b).

Technological progress in agriculture, however, usually requires considerably more inputs such as fertiliser, pesticides and new high-yield varieties, as well as hightech equipment compared to traditional agriculture. There is a general consensus that agricultural production technology has its limits. Moreover, agricultural technologies that require excessive inputs are unsustainable since they have harmful effects on the ecological system. At a minimum, these technologies increase acidity levels in the soil and eventually exhaust soil productivity.

As a result, the rate of growth in yield, which is an indicator of advances in agricultural productivity, has shown a downward trend for most products. The average annual growth rate of the yield for grain was 1.9 per cent in the 1970s and 2.3 per cent in

the 1980s, but it has fallen to 0.2 per cent in the 1990s. Accordingly, world grain production increased at diminishing rates and in some cases it has declined. That is, the average annual growth rate dropped from 2.8 per cent in the 1970s to 1.6 per cent in the 1980s, and then to -0.5 per cent in the 1990s. World meat production also increased at diminishing rates of 5.1 per cent in the 1970s, 2.8 per cent in the 1980s and 1.3 per cent in the 1990s. Production reduced not only in its growth rate but in its production level in the 1990s. The growth rate of sugar also decreased from 2.1 per cent to 1.4 and 0.8 per cent but that of peanuts rather increased from 1.0 per cent to 3.0 and 3.9 per cent during the same period (See Table 5).

**Table 5: Trend of Growth Rates in Production and Yield**

Period	Grains %	Grain Yield %	Meat %	Milk %	Peanuts %	Sugar %
1970s	2.8	1.9	5.1	1.6	1.0	2.1
1980s	1.6	2.3	2.8	1.4	3.0	1.4
1990s	-0.5	0.2	1.3	-2.7	3.9	0.8

Source: US Department of Agriculture (1997).

While the production of some commodities such as wheat, corn, soybean, rice, beef and pork have rapidly increased for several decades, the production levels of other foods have inevitably decreased both in quantities produced and in area cultivated. For example, the production of oats, sorghum and millet has decreased with competition for land use contributing to reduced production.

World per capita grain production has almost been constant at 291 kilograms in 1970 and 296 kilograms in 1995. Average growth rate of per capita grain production, however, decreased from 0.95 per cent in the 1970s to -0.16 per cent in the 1980s and then to -1.97 per cent in the 1990s. That means the growth rate of world grain production has been higher than that of world population until the 1970s, but since then the trend has reversed. Per capita world meat production increased from 18 kilograms in 1970 at a growth rate of 3.2 per cent in the 1970s, but the growth rate dropped to 1.1 per cent in the 1980s and then to -0.2 per cent in the 1990s since per capita production has been constant at around 27 kilograms in the 1990s.

Per capita production of other commodities also showed similar trends to those of grains and meat: per capita production of milk has decreased from 91 kilograms in 1970 to 67 kilograms in 1995. Though the growth rate of per capita peanut production has increased from -0.8 per cent in the 1970s to 2.5 per cent in the 1990s, that of sugar showed a rapid decrease from 0.4 per cent to -0.7 per cent during the same period, showing relatively stable per capita production since the 1970s. However, per capita production of rapeseed has steadily increased from 1.9 kilograms to 6.2 kilograms, while that of cotton oil has decreased from 0.73 kilograms in 1970 to 0.68 kilograms in 1995.



Brown et al. (1994) asserted that the growth in grain production has slowed abruptly, rising at scarcely 1 per cent annually from 1984 to 1993. As a result, per capita grain production fell 12 per cent during this period. They found the declining trend of crop response to fertiliser use from 9.1 during 1950–1984 to 1.8 during 1984–1989. The world grain yield per hectare rose 2.3 per cent a year from 1950 to 1984, but from 1984 to 1993, yield rose only 1 per cent annually. This slowdown is a worldwide phenomenon. For example, the USA's yield gain per decade, which totalled 43 per cent in the 1960s, dropped to 20 per cent in the 1970s and to a mere 10 per cent in the 1980s.

The FAO (1995a) shows that per capita food production during the period 1961–1991 increased 19.3 per cent and 28.9 per cent in developing countries and developed countries, respectively. The growth rate of grain production has slowed down since the mid-1980s and more than 800 million people still suffer from malnutrition.

The US Department of Agriculture (1996) estimated that both cereal production and imports have increased substantially in East Asia, from an average of 145 million tonnes of production in the early 1960s to 445 million tonnes in the early 1990s and from 10 million tonnes of imports to over 30 million tonnes during the same period. Meat production has also expanded during the last three decades.

Rosegrant et al. (1995) found that price elasticities of supply for crops are generally small, ranging from 0.05 to 0.4, with a few higher elasticities for some crops in specific countries. The relatively small supply elasticities are consistent both with a review of past literature and with recent estimates of dynamic supply response for China, India, Indonesia, and other Asian countries.

Brown (1995) also worried about China's rapid industrialisation of the past decade which spawned more than 200 new cities, as more than 100 million people have migrated from rural areas to the cities. In 1988 and 1989, the country lost more than 1 million hectares of cultivated land, 16 per cent of which was converted to nonfarm purposes such as urban, industrial, or infrastructural uses. If urban and industrial claims on cropland have continued at the same rate in the nineties, China has already paved over 435,000 hectares of cropland this decade, which is an area that produces enough grain to feed 10 million Chinese. Worse still, urban expansion often claims the best agriculture land.

The carryover stocks of grain is a key indicator of the global food situation. Historically, we know that grain prices were driven upward with the declining stocks as in the early 1970s. That is, it decreased from 217 million tonnes in 1971 to 180 million tonnes in 1972 and grain prices rose more than 50 per cent in the next year. Thereafter, it increased to 465 million tonnes in 1986 and prices fell down. Major grain stocks, however, have shown the declining trend again in the 1990s, from 339 million tonnes in 1990 to 234 million tonnes in 1995, a 30 per cent decrease.

Rice decreased from 59 million tonnes in 1990 to 50 million tonnes in 1995, wheat from 145 million tonnes to 100 million tonnes, corn from 81 million tonnes to 56 million tonnes and coarse grain also decreased, from 135 million tonnes to 85 million tonnes. As a result, grain prices also showed increasing trend during the same period.

The stock-to-use ratio also decreased from 18.8 per cent in 1971 to 15.3 per cent in 1972 while it was a record high, 28.5 per cent, in 1986. But it dropped again to the historically lowest level of 13.4 per cent in 1995.

Eor and Kim (1995) illustrated the inverse relationships between stocks and prices of wheat, rice and corn. That is, prices of wheat and other grains have changed in the opposite direction to the changes in stocks.

ABARE (1996a) emphasised the importance of agricultural prices in determining agricultural production levels. The surge in world market prices for grain in the mid-1970s was followed by a large investment response. The planting area of rice, wheat, and coarse grains increased from 665 million hectares in 1972-1973 to 701 million hectares in 1976-1977. The high world prices provided an incentive for the adoption of high-yielding varieties and the average yield of wheat rose from 1.57 tonnes per hectare in 1972-1973 to 1.92 tonnes per hectare in 1982-1983, an increase of 21 per cent. In the 1990s, no further increases have been noted.

The higher prices were an important contributor to the substantial increase in world grain production and these production responses and weak demand growth brought a period of excess supply through the 1980s. As a result of excess supply and low prices, there has been a low level of investment since the early 1980s and the United States applied large annual acreage set-aside programs in the mid-1980s. In 1995-96, market prices for grains reached high levels. However, they have since declined and it is uncertain whether the short period of relatively high prices would be sufficient to result in increased levels of capital investment in agriculture.

ABARE (1996) asserted that prior to the recent period of low stocks and high prices, the most prominent comparable period on a global scale was the mid-1970s and, at the peak in 1973-1974, real world wheat prices were 130 per cent above the long term average. The stock-to-use ratio for grain was low by historical standards in the mid-1970s and mid-1990s. In the case of wheat, the ratio fell to levels which were just as low in 1987-1989, with no comparable price surge because of intense competitive export subsidies.

### ***Food production in the APEC region***

Grain production in the APEC region increased by 81 per cent from 460 million tonnes in 1970 to 834 million tonnes in 1995, with 85 per cent of the increase due to the growth of yield while only 15 per cent was due to an expansion of cultivated land area. Meat production increased more rapidly, from 27 million tonnes to 90 million tonnes, during the same period (See Table 6).

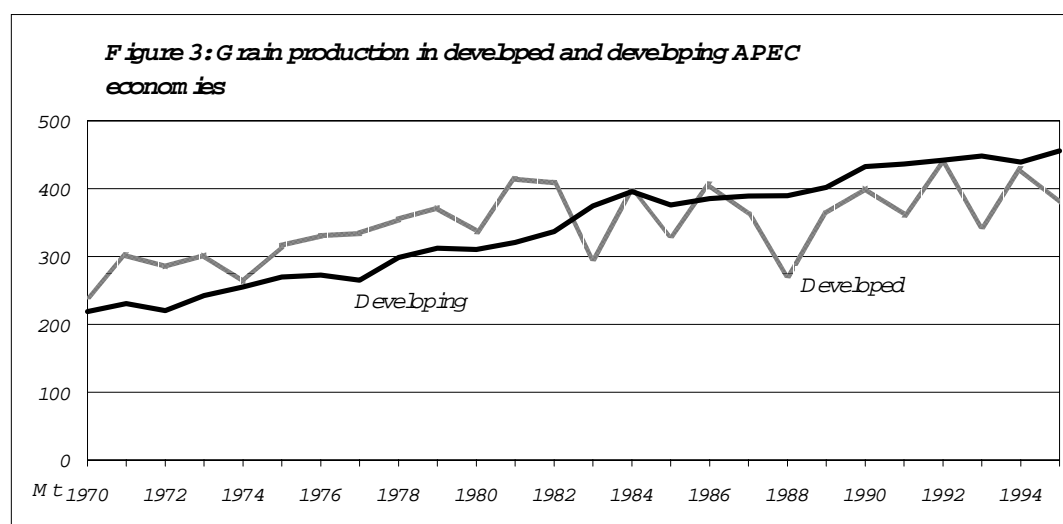
**Table 6: APEC Food Production**

	Grain kt	Meat kt
1970	460335	27312
1975	585434	37806
1980	647048	46826
1985	807051	54981
1990	839315	67413
1995	834275	89795

Source: US Department of Agriculture (1997b)

Member economies of APEC can be classified into two groups, developing and developed economies. Grain production of the developing economies has increased steadily while that of the developed economies has been fluctuating. The level of production was lower in the developing economies than that in the developed economies until the mid-1980s. Since then, the former caught up with and sometimes exceeded the latter (See Figure 3).

Average annual growth rates of production were 3.1 per cent and 3.4 per cent in the developing and developed economies, respectively, during 1970-1995. And the contribution of growth in yield to the increases in production has been 94 per cent in the developing economies and 72 per cent in the developed economies. This implies that there are difficulties in expanding cropland in the developing regions, possibly because of the diversion of cropland to industrial and residential uses (See Table 7).



Source: US Department of Agriculture (1997b).

Actually, the average annual growth rate of cultivated land in the developing economies was 0.25 per cent while that of the developed economies was 0.62 per cent. And in the 1990s, grain production increased in the developing economies while it decreased in the developed economies as the cultivated area declined in both regions.

**Table 7: Contribution to the Growth in Production: 1970 to 1995**

	Growth in Production %	Growth in Yield %	Contribution of yield %
Developing economies	3.1	2.9	94
Developed economies	3.4	2.4	72

Source: US Department of Agriculture (1997).

The grain yield has grown at a falling rate of 2.5 per cent in the 1970s and 1.3 per cent in the 1990s. As a result, total grain production increased at diminishing growth rates: 3.5 per cent in the 1970s, 1.2 per cent in the 1980s, and 0.3 per cent in the 1990s. Meat production also increased at a diminishing rate, from 6.0 per cent in the 1970s to 3.9 per cent in the 1980s before rebounding to 5.8 per cent in the 1990s (See Table 8).

**Table 8: Trend of Growth Rates in Production and Yield in APEC**

	1970s	1980s	1990s
Growth rate in Grain Production	3.5	1.2	0.3
Growth rate in Grain Yield	2.5	2.1	1.3
Growth rate in Meat Production	6.0	3.9	5.8

Source: US Department of Agriculture (1997b).

Per capita grain production in the region increased, as it did throughout the world, from 308 kilograms in 1970 to 420 kilograms in 1985 but it decreased to 380 kilograms in 1995. Therefore, the growth rate of per capita grain production declined from 1.8 per cent in the 1970s to 0.2 per cent in the 1980s and then to -0.5 per cent in the 1990s. Reduction in per capita grain production in the 1990s implies that the growth rate of grain production was lower than the growth rate of population. Per capita meat production increased from 18 kilograms in 1970 to 41 kilograms in 1995 with declining growth rate until the 1980s, from 3.8 per cent to 2.4 per cent, and rebounding growth rate of 4.3 per cent in the 1990s. It is noteworthy that both per capita grain and meat production in APEC are higher than those of the world.

Rice production increased from 125 million tonnes in 1970 to 211 million tonnes in 1995, showing a 69 per cent increase. About 91 per cent of the increase was due to the

growth in yield while the expansion of cultivated land accounted for only 9 per cent. Rice production more than doubled in Indonesia, the Philippines and the United States while it decreased in Taiwan and Japan. The increase in rice production was mainly due to higher yields in China, Indonesia and Korea while it grew because of expanded land area in the United States and the Philippines. The share of APEC in world rice production has remained constant at around 60 per cent during the same period. The growth rate for yield of rice has been stable at 2.0 per cent in the 1970s and in the 1980s before declining to a lower rate of 1.1 per cent in the 1990s. Thus, the growth rate of total production diminished from 2.6 per cent in the 1970s to 0.3 per cent in the 1990s. Per capita production, the more important indicator of food problem, increased from 83 kilograms in 1970 to 96 kilograms in 1995. But its growth rate also declined from 0.9 per cent in the 1970s to -0.8 per cent in the 1990s (See Table 9).

**Table 9: Per Capita Production in APEC**

	Rice kg	Wheat kg	Corn kg	Coarse grain kg	Beef kg	Pork kg	Broiler kg
1970	83	58	105	166	9	6	3
1975	86	83	131	185	10	10	3
1980	89	87	145	186	9	13	4
1985	98	104	167	218	9	15	5
1990	98	109	162	198	8	17	7
1995	96	96	156	189	9	23	9

Source: US Department of Agriculture (1997).

Wheat production increased from 87 million tonnes in 1970 to 210 million tonnes in 1995, with 75 per cent of the increase due to growth in yield. The prominent single economy that contributed to the growth of regional wheat production was China, where wheat production increased by 250 per cent or more. The US, Canada and Australia also played a role in increasing regional wheat production. The increase in that production has mainly been led by yield growth in China (83 per cent) and in Australia (78 per cent) while it was due to the growth of area cultivated in the US (66 per cent) and Canada (57 per cent). The share of the APEC region in world wheat production increased from 28 per cent in 1970 to 39 per cent in 1995. The growth rate of wheat yield was relatively stable at 2.3 per cent in the 1970s and 2.4 per cent in the 1980s. However, it decreased to 0.8 per cent in the 1990s. Accordingly, wheat production grew at a diminishing rate, from 5.6 per cent in the 1970s to -1.0 per cent in the 1990s. Per capita production also grew from 58 kilograms in 1970 to 87 kilograms and 109 kilograms in 1980 and 1990, respectively, but it decreased to 96 kilograms in the 1990s, showing the declining growth rate of 3.8 per cent in the 1970s, 0.15 per cent in the 1980s and -2.1 per cent in the 1990s.

Regional corn production increased from 158 million tonnes in 1970 to 343 million tonnes in 1995, showing a 77 per cent increase stemming from yield increase with the remaining 23 per cent from increased land area. The US was the most important economy that contributed to increasing regional corn production, followed by China, Mexico and Canada. Growth in yield led the increase in production in the US, China and Mexico, but

increased land area initiated the increase in Canada. The share of APEC in world corn production increased from 59 per cent to 68 per cent during the same period. Corn yield grew at a diminishing rate of 2.7 per cent in the 1970s and 1.8 per cent in the 1980s and 1.4 per cent in the 1990s. Similarly, total corn production grew at rapidly diminishing rates, 4.9 per cent in the 1970s, 1.3 per cent in the 1980s and 1.4 per cent in the 1990s. As a result, per capita production increased from 105 kilograms in 1970 to 167 kilograms in 1985 and then decreased to 156 kilograms in 1995, showing sharply declining growth rate of 3.2 per cent in the 1970s to -0.2 per cent in the 1980s and then a slightly increasing rate of 0.2 per cent in the 1990s.

Differently from production of main grains that showed increasing trends at diminishing growth rates, meat production in APEC grew at an increasing rate. The production of beef and veal increased from 14 million tonnes in 1970 to 20 million tonnes in 1995, showing a declining rate of 2.1 per cent in the 1970s and 1.4 per cent in the 1980s and then an increasing rate of 3.3 per cent in the 1990s. Per capita production has been relatively stable at 9 kilograms during the whole period, showing rising growth rate of 0.3 per cent in the 1970s and 2.2 per cent in the 1990s.

Pork production increased from 9.5 million tonnes in the 1970s to 51 million tonnes in 1995, showing more than a 5 times increase. Average annual growth rates were maintained at around 7 per cent, which is much higher than the growth rate of population. Per capita production increased from 6 kilograms in 1970 to 23 kilograms in 1995 with relatively stabilised growth rate of 8.2 per cent in the 1970s and 5.7 per cent in the 1990s.

Broiler production increased from 4.3 million tonnes in 1970 to 18.7 million tonnes in 1995, an almost 4 times increase. Growth rate of production has been rather steady at around 6.1 per cent during the whole period. Production per person increased from 3 kilograms to 9 kilograms, showing constant increasing growth rate of 4.3 per cent in the 1970s and 4.9 per cent in the 1990s.

## ***Conclusions***

World food production has steadily increased since the early 1960s. Increases in grain production stems mainly from increases in yield rather than increases in area cultivated. Since the growth rate of productivity or yield has shown a downward trend for most products, world production of grains and other commodities increased at diminishing rates, showing 'S shaped' curves and in some cases declined.

World per capita grain production has relatively been constant, but average growth rate of per capita production decreased since the 1970s and showed negative growth in the 1990s. That means the growth rate of world grain production has been higher than that of world population until the 1980s, but since then the trend has been reversed. Per capita world meat production also increased, but the growth rate dropped since the 1980s, showing constant per capita production in the 1990s.

The stock to use ratio of grain decreased from 18.8 per cent in 1971 to 15.3 per cent in 1972 while it reached a record high of 28.5 per cent in 1986. But it dropped again to the historically lowest level of 13.4 per cent in 1995 and caused soaring prices.

Per capita production of most grains in APEC region have increased steadily until the mid-1980s or beginning of the 1990s but it decreased since then, showing 'S-shaped' curves. Per capita production has been constant for beef and veal while those of pork and broiler have increased at relatively stable growth rates over the same period.

#### **4. TRADE**

As world economy achieved remarkable growth, world trade has increased much since 1970. Total amount traded has increased from 574 billion dollars in 1970 to ten trillion dollars in 1995, showing 17 times increase. World agricultural trade has also increased from 108 billion dollars to 887 billion dollars, showing 8 times increase, but share of agricultural trade in total trade has reduced from 18.8 per cent to 8.8 per cent.

Total trade in APEC has increased more rapidly than that of the world economy. It has increased more than 24 times, from 186 billion dollars in 1970 to 4.5 trillion dollars in 1995. Agricultural trade in the region has also expanded from 32 billion dollars to 307 billion dollars, showing almost 10 times increase. Thus, the share of agriculture in the regional trade has reduced from 17.2 per cent to 6.8 per cent. Trade of agricultural products has less rapidly increased than that of other sectors not only in the world but also in the APEC region

##### ***World agricultural trade***

World trade in agricultural products has taken only a small proportion of total production. World total exports of wheat amount to about 20 per cent of world production, and exports of coarse grains amount to less than 15 per cent, for rice, less than 5 per cent and for total grains, they are less than 10 per cent on an average. The same is true for livestock: beef and veal, 5 per cent, pork, 7 per cent and broiler, 15 per cent. Although the ratios are more or less higher for sugar (28 per cent) and dairy products such as milk powder (51 per cent), cheese (21 per cent) and butter (23 per cent), they are still low for oilseed such as cotton seed (1.7 per cent) and rapeseed (17 per cent). One important reason why the proportion traded has been relatively small can be found from the historical characteristics of food production that food has been produced for self-sufficiency in most regions rather than for exports. As a consequence, world food markets are much more unstable than industrial goods markets.

The number of grain exporting countries is much smaller than that of the importing countries which might contribute to the instability of world grain markets. Major exporting countries are five or so for wheat and rice but are less than three for corn and soybean. Among the importers, there are three main types of countries (Atkin 1992). First type is the countries that have chronic food deficits and their import requirements tend to be large and stable. Second type is the countries whose import requirements are

small and stable. Finally, there are some countries that rely on the world market to close the gap between domestic production and consumption. Obviously, their import needs vary considerably depending on the vagaries of domestic production. These are mostly developing countries, including the former socialist countries.

Developing countries account for about two-thirds of world wheat imports and more than 40 per cent of world coarse grain imports. While grain imports of the former socialist countries such as Russia and Uzbekistan have decreased much in the 1990s, some of the rapidly industrialising countries in Asia such as China, Indonesia and Korea have become large importers in world grain markets. On the other hand, grain exports in India, Thailand and the US have increased while that of China has decreased in the beginning of the 1990s.

### *Agricultural trade in the APEC region*

The importance of APEC in world trade has progressively increased. APEC's share in the world trade was 45 per cent in 1995, a significant increase from 32 per cent in 1970. Its share in the world agricultural trade has slightly increased from 29.5 per cent to 34.6 per cent. As its agricultural trade increased, APEC's share of world agricultural imports rose from 27.5 per cent to 33.7 per cent and that of exports from 31.6 per cent to 35.6 per cent during the same period.

Agricultural trade of APEC has undergone three phases: a steady increase during the 1970s, a stagnant period in the early 1980s and a rapid increase since the mid-1980s. Although agricultural trade of APEC member economies as a whole has been balanced during the 1970-1995 period, exports of five agricultural exporting economies Australia, Canada, New Zealand, the US and Thailand have increased much less rapidly than imports of the remaining members since the late 1980s when implementation of agricultural trade liberalisation has been discussed at the Uruguay Round. As a result, the latter has significantly exceeded the former in recent years. The gap between them might be imported from outside countries such as the EU.

Agricultural exports of APEC members increased to \$155 billion in 1995 from \$16 billion in 1970 showing almost ten times increase. Agricultural imports also increased as much from \$16 billion to \$152 billion during the same period. The major trade surplus countries in agricultural trade are Canada, the US, Australia, Indonesia, New Zealand, Malaysia, and Thailand while trade deficit countries in agriculture are Japan, Korea, Hong Kong Chinese Taipei and Singapore.

Major agricultural importers in APEC are Japan, the US and China and newly emerging exporters, China and Thailand. However, the share of agricultural trade in the nation's trade is high in New Zealand, Chile, Papua New Guinea, Australia, Thailand and Indonesia. The leading agricultural exporter is the United States and it is followed by Canada, China and Australia. Growth rates of agricultural imports have been relatively high in Korea, Thailand and Hong Kong while they are relatively low in the NAFTA countries and ANZCERTA member countries.



Rice trade is relatively small compared to its production. Rice is mostly consumed within the countries where it is produced. This has led to a large degree of volatility of the world rice market. The compensating variation of world rice price during the 1969-90 period was 26.1 (Choi et al. 1993). This volatility results from the fact that almost half of Asian rice is rainfed, and hence subject to vagaries of the monsoon. Most of rice traded is Indica rice which is grown mainly in South and South East Asia and Southern China. Indica rice accounts for about 87 per cent of world trade while Japonica rice, mostly grown in Japan, Korea and north eastern China accounts for 11 per cent of world trade and constitutes a fairly thin market (Yamauchi et al. 1994). Major rice exporting countries are Thailand, the US and Australia while the main customers are Indonesia, Japan and China.

Wheat is one of the commonly traded grains with more than 100 million tonnes being traded in world markets annually. Wheat exports by APEC countries has increased 50 per cent during the 1970-1995 period. It was 62 million tonnes, mostly exported by the United States, Canada and Australia. Wheat imported by APEC countries has increased about three fold during the same period. The main importers are Japan, China, Korea and Indonesia. The exporting price of wheat was stable or decreasing until the late 1980s, but it has rebounded and remains strong in the mid-1990s.

APEC countries supply more than 50 million tonnes of corn or 70 per cent of world corn exports. They also import about 35 million tonnes per year in the 1990s. The US accounts for most of the exports while the main importers are Japan, China, Korea and Malaysia. The gap between quantities supplied and demanded by APEC members has been narrowed since its demand for corn as a feed grain increased rapidly as the demand for meat expanded. Export supply increased 3.3 times and imports increased 5.4 times during the 1970-95 period.

The characteristics of agricultural trade that quantity traded is small relative to production caused the instability of food markets since small changes in food production might result in huge fluctuations in supply and prices. The fact that major exporters are geographically concentrated in some specific regions and that their shares of world exports are increasing also deepen the instability because food productions are closely dependent upon the natural conditions such as, water, temperature and weather. The shares of major exporting countries increased from 53 per cent to 59 per cent for wheat, from 64 per cent to 75 per cent for soybean, from 70 per cent to 75 per cent for corn, from 27 per cent to 40 per cent for beef and from 10 per cent to 16 per cent for dairy products over 1990-1996 period. As a result, food market instability is resulted from supply-side rather than demand-side since food productions are vulnerable to sudden fluctuation while food consumption is relatively stable.

## CONCLUSIONS - MAIN COMMODITIES APPROACH

World grain production has increased until recently and the increase in total production has mostly resulted from the growth in yield or productivity rather than the expansion of cultivated area. Since it is extremely hard to expand cultivated land area, growth in grain production should depend upon increases in yield through technological progress. However, because of the law of diminishing marginal product on the one hand and the unsustainable characteristics of modern agricultural production technology on the other hand, yield increases along an S-shaped curve. That means yields have approached to its maximum point. In fact, the growth rates of yield and total production of most grains have declined since the mid-1980s. Therefore, per capita grain production has decreased indicating that world population has increased more rapidly than grain production since then.

World meat production also increased at diminishing rates over the whole period. Stocks of grain have been closely related to changes in prices. The stock-to-use ratio has declined since the 1980s and the ratio in 1995 has declined to below half its 1986 level.

There exist inverse relationships between stocks and prices of grains. Prices of grain rise when the level of stocks declines, and vice versa.

In the APEC region, grain production has followed the trend of the whole world. It has increased at a diminishing rate since the 1970s. Per capita grain production has decreased since the mid-1980s, as population has grown faster than grain production. Meat production, however, increased even more in the 1990s, which reflected the substitution of meat production for grain production.

In APEC, grains for export have been produced mostly in developed economies in North America and Oceania. Figures on grain production in the developing and developed economies show very clearly that the former has been stable and increasing, while the latter has been unstable. It can be interpreted that both regional concentration of production and production control policies in the developed economies has resulted in those fluctuating trends.

The proportion of trade in agricultural production has generally been low. Developing countries account for about two-thirds of world wheat imports and more than 40 per cent of world coarse grain imports. While grain imports of the former socialist countries such as Russia and Uzbekistan have decreased much in the 1990s, some of rapidly industrialising countries in Asia such as China, Indonesia and Korea have become large importers in the world grain markets. On the other hand, grain exports of India, Thailand and the US have increased while that of China has decreased in the beginning of the 1990s.

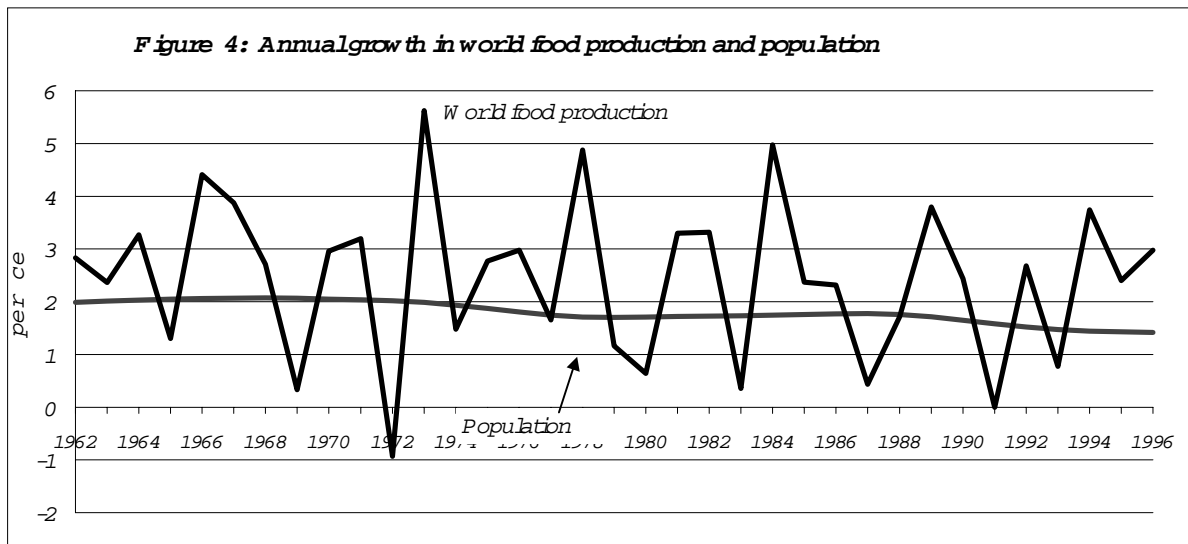
World trade in meat has steadily increased reflecting both expanded demand in importing countries and a need to import increasing quantities to supplement domestic production in order to satisfy demand. There has also been a trend toward increasing imports of high value added and processed foods.

Fundamental problem of food market is the instability of the market which implies severe fluctuations in food prices. Food supply is unstable due to the facts that trade proportions of food production are so low and that food exporters are geographically concentrated in some specific regions and their shares in world food exports are increasing. In conclusion, food market instability is resulted from supply-side rather than demand-side since food productions are vulnerable to excessive changes while food consumption is relatively stable.

### 3B: THE AGGREGATE FOOD APPROACH ON PRODUCTION, STOCKS AND TRADE

#### *World food production*

World food production has been increasing steadily since the early 1960s at rates that have averaged slightly above world population growth. As a result, average consumption levels per person have been rising gradually. Total world food production, as indicated by the FAO index of world food production, rose by 82 per cent between 1970 and 1996. Over that same period, world population increased by 56 per cent and the index of food production per person, which may be used as a proxy for consumption per person, increased by 17 per cent. Over time, food production has been increasing at a faster rate than population, but the rates of increase in production have varied from season as can be seen from figure 4. As well as production having risen at a faster rate than population, it has been rising more rapidly than demand when considered at the farm level and, as a consequence, world market prices have trended downwards in real terms (See Figure 1).



Source: FAO (1997a).

As indicated in the section on demand and as is evident from figure 4, the rate of increase in world population has been slowing — the rate of increase in production has been declining with it. However, over time, the trend rate of increase in production is keeping ahead of the trend rate of increase in population. Trend growth rates in food production, population and in production per person are shown in table 10.

**Table 10: Trend Annual Compound Growth Rates in World Food Production, Population and Food Production Per Person**

	1970-80 %	1980-90 %	1990-96 %
World food production	2.48	2.36	2.16
Population	1.83	1.73	1.46
Food production per person	0.65	0.63	0.68

Sources: FAO (1997a).

These substantial increases in food production over time have been achieved despite there having been only a modest increase in areas cropped. The total area of arable land and permanent crops in 1995 was only 6.3 per cent above that in 1970. Most of the increase in production has come from the interaction of economic incentives with technological advances that have resulted in larger amounts being produced per unit of area. However, the newer technologies have required much increased usage of inputs including fertilisers, pesticides and water. Resultant environmental damage and depletion of water resources have been factors limiting production and raising concerns about the sustainability of production increases.

Advances in technology and associated increases in productivity (output per unit of input) have been central to world food production rising despite real market prices having followed a gradually declining trend. The growth was particularly rapid in the 1960s and 1970s as the green revolution technologies became adopted. It was also rapid in China during the 1980s as those technologies interacted with incentive structures arising from reforms dating from the late 1970s (CIMMYT 1989). As the green revolution technologies are now widely applied, the rapid gains from the initial adoption of those technologies are slowing, with advances in those technologies becoming more incremental as improvements in varieties and production techniques are developed. Nevertheless there are many farmers who are attaining yields that are far below levels produced either by those using the most advanced methods or those obtained under experimental conditions. At the same time, advances are being made in a number of other technologies that are further increasing yield potential.

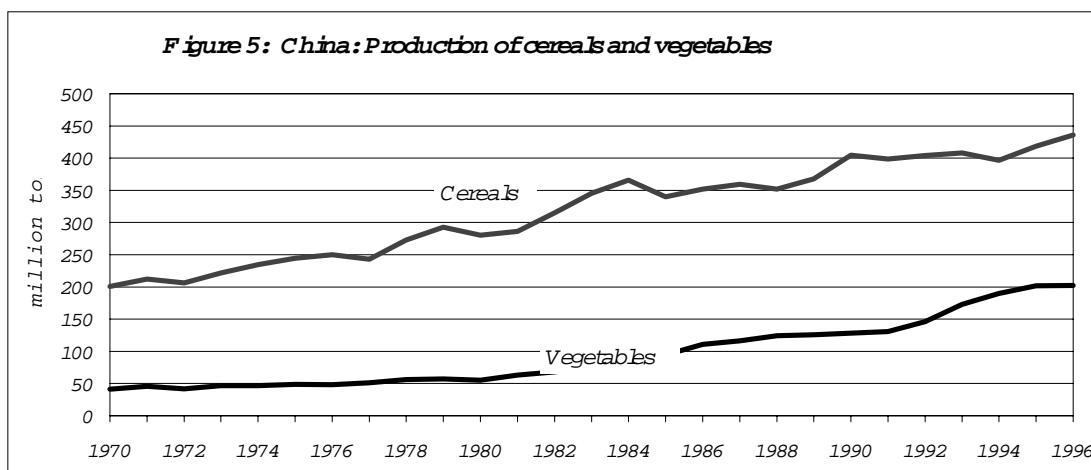
These include further improvements in developing high yielding seeds; advances in biological controls and integrated pest management; increasing use of bio technology to raise yields directly and to tailor plants to conditions in specific growing areas, such as

arid and semi arid areas and cold climates with short growing seasons; application of minimum tillage techniques to make better use of moisture and to reduce environmental degradation; use of remote sensing and field monitoring techniques to identify areas of fields where yields are low so that soil deficiencies can be identified and remedied; genetic improvements and use of hormone technologies in livestock to increase feed conversion rates and raise growth rates and yields of animal products. There has been some concern about declining public investment in research and development in agriculture and that this could slow the advance of technologies that enable food production to increase to meet the rising demands of increasing and more affluent populations. However, as Thompson (1997) points out, there has been an upsurge in private investment in research and development, especially in North America, largely reflecting intellectual property protection which can ensure that the private sector can reap the returns on its investments in research.

It is important in examining changes in food production over time to consider food as a whole rather than just some leading or staple foods. This is because diets are changing as incomes, tastes and life styles change and because of the fact that what is consumed is also what is produced, apart for an element of losses in handling. If, for example, only grains and meats are considered, account is not adequately taken of major changes which are occurring in consumption of other major food groups including, vegetables, fruits, oilseeds and sea foods. Indeed, in recent years, there have been major changes in the composition of diets in terms of the balance between food groups and also in different foods within groups which result in consideration of grains and meat only, being misleading. These changes in diets arise from the interaction of changes in effective demand with factors that influence supply with that interaction arising through prices faced by both consumers and producers. The supply side factors include the profitability of producing various types of food relative to alternative activities, which in turn is influenced by many considerations, some of which include the availability and quality of suitable land, the state of technology and the cost and availability of inputs.

Over time, as diets change, the relative profitability of the items which become more highly in demand draws greater relative amounts of resources into producing those items than into items where demand tends to slacken in relative terms as incomes rise. As indicated in the section on demand, direct human consumption of cereals tends to rise either less rapidly than that for meats, fruits, vegetables and oilseeds or to decline as incomes rise. These changes have been reflected in changes in the relative world production of these food groups over time. One of the most important developments in these changes in recent years has been a significant change in the orientation of crop production for the world as a whole away from cereals towards fruit and vegetables and oilseeds.

This reorientation has been particularly marked during the 1990s in China where the product weight of vegetables produced as a percentage of that of cereals produced rose from 20 per cent in 1980 to 46 per cent in 1996 (See Figure 5). China accounts for approximately one fifth of world production of cereals and over one third of world production of vegetables, so changes in its relative production levels of these crops have a marked impact on world trends.



Source: FAO (1997a)

The reorientation of production between crops can have important implications for changes in the absolute levels of food production at any given state of technology. Production of vegetables, for example, could give higher yields of food, at least in terms of product weight and also in terms of market value, than production of cereals on the same land. This same kind of reorientation can also be recognised for meats where, on a world scale, poultry and pigmeat production are rising relative to beef production. Poultry is a more efficient converter of feed, including feed grains and protein concentrates, than pigs and pigs are more efficient converters than cattle. Consequently increases in meat production have been more rapid than those in feed grains.

When comparing growth rates in production and production per person for the major food groups over periods of time it is important that trend rates of annual growth are used rather than growth rates determined from specific production periods. This is because of relatively high rates of annual variability in production, as is evident for food in total from Figure 4. Trend rates of growth in world production and in production per person for grains, vegetables, fruits, oilseeds, meats and milk are shown in Table 11.

An important factor that has contributed to the decline in the rate of growth in world production of cereals, and dairy products in the 1990s has been a substantial reduction in output in the former socialist countries in the Former Soviet Union and Eastern Europe. These regions, in particular the Former Soviet Union, have been large agricultural producers. With the collapse of the former system of government and the removal of many production and consumption subsidies, both production and consumption of these products have fallen substantially. Between 1990 and 1996, production of cereals in the Former Soviet Union and Eastern Europe fell from 325 million tonnes to 186 million tonnes. Had no reduction in production occurred in the Former Soviet Union and Eastern Europe, the average annual growth rate in world cereal production in the 1990s would have been 1.8 per cent per year. Such a growth rate would have been much the same as that in the 1980s as indicated in Table 11. The decline in production of cereals in the Former Soviet Union and Eastern Europe which was induced by political and economic disruption and not by limits to yields, was therefore clearly a key

determinant of the slowing of world production growth for cereals in the 1990s. For milk where, production in the former Soviet Union and Eastern Europe fell from 145 million tonnes in 1990 to 97 million tonnes in 1996. Had that reduction not occurred, the average annual growth rate in milk production in the 1990s would have been 1.18 per cent, which is somewhat lower than the average in the 1980s but by nothing like as much as is apparent had not the abnormal conditions in the former socialist countries not been taken into account.

**Table 11: World: Major Food Groups: Trend Annual Growth Rates in Production and Production Per Person**

Item	1970 to 1980 %	1980 to 1990 %	1990 to 1996 %
<b>Total production a</b>			
cereals	2.64	1.78	0.57
oilseeds	3.65	3.93	3.69
vegetables	2.93	3.62	3.62
fruits	2.33	1.72	2.63
meats	2.97	2.86	3.17
milk	1.81	1.56	-0.08
<b>Production per person</b>			
cereals	0.81	0.05	-0.89
oilseeds	1.82	2.20	2.23
vegetables	1.10	1.89	2.16
fruits	0.54	-0.01	1.17
meat	1.14	1.14	1.71
milk	-0.02	-0.16	-1.54

**a These growth rates are derived from FAO data and differ in some instances from those in table 5 which are derived from USDA data.**

**Source: Derived from FAO (1997a).**

Although the rate of increase in total world food production has been gradually declining since the 1970s, it has, on average over time, been staying ahead of population growth rates. This is despite a marked slowing in rates of production growth for cereals which constitute the main food staple and an important input into animal products.

Along with the advances in aggregate production relative to population, there has been a decline in the incidence of malnutrition, although it remains a major problem, especially in Africa and South Asia. The FAO estimated that in 1970 the number of malnourished people in the world was 950 million or 26 per cent of world population. By 1995, the estimate was 800 million or 14 per cent of the world total (Alexandratos 1995). While substantial progress has been made in addressing the problem of malnutrition, the numbers of malnourished people remain unacceptably high. The problems of malnutrition arise primarily from poverty, isolation, low levels of education, lack of infrastructure,

health problems, regional conflicts and antiquated and inefficient land tenure, property right and incentive structures (FAO 1996; Platteau 1992).

Concern regarding the sustainability of food production systems is apparent in three main areas. One is the demand for land to meet rising food requirements and competition for land which has been used for agriculture as a result of urbanisation and industrialisation. Another is stress on the quality and availability of water. The third is threats to the sustainability of fishery resources as a result of over fishing and pollution (Mace 1997). Competition for land use is limiting the availability of land for agriculture in some countries, especially in rapidly expanding economies where there are large populations relative to available land. Most such economies are in Asia, and for China, Japan and the Republic of Korea in total, the area of arable land and permanent crops declined by 7 per cent between 1970 and 1995 (FAO 1997b). There has also been some reduction in Indonesia in the 1990s (consistent data for earlier periods were not obtainable). However, for Asia as a whole, including those countries, the area of arable land and permanent crops rose by 5.5 per cent over the period from 1970 to 1990. Since then it has been relatively static with increases in some countries counterbalancing the reductions in others. In aggregate, the world area of arable land and permanent crops rose by 6.3 per cent between 1970 and 1995 with the largest growth occurring in South America where the increase was 46 per cent. As indicated above, most of the increase in agricultural production since 1970 has been from higher yields rather than increases in areas. Thompson (1997, p. 14) indicated that 'there exists a limited amount of additional fertile, well watered, non-erodible, unforested land available in the world that can be brought into agricultural production at low cost. This tends to be in North and South America and southern Africa. There is somewhat more land that can be brought into production with significant investment in reclamation and irrigation'. In addition, there are significant areas of land that can be brought into food production in Australia if the market incentives exist. This was exemplified by a 2.1 million hectare, or 23 per cent increase in Australian plantings of wheat in 1996-97 following a surge in world market prices in 1995-96 – at the same time plantings of other crops were approximately maintained (ABARE 1997). Thompson (1997) also concluded that 'there exists a great deal of much higher productivity technology available in the world than is presently in use'. Consequently there is a potential for substantially higher production than at present even using current technologies.

One of the most important areas of concern for the sustainability of agricultural production systems is the availability of good quality water, given rising competition for available supplies from urban areas, industrial uses and the requirements to maintain the environment. Many of the technologies which have been used to increase food production have been water intensive and have utilised large amounts of fertiliser and pesticides which have contributed to water quality problems. Water is an input which has been supplied to farmers in most countries under pricing systems where the focus is on short term water allocation rather than on long term sustainability, especially if its opportunity cost to others in the society, the importance of water in maintaining the quality of the environment and the requirements of future generations are taken into account (Cummings and Nercissiantz 1992, Reidinger 1992). With present technologies, there are far more efficient and less wasteful ways of utilising irrigation water in agriculture than are



currently being widely used. However, their application can involve significant capital costs which may initially slow rates of increase in production.

### ***Production in APEC economies***

The broad trends and issues indicated in the previous section for the world apply for also APEC economies. It may be noted that most of the countries indicated above where rapid economic growth and limited land areas are resulting in a declining area of land for food production are APEC economies. However, for the largest of these countries, China, food production is still rising much more rapidly than population despite the pressures on the land base. Between 1990 and 1996, total Chinese production of food per person, as measured by the FAO index of food production per person, increased by 40 per cent. Although production per head was relatively constant for grains, there were very large increases for other major food groups including vegetables (50 per cent), meat (86 per cent) and fruit (100 per cent).

### ***Trade and stocks***

Specialisation and trade enable the generation of higher levels of income and wealth than if individual countries try to be self sufficient in everything. Such efforts at self sufficiency result in much of the country's resources being directed into producing goods and services which utilise scarce and therefore costly resources, resulting in lower incomes and wealth than through greater specialisation and trade.

Traditionally, there have been substantial natural barriers to the extent to which demand for food in many countries could be met through imports because of the perishable nature of many foods. Many countries and areas within them did not have the necessary transport, refrigeration and commercial infrastructure to import and widely distribute many necessary foods. For many countries also, a large proportion of the population lived through subsistence agriculture, producing most of their food requirements directly. All of these factors resulted in a high proportion of food supplies in many countries being domestically produced and of world food production being sourced mostly in the countries where it was consumed. As a result, world trade tended to represent a relatively small proportion of world production.

However, these traditional patterns are changing as many countries industrialise. Populations are increasing and becoming more urbanised and average incomes are increasing rapidly, resulting in increasing demand for a wider variety of foods and the services associated with them — often demands that can not adequately be met from domestic production or which can be met at lower cost by others. Infrastructures are being improved and advances in food technology and transport are enabling increasingly efficient transport and marketing of high quality products which were previously not traded much internationally because of their perishability, in areas distant from the country or region of origin. These developments complement the gains that can be made from trade to result in increasing proportions of world food supplies being traded.

Along with the trend towards industrialisation, the demand for resources within industrialising countries to meet the rising demands of manufacturing and service industries tends to compete resources such as labour and also some land away from agriculture. Because of these competitive forces and the rapid economic growth, agriculture tends to decline in relative terms within the economy. Often the political response to these forces is for governments increasingly to protect domestic agricultural industries (Anderson and Hayami 1986) which, because of the increasing opportunity cost of the resources which they utilise, become increasingly costly to support. However, the adoption of such support policies for agriculture sustains the established pattern of most food supplies for the country being domestically produced, or at least slows the rate at which imports increase. These factors have contributed to imports constituting relatively small proportions of world production for most food commodities although the proportions are rising for many commodities.

For some bulk commodities such as cereals, the technical barriers to international trade have been greatly reduced through advances in shipping and handling at ports. However, many countries still have very inadequate infrastructure and internal transport networks which result in regions continuing to be effectively sealed off from access to supplies from other regions or countries. Those regions can remain vulnerable to food shortages which otherwise could have been overcome through access to supplies produced elsewhere.

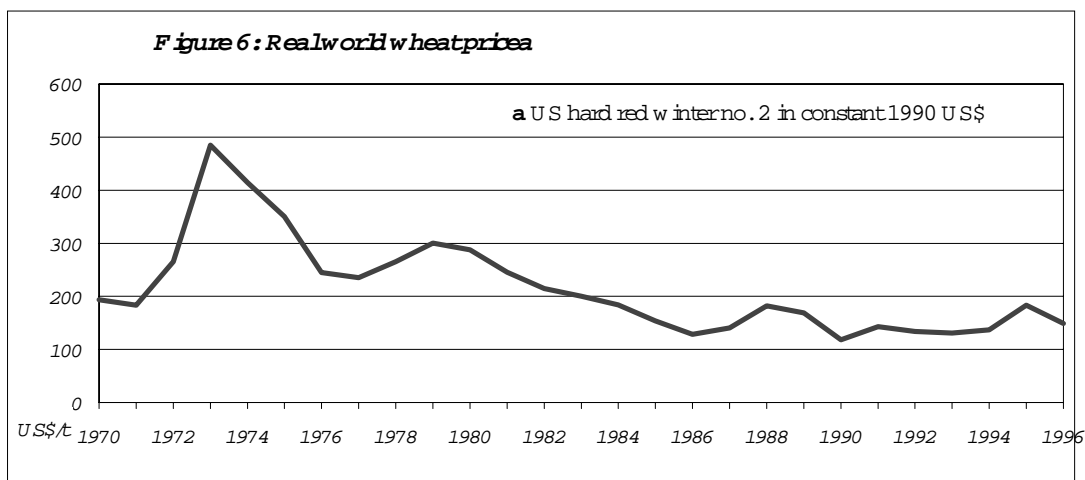
The traditional patterns of high regional and national self sufficiency in food that are sustained by the efforts to protect agriculture in industrialising and industrialised importing countries result in trade still accounting for only a small proportion of world production for many items. Most support for agriculture has been through maintaining domestic prices at stable levels above world market prices. By so doing, domestic production and consumption are not responsive to the wider international variations in supply and demand as indicated by world market prices. This lack of responsiveness throws the need to respond to variable demand internationally onto producers in the exporting countries that do not insulate, or which minimally insulate their producers from world market price signals.

Although international agricultural market prices have been variable, there is little evidence that they are becoming any more variable in recent years. Probably the most variable period for international agricultural prices in the period examined was the 1970s as can be seen for wheat in figure 6. Variability in world market prices and supplies is induced by the interaction of a number of factors, important among which are seasonal variations, periodic variations in demand and national government policies which impede the responses of producers and consumers to world market price signals (Tyers and Anderson 1992).

If barriers to trade and levels of market distorting protection in many countries were to become much lower, the responses of both production and consumption to changes in world supply and demand conditions would be spread throughout the world and not concentrated in just those countries where producers and consumers respond primarily to world market prices. Under such conditions, production and consumption for the world overall would become more responsive to changes in supplies and demand

globally, increasing availability through trade and making world market prices more stable. At times of global shortage, world prices would increase, reducing quantities consumed and encouraging production – conversely, at times of heavy supplies, world prices would fall, increasing quantities consumed and reducing quantities produced. Production responses on a world scale can be relatively rapid because of the seasonal differences in the northern and southern hemispheres. Importing countries could draw on a truly global pool of supplies and their producers and consumers would respond much more directly and efficiently to market signals for the world as a whole. Under those conditions the insecurity that some importing countries might feel about relying on supplies from the international market would be reduced. Also, the risks associated with production for the currently relatively small export market would be reduced.

Even with the high levels of agricultural protection and support that apply in many relatively land poor Asian countries that have large and rising populations, there are powerful economic forces drawing them towards greater imports to meet their rising demand for food. Pressures on land and competition for other resources make it increasingly costly to satisfy domestic demand from internal production. Also, if imports are restricted or subject to high duties, many of the benefits of economic growth, in terms of more abundant supplies and variety of foods at competitive prices, that consumers in these countries might expect from economic growth would be largely denied them. As a result of these factors and others such as participation in efforts to advance international cooperation are contributing to imports becoming more important in total food supplies, for example in Japan and in the Republic of Korea.



Source: ABARE (1996b).

The ability to draw quantities from the world market is providing greater amounts and variety of food to these countries than could be produced domestically, except at extremely high cost, to meet their rising demand and to enhance gains to their economic welfare through trade. The underlying cause of increasing imports by these countries is not trade liberalisation, it is rising demand and limited domestic production capacity — the degree to which trade in food is liberalised contributes to these countries being able to satisfy their rising demand for food in an economically efficient way.

The increases in imports of some major agricultural products by countries in South East and East Asia have not been placing undue strains on the ability of exporting countries to provide supplies. While imports of commodities such as cereals and dairy products have been increasing markedly into these areas over the past decade, there has been a major decline in imports by the Former Soviet Union, the economies of which are having difficulty in adjusting to their changing political and economic systems in the wake of the collapse of the central planning system. These countries which were formerly large importers of grain, meat and dairy products can not now afford to purchase large quantities of imports. Consequently, while import demand for food has been rising in many Asian economies it has not been accompanied by comparable increases in world import demand. In fact, for both cereals and dairy products the total volumes traded internationally have hardly increased since the early 1980s. (It is important in this context to ensure that, when examining changes in trade volumes over time, internal trade between members of the European Union is excluded).

Another issue that has a bearing on trade, world prices and food security, is the level of stocks. There has been a downward trend in stocks for major agricultural commodities in recent years. A large proportion of world stocks for major products entering world trade including cereals, dairy products and meat have been held in exporting countries. For cereals and dairy products, such stocks peaked in the mid 1980s and have since declined markedly. The world stock-to-use ratio for cereals fell to its lowest level since the early 1960s in 1996 and although it has since risen somewhat, it is still low by historical standards. As mentioned in the 'main commodities approach', an inverse relationship can be observed between stock levels and world market prices — world prices tend to be low when stocks are large and high when they are low. This relationship has clearly applied from year to year. However, over time there have been downward trends in both world market prices in real terms and in stock-to-use ratios — in 1997, the stock to use ratio for wheat is similar to that at the beginning of 1973-74 when world market prices were more than double current levels in real terms. Markets are adjusting to lower stock levels. Also the perceived need for stocks as a buffer against instability of food supplies is less now than in earlier years given advances in communications and transportation.

Several factors have contributed to this. One is that advances in transportation and improvements in infrastructure enable the smaller stocks to be more efficiently directed to users in distant markets and also are markedly reducing losses through spoilage in storage. Another is that the main reason for the periodic high levels of stocks in past years was price support and intervention arrangements in the industrialised countries.

Increasingly, these countries, primarily the United States and the European Union, are adopting forms of support for their producers which rely less on the setting of internal prices above market clearing levels along with government intervention purchasing of public stocks. Increasingly, support in those countries is being provided by direct payments which are not linked to current production or prices and are less market distorting than former support arrangements. Because the traditional forms of support were both costly and inefficient, those countries are reluctant to embrace policies which involve the accumulation of stocks which is also costly and inefficient. If importing

countries were very concerned about supplies from the world market becoming less secure because stocks are now lower in the exporting countries, it could be expected that they would have established greater stock holding capacity themselves which could be filled from imports at times of abundant world supplies and low prices. This has not been apparent.

An issue has been raised in the 'main commodities approach' concerning a propensity for food production to become more concentrated in a small number of exporting countries with large shares in world exports. Most food exports, especially those of grain, have been from industrialised countries. However, growth in world production of grains has been more rapid and larger in the developing countries than in the developed or industrialised countries (See Figure 3). While there has been a tendency towards a relatively small number of large firms in the world grain market, there is a high level of competition between those firms which derive their profits from maximising volumes handled and not through restricting trade with a view to extracting scarcity rents from the market. The degree of competition is such as to prevent such rent seeking behaviour.

### *Agricultural trade in APEC economies*

Trade in food in the APEC region as a whole is approximately in balance (table 12). The region is diverse. It includes the world's largest single food importer, Japan and the largest exporter, the United States. Because of its geography, much of the trade in food within the APEC region is between the APEC economies themselves. However, several members also have substantial trade with non APEC economies, especially in Europe and Latin America. Many of the APEC economies, such as the United States, China, and Canada are both large importers and exporters reflecting the diversity of their agricultural industries, the extent of their demand and regional supply and demand factors.

From a perspective of economic efficiency and of supply security for food, it might not particularly matter if APEC as a region is self sufficient in food, a net importing region or a net exporting region, provided adequate supplies are available to satisfy the demand of countries within the region. If each economy within the region is able to obtain the benefits from trade, including that in food, to advance its economic well being it should not be of major concern whether supplies that are purchased within the region are sourced from within that region or if exports from within the region are to APEC or non APEC economies. As indicated in the section on demand, the trend in world market prices for food has been downward, so world import demand has not been rising as rapidly as supplies over time.

This suggests that supplies traded internationally are becoming more readily available relative to demand than previously.

**Table 12: APEC Members: Trade in Food and Animals and Total Agricultural Commodities, 1994**

Country	Food and live animals		Total agriculture	
	Imports US\$ billion	Exports US\$ billion	Imports US\$ billion	Exports US\$ billion
Australia	1.3	8.5	2.0	12.0
Canada	7.0	8.1	8.6	11.2
Chile	0.6	1.5	0.8	1.8
China (include. Taiwan)	5.2	9.7	12.4	14.5
Hong Kong	4.9	1.8	9.5	5.4
Indonesia	1.8	2.0	3.1	4.8
Japan	25.7	0.9	37.7	1.6
Malaysia	2.3	1.4	3.2	6.6
Mexico	4.7	3.3	7.1	4.0
New Zealand	0.6	4.2	0.8	5.4
Philippines	1.4	0.8	1.9	1.4
Papua New Guinea	0.2	0.2	0.2	0.4
Republic of Korea	4.1	0.9	7.8	1.3
Singapore	2.8	1.8	4.9	4.0
Thailand	1.2	5.1	2.4	7.1
United States	20.5	32.2	30.9	52.3
Total APEC	84.3	82.4	133.3	133.8

Source: FAO (1995b).

## CONCLUSIONS - AGGREGATED FOOD APPROACH

Over the period since 1970, world and APEC food production has increased more rapidly than population and average consumption levels have been rising.

Population growth rates globally and in almost all countries are declining, with the reductions related to increasing incomes, changing age structures, and changing societal values which are reducing fertility rates and numbers of children per family.

World effective demand for food has not been rising as rapidly as food supplies and market prices are exhibiting a long term downward trend in real terms. Along with these developments, the incidence of malnutrition is declining significantly in terms of absolute numbers and dramatically as a proportion of total population. Nevertheless a large number of people still suffer from malnutrition, especially in Africa and South Asia, primarily as a consequence of poverty and inadequate infrastructure.

The APEC region in aggregate is experiencing rapid economic growth, with the growth being concentrated in many Asian countries.

Important changes are occurring in the composition of diets in APEC members along with increasing incomes. These include a reduction in the relative, and in some instances absolute, importance of starchy staples including grains, increasing demand for meats and dairy products and rising demand for other food crops including fruits, vegetables and vegetable oils.

Imports of some major staple foods including grains are expanding in the APEC region, but they have been static on a global basis since the early 1980s with the increases in APEC members being offset by reductions in other areas, in particular the Former Soviet Union.

There has been a marked diversity between APEC members in the extent to which imports have been contributing to growth in food supplies. Broadly, imports are becoming proportionately more important in Asian economies with the notable exception of China. This greater use of imports reflects increasing demand as incomes and population rise, the allocation of an increasing share of resources in these economies to industrial products in which they have a comparative economic advantage and constraints on domestic food production because of limited agricultural resources.

Overall, APEC members have been exporting approximately the same value of food as they import in recent years.

The situation of stocks in attaining food security globally and in APEC is changing with declining stocks in industrialised countries. Reductions in stocks in those countries have resulted largely from the gradual withdrawal from economically costly, and often ineffective policies that use stock accumulation as a means of supporting domestic producer prices. Advances in transportation and storage facilities are enabling the smaller stocks to be more effectively used.

Although urbanisation and environmental degradation are important factors limiting rates of growth in agricultural production there is substantial scope for increased production, even at the present state of technology, mainly through improved production methods. There is also some, though limited scope, if required, for cultivation of extra land (in APEC members, most of this land in North America and Oceania. On a global basis the main potential is in South America and Southern Africa while areas that have been taken out of production in the Former Soviet Union and Eastern Europe could be returned to production if required). New and improved technologies are continuing to be developed, offering additional and continuing scope for increasing food yields and production. The rate of development and application of these technologies will depend on profit incentives. Such incentives have been relatively low since the mid 1980s because of depressed market prices, especially for grains.

The record since 1970, both globally and in APEC has been one of rapid advances in agricultural technology and productivity which have increased supplies of food more rapidly than both population growth and effective demand. Lower population growth rates are contributing to demand conditions which are reflected in lower growth rates in supplies over time.



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## **Report on Area 2**

# **Food Processing and Distribution in the APEC Region**

## **Philippines, Indonesia and Canada**

## FOOD PROCESSING AND DISTRIBUTION IN THE APEC REGION

### I. INTRODUCTION

Under the auspices of the Asia-Pacific Economic Cooperation (APEC) Task Force on Food, the member economies of Canada, Indonesia and the Philippines are shepherding the Task Force's efforts in undertaking the Area 2 study on food processing and distribution. The shepherd member economies shall describe the key trends in production, consumption, and trade of processed foods in the APEC region as well as the factors that have the potential for influencing future growth and development in the sector. Some of these are trade measures, investment policies, labor, raw materials, consumer preferences, technology changes in food processing and transport infrastructure, storage systems, and quality control in food distribution systems.

The report highlights the following key trends. Overall, per capita consumption and production of processed food in the region have grown substantially over the past 30 years, with the greatest rate of increase in consumption occurring in Asian economies and the greatest rate of increase in production occurring in North America as well as in Australia and New Zealand. While the dietary patterns of all member economies have been influenced by the availability of an expanding range of processed foodstuffs, the greatest change in the dietary composition has occurred in Asian economies, which have moved away from rice and grain consumption to a greater intake of meat and dairy products. Technological developments, both in farming techniques as well as in food processing, have been an important factor in these trends, as have developments in storage and transport facilities.

Many of the region's economies have reached optimal caloric intake levels, and others are well on the way to achieving this. While cultural factors, along with economic and population growth rates, will determine future consumption patterns, the outlook is for continued dietary diversification within the region. Liberalization of trade flows has played an important role in ensuring the food requirements of the region are met, and will continue to do so. As increasing urbanization leads to greater demand for more highly processed foodstuffs, infrastructure will be important in ensuring efficient distribution of processed food. Investment in production facilities, storage and transport will therefore be important in meeting projected future demand.

The extent of value adding distinguishes processed from unprocessed food in this report. Foodstuffs produced after adding significantly to the value of primary agricultural products are considered processed. Such substantive value adding embodied in processed food relative to their primary state may result from significant physical processing or extensive activities in packaging and distribution of primary agricultural products.<sup>1</sup> More

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<sup>1</sup> Conventionally, commodities subjected to minimal processing to preserve their qualities to enable them to be traded are generally regarded as unprocessed. This includes chilling or freezing of whole fish and fruit and vegetables. Any further processing classifies foodstuffs as processed. Cereal preparations, honey, sugar, coffee, tea and cocoa are classified as unprocessed food.

specifically, the following commodities are considered processed food for the purpose of this report: meat and its preparations, dairy products, nuts and oilseeds, fish and fish products, and fruits and vegetables. In contrast, cereals and their preparations, roots and tubers, pulses, sugar and honey, cocoa, coffee, and tea and mate are considered raw food. Four data sets were used in this study: the Food and Agriculture Organization's (FAO) *State of Food and Agriculture 1995*, the Global Trade, Assistance and Protection (GTAP) Version 3 Database; the electronic version of the Schedules of Market Access Concessions under the Uruguay Round Marrakesh Protocol of GATT 1994; and the notifications of member economies to the World Trade Organization (WTO) Committee on Sanitary and Phytosanitary Measures (SPS Committee). Supplementing the above databases are secondary data obtained from studies by agencies such as the World Bank, and Economic and Social Commission for Asia and the Pacific (ESCAP).

## II. STATUS OF FOOD PROCESSING IN THE APEC REGION

### Trends in Processed Food Consumption

Per capita consumption of processed food in the APEC region in the 30 years ending in 1991 grew by 1.84 percent per annum, increasing from 483.16 kilo calories (kcal) to 834.38 kcal. After a slump in the 1970s, it picked up in the 1980s, increasing by 2.08 percent per annum during the period. The growth rates of such consumption in the 1960s and 1970s were 1.90 and 1.52 percent per annum, respectively (See Table 1).

**Table 1. APEC Region: Per Capita Processed Food Consumption in Kilo Calories, by Source: 1961 to 1991**

Source	1961		1971		1981		1991	
	Amount	%	Amount	%	Amount	%	Amount	%
Meat & Offals	113.62	23.5	158.57	27.2	187.39	27.6	250.31	30.0
Animal Fats	0.69	0.1	0.61	0.1	0.48	0.1	1.14	0.1
Milk excluding butter	76.00	15.7	71.05	12.2	69.71	10.3	73.26	8.8
Sweeteners	142.94	29.6	165.18	28.3	174.66	25.7	197.14	23.6
Nuts & Oilseeds	3.71	0.8	4.01	0.7	4.17	0.6	4.26	0.5
Fruits including wine	33.64	7.0	37.77	6.5	43.78	6.4	51.70	6.2
Vegetables	39.67	8.2	45.43	7.8	50.39	7.4	58.06	7.0
Vegetable Oils	72.91	15.1	100.91	17.3	148.23	21.8	198.51	23.8
Total	483.18	100	583.53	100	678.81	100	834.38	100
Growth Per Year	--		1.90%		1.52%		2.08%	

Source: Food and Agriculture Organization

The level and diversity of food demand in the APEC region are expected to continue growing. In the 30 year period ending in 1991, per capita food consumption in the region increased by 1.71 percent per annum. This growth was particularly rapid in Japan in the early part of the period, and in economies such as China in more recent times, while other member economies such as the US, Canada and Australia whose living standards were higher at the start of the period experienced lower and more steady rates of growth over the period.

This growth in food consumption and the diversity of diet in the APEC region are the result of robust economic growth which averaged 2 percent a year during the period.

Processed food diet diversity in the region has changed during the period. Meats and offals increasingly became important sources of nutrition, their share in the total per capita kilo calories consumed in the region increasing from 23.5 percent to 30 percent. The share of vegetable oils also increased from 15.1 percent to 23.8 percent. On the other hand, those of sweeteners and milk decreased, from 29.6 percent and 15.7 percent, to 23.6 percent and 8.8 percent, respectively. The proportion of vegetable consumption to the total hardly changed and remained steady in the range of from 7 to 8 percent (See Table 1). While the consumption of rice and other grains in the region has increased substantially over the past 30 years, consumption of animal protein has grown even more rapidly. This growth in animal protein consumption has occurred throughout the region, but has been more marked in Asian member economies.

### ***Trends in Processed Food Production***

In 1991, the APEC region produced a total of 316.3 million MT of processed food. Of this amount, the largest portion, 29.3 percent, is accounted for by cow's milk while the respective contributions of fruits and vegetables to the total were 22.9 and 22.6. The rest are oilcrops, various kinds of meat, and nuts (See Table 2).

The output of processed food in the APEC region in the 30 years ending in 1991 grew by 2.05 percent per annum, increasing from 171.9 million metric tons in 1961. Growing at the rates of 2.32 percent in the 1960s and 2.38 percent in the 1970s, production of processed food in the region decelerated and grew by only 1.46 percent per annum in the 1990s.

### ***Trends in Processed Food Trade***

By far the major proportion of processed food produced in APEC economies tends to be consumed within the economies producing it. Trade in processed food represents only a small proportion of both exports and imports within the region. For example, in 1995, exports of processed food within the region accounted for 3.7 percent of total exports, and 3.7 percent of total imports. For the US, which is the major exporter of processed foods by value, exports to the region accounted for only 4.3 percent of its total exports to the region and 2.2 percent of its imports in 1995. For Japan, the major importer of processed



foods by value, imports from the region accounted for 10.1 percent of total imports in 1995. (The comparable figures for Korea and China are 3.0 and 3.2 percent respectively).<sup>2</sup>

*Trade in General.* Aggregate trade figures clearly illustrate the growth in processed food trade within the region, with beverages and tobacco and meat and dairy (milk) products showing the greatest rate of growth. The exports of processed food items within the APEC region expanded over the period from 1984 to 1993 at the rate of 10.45 percent per year. The value of exports in meat products, milk products, and beverages and tobacco grew at the respective annual rates of 12.66, 12.20 and 15.83 percent (See Table 3). Exports of processed rice and other processed food items likewise expanded at nearly five percent and 8.36 percent per year, respectively. A similar growth pattern applies to imports. Member economies likewise expanded their imports in processed food products from within the region over the same period at an annual rate of 10.35 percent.

**Table 2. APEC Region: Processed Food Production by Kind, 1961 to 1991, in '000 MT**

Kind	1961		1971		1981		1991	
	Amount	%	Amount	%	Amount	%	Amount	%
Cow's Milk	66,757	38.84	68,783	31.81	81,268	29.71	92,731	29.32
Fruits	35,719	20.78	51,226	23.69	68,679	25.10	72,351	22.87
Vegetables	36,688	21.34	49,880	23.07	60,010	21.93	71,430	22.58
Oilcrops	8,115	4.72	11,749	5.43	20,871	7.63	27,793	8.79
Beef & Veal	8,474	4.93	11,747	5.43	12,717	4.65	13,585	4.29
Pigmeat	6,749	3.93	9,427	4.36	11,942	4.37	12,947	4.09
Poultry Meat	3,166	1.84	5,212	2.41	8,460	3.09	13,824	4.37
Hen Eggs	5,042	2.93	6,870	3.18	7,920	2.89	9,756	3.08
Mutton and Lamb	875	0.51	856	0.40	824	0.30	778	0.25
Nuts	309	0.18	473	0.22	892	0.33	1,109	0.35
Total	171,894	100	216,223	100	273,583	100	316,304	100
Growth Per Year	--		2.32%		2.38%		1.46%	

Source: Food and Agriculture Organization

The basket of processed food products exported in the region had changed in the period from 1984 to 1993. The contribution of meat products, milk products, beverages and tobacco to total exports increased over the period at the expense of processed rice and other processed food items. Meat products accounted for 21.17 percent of the total in 1984 and 25.31 percent in 1993 (See Table 3). The corresponding figures for milk products and beverages and tobacco are 4.02 and 10.86 percent in 1984, 4.63 and 16.66

<sup>2</sup> Source: The APEC Region Trade and Investment, November 1997. Department of Foreign Affairs and Trade, Australia, November 1997.

percent in 1993, respectively. The respective shares of processed rice and other processed food items dropped from 2.3 percent in 1984 to 1.46 percent in 1993 and from 61.65 percent to 52.02 percent, respectively. Despite these changes, the various processed food items making up the aggregate of other processed food account for the bulk of processed food exports in the region, although meat products as well as beverages and tobacco appear to be catching up.

**Direction of Trade.** The processed food market in the APEC region has become more integrated. During the 30-year period from 1964 to 1993, the number of APEC member-economies with whom other member-economies trade, either as markets or as sources of processed food products increased, in some cases, quite dramatically.

In order to determine the extent of the change in the degree of integration in the market for processed foods in the APEC region, a comparison of the bilateral trade relationships of individual member-economies at two points in time, namely, 1964 and 1993, was made. More specifically, the number of trading partners accounting for at least 75 percent of the exports or imports of an individual member-economy was ascertained at each point in time. The results were then compared.

The markets of member-economies in 1964 were less diversified. Seventy five percent of the respective exports of six member-economies, representing 42.9 percent of the fourteen APEC member economies for which trade data are available, went to only one country within the region (See Table 4). Three member-economies, or 21.4 percent of the total, sold the bulk of their exports to two trading partners, while 75 percent of the respective exports of four economies, or 28.6 percent of the total, went to three economies. Only one member-economy, the US, exported most of its exports to five trading partners within the region.

**Table 3. Trade in Processed Food Items of APEC Member-Economies, by Food Group, Value in Thousand USD at current prices: 1984 and 1993**

Commodities	Year	Value	Exports		Value	Imports	
			Annual Growth Rate (%)	Percent Share to Total		Annual Growth Rate (%)	Percent Share to Total
Processed Rice	1984	359,240		2.30	313,041		2.08
	1993	556,265	4.98	1.46	509,105	5.55	1.39
Meat Products	1984	3,306,172		21.17	3,297,222		21.88
	1993	9,663,814	12.66	25.31	9,597,657	12.60	26.25
Milk Products	1984	627,792		4.02	620,758		4.12
	1993	1,768,502	12.20	4.63	1,721,514	12.00	4.71
Other Food Products	1984	9,626,893		61.65	9,229,790		61.24
	1993	19,835,850	8.36	51.94	18,644,412	8.13	51.00
Beverages & Tobacco	1984	1,695,067		10.86	1,611,137		10.69
	1993	6,363,489	15.83	16.66	6,085,305	15.91	16.65
All Commodities	1984	15,615,164		100	15,071,948		100
	1993	38,187,920	10.45	100	36,557,993	10.35	100

Source of Basic Data: GTAP

After thirty years, the markets of APEC member-economies became more diversified. In 1993, only three economies, or 21.4 percent of the total, had at least 75 percent of their respective exports going to one country in the region, compared to close to 43 percent in 1964. The largest number of economies, five or 35.7 percent of the total, sold at least 75 percent of their respective processed food exports to four economies in the region. Two member-economies, representing 14.3 percent of the total, on the other hand, sold 75 percent of their processed food exports to five economies. One country, New Zealand, had six trading partners accounting for 75 percent of its exports in that year.

There were exceptions at the individual country level to this trend. The number of markets accounting for at least 75 percent of the exports of the US, for instance, shrank from five in 1964 to three in 1993. Chinese Taipei, Canada, and Mexico continued to have essentially only one destination each for their respective exports.

In the case of imports, there was one less economy in the region that had only one trading partner accounting for at least 75 percent of their respective imports of processed food products. Five economies, or a third of the total, had four trading partners supplying at least 75 percent of their imports. Another three economies sourced their imports from five other member-economies. One country, Indonesia, traded with six other APEC members for at least 75 percent of its imports.

***Trends in the Trade of Processed Rice.*** Thailand sold close to 83 percent of the total exports of processed rice of APEC member economies to other member economies in 1993. Meanwhile, five member economies accounted for the bulk of rice imports from Thailand and the United States. These economies are Japan, Malaysia, Singapore, Canada and the United States. Each economy accounted for at least 12 percent of total rice imports (See Table 5).

**Table 4. Frequency Distribution of APEC Member-Economies by Number of Trading Partners Buying at Least 75 Percent of Their Imports**

Number of Trading Partners	Year	Exports		Imports	
		Member Economies Selling 75 % of Respective Exports		Member Economies Buying 75 % of Respective Imports	
		Number	Percent	Number	Percent
1	1964	6	42.86	4	26.67
	1993	3	21.43	3	20.00
2	1964	3	21.43	3	20.00
	1993	2	14.29		
3	1964	4	28.57	4	26.67
	1993	1	7.14	3	20.00
4	1964			4	26.67
	1993	5	35.71	5	33.33
5	1964	1	7.14		
	1993	2	14.29	3	20.00
6	1964				
	1993	1	7.14	1	6.67
Total		14	100.00	15	100.00

Source of Basic Data: GTAP

***Trends in the Trade of Meat and Meat Products.*** The US, Australia, New Zealand, and Canada were the top four APEC member-economies exporting meat and meat products to the APEC region during the ten-year period ending in 1993. On the other hand, Japan was the largest meat importer, accounting for nearly 54 percent of the total. The US was the second largest importer, its imports averaging 22.5 percent of the total.

***Trends in the Trade of Beverages and Tobacco Products.*** More than half (52.2 percent) of the beverages and tobacco products exported by APEC member-economies to other APEC member-economies was accounted for by the US. Canada and Singapore were the second and third largest exporters of the same commodities. Japan and the US, on the other hand, were the largest importers of the same goods, buying 40.4 percent and 29.2 percent of the total.

***Trends in the Trade of Milk Products.*** New Zealand and Australia accounted for slightly over 70 percent of all exports of milk products made by APEC member-economies within the region in 1993. Intra-APEC imports of milk products were relatively more evenly distributed, with Japan, Malaysia, Mexico, and the Philippines each importing 10 percent or more of the total.

***Trends in the Trade of Other Processed Foods.*** The US was the largest exporter of other processed foods to other APEC economies, selling close to thirty percent of the total in 1993. Malaysia, Thailand, and Canada were the next largest exporters of the products, each accounting for slightly more than 10 percent of the total. On the other hand, the US, Japan, and Canada were the largest importers of the same, with both the US and Japan importing in the neighborhood of a quarter of the total.

**Table 5. Sources of Exports and Destination of Imports of Processed Food Products in the APEC Region: 1993\***

Member Economy	Processed Rice		Meat Products		Milk Products		Other Food Products		Beverage & Tobacco		All Commodities	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Australia	1.49	2.17	25.03	0.20	33.13	3.42	7.87	3.91	2.21	1.50	12.35	2.49
Canada	0.15	12.06	10.50	8.97	2.71	2.38	11.16	14.03	18.92	3.20	11.74	10.32
Chile	-	0.21	0.02	0.03	0.00	1.22	2.64	0.23	1.16	0.42	1.57	0.25
Chinese Taipei	0.06	0.00	11.86	1.55	0.07	8.42	5.26	2.98	0.49	0.42	5.82	2.39
Indonesia	0.52	0.95	0.10	0.23	0.17	3.75	3.20	1.95	1.50	0.69	1.95	1.36
Japan	0.06	20.57	0.13	53.90	0.41	17.28	3.70	27.05	2.63	42.84	2.41	36.18
Korea	0.01	1.66	0.87	3.64	0.01	1.09	3.41	5.00	0.48	7.18	2.07	4.77
Malaysia	0.06	12.84	0.17	0.54	2.54	11.71	9.82	3.83	0.83	2.36	5.40	3.22
Mexico	-	4.58	0.35	6.71	0.05	20.91	2.94	5.79	5.96	2.09	2.61	6.11
New Zealand	0.00	1.54	9.51	0.22	40.35	0.35	2.08	1.56	0.30	0.76	5.41	1.02
Philippines	0.01	7.09	0.00	0.20	0.01	11.99	4.00	1.39	0.31	0.72	2.13	1.54
Singapore	1.03	18.32	0.13	1.19	1.85	7.06	3.46	6.90	16.91	7.79	4.75	5.72
Thailand	82.74	0.00	3.82	0.07	0.37	5.63	10.73	1.35	1.37	1.58	7.99	1.24
United States	13.87	18.02	37.50	22.54	18.34	4.80	29.71	24.03	46.93	28.44	33.80	23.38
Total	100	100	100	100	100	100	100	100	100	100	100	100

\* No data on Chinese trade in GTAP

Source of Basic Data: GTAP

## **INFRASTRUCTURE DEVELOPMENT**

The discussion in the preceding section highlighted the important role food trade has taken in helping increase per capita food consumption in the APEC region. Member economies with inadequate capacity to produce food were able to attain higher levels of food consumption through trade. In this and the following two sections, the report briefly takes up the respective influences of infrastructure investments, trade facilitation measures and tariff measures on the overall trend of trade.

### **Importance of Infrastructure**

General infrastructure, comprising transport, storage and handling as well as good distribution and communication systems, is essential for the development of processed food industries and sustained economic growth. The extent to which agricultural production can be efficiently and fully utilized, and the food demands of growing urban populations met, depend on appropriate and integrated infrastructure.

The APEC member economies have all enjoyed relatively high per capita economic growth since 1965. Recently, most of them have implemented reforms aimed at increasing industrial competitiveness and liberalizing their domestic markets. The level of infrastructure development of member economies determines their capacity to respond to, and thus benefit from, the ever-increasing APEC intra-regional trade. Infrastructure also helps determine one country's success and another's failure in diversifying production, coping with population growth, reducing poverty, or improving environmental conditions.

While the precise linkages between infrastructure investments and economic development are still open to debate, several studies indicate that the two are correlated. Data from the World Bank (WB 1994) point out that infrastructure capacity grows in tandem with economic output. A one percent increase in infrastructure is associated with a one percent growth in gross domestic product in a fairly good number of economies. These studies suggest that the infrastructure investments in Japan, Chinese Taipei, the United States and South Korea have rates of return reaching 96 percent.

### **Availability of Infrastructure**

Providing infrastructure services to meet the demand of businesses, households and other users is one of the major challenges of economic development. The availability of infrastructure has increased significantly in the APEC developing economies over the past several decades. In many cases, however, the full benefits of past investments are not being realized, resulting in a serious waste of resources and loss of economic opportunities. This outcome is frequently caused by inadequate incentives embodied in the institutional arrangements for providing infrastructure services.

Within the region, there are wide variations in the current levels of infrastructure available for encouraging the establishment of efficient food processing industries, as well as

variations in the nature of infrastructure required for particular situations. It is not possible, within the scope of this report, to go beyond a general statement as to the importance of appropriate infrastructure as an essential requirement for the establishment and development of food processing industries. However, the following highlights a number of areas where there is a need for improved infrastructure. Aside from general national economic policies, there should be scope for targeted investment and cooperation in the development of infrastructure in the food processing sector.

According to the WB, the services associated with the use of infrastructure account for roughly 7 to 11 percent of GDP, with transport being the largest sector. Transport alone commonly absorbs 5 to 8 percent of total employment. A sample of developing countries shows that infrastructure typically represents about 20 percent of total investments and 40 to 60 percent of public investments. It is evident from the same data that countries that enjoy high per capita income also have high availability ratios of infrastructure per person, in terms of paved roads, railways and telecommunication facilities.

**Road Transport.** Recent surveys in Indonesia indicate that roads and interisland shipping are the most crucial elements of the infrastructure system. Respondents considered the road network adequate in all areas surveyed, although the quality of maintenance varied. Trucking services are widely available for short-term or long-term contracts. There were perceptions, however, that the cost of capital and vehicles were too high, preventing trucking firms from investing in better equipment and small firms from acquiring their own vehicles. Taxes and fees were also perceived to be prohibitive.

Under the auspices of the ESCAP, a proposal for an integrated Asian land transport system was adopted. The proposed Asian highway is supposed to extend from Afghanistan and Iran to Thailand, Vietnam, Indonesia and the Philippines. These road networks, approximately 90,000 kilometers in length, shall be built by the individual nations according to standard international specifications.

**Rail Transport.** Maintenance and technological upgrading rather than track expansion have been emphasized in railway development in most countries and railway route electrification has made strong headway in most countries in the region. With China undertaking the largest new railway construction, Southeast and East Asian members of the APEC have extended their railway networks, by 2.1 percent and 2.7 percent per year, respectively, during the period from 1986 to 1994. Meanwhile, the developed countries of the region reduced their route length by almost two percent by closing loss-making segments (ESCAP, 1997). Most of the projects to construct inter-country railways in this region are under study to determine their feasibility. The proposed Trans-Asian Railway is intended to be an extensive network, consisting of five major land bridges. Only one bridge has been completed so far.

**Air Transport.** The present air infrastructure facility in the area is quite capable of supporting the needs of transporting merchandise products as new, medium to large-size airports of international standard are being established in many countries. Nonetheless there is the need for sophisticated navigational/radar system to be installed at these new

airports. The needs of modern cargo facilities attached to existing or future airports are also being given greater attention.

***Shipping and Ports.*** Shipping capacities have grown in most APEC member economies over the past few decades, with most developing countries having their own national shipping lines. A major concern of developing countries was the change in operating practices and the route structures of the large international consortia. Prior to the advent of containers, the major ports in most countries received direct calls for vessels operating on the major trade routes. The existing practice now is to deploy large mainline vessels on routes that only called at a small number of large transshipment ports, and have smaller feeder vessels ship to neighboring countries.

Based on an Indonesia survey, the shallow drafts in ports and inadequate loading and unloading facilities were often the subject of criticisms. Only small ships could get access to ports with shallow drafts, making the transport of heavy, high bulk-low value goods like cement, fertilizer and animal feed especially inefficient and vulnerable to contamination and spoilage. Inadequate loading and unloading facilities, on the other hand, result in unreliable shipping schedules.

***Telecommunications.*** The member economies have adopted digital electronic systems controlled by computer processors. These systems are able to provide more reliable, high-quality services options. Other developments in the telecommunications field include fixed telephone networks, facsimile, data transmission and inter services, as well as mobile/cellular telephone services.

## **TRADE REGULATORY MEASURES IN FOOD PROCESSING**

As with other goods and services, the movement of processed food across member-economies within the APEC region is, to a significant extent, subject to a number of regulatory measures. These measures, the most salient of which are customs procedures, labeling, quality assurance and market information services (LAMIS), and SPS measures, have the potential to create inefficiencies, increasing the cost of goods and services in the process. Inappropriate regulatory services can also impinge on trade and reduce the degree of choice, while engendering miss-allocation of resources, investment, and human capital.

### **Customs Procedures**

In its 1996 Report to Economic Leaders, the APEC Business Advisory Council remarked that the following were involved in an average international trade transaction: 27-30 different parties; 40 documents; 200 data elements (30 of which are repeated many times); and the re-keying of 60-70% of all data at least once. Recognizing the role customs procedures and services can play in engendering such burden on trade, APEC member-economies, through the APEC Sub-Committee on Customs Procedures (SCCP), have undertaken initiatives to improve such procedures and services within the region. Such



initiatives that focus on the institution of facile, transparent, consistent, and simple customs clearance procedures, include *Pre-Approval Release* of a range of low-risk goods to eliminate the need to provide repetitive information on their shipments; *Pre-Arrival Release* through the transmission of shipment information while the goods are en route, thereby making possible a decision whether to examine or release the shipment prior to its arrival; *Risk Management* by focusing customs' resources on areas of greatest risk, thereby providing faster and more consistent service for low-risk shipments and decreased business trading costs; and *Periodic Verification or Periodic Audit* rather than shipment-by-shipment reviews, focusing on building compliance levels with clients.

More specifically, the APEC SCCP's Action Plan hopes to:

- (a) Harmonize tariff structures with the HS Convention;
- (b) Make customs procedures, including information on customs laws, regulations, administrative guidelines, procedures and rulings, transparent;
- (c) Simplify and harmonize customs procedures on the basis of the Kyoto Convention;
- (d) Adopt and Support the UN/EDIFACT;
- (e) Adopt the Principles of the WTO Valuation Agreement;
- (f) Adopt the Principles of the WTO Agreement on Trade-Related Intellectual Property Rights (TRIPS);
- (g) Introduce clear appeals provisions;
- (h) Introduce an Advance Classification Ruling System;
- (i) Provide for temporary importation through the institution of the A.T.A. Carnet Convention or the Istanbul Convention;
- (j) Harmonize APEC data elements;
- (k) Promote risk management techniques; and
- (l) Establish guidelines on Express Consignments Clearance.

### **Information Services and Regulations**

Information corrects asymmetries and improves efficiencies. Imperfect and asymmetrically held information leads to one of two outcomes: either a market fails to exist for a product or the market provides lower quality products than would be optimal. Consequently, services and regulations which make information available and understandable - such as labeling, quality assurance and market information services (LAMIS) - play a vital role in the efficient functioning of markets, and in the rational utilization of resources.

When appropriately designed, LAMIS has the capacity to facilitate trade, promote greater competition, improve accountability up and down the value chain, and lower waste and costs throughout the food sector. More specifically, it provides a common language or framework that better facilitates exchange in the market, as well as the settlement of payment. It can also serve as a dispute settlement mechanism, displacing (often costly) arbitration in some instances and providing a frame of reference for arbitration in other

instances, as well as a basis for product differentiation and preference-based marketing, thereby reducing waste. Finally, it encourages better accountability up and down the value chain, both through official regulatory agencies and through self-regulation mechanisms.

All APEC economies implement LAMIS. However, a great variety of nomenclature and reporting formats exist across the member-economies. This has retarded trade, accountability, and the efficient functioning of markets, both within the economies, and between and among them. If LAMIS is to fulfill its full potential in facilitating trade and improving efficiencies and accountability, APEC economies need to work together to establish a common set of nomenclature and reasonably consistent reporting formats for such information services.

### **SPS Measures**

Sanitary and phytosanitary (SPS) measures play a particular role in ensuring the safety of food which is traded as well as in protecting human, animal, and plant health. A number of member economies have advanced technological capacity to ensure the quality and safety of processed food, and there is scope for this to be disseminated throughout the region by a number of means. These include technical assistance and training investment. Considerable progress has been made in developing international standards for a wide range of processed foods, and it is in the interest of all member economies to apply such standards, where relevant to their circumstances. Mutual recognition agreements, under which countries accept the standards of others where it can be demonstrated that differing standards meet the importing country's requirements, also provide an effective means of ensuring that trade flows are not unduly jeopardized by such differences.

At present, 16 of the 18 APEC economies are members of the WTO and thus are signatories to the Agreement on the Application of SPS Measures. This Agreement is important in that it is designed to ensure that market liberalization measures achieved through the WTO Agreement on Agriculture are not undermined through the application of SPS measures which are not justifiable on scientific grounds.

It also recognizes the right of governments to impose SPS measures to protect human, animal or plant life or health. However, it also stipulates that such measures must be based on science, should be applied only to the extent necessary to protect human, animal, or plant life or health, and should not arbitrarily discriminate between WTO members where identical or similar conditions prevail.

While the Agreement calls for members to harmonize their SPS measures with internationally agreed standards, guidelines or recommendations where these exist, members may deviate from such standards where they can demonstrate the need to do so to achieve an appropriate level of SPS protection for their particular circumstances. Members are also required to notify member economies through the WTO Secretariat about any amendments to pre-existing measures or any new SPS measures introduced from 1 January 1995 when the Agreement entered into force. It must be noted that the Agreement does not require WTO members to notify all SPS measures.

The underlying objective of the Agreement in this regard is that greater predictability and uniformity of SPS measures will be achieved through increased stringency in the determination of measures based on scientific principles and scientific evidence.

The SPS measures developed by the Codex Alimentarius Commission, the Office International des Epizootic (OIE), and by organizations operating within the International Plant Protection Convention (IPPC) are used as basis for harmonization. The Codex Alimentarius Commission is an international inter-government organization of 159 countries established in 1962 to protect the health of consumers on a global scale and ensure fair practices in the food trade. It provides a forum where member countries exchange information and ideas relative to food quality and safety issues. Through the Codex Alimentarius, it establishes food standards, hygienic and technical practice and related guidelines and recommendations which can be used by countries both to protect consumers and facilitate trade.

Concerns have been expressed that the Codex, specifically the Code of Hygienic and Technical Practice, is largely related to composition parameters and thus has only a marginal SPS focus. Because the WTO-SPS Agreement references Codex as a basis for establishing acceptable SPS measures, the WTO and the Codex Alimentarius Commission are examining means to identify Codex text that are specifically SPS oriented, thereby facilitating the administration of the WTO-SPS Agreement. Moreover, it has been pointed out that many Codex measures are incomplete, evolving, and open to interpretation. This, it had been claimed, makes it difficult to determine equivalency or harmonization of practices among WTO and APEC member-economies. Since economies may interpret these components differently, adoption of the Codex does not imply equivalency or that SPS measures are harmonized at all.

The OIE, on the other hand, is an inter-governmental organization of 147 countries. Its main objectives are to: 1) inform governments of the occurrence and course of animal diseases throughout the world, and of ways to control these diseases; 2) coordinate, at the international level, studies devoted to the surveillance and control of animal diseases; and 3) harmonize regulations for trade in animals and animal products among member countries. The organization publishes the OIE Manual of Standards for Diagnostic Methods and Vaccines (the Manual) which provides standardized techniques and vaccine control methods for use in international trade. It also provides the International Animal Health Code (the Code) which defines the animal health conditions to be fulfilled in order to avoid the risk of transmitting infectious diseases of animals from one country to another. As of November 1997, sixteen of the eighteen APEC economies are members of the OIE.

The IPPC, meanwhile, is an international treaty in effect since 1957 under the auspices of the FAO, with 105 signatory countries. Its principal objective is to maintain and increase international cooperation in controlling pests and diseases of plants and plant products, and in preventing their introduction and spread across national boundaries. Its provisions include: a) the adoption of measures specified in the convention by each country; b) the setting up of official plant protection organizations in each country which inspect for plant

pests or diseases, issue phytosanitary certificates, and carry out research in the field of plant protection; and c) the regulation of trade of plants and plant products.

To illustrate the state of harmonization with international standards achieved in the APEC region, the level of Maximum Residue Limits (MRLs) imposed on rice and pineapple by several member-economies were compared with the levels recommended by the Codex. More specifically, the thirteen substances for rice and 10 substances for pineapple for which MRLs are established under the Codex were included in the analysis.<sup>3</sup> The limits of 12 of the 18 member-economies, namely Australia, Canada, Chile, Japan, Korea, Malaysia, Mexico, New Zealand, Singapore, Chinese Taipei, Thailand, and the USA were considered.

The analysis show that nine out of the 12 economies analyzed have, at most, half of their respective MRLs in pineapple greater than or identical with those of the Codex. In the case of rice, five economies are similarly situated (See Table 6).

Notifications submitted by member economies to the WTO SPS Committee were also used to illustrate the degree of harmonization among APEC economies. More specifically, it reviewed the 93 notifications submitted by Canada, Chile, Japan, Korea, Malaysia, Mexico, New Zealand, Singapore, the Philippines, Thailand, and the USA during the period from January 1 to November 30, 1997.

**Table 6. Percentage of Regulatory MRLs Greater or Identical to Codex Standard**

Economy	Rice	Pineapple
Australia	69%	10%
Canada	69%	70%
Chile	54%	0%
Japan	15%	20%
Korea	69%	90%
Malaysia	54%	50%
Mexico	23%	10%
New Zealand	100%	100%
Singapore	85%	40%
Chinese Taipei	38%	20%
Thailand	0%	10%
USA	38%	50%

**Source of Basic Data: Canadian Pest Management Regulatory Agency**

<sup>3</sup> Data on these MRLs were obtained from a data base maintained by the Canadian Pest Management Regulatory Agency (PMRA).

The analysis show that 79 percent of the notifications fell within the jurisdiction of the Codex Alimentarius Commission; 18 percent within the jurisdiction of the OIE and 3 percent within the jurisdiction of the IPPC. Moreover, 73 percent claimed that the proposed change had no relationship to an existing international standard.

Both these illustrations suggest that few member economies of APEC base their SPS measures with those developed by international standards setting bodies. It shows diversity in measures being imposed by member economies. Such diversity may be attributed to the varying risk assessment techniques being used in achieving the appropriate level of sanitary and phytosanitary protection from such risk. These illustrations also demonstrate that SPS measures are not static. The development of new production and processing procedures, of new inputs and products, as well as, of improved health and safety scientific evidence generate a need for constantly evolving SPS measures.

The key issue in ensuring APEC economies are able to maximize food trade is to ensure SPS measures, including quarantine measures, are applied consistently with the SPS Agreement. There are many instances of long standing quarantine controls which countries are in the process of reviewing in the light of the availability of advanced scientific equipment. The processes associated with examining scientific data and demonstrating the efficacy of treatment processes can be complex and time consuming. Similarly, there should also be scope for progressively increasing the extent to which the SPS measures of other countries can be accepted amongst member economies.

## **ACCESS INTO THE APEC REGION: TARIFF BINDING COMMITMENTS ON FOOD OF APEC MEMBER-ECONOMIES UNDER THE GATT URUGUAY ROUND FINAL ACT**

Tariffs and other border measures have a particular role in influencing trade flows and hence the availability of competitively priced food to consumers. Tariffs have the capacity to impact directly on the development of food producing industries. High levels of protection accorded by tariffs (as well as other border restrictions) limit the flow of trade in processed food in the region and lowers the capacity of the region to meet the rising demand for processed food of the growing population in this economically-dynamic region of the world. Tariff escalation (i.e., higher levels of tariffs for processed goods compared with basic inputs) may lead to further distortions in the allocation of resources in agriculture and food production.

Under the multilateral trade system of the WTO, all tariffs on agricultural products which include all foods, are required to be bound. Because agriculture has only begun to be brought within the GATT/WTO framework with the conclusion of the Uruguay Round of negotiations, these tariff rates on food tend to be high. The procedure that was applied under the Uruguay Round to convert non-tariff into tariff measures resulted in many high bound tariffs and tariff rate quotas which continue to impose substantial limitations on food flows.

The following section discusses the tariff bindings committed by the individual APEC member- economies on their processed food items under the Uruguay Round. Discussions in it are based on averages of the tariffs imposed at the eight-digit level of the Harmonized System (HS) Code, aggregated at the four-digit level. It is important to stress that only ad valorem tariffs were considered in the analysis. Thus, if the tariff structure required both an ad valorem and/or a specific tariff, then only the ad valorem tariff was considered. It is also important to note that, for most of the economies, these numbers refer to ceiling bindings that may be higher than the actual tariffs they are applying on their processed food products. The analysis provides a useful indicator of the level of protection provided by tariffs. A further qualification which needs to be taken into account is that average tariffs, while providing a useful indicator of the overall level of tariff bindings, fail to disclose the range of tariff rates making up the average.

While it may be more meaningful to undertake the tariff analysis using applied tariffs rather than bindings, it was extremely difficult to obtain such applied tariffs. Considering that applied tariffs can also be revised as long as these do not go beyond the bindings, then the bindings become more indicative of the scope of cooperation among APEC member-economies in reducing import restrictions.<sup>4</sup>

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<sup>4</sup> It is unfortunate that this report failed to utilize both ad valorem and specific tariffs in the analysis. Perhaps this could be the scope of further work on the topic.

## Overview of Tariff Policies in the APEC Region

Of all the member-economies, Indonesia, the Philippines, Mexico, Thailand, and South Korea impose, by far, relatively high rates of tariff protection on their respective processed food industries. All of the tariff lines of Indonesia for which data is available have average tariffs of at least 30 percent, with 86.25 percent of these rates ranging from 30 percent to 50 percent. In the Philippines and Mexico, 81.25 percent of the tariff lines have rates ranging from 30 percent to 50 percent. In the Philippines, the rest of the lines have rates of from 10 percent to 30 percent, while in Mexico, the rest of the lines have varying rates.

In Thailand, 42.5 percent of the tariff lines have average tariff rates ranging from 30 percent to 50 percent, while 38.75 percent has rates ranging from 10 percent to 30 percent. Eleven percent of the tariff lines in Thailand have rates averaging more than 50 percent. South Korea, for its part, has the largest number of tariff rates averaging more than 50 percent among the APEC member-economies, 20 percent of its lines having the said average rate. However, only 30 percent of South Korea's tariff lines average from 30 percent to 50 percent while 42.5 percent has rates averaging from 10 percent to 30 percent.

On the other hand, Hongkong, Singapore, Australia, Canada, and New Zealand accord relatively lower protection on their respective processed food sectors. Almost all of the 80 tariff lines in Hongkong (98.75 percent) and Singapore (97.5 percent) have rates averaging from 0 percent to 10 percent. Eighty-seven percent of the lines of Australia, and 75 percent of the lines of Canada has have same rates. In New Zealand, 72.5 percent of the tariff lines have the same average (See Table 7).

***Meat and Meat Products.*** In general, APEC member-economies maintain lower tariffs for meat of sheep and horses than they do for meat of bovine animals and swine. The bound rates committed by these economies on meat of sheep and horses average 16.5 and 18.9 percent, respectively, while the bound rates of these economies on meat of bovine animals and swine average around 25 percent and 27 percent, respectively (See Table 8).

The bound rates for processed meats in the APEC region are likewise generally higher than fresh meats. For instance, the bound rates committed by APEC member-economies on sausages and similar products average 25.75 percent while those on frozen meat of bovine animals average 24.4 percent.

Of all APEC member-economies, Hongkong imposes the lowest bound rates, its rates averaging 0 percent. Australia also imposes 0 percent tariffs on most meat products, its bound rates for these commodities averaging 1.67 percent. The US imposes the next lowest bound rates, these tariffs averaging 3.67 percent. On the other hand, Indonesia, Mexico, and Canada impose the highest average bound rates on meat and meat products. Indonesia's bound rates generally amount to 50 percent, and average 46.2 percent, the highest among the APEC member-economies. Mexico's bound rates, on the other hand, range from 45 percent to 24 percent, averaging 44.4 percent. Canada's average bound rate for meat products is the result of high average bound tariffs of 128 percent, 106 percent,

and 105 percent for poultry meat; for salted, smoked, or dried meat or meat in brine; and for sausages. For meats other than those of bovine, Canada's bound rates averages 0 percent.

**Table 7. Frequency Distribution of Tariff Lines of Processed Food by Average Bound Ranges 1994**

	0%-10%		10%-30%		30%-50%		50%+		Others		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	
Australia	70	87.5	5	6.25	0	0	0	0	5	6.25	80
Brunei	0	0	65	81.25	11	13.75	0	0	4	5	80
Canada	60	75	4	5	0	0	12	15	4	5	80
Chile	0	0	69	86.25	10	12.5	0	0	1	1.25	80
China	0	0	12	15	60	75	7	8.75	1	1.25	80
Hongkong	79	98.75	0	0	0	0	0	0	1	1.25	80
India	0	0	0	0	69	86.25	10	12.5	1	1.25	80
Japan	44	55	28	35	3	3.75	0	0	5	6.25	80
Korea	4	5	34	42.5	24	30	16	20	2	2.5	80
Malaysia	42	52.5	30	37.5	0	0	4	5	4	5	80
Mexico	1	1.25	3	3.75	65	81.25	1	1.25	10	12.5	80
New Zealand	58	72.5	21	26.25	0	0	0	0	1	1.25	80
Philippines	0	0	8	10	65	81.25	0	0	7	8.75	80
Singapore	78	97.5	0	0	0	0	0	0	2	2.5	80
Thailand	4	5	31	38.75	34	42.5	9	11.25	2	2.5	80
USA	48	60	14	17.5	0	0	1	1.25	17	21.25	80

Source of Basic Data: GATT, 1994.

**Fish and Fish Products.** Tariffs are generally low for fish and fishery products in the APEC region, the bound rates imposed by the member-economies averaging in the range of 14 percent. Across member-economies, however, averages vary widely. Indonesia imposes an average of 40 percent, the highest among the economies. China's bound rates average 37 percent while Chile's average 25 percent. On the other hand, Hongkong's bound rates average 0 percent while the averages for Australia and the US were 1.67 percent and 1.83 percent, respectively.

**Dairy and Animal Products.** The bound rates of APEC member-economies for dairy and animal products are generally high, averaging 43.6 percent. The average bound rate for concentrated milk and cream was highest among such products, amounting to 51.8 percent, while that for whey was lowest at 26.6 percent.



As with other commodities, the average bound rates imposed within the APEC region varies substantially across member-economies. Hong Kong, China imposes 0 tariffs on all dairy and animal products. Australia, for its part, imposes a 0 percent tariff on cheese and curd and on milk and cream, not concentrated, and a 1 percent tariff on the rest of the dairy and animal products. Canada, on the other hand, imposes an average bound tariff rate of 208 percent on such commodities. Its bound rates range from an average of 246 percent for cheese and curd, to an average of 133 percent for milk and cream, not concentrated. Indonesia, meanwhile, imposes an average of 102 percent, its bound rates ranging from 182 percent for concentrated milk and cream, to 40 percent for whey.

***Vegetables and Vegetable Products.*** The average bound rates for vegetables and vegetable products in the APEC region varies across commodities, ranging from as high as 45.5 percent for fresh and chilled potatoes, to the 20 percent for carrots, turnips, salad beetroot, etc. These rates average 23.9 percent.

South Korea imposes the highest bound rates, such rates ranging from the high of 304 percent for fresh and chilled potatoes, to the low of 27 percent for cabbages and cauliflowers, averaging 69.2 percent. Indonesia has the next highest bound rates, imposing an average of 45.8 percent. Its rates range from the high of 50 for, among other products, fresh and chilled, shelled or unshelled leguminous vegetables to the 40 percent for fresh or chilled cucumbers.

Aside from Hongkong, which imposes a uniform 0 percent tariff for all vegetables and vegetable products, Canada and Australia have the lowest tariff bindings for such commodities. Canada's bound rates for the products average 3.94, ranging from the 17 percent for prepared or preserved tomatoes, to the 0 percent for fresh or chilled tomatoes. Australia's bound rates, on the other hand, average 4.33 percent, ranging from the 12 percent for dried vegetables, to the 1 percent for cabbages and cauliflowers.

***Fruits and Fruit Products.*** The bound rates committed by the member-economies of the APEC for fruits and fruit products range from the average of 31.6 percent for other dried fruit, to the average of 18.9 percent for fresh or dried grapes. These tariffs average 23.7 percent.

The APEC member economy that imposes the highest average bound rates for fruits and fruit products is South Korea, followed by Indonesia and Mexico. South Korea's bound rates amount from the high average of 128 percent for other dried fruit, to the low of 21 percent for fresh or dried grapes, averaging 59.9 percent. Those of Indonesia, on the other hand, average 48.1 percent, and range from the 60 percent for peel of citrus fruit or melons, to the 40 percent of fresh or dried bananas. Those of Mexico, meanwhile, average 45.3 percent, ranging from the 128 percent for other dried fruit, to the 36 percent for fresh or dried grapes, among other fruits and fruit products.

Aside from Hong Kong, China, the APEC member-economies having the lowest tariff bindings for fruits and fruit products include Canada and Australia. Canada has bound rates of from a high of 7 percent for jams, jellies, marmalade, etc., to a low 0 percent for peel or citrus fruit or melon. These rates average 1.93 percent. Those of Australia, on the

other hand, average 3.8 percent, and range from 11 percent for fruit juices and vegetable juices, to 0 percent for fresh or dried bananas.

***Animal and Vegetable Oils and Fats.*** The bound rates for animal and vegetable oils and fats among APEC member-economies varies from an average of 13.5 percent for fats of bovine animals, to the 32.1 percent of soya bean oil and its fractions. These rates average 20.7 percent.

Thailand, China, and Mexico impose the highest average bound rates for animal and vegetable oils and fats among the APEC member-economies. Thailand's rates average 50.8 percent, the highest among the member-economies, ranging from the 146 percent for soya bean oil and its fractions, to the 27 percent for, among other products, pig fat. Those of China average 45.2 percent, and range from the high of 122 percent for soya bean oil and its fractions, to the low of 18 percent for lard oil, etc. Meanwhile, the rates of Mexico range from 18 percent for fats of bovine animals, to the 45 percent for the rape, colza or mustard oil and fractions, in all averaging 41.4 percent.

Hong Kong, China, which imposes 0 tariff rates on such products, and New Zealand, Australia, and Japan have the lowest bound rates for animal and vegetable fats and oils among the APEC member-economies. New Zealand's bound rates average 3 percent, from a high of 14 percent for margarine, to the 0 tariff for, among other products, fats of bovine animals. From a high of 8 percent for margarine to a low of 0 percent for, among other products, olive oil and its fractions, Australia's bound rates average 3.6 percent. Meanwhile, Japan's bound rates for animal and vegetable fats average 3.7 percent, imposing a high of 15 percent for margarine to 0 percent for fats of bovine animals.

***Processed Cereals.*** Among the processed cereal products, APEC member-economies committed the highest bound rates for pasta at an average of 23.5 percent and the lowest for tapioca at an average of 18.6 percent. Indonesia, China, and the Philippines committed the highest bound rates for processed cereals. Indonesia's rates average 42.5 percent, imposing 48 percent on pasta and 40 percent for tapioca. China imposes a uniform 40 percent on all cereal products, while the Philippines imposes 40 percent on pasta and 35 percent on foods prepared from cereals. Hong Kong, China on the other hand, imposes a 0 tariff on such products.

***Beverages.*** APEC member-economies impose relatively high tariff rates on beverages. These economies impose an average of 44 percent on vermouth as bound rates while imposing a 41 percent bound rate on other fermented beverages. Indonesia and China impose the highest rates, the bound rates of these economies averaging 144 percent, and 135 percent, respectively. Aside from Hong Kong, China, which also imposes a 0 percent on such products, New Zealand imposes the lowest rate on beverages, its rates averaging 6.5 percent.

**Table 8 APEC Region: Average Bound Rates for Various Processed Food Products, in %**

PRODUCTS	HS	Aus	Bru	Can	Chl	Chi	HK	Ind	Jap	Kor	Mal	Mex	NZ	Phi	Sin	Tha	USA	AVE.	
Meat & Meat Products	0201	0	20	27	25	38	0	50	50	40	15	45	0	38	3	50	15	26	
	0202	0	20	0	25	33	0	50	50	40	15	45	0	37	10	50	15	24.37	
	0203	0	20	0	25	40	0	50	2	24	139	45	9	40	10	33	0	27.31	
	0204	0	20	0	25	35	0	50	0	23	15	24	0	35	8	30	0	16.56	
	0205	0	20	0	25	40	0	50	0	27	15	45	0	40	10	30	0	18.87	
	0206	0	20	0	25	34	0	41	13	18	8	33	11	35	10	32	0	17.5	
	0207	0	45	128	25	39	0	42	8	21	65	38	17	40	10	32 *		34	
	0208	1	20	0	25	40	0	41	0	21	12	33	13	40	7	33	3	18.06	
	0209	0	20	72	25	40	0	50	6	7	5 *		0	40	10	30	3	20.53	
	0210	0	24	106	25	40	0	50	8	24	85	45	10	40	10	40	2	31.81	
	1601	8	20	105	25	40	0	40	0	25	13	45	8	40	10	30	3	25.75	
	1602	11	20	57	25	40	0	40	17	60	13	45	11	41	10	36	3	26.81	
Ave.		1.666	22.41	41.25	25	38.25	0	46.16	12.83	27.5	33.33	44.36	6.583	38.83	9	35.5	3.666	23.96	
Fish & Fishery Products	0304	*	*	*	25	37	0	40	3	10	15 *		0 *		10	5	1	13.27	
	0305	0	22	0	25	38	0	40	9	20	15 *		0 *		10	7	2	13.42	
	0306	*		23	3	25	34	0	40	4	14	21 *		5 *		10	5	1	14.23
	0307	*		20	0	25	33	0	40	6	20	30 *		1 *		10	5	0	14.61
	1604	5	20	6	25	40	0	40	9	20	10 *		6 *		10	26	5	15.85	
	1605	0	20	4	25	40	0	40	7	20	20 *		7 *		8	20	2	15.21	
	Ave.		1.666	21	2.6	25	37	0	40	6.333	17.33	18.5		3.166		9.666	11.33	1.833	14.43

PRODUCTS	HS	Aus	Bru	Can	Chl	Chi	HK	Ind	Jap	Kor	Mal	Mex	NZ	Phi	Sin	Tha	USA	AVE.
Dairy & Other	0401	0	20	133	25	27	0	40	21	36	25	38	8	18	10	41 *		29.46
Animal	0402	1	25	195	32	69	0	182	25	141	5	40	11	24	10	53	16	51.81
Products	0403	1	20	135	25	40	0	83	27	45	10	38	19	32	5	25	18	32.68
	0404	1	20	124	25	24	0	40	27	45	3	38	10	22	10	27	10	26.62
	0405	1	20	207	32	40	0	125	30	89	4	33	6	30	0	23	9	40.56
	0406	0	20	246	32	40	0	40	31	36	9	45	9	33	10	30	11	37
	Ave.	0.8	25	208	34.2	48	0	102	32.2	78.4	11.2	46.4	12.6	31.8	9	39.8	12.8	43.63
Eggs	0407	0	40	201	25	35	0	40	13	27	56	40	0	40	10	29 *		37.06
	0408	0	20	9	25	40	0	40	20	30	5	38	0	40	10	27 *		20.26
	Ave.	0	30	105	25	37.5	0	40	16.5	28.5	30.5	39	0	40	10	28		28.66
Vegetables & Vegetable Products	0701	5	20 *		25	40	0	50	4	304	5	9	0	40	10	125 *		45.5
	0702	1	20	0	25	25	0	50	3	45 *		36	0	40	10	40 *		21.07
	0703	1	20	0	25	40	0	45	4	115	10	36	6	40	10	80	20	28.25
	0704	1	20	0	25	40	0	50	3	27	22	36	8	40	10	40	12	20.87
	0705	1	35	0	25	36	0	50	3	32	6	36	8	40	10	40 *		21.46
	0706	1	20	0	25	40	0	50	3	33	9	36	8	40	10	40	6	20.06
	0707	1	50	0	25	40	0	50	3	27	9	36	8	40	10	40 *		22.6
	0708	1	50	0	25	40	0	50	3	27	6	36	8	40	10	40	0	21
	0709	4	20	0	25	39	0	50	3	58	7	36	6	40	10	40	14	22
	0710	7	46	9	25	40	0	50	8	34	6	36	9	40	6	40	10	22.87
	0711	2	20	5	25	40	0	49	9	89	8	36	16	40	10	40	7	24.75
	0712	12	38	4	25	40	0	40	9	87	8	36	16	38	10	64	9	27.25

PRODUCTS	HS	Aus	Bru	Can	Chl	Chi	HK	Ind	Jap	Kor	Mal	Mex	NZ	Phi	Sin	Tha	USA	AVE.
	0713	2	20	1	25	12	0	40	3	177	3	36	1	30	10	38	0	24.87
	2001	8	20	4	25	40	0	40	12	39	18	37	12	40	10	30	9	21.5
	2002	11	20	17	25	40	0	40	13	41	14	37	24	37	10	30	12	23.18
	2003	5	20	9	25	40	0	40	11	44	12	37	13	40	10	30	4	21.25
	2004	8	20	10	25	40	0	40	13	35	15	37	14	35	8	30	7	21.06
	2005	7	20	8	25	40	0	40	13	31	12	37	12	39	8	33	8	20.81
	Ave.	4.333	26.61	3.941	25	37.33	0	45.77	6.666	69.16	10	34.77	9.388	38.83	9.555	45.55	8.428	23.91
Fruits & Fruit	0803	0	50	0	25	27	0	40	16	90	5	36	0	50	10	40	0	24.31
Products	0804	0	41	0	25	37	0	50	6	43	8	36	0	40	10	39	30	22.81
	0805	1	28	0	25	47	0	45	15	90	11	36	0	41	10	38	1	24.25
	0806	10	20	2	25	38	0	40	9	21	22	36	0	40	10	30	0	18.93
	0807	0	50	0	25	40	0	45	4	45	11	36	0	40	10	40	13	22.43
	0808	1	20	2	25	35	0	43	11	45	20	45	5	40	5	30	0	20.43
	0809	1	20	2	25	40	0	48	7	41	17	41	1	39	10	40	0	20.75
	0810	1	37	0	25	40	0	48	6	106	6	41	0	40	9	39	0	24.87
	0811	2	20	4	25	40	0	60	11	72	5	45	9	40	10	37	7	24.18
	0812	6	20	2	25	40	0	47	15	41	14	45	16	40	10	40	11	23.25
	0813	7	20	2	25	38	0	43	8	128	7	128	1	39	10	42	8	31.62
	0814	1	20	0	25	40	0	60	2	33	5	36	8	40	10	40	0	20
	2007	8	20	7	25	40	0	48	22	42	10	36	16	40	10	30	6	22.5
	2008	8	20	5	25	40	0	51	16	49	13	45	13	40	10	32	132	31.18
	2009	11	20	3	25	40	0	54	22	52	14	37	18	45	10	37	0	24.25
	Ave.	3.8	27.06	1.933	25	38.8	0	48.13	11.33	59.86	11.2	45.26	5.8	40.93	9.6	36.93	13.86	23.72

PRODUCTS	HS	Aus	Bru	Can	Chl	Chi	HK	Ind	Jap	Kor	Mal	Mex	NZ	Phi	Sin	Tha	USA	AVE.
Animal & Vegetable	1501	0	20 *		25	23	0	40	3	17	5 *		0	35	10	27 *		15.76
	1502	1	20	3	25	21	0	40	0	18	5	18	0	15	10	27 *		13.53
Fats and Oils	1503	0	20	8	25	18	0	40	4	7	5	29	8	30	10	27 *		15.4
	1504	*	20	6	25	30	0	40	4	4	5 *		6	45	10 *	*		16.25
	1507	8	20	5	32	122	0	35 *		13	5	45	3	25	10	146	13	32.13
	1508	8	20	7	32	57	0	40 *		27	5	45	0	40	10	27 *		22.71
	1509	0	20	0	32	18	0	40	0	27	5	45	0	40	10	27 *		17.6
	1511	2	20	9	32	27	0	40	3	27	10	45	0	50	10	143	0	26.12
	1512	8	20	8	32	66	0	40 *		20	5	45	0	39	10	27	3	21.53
	1513	1	20	9	12	27	0	40	2	23	9	45	7	50	10	98	0	22.06
	1514	8	20	9	32	100	0	40 *		34	5	45	0	50	10	27	3	25.53
	1515	3	20	4	32	44	0	40	2	71	6	45	0	38	10	27	2	21.5
	1516	0	20	11	25	40	0	40	4	25	8	45	4	37	10	27	8	19
	1517	8	20	9	25	40	0	51	15	20	0	45	14	37	10	30	13	21.06
	Ave.	3.615	20	6.769	27.57	45.21	0	40.42	3.7	23.78	5.571	41.41	3	37.92	10	50.76	5.25	20.72
Cereal, starch & Milk Preparations	1902	8	20	6	25	40	0	48	17	54	18	36	19	40	10	30	5	23.5
	1903	0	20	0	25	40	0	40	10	27	10	36	0	40	10	40	0	18.62
	1904	7	20	5	25	40	0	40	16	17	17	36	18	35	8	30	8	20.12
	1905	6	20	4	25	40	0	42	18	22	11	36	14	38	10	36	1	20.18
	Ave.	5.25	20	3.75	25	40	0	42.5	15.25	30	14	36	12.75	38.25	9.5	34	3.5	20.60
Beverages	2205	15 *		3	25	135	0	150	19	30 *		45	9	40 *		57 *		44
	2206	7 *		16	25	135	0	137	30	30 *		45	4	35	10	60 *		41.07
	Ave.	11		9.5	25	135	0	143.5	24.5	30		45	6.5	37.5		58.5		42.53

## **Report on Area 3**

### **Linkages between Food Production and Environment**

#### **Chinese Taipei and New Zealand**

## EXECUTIVE SUMMARY

The UN Earth Summit held in Rio de Janeiro in 1992 adopted “Agenda 21,” an action plan to achieve sustainable human prosperity in harmony with environment. With regard to agriculture, this plan set out an action program for sustainable agriculture and rural development (SARD), which seeks to bring food production into harmony with the environment. Today, SARD is one of the important guidelines for agricultural planning and decision-making.

It is widely asserted that the world’s stock of renewable resources is currently being consumed at an unsustainable rate (UNEP, 1995). In particular, the following trends in the status of natural resources are highlighted:

- On average, increased agricultural productivity over the past three decades has provided for a better fed world; however, in parts of Africa serious problems of food shortages and famine still prevail.
- The rate of deforestation in the tropics averaged about 1 per cent per year during the 1980s; this maybe sufficient to commit between 2-8 per cent to the planet’s species to extinction within 25 years. Unsustainable use of deforested lands is stimulating soil degradation.
- Approximately 17 per cent of the world’s soils are considered degraded as a result of human activities.
- A dozen or so countries are currently consuming almost all or even more than their total annual supply of renewable fresh waters.
- Despite rapid growth in the number and extent of nationally and internationally-designated protected areas in recent decades, less than 5 per cent of the world’s land area is currently protected.

The APEC region by no chance could be exempt from the pressure of similar types. The APEC region is characterized by the diversity of capabilities of agricultural production from economies of exporting agricultural commodities to importing economies. Thus, the problems concerning the linkage between agriculture and the environment are quite different among the member economies, depending on their agricultural production capacities, natural environment, resource constraints, etc. On the whole, however, as population continues to grow and arable lands to decline in the APEC region, the pressure to meet demand of food remains politically and economically not negligible. Although it could be mitigated through such strategies as more intensive and efficient production, freer trade, composition change of consumption, etc., different strategies inevitably result in different impacts on the rural economy and the environment as well. Excessive intensive production, for example, may involve heavy application of chemicals and has a possibility to lead to environmental pollution, although in the case of nutrient deficit soils higher inputs of fertilizer are needed to compensate soil productivity and to increase food production.

As another example, freer trade reduces price distortion which leads to a more efficient reallocation of resources. The impact of this reallocation on the domestic and global environment is difficult to determine.



Although the physical, chemical and biological effects of food production on the environment are readily understandable and predictable, they are complicated by many factors, including agricultural practices, agricultural and environmental policies, institutional changes, the consumer and producer's characteristics, and multilateral agreements (e.g., WTO, and various Conventions such as CITES, Biodiversity Convention, Framework Convention on Climate Change (FCCC), etc.). Identification of the underlying driving forces of the complication would be much helpful to reconcile the linkages between food production and the environment and to realize sustainable development. This is particularly important for a region as diversified as APEC. Accordingly, this paper is designed to achieve the following objectives:

- a) To identify the positive as well as the negative environmental effects associated with agricultural production (Section II). The impact of environmental degradation and the constraints of natural resources on food production will also be explored (Section III).
- b) To identify the economic and institutional factors that could intensify the environmental effects of food production (Section IV). Literature in this aspect will be surveyed to find the differences of views and any areas where little work exists. Particular emphasis will be placed on the comparative analysis of the case studies conducted by the member economies (Section V).
- c) To identify strategies, policy options and cooperation plans that member economies are initiating to enhance domestic and regional environmental quality for sustainable agriculture.

In reviewing these objectives it is important to realize the great diversity of agricultural production systems in the APEC region. The interrelationship between agriculture and the environment, and the issues that this raises, varies depending on the production system under consideration. These systems include:

- grain production ranging through intensive paddy rice production in Japan, China, Chinese Taipei, etc., to large scale broad acre wheat, corn, soy bean, etc. of the United States, Canada and Australia.
- vegetable and process crop production ranging from family based production in Asia to large scale process crops in the United States;
- permanent horticulture and tree crops present in all economies with crops varying by region, e.g., bananas, apples, citrus, etc;
- annual horticulture, including small fruits, in all economies with crops varying by region, e.g., strawberries, etc;
- dairy production ranging through pastoral grazing systems as in Australia and New Zealand to partially housed animal systems as in Japan, Canada and the United States; and
- meat production ranging through family based production in Asia to rangeland grazing systems such as Australia and the United States, to more intensive based systems such as New Zealand, to intensive grain fed fattening operations such as the United States and Japan.

# LINKAGES BETWEEN FOOD PRODUCTION AND ENVIRONMENT

## I. INTRODUCTION

The UN Earth Summit held in Rio de Janeiro in 1992 adopted “Agenda 21,” an action plan to achieve sustainable human prosperity in harmony with environment. With regard to agriculture, this plan set out an action program for sustainable agriculture and rural development (SARD), which seeks to bring food production into harmony with the environment. Today, SARD is one of the important guidelines for agricultural planning and decision-making.

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## II. ENVIRONMENTAL EFFECTS OF FOOD PRODUCTION

The linkages between agricultural production and the environment are rather complex and could be classified in several ways (Baumol and Oates, 1993; Huang, 1995). In either way, the environmental effects of agricultural production could be positive as well as negative.

### **Negative Effects**

The major negative local externalities and their sources are summarized in Table 1. Of the most concern are water pollution, land degradation and greenhouse effect, of which agricultural production remains one of the polluting sources. The three aspects in the APEC region are briefly described as follows.

#### **1. *Water Pollution***

Agriculture is one of the primary water polluting sources in some member economies. It is, for example, the largest source of river pollution in the United States, accounting for 64% of the polluting sources. Sediment, nutrients and acidity are the major types of pollution, accounting for 47%, 13%, and 7%, respectively (Lean and Hinrichsen, 1994).

In other economies, agricultural production may not be the primary source of river pollution.<sup>1</sup> More and more pollutants, however, had been discharged to waterways due to more intensive farming practices.

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<sup>1</sup> Instead, industrial discharge is the primary source in most Asian member economies, e.g., Chinese Taipei, Japan, Korea, etc.

**Table 1. Selected environmental negative effects of agriculture**

<b>AGRICULTURAL PRACTICES</b>	<b>SOIL</b>	<b>GROUNDWATER</b>	<b>SURFACE WATER</b>	<b>FLORA</b>	<b>FAUNA</b>	<b>OTHERS</b>
Land development: land consolidation program	Inadequate management leading to soil degradation Mass movement erosion	Other water management influencing ground water table	Sediment deposition, Loss of flood capacity	Loss of species Loss of habitat	Loss of habitat	<b>Air, noise, landscape, agricultural products</b> Loss of ecosystem, loss ecological diversity, land degradation, greenhouse effects
Irrigation, drainage	Excess salts, water logging Land subsidence due to over abstraction	Loss of quality (more salts), drinking water supply affected	Soil degradation, siltation, water pollution with soil particles	Drying out of natural elements, affecting river ecosystems		
Tillage	Wind erosion, water erosion					
Mechanization: large or heavy equipment	Soil compaction, soil erosion		Sediment deposition, Loss of flood capacity	Loss of habitat	Loss of habitat	Combustion gases, noise
Fertilizer use		Nitrate leaching affecting water	Nutrient enrichment, eutrophication	Effect on soil microflora		
- Nitrogen	Accumulation of heavy metals (Cd)		Run-off, leaching or direct discharge leading to eutrophication	Eutrophication leads:		Stench, ammonia, greenhouse effects
- Phosphate						
- Manure, slurry	Excess accumulation of phosphates copper (pig slurry)	Nitrate, phosphate (by use of excess slurry) Microbiological contamination	Microbiological contamination	to excess algae and water-plants	to oxygen depletion affecting fish	
-Sewage sludge, compost	Accumulation of heavy metals, contaminants	Microbiological contamination	Microbiological contamination			Residues
Applying pesticides	Accumulation of pesticides and degradation products	Leaching of mobile degradation products	Pesticide residues and water contamination	Affects soil microflora; resistance of some weed	Poisoning resistance	Evaporation; spray drift, residues
Input of feed additives, medicines	Possible effects					Residues
Modern buildings (e.g., silos) and intensive livestock farming	See: slurry	See: slurry	See: slurry			Ammonia, offensive odors, noise, residues.  Infrastructure: aesthetic impacts

In fact, Asia's rivers are considered the most degraded in the world. For instance, out of 78 rivers monitored in China, 54 are seriously polluted with untreated sewage, agricultural nutrients and industrial wastes. In Chinese-Taipei, 15 out of 16 major dams are under eutrophication for improper tillage and chemical uses. Moreover, the length of severely polluted rivers increases from 5.69 percent of the total river length in 1983 to 10.4 percent in 1992. Some of the cases could be specifically attributable to husbandry (e.g., pig raising) along the upper stream. It not only contaminates rivers, but gives rise to substantial damage to aquaculture in the down stream. Such types of pollution conflicts are even more difficult to settle by such traditional method as Coasian approach (Huang, 1977). More than 40 of Malaysia's rivers are so polluted with industrial and agricultural wastes that they are said to be biologically dead. Similarly, the rivers run through Manila are so full of untreated industrial wastes and raw sewage that they are almost devoid of life.

Manure waste is another important polluting source of groundwater. Despite the environmental effect of manure is mainly a local issue, it is complicated by freer trade and global concern about greenhouse gases (GHGs) and deserves extensive attention in the APEC region. As member economies have recognized such complication, their environmental, industrial, and trade policies are under revision accordingly. It is worthwhile to address the potential welfare change and distributional effects originating from policy adjustments, particularly within the APEC region.

While it is clear that agriculture is one of the sources of water pollution, it is important that this factor is seen in the context of agriculture as a consumer of water. In most, if not all APEC economies, agriculture will be the major consumer of water, particularly for purposes of irrigation, stock watering and processing of food. Consequently agricultural activity is primary source of water pollution and imposes significant costs across the agricultural sectors as a whole.

In several economies, including Australia, Japan, New Zealand, Canada, Chinese Taipei, and the United States, there has been considerable effort being directed towards reducing the adverse impacts of agriculture on water quality. Examples of such measures include education, scientific research, land policy and regulatory responses. Specifically, Chinese-Taipei has decided to impose effluent charges on all industries, which will be effective in 1998. Food processing industry will be among the list of those significantly affected.

## **2. *Land degradation***

A broader definition of land degradation includes the followings: soil contamination, salinization, productivity loss, soil erosion, and land subsidence.<sup>2</sup> Throughout the history, societies have suffered from incidents of local or regional land degradation.

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<sup>2</sup> The term "land degradation" is generally used to signify a loss or reduction of land productivity and outbreak or increase of landslides as a result of human activity.

The pace of land degradation has accelerated since World War II, as rapidly increasing numbers of people try to meet their needs for food. A recent study sponsored by the UNEP found that over the last 45 years, 11 percent of the Earth's plant-supporting soils had been degraded to the point that their original biotic function had been partially destroyed (See Table 2).

On the basis of the GLASOD work, it is estimated that  $1.2 \times 10^9$  hectares, representing 10.5 per cent of the world's vegetated surface, have been "moderately", "strongly", and "extremely" degraded since 1945. Of this,  $9.3 \times 10^6$  hectares (approximately the size of Italy) are classified as "extremely" degraded, i.e., the land is considered to be unsuitable for agriculture and impossible to restore. World-wide, an additional area of  $749 \times 10^6$  hectares is categorized as "lightly" degraded, i.e., the soil can be restored through appropriate farm preservation practices.

Poor agricultural practices (28%), overgrazing (35%), and deforestation (30%) all contribute to land degradation (World Resources Institute, 1993). In North America, most land degradation is related to agriculture, especially the misuse of modern farming technologies (e.g., improper use of chemicals). In contrast, soil degradation in Australia is largely due to a combination of salinization, due to elevated water tables following land clearing, acidification, due to pasture management practices, and overgrazing. An estimated 40 percent of soil degradation in Asia and 41 percent in South America are the results of deforestation.<sup>3</sup>

**Table 2. Degraded land around the world: 1945-1990**

Region	Total degraded area (million acres)	Total land area in region (million acres)	Degraded land as a percentage of total land in region
Asia	1,845.8	6,630.5	27.8%
Africa	1,221.2	7,335.9	16.6%
South America	601.4	4,338.7	13.9%
Europe	540.9	6,818.6	7.9%
Oceania	254.3	1,947.8	13.8%
North America	236.0	4,551.5	5.2%
Central America and Mexico	155.2	742.5	20.9%
World	4,854.0	32,365.5	

Source: World Resources: 1992-1993, Table 8.1, p. 112.

<sup>3</sup> Europe suffers the most soil degradation in percentage terms; 16 per cent ( $158.3 \times 10^6$  hectares) of its vegetated area falls into the categories "moderately", "strongly", and "extremely" degraded. The main forms of soil degradation are physical or chemical degradation. Moreover, Europe is the only region where industrial activities contribute significantly to soil deterioration (6 per cent).

Land subsidence, mainly caused by excessive groundwater extraction, represents another distinct example of soil degradation of great concern in some economies. In some areas of Chinese Taipei, for example, land surface is as many as three meters below the sea level. The environmental impacts from land subsidence are manifold, including seawater intrusion, property and production losses, sea dyke destruction, sanitary degradation, etc. The potential loss could be further expanded as a result of global warming.

Despite that aquaculture production (shrimp and eel in particular) is one of the most profitable ventures in some economies, the associated environmental costs may far exceed the realized profits.<sup>4</sup> Obviously effective measures are warranted to reduce the divergence between the private and social benefits of resources use.

### **3. *Greenhouse effects***

As the emission of carbon dioxides continue to increase worldwide (See Table 3) and the potential impacts of global warming are multifold, greenhouse effects have attracted significant attention in the international communities (IPCC, 1995). Although uses of fossil fuels and industrial processes are the major sources of GHGs, emissions from paddy fields, wet lands, fertilizers, cattles and deforestation are not negligible.

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<sup>4</sup> It was estimated that the annual net social loss from eel aquaculture in a southern county of Chinese Taipei is more than NT\$10 billion (Huang, 1990). The environmental cost due to land subsidence explains the largest share of the loss. Water pollution from aquaculture is receiving more attention recently. There is, however, insufficient evidence to show that effluent standards have been effectively enforced in those economies where aquaculture is an economically important venture.



**Table 3. Emission estimates of CO<sub>2</sub> in selected areas**

	1990 (Mt)	2020 (Mt)	Rate of increase (%)	Average annual increase rate (%)
<i>Selected Annex I countries</i>				
United States	5168	6371	23.28	0.70
European Union	3110	3675	18.17	0.56
Japan	1238	1679	35.62	1.02
Canada	466	612	31.33	0.91
Australia	268	386	44.03	1.22
New Zealand	27	42	55.56	1.49
<i>Rest of World regions</i>				
China	2974	10162	241.69	4.18
ASEAN <sup>(a)</sup>	266	777	192.11	3.64
Asian NICs <sup>(b)</sup>	529	1224	131.38	2.84
Other Economies	8059	15909	97.41	2.29
<b>World</b>	<b>22105</b>	<b>40837</b>	<b>84.74</b>	<b>2.07</b>

a) Vietnam and Singapore are not included.

b) Asian NICs include South Korea, Singapore, Hong Kong, Malaysia, and Chinese Taipei.

c) The table shows total CO<sub>2</sub> emission from countries/areas and does not illustrate agricultural or food sectoral contribution within that.

Source: MEGABARE.

The emission and absorption of GHGs such as CH<sub>4</sub> and N<sub>2</sub>O from agricultural fields are however very uncertain. It is urgently needed to establish an appropriate way to measure the emission and absorption of GHGs from agricultural fields.

What even more important is that FCCC calls for Annex 1 countries to aim to return their greenhouse gas emissions to 1990 levels by the year 2000. It is expected that different measures may be undertaken by different economies in the near future (OECD, 1994, 1995). Such instruments as carbon tax, tradable emission quotas and joint implementation will have profound impacts on agricultural production as well as on the environment. There are several multination models developed to assess the incidence and the distribution of the benefits and costs from such measures (e.g., GREEN, RUNS, Global 2100, MEGABARE and GIGABARE). None of them, however, have specifically focused on the APEC region. The development of similar model with specific attention on the APEC member economies may be worthwhile for our society, since it was found that different groupings of regions or economies might lead to different results and implications (ABARE, et al., 1995; Huang, Hsu, and Lee, 1997). Further research and analysis to lower uncertainties and improve effectiveness of policies and measures as well as estimation methodologies of emissions of GHGs in the agricultural sector are, therefore, needed to reduce GHG emissions & simultaneously increase food production to meet the increasing demand for food in the APEC economies.

### Positive Effects

Along with a number of negative environmental impacts, some environmental benefits are also generated by agricultural production. To identify these benefits, the

OECD sponsored a Seminar on Environmental Benefits from Sustainable Agriculture in Helsinki, September 1996. One of the participants, Professor Daniel Bromley from the University of Wisconsin, classified the environmental benefits of agriculture under three headings: (a) amenities, (b) habitats, and (c) ecological processes. The environmental benefits of paddy field, one of the most important food production factors, are recognized by some economies (e.g, Japan, Korea, and Chinese Taipei). The multidimensional functions of paddy fields include the following external benefits:

- Physical and chemical functions
- Recharge of groundwater, water quality conservation, flood control, erosion prevention, etc.
- Biodiversity functions, Preserving ecosystems and natural habitats for wildlife, etc..
- Amenity and cultural functions, Preserving scenery and open space, enhancing opportunities for recreation and social stability (especially during the periods of economic recession), etc.<sup>5</sup>

The above external benefits had been evaluated in some economies by means of the substitution method and the contingent valuation method (CVM). For example, the annual contribution of Japan's agriculture and rural areas to the public welfare was estimated to be 4 trillion yen (Nomura Research Institute, 1996), which is about one third of the total value of agricultural production in 1994. This estimate sheds some light on the importance of agriculture in preserving environment in Japan.

The environmental benefits of paddy fields are not confined to Japan. In Thailand, for example, paddy fields along the middle course of the Chao Phraya River provide great capacity in conserving water and flood absorption. In 1986, a relatively dry year; water stored in these paddy fields was about 10.1 billion cubic meters, while in the wet year of 1988, it reached 17.4 billion cubic meters (Hayase and Masumoto, 1997). These volumes are equivalent to the annual flow of water into the Phumibol and Sinikit Dams. Such storage capacity helps a lot to reduce flood damage to the city of Bangkok, which is located in the down stream.

Empirical results from Chinese Taipei also support the existence of such benefits as water conservation and flood control (see Table 4). Japan also showed in the OECD's seminar on Environmental Benefits held in Helsinki in 1996 that ecological services of paddy field, especially those of erosion prevention and flood control, will be decreased by abandonment of rice cultivation. This implies that reduction of paddy field area, if happened due to freer trade, will weaken the land conservation functions displayed by paddy field.

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<sup>5</sup> For instance, Chinese Taipei, in response to the challenge of free trade, has successfully assisted and encouraged many farms to restructure their business to accommodate the functions of livelihood (or outdoor recreation) and ecology, while at the same time maintaining their traditional farming practices.

**Table 4. The contribution of paddy fields to water conservation and flood control: the case of Chinese-Taipei**

Year	Cropping areas		Quantity of water conserved (billion m <sup>3</sup> )	Flood flow controlled (billion m <sup>3</sup> )
	First crop (ha)	Second crop (ha)		
1982	316,516	343,075	5.833	0.583
1983	324,449	321,406	5.719	0.546
1984	285,903	301,283	5.194	0.512
1985	277,538	286,854	4.994	0.488
1986	268,872	268,851	4.759	0.457
1987	255,356	246,725	4.445	0.419
1988	240,828	230,632	4.173	0.392
1989	243,215	233,337	4.219	0.397
1990	242,422	212,995	4.035	0.362
1991	227,517	201,421	3.800	0.342
1992	209,476	187,776	3.519	0.319
1993	212,085	179,372	3.469	0.305
1994	196,331	170,009	3.246	0.289
1995	197,591	165,908	3.222	0.282

Source: Tsai (1996), and Lee (1997).

### III. RESOURCE CONSTRAINTS

As far as the linkage of agriculture and environment is concerned, land, forest and water resources are among the most important factors to be considered. In a community as diversified as the APEC, endowments of such natural resources vary significantly from economy to economy (see Table 5), and, therefore, impose different constraints on food production and environmental preservation. Given the increasing demand for food and environmental quality and the decreasing supply on per capita basis (World Watch Institute, 1994), the APEC region must be integrated economically and interactively to deal with the new challenges in the environmental era (Brown, 1994).

#### Land

Statistical data exhibits that the areas of arable land per capita in the APEC region has been decreasing at a significant rate. Although the decrease in arable areas is accompanied by productivity growth in some economies (FAO, 1995), each economy may encounter certain problems of different nature. Some economies are experiencing food surplus, while others still have shortage problem. Irrespective of the current facts, soil degradation may place sever restriction on potential supply of the whole region in the long run.

## **Forest land**

Forest land has a variety of functions related to agriculture and environment. Fortunately, forest land in the APEC region had remained rather stable in the past decades (FAO, 1995), despite that some economies have been experiencing deforestation problem. The issue lies in the fact that natural endowment of forest land among the APEC economies varies dramatically (see Figure 1). Since sustainable growth of forestry is so important to food and environment that more international cooperation for forestry preservation should be encouraged in the future.

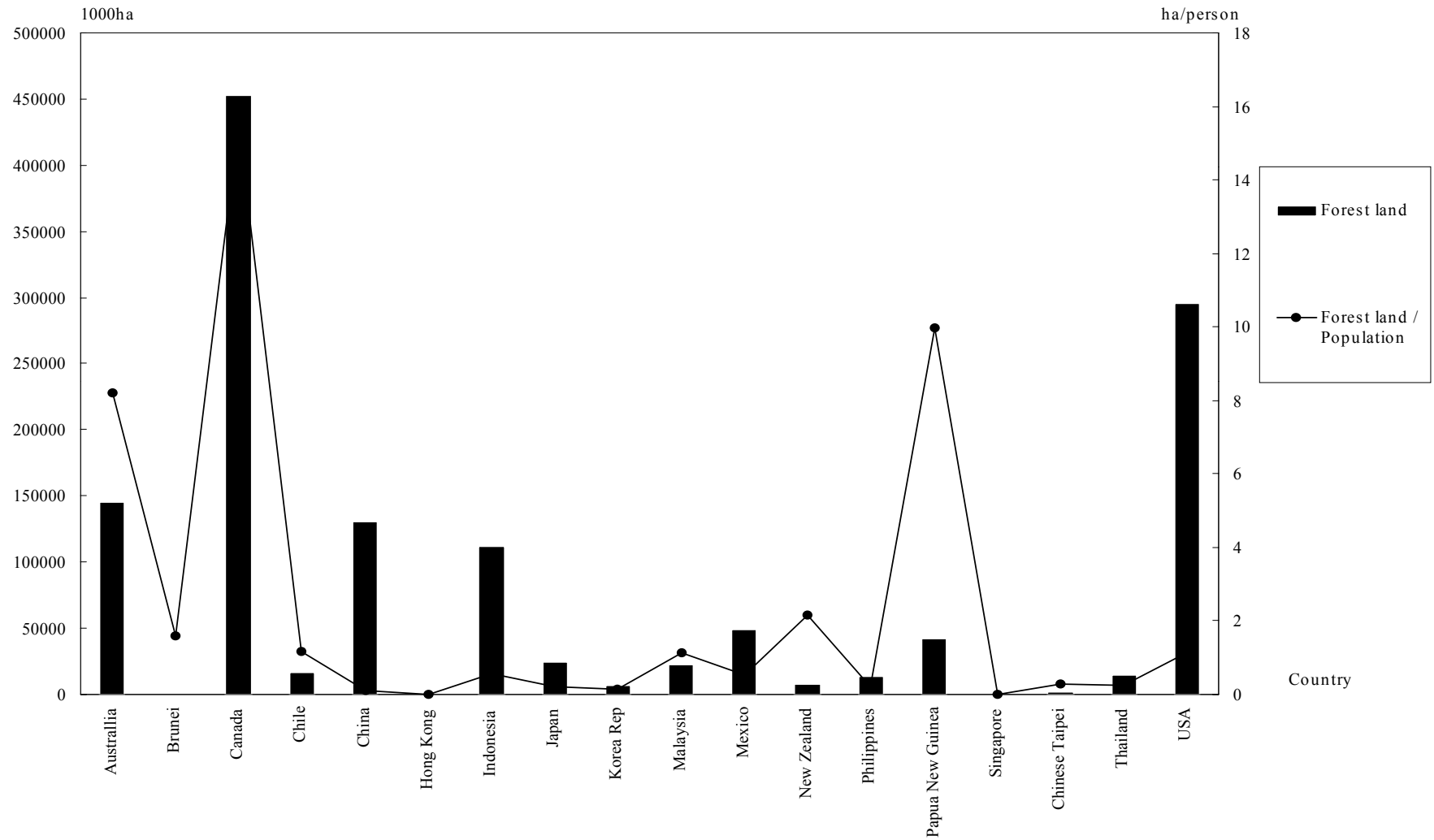
## **Water**

Constraints from the quantity and quality of water resources might become one of the most serious problems for the coming century not only in the APEC region, but also in the world as a whole (Lean and Hinrichsen, 1992). Identification of the factors causing water scarcity is important, but searching for efficient ways to mitigate the underlying crisis is even more emergent.

**Table 5. Quality of life and Natural Resources in the APEC Economies: 1993**

Economies	Quality of Life				Land Use and Habitats					Water				
	Life Expectancy (years)	Infant Mortality (Per 100)	Population Under 15 Years	Population Over 65 Years	Cropland (sq. miles)	Permanent Pasture (sq. miles)	Forest and Woodlands (sq. miles)	Wilderness Area (sq. miles)	Protected Areas (sq. miles)	Renewable Supply (cubic miles)	Total Use (cubic miles)	in agriculture	in industry	in homes and cities
Australia	76.1	8.0	21.5%	9.5%	188,934	1,613,869	409,266	885,835	176,272	82.3	4.3	33.0%	2.0%	65.0%
Canada	76.7	7.0	20.0%	10.0%	177,452	127,413	1,382,239	2,473,308	190,935	696.1	10.1	8.4%	80.4%	11.2%
Chile	71.5	20.2	30.4%	5.4%	17471	51931	33977	89136	52702	112.3	4.0	89.0%	5.0%	6.0%
China	69.4	32.0	26.3%	4.9%	371,100	1,231,969	488,282	813,807	84,738	671.8	110.4	87.0%	7.0%	6.0%
Chinese Taipei	74.95	6.64	24.1	7.5%	3,376	18	7,204	5	90	12.7	4.2	79%	9	12
Indonesia	60.2	75.0	33.4%	3.3%	82,085	45,560	437,965	45,407	68,725	607.1	4.0	76.0%	11.0%	13.0%
Japan	78.3	5.0	17.0%	10.1%	17,903	2,479	96,931	0	9,276	131.3	25.9	49.5%	33.4%	17.0%
Korea	69.4	25.0	23.0%	4.1%	8,212	347	25,039	0	2,231	15.1	2.6	75.0%	14.0%	11.0%
Malaysia	69.5	24.0	37.6%	3.3%	18,842	104	74,672	10,981	4,487	109.4	2.3	47.0%	30.0%	23.0%
Mexico	68.9	43.0	35.0%	3.2%	95,405	287,641	166,023	11,777	36,369	85.8	13.0	86.0%	8.0%	6.0%
New Zealand	74.8	11.0	22.4%	10.0%	1,958	52807	28263	14373	10962	95.3	0.3	44.0%	10.0%	46.0%
Papua New Guinea	53.9	59.0	40.0%	1.9%	1498	324	147606	15069	112	192.2	0.0	49.0%	22.0%	29.0%
Philippines	63.5	45.0	38.4%	3.0%	30772	4788	40734	0	2255	77.5	7.1	61.0%	21.0%	18.0%
Singapore	73.5	8.0	23.2%	4.9%	4	0	12	0	10	0.1	0.0	4.0%	51.0%	45.0%
Thailand	65.0	28.0	29.3%	3.4%	85429	2973	54981	10847	19713	26.4	7.7	90.0%	6.0%	4.0%
U. S. A.	75.5	10.0	21.2%	11.4%	733263	932305	1134749	170108	379698	594.6	112.1	42.0%	46.0%	12.0%

Figure 1. Forest land in APEC region: 1994



#### IV. FACTORS INTENSIFYING THE ENVIRONMENTAL EFFECT OF FOOD PRODUCTION

##### Land Use and Tillage Practice

As discussed in the literature, the type of crop, the tillage practices and the weed control methods all affect the amount of soil cover provided by cropping activities within a region. Trends in soil cover, can, therefore, be affected by changes in all of these factors simultaneously (See Table 6). In addition, soil loss and the demands for chemicals may also vary between crops, resulting in different degrees of environmental effects (See Table 7).

**Table 6. Categorization of crop/tillage practices into soil cover categories**

<i>Crop</i>	<i>Tillage practice</i>		
	Conventional	Conservation	No-till
Corn	Low	Medium	High
Potatoes	Low	Medium	Medium
Wheat, Barley, Oats	Medium	High	High
Hay	High	High	High
Fruit and Berries	Medium	High	High
Tobacco	Low	Medium	Medium
Canola	Low	Medium	Medium
Soybeans	Low	Medium	High
	<i>Weed control</i>		
	Tillage	Tillage/Chemical	Chemical
Summerfallow	Low	Medium	High

Source: Huffman and McGovern (1996), Table 1, p.10.

**Table 7. Soil loss and demands for chemicals by crops**

Crops	Relative soil loss	Relative demand for fertilizers	Relative demand for pesticides
Rice	Less	Moderate	High
Cotton	Most	High	High
Soybean	Most	Low	Moderate
Corn	Moderately	Highest	High
Sorghum	Moderately	High	Moderate
Wheat	Less	Moderate	Low
Barley	Less	Moderate	Low
Oat	Less	Moderate	Low

Source: Reichelderfer (1989), p.8.

In essence, the agriculture-environment process depends on the spatial and temporal patterns of five factors in combination (OECD, 1993):

- crop and livestock production rates per unit area;
- amount of land in production (or rotation) of each crop and livestock enterprise, and amount of uncultivated land;
- environmental characteristics of the land resources (e.g., erodibility, leachability, precipitation patterns);
- amount of non-land input use per unit of area (e.g., chemical intensity); and
- nature of non-land input use (e.g., chemical solubility).

### **Improper Use of Inputs**

Globally, fertilizer consumption has doubled over the last twenty years. The APEC region has been experiencing intensive use of chemicals. Asia in particular saw the largest relative growth, almost 400 per cent. Table 7 reveals that most of the negative environmental effects due to crop production are associated with misuse of chemicals. Excessive use of pesticides, for example, is commonly observed in some member economies. The underlying rationales must be understood before effective strategies could be initiated to reduce chemical intensity and mitigate environmental impact.

Economic theories have demonstrated that the socially optimal level of pesticide use should be less than the efficient level under perfect competition (Hueth and Regev, 1974); Feder and Regev, 1975; Regev, Gutierrez and Feder, 1976; Harper and Zilberman, 1989). Excessive use of chemicals is economically unjustifiable from the standpoint of farmers and detrimental to the environment. How to induce farmers to use chemicals in a socially optimal way becomes essential to integrate agriculture and the environment (OECD, 1989). To identify effective solutions, the underpinnings of excessive use must be understood by the use of empirical studies.

The literature indicates that there are several major hypotheses to explain excessive chemical application. While risk attitude hypothesis (RAH) and marginally risk-reducing hypothesis (MRDH) are empirically supported in the United States (Antle, 1988; Lambert, 1990), they fail to explain the situation where a risk-neutral producer overuses chemicals. More importantly, the acceptance of RAH or MRDH does not shed any light on policy-makings since under either circumstance the farmers may perceive overuse to be in their self-interest, and individual attitude towards risk cannot be changed in a short period of time. Nevertheless, empirical evidence indicates that subjective expectations hypothesis (SHE) seems to be a valid rationale of excessive pesticide use in some economies (Huang, 1991). To correct the producer's behavior under such circumstances, one might propose a Pigovian tax (e.g., Hueth and Regev, 1974) or integrated pest management (IPM) (e.g., Harper and Zilberman, 1989). Such policy instruments are well justified regardless of which hypothesis is valid for overuse of pesticides. Should RAH or MRDH be the proper underpinnings to explain pesticide overuse, there will be no valuable policy implications. This is because, under either circumstance, it may be rather difficult to persuade producers to reduce pesticide use due to the facts that overuse might be privately optimal and risk



attitude is so individually specific that it would be hardly changed within a short period of time.

### Farm Supporting Programs

The environmental impact of farming not only varies from crops to crops, but could be intensified to a great extent by farm supporting programs. Some agricultural products are supported by governments through various intervention programs such as price support, input subsidies and trade barriers. The arguments given for these support programs include the following: rural employment, farmer income, food security and the amenity value of agricultural resources.

Economic theories contend that farmers, under many circumstances, could be induced by price support programs to use more inputs than the case when such programs do not exist, leading to a possibility of intensifying the environmental effects of production. This conjecture had been supported by a great deal of empirical studies in the literature. As shown in Table 8, different programs generate different environmental effects.

**Table 8. Estimated Environmental impact of agricultural policies in the short run**

Types of policies	Environmental Impact on			
	Soil loss	Wildlife habitat	Chemical intensity	Total use of chemicals
Increase in product price	↑	↓	↑	↑
Production-oriented farm supporting programs	↑	↓	↑	↑
Instruments to reduce production risk	↑	↓	↓	↑
Subsidy/Loan	↑	↓	↑	↑
Set-aside	↓	.	↑	↓
Product standards	.	.	↑	↑

Source: Huang (1996), Table 1-2, p.4.

↑ = increases; ↓ = decreases; 0 = remains the same.

The New Zealand experience of agricultural reform provides an interesting case study. Prior to 1984, agricultural support and resource development policies encouraged farming systems and land use patterns that in some areas were not sustainable. For example, the livestock price supports, when combined with fertilizer and land development subsidies, diverted significant amounts of financial and scientific resources into pastoral farming systems. This package of subsidies encouraged clearance of native forest, followed by sowing and heavy fertilization of pasture. The artificial profitability of livestock farming, especially sheep, encouraged farmers to run stock numbers that exceeded the long-term productive capacity of the land resources. Government's willingness to assist farmers after adverse climatic events further reduced risk exposure and the cost of farms exceeding biological and physical limitations.

New Zealand removed agricultural subsidies in the mid-1980s. These included fertilizer subsidies, guaranteed minimum prices for sheepmeat and wool, policies to encourage development of new land, and many other trade restrictions and distortions. Several trends were evident directly after the removal of subsidies:

- a decline in sheep numbers, resulting less pressure on hill country pasture;
- an increase in afforested area, mainly due to planting on farmland;
- a decrease in the use of fertilizers;
- a decrease in the use of pesticides.

Since 1990, the decline in sheep numbers has continued. This has been partially offset by an increase in numbers of dairy cows, but total stock units still declined by 8% during the period 1985-1993. Meanwhile, the increase in planted forest area has also continued, with a cumulative increase for the 1985-1992 period of 22%. The increase in forest planting has been driven by a number of factors including the increased returns to forestry, especially relative to the declining returns to pastoral farming. The removal of agricultural subsidies allowed this divergence in returns to be fully reflected in farm profitability and land prices. This has contributed to the increasing rate of forest plantings, with its positive implications for soil conservation, water quality and absorption of carbon dioxide.

Some of the other short run trends identified above are no longer observable. For example, the use of fertilizers and agrochemicals, including the level of nitrogen input, has increased over recent years as product prices in some sectors have recovered. The recent changes in fertilizer and pesticide use confirm that input use is sensitive to farm incomes and, by inference, the level of government assistance. If New Zealand had not removed its agricultural subsidies, input use would have probably been higher than it is today. All of these changes lessen the likelihood of farming systems causing the degradation of marginal lands and off-site contamination of water resources.

## **Trade Liberalization**

Trade and trade policies are another important institutional factor that has received a great deal of attention in recent years. The linkage between trade and environment, for example, has been extensively debated in international forum such as WTO. Particular concerns are about the environmental effects of freer trade, either at the local or global level, and the impacts of environmental measures on trade. In fact even economic theory could deliver ambiguous conjectures in this regard.

Theoretically speaking, the impact of freer trade on environment could be decomposed into five different categories, namely, terms-of-trade effect, structural effect, scale effect, technology diffusion effect, and regulatory effect. Each of them may be positive as well as negative to the environmental quality (see Table 9).

When considering the impact of trade liberalization, it is important to realize that trade barriers have an impact on the environment. In particular, trade barriers such as tariffs and quantitative restrictions support agricultural producers by raising domestic prices. Studies say that many of the producers protected by these barriers use intensive production techniques which may result in higher agrochemical use. Resources that are better suited for use in other forms of production are diverted into these protected agricultural sectors.

While analysis can be made of some specific environmental effects of trade liberalization, assessing the overall environmental effect is a very complicated and difficult exercise. The environmental impact of trade liberalization, particularly agricultural and food, within the APEC region has not been empirically estimated. However, there are no sufficient empirical studies concluding that trade liberalization has systematically harmed the environment.

One of the main benefits of trade liberalization is that it promotes more efficient use of resources. Lowering trade barriers would be particularly beneficial to the environment as it would result in reduced price support to agricultural producers. This gives correct price signals and those that do not have a comparative advantage in agriculture will reduce production, thus relieving environmental pressure. By raising incomes, trade liberalization would generate new resources to tackle environmental problems and poverty, and reduce rates of population growth.

Trade liberalization may have a number of negative effects on the environment. The expansion of agriculture production in regions that benefit from trade liberalization may result in new environmental pressures including deforestation, impact of agrochemicals and livestock on soils and ground water, potential loss of biodiversity through transfer of natural ecological habitats to farm land. On the other hand, land abandonment that results from trade liberalization may cause such problems as soil erosion and pest proliferation. However, trade liberalization should be part of a reform package that includes appropriate economic and environmental policies. An integrated policy approach such as this will ensure negative environmental effects of trade liberalization are minimized.

The net effect on the environment depends on the sum of these positive and negative effects, and will vary substantially across commodities and countries. There is also likely to be a difference between the long run and short run effects.

**Table 9. Environmental Effects of Trade Liberalization**

	Positive effects	Negative effects
Terms-of-Trade Effect	Changes in terms of trade favor the production of commodities that involve less use of natural resources, chemicals, etc.	Changes in terms of trade favor the production of commodities that relies on intensive use of natural resources, chemicals, etc.
Structural Effect	Consumption and production of commodities are switched to a bundle which is more environmentally friendly	Consumption and production of commodities are switched to a bundle that is more polluting.
Scale Effect	Increase in production scale and specialization strengthens the firm's capability and willingness to invest environmental protection.	Production specialization increases production scale and, therefore, consumes more inputs and discharges more pollutants to the environment.
Technology Diffusion Effect	Trade liberalization facilitates the diffusion and innovation of clean technologies.	Trade liberalization might induce more transboundary transaction of polluting commodities and hazardous wastes
Regulatory Effect	The governments may adopt stricter environmental and product standards in the national level to prevent ecological dumping, or to meet the increasing demand for better environmental quality.	The governments may enforce environmental regulations in more lenient way to mitigate the impact of freer trade on the international competitiveness of domestic exporting industries.

## V. A Case Study from New Zealand

We consider that the evolution of agricultural and environmental policies in New Zealand provides an example of an integrated approach. New Zealand has made considerable progress in developing a coordinated and balanced set of policies with the core objective of sustainable use and development of the nation's natural resources in all sectors including agriculture. Central to this was the enactment of the Resource Management Act 1991 (RMA) which brought all activities relating to the management of land, water, air, and the coastal environment under one Act. The RMA has one clear and overriding purpose: to promote the sustainable management of New Zealand's natural and physical resources for the benefit of present and future generations.

The RMA continued previous practice of assigning most environmental responsibilities to local government. These include soil conservation activities, water quality monitoring and control, etc. Under the RMA, councils are developing policies, in consultation with their communities, to address these issues. There is now a much greater recognition that economic development often brings with it environmental risks, and the RMA requires that these be addressed when projects are under consideration for planning approval. However, proposals are considered on the basis of environmental effects rather than regulation of the activity *per se*.

In addition, the OECD Polluter Pays Principle is generally applied in New Zealand. For a range of activities, farmers must obtain environmental permits from Regional Councils and, in an increasing number of circumstances, must pay the administrative costs and on-going monitoring costs associated with the permit. The reduction of Government assistance in the funding of pest management, flood control and drainage programs has now required an increase in user-pay funding, through special property tax assessments on the landowners who benefit. In some cases, regional councils charge for technical advice, including assistance with soil conservation planning. Farmers are required to install effluent treatment and disposal systems at their own cost. They run the risk of fines if these systems do not comply with local government regulations.

This is all part of a wider movement in New Zealand Government towards "user-pays," i.e., requiring payment for services from those who benefit from them, or from those who generate the costs. This ensures that services are not demanded unless fully justified, and that the community does not pay for services required by an individual or a small group. Both objectives are consistent with polluter pays principle.

Although there is still some way to go, New Zealand is moving towards internalization of environmental costs in order to encourage the efficient and sustainable use of natural resources.

The New Zealand Government released a position paper on sustainable agriculture in 1993, as part of a wider policy on sustainable land management. Sustainable agriculture is defined as the use of farming practices which maintain or improve the natural resource base, and any parts of the environment influenced by agriculture, are financially viable, and allow people and communities to provide for their economic and cultural well-being. The Ministry of Agriculture has undertaken a facilitation program designed the adoption

of sustainable agricultural practices, and regional councils are also promoting sustainable agriculture as part of their responsibility under the Resource Management Act.

To address non-point source pollution problems, local authorities are encouraging landowners to take collective responsibility for devising solutions to meet community expectations. Farmers are increasingly recognizing that forestry plantings are sustainable complement to their farming systems which, in addition to being profitable, can help to address priority environmental issues. The farming sector has taken several initiatives to address environmental issues, including codes of practice, formation of landcare groups and development of on-farm indicators by farmers themselves.

In many cases, farmers are motivated not just by the desire to do the right thing, or the possibility of regulatory pressure if problems are not addressed, but also by market considerations. Farming leaders sense that consumers in New Zealand and in overseas markets are increasingly interested in how a product is produced, in addition to traditional quality concerns. They are therefore supporting efforts to establish systems to ensure that their production systems are sustainable and that this can be demonstrated to consumers. Thus, in a variety ways, the environmental costs and benefits of sustainable agriculture are being internalized to the production process.

## **VI. STRATEGIES TO RECONCILE AGRICULTURE AND THE ENVIRONMENT**

In a diversified region such as APEC, much more mutual understanding and cooperation among member economies are indispensable to successfully reconcile agriculture and the environment, and move toward sustainable development in the region. The realization of this goal will, to a great extent, rely on an integrated approach, which requires environmental considerations to be taken fully into account at an early stage in the development and implementation of agricultural policies. Likewise, during the formulation and implementation of environmental policies full consideration must be given to the potential impacts on agricultural production, prices and incomes.

To achieve sustained environmental benefits, agricultural policies need to be coordinated with policies affecting macroeconomic conditions, environmental management, and disaster relief, among others.

As noted by OECD (1993), any successful policy integration should reflect the following interdependent factors:

- the need to enhance the positive contribution which agriculture can make to the environment;
- the need to reduce the negative impact of agriculture on the environment; and
- the importance of adapting agricultural policies so that they take full account of the environment.

It is also recognized that integration of agricultural and environmental policies requires a clear understanding of the fundamental concepts underlying sustainable

development. Although there are many ways to define the concept of sustainability, at least three common precepts are worth noting (Pearce, 1989):

- (1) *Sustainability is about being fair to the future, or intergenerational welfare.* More specifically, the central goal is to maintain a certain environmental stock, or its equivalent, for current and future generations.
- (2) *To achieve sustainability, the private and/or public decision processes (accounting systems) must incorporate the shadow prices of environmental quantity and quality dimensions.*<sup>6</sup>
- (3) *Conservation of non-sustainable, irreversible environmental assets is critical to a sustainable natural resource base.*

While these broad sustainability goals are essential to a clear understanding of general policy directions, the articulation of more specific principles is necessary to develop programs for integrating agricultural and environmental policies. Some studies insist that, among others, the following principles, which are drawn from policies adopted in certain countries, should be considered, taking into account the site-specific nature of linkages between agriculture, food and the environment. The order of presentation is from broader to narrower, more specific topics, rather than in order of importance.

- *View rural countryside assets as a source of agricultural products and environmental services.*
- *Promote comprehensive resource use efficiency by directly or indirectly including environmental shadow prices.*
- *Alter agricultural commodity program provisions that cause input and crop or livestock output distortions which result in environmental degradation.*
- *Encourage farmers to recognize that it is in their and society's interests to maintain and enhance the farm's environmental asset base.*
- *Promote pollution prevention over waste management.*
- *Target specific environmental objectives rather than use broad agriculture-environmental initiatives.*<sup>7</sup>
- *Develop appropriate methods to apply the polluter-pays principle to agriculture in the APEC region..*

The OECD (1993) suggests the following four basic steps for better achieving integration between agriculture and environmental objectives.

- (1) The first step is to remove the production subsidies causing environmental distortions. This involves separating subsidies from a specific crop and livestock enterprises, and specific production levels. If there are environmental benefits arising from production

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<sup>6</sup> Shadow prices reflect social opportunity costs of using the resources, whether traded in markets or allocated in some non-market manner.

<sup>7</sup> For instance, OECD country policies are generally evolving from oriented environmental instruments to more specific natural resource management targets. Recent direction of the US Conservation Reserve Program and the EU Common Agricultural Policy are good examples.

subsidies, then these are achieved by accident rather than design. If an economy wishes to maintain these environmental benefits they would be better achieved through specific programs described in step three.

- (2) The next step is to make sure that the remaining agricultural support programs decoupled from production are designed and operated in such a way that they help achieve desired environmental outcomes.
- (3) The third step is to implement supplemental programs for any remaining environmental objectives, whether reducing the negative, or maintaining and increasing the positive environmental effects.
- (4) The final step involves the establishment of research, education and advisory programs to complement environmental goals.

It should be noted that the OECD (1997) recently pointed out the following:

“The environmental services from agriculture are jointly produced from farming practices, and when a market exists to remunerate these services the market itself will bring forth environmental benefits and contribute to farmers’ income. However, where markets are incomplete there is a difficulty in reflecting and transmitting to farmers the appropriate level of environmental benefits demanded by society. In these cases collective action maybe justified.”



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## **Report on Area 4**

### **Future Trends in Food Supply and Demand**

#### **Japan and United States**

## **APEC AGRICULTURE AND TRADE: FUTURE TRENDS IN FOOD SUPPLY AND DEMAND**

### **EXECUTIVE SUMMARY**

In assessing future trends in food supply and demand in the APEC region in the medium and longer term, both quantitative and qualitative procedures were used to develop a more comprehensive and complete view of the future opportunities and challenges facing APEC.

### **APEC Outlook**

Agricultural economists generally show a guarded optimism about the outlook for the global agriculture and food situation. Their projections, based on quantitative models, show that agricultural production will keep pace with population growth and the increase in demand generated by rising incomes. Food consumption per capita will increase slightly as agricultural production grows at a slightly faster rate than population. As a result, real agricultural prices will fall slightly over the next 10-20 years. Some studies have considered more severe environmental and other restrictions constraining production growth and indicate rising real prices.

APEC Asia continues to be the bright spot. Asian diets will continue to diversify, shifting proportionately from grains to meats, fruits, vegetables, and processed foods. Feed grain consumption is forecast to increase rapidly and grain consumption shifts to wheat-based food. With these changes in diet in Asia, agricultural imports rise. This also increases exports of APEC economies with a comparative advantage in agriculture and exportable surpluses.

APEC economies have begun to reduce trade barriers and increase their reliance on markets to efficiently allocate resources to meet the increasing demands for a larger variety of food products. Nevertheless, trade barriers remain relatively large in East Asia, particularly in the agriculture and processed foods sectors. There are trade liberalization studies on the APEC region that show Asia as the biggest gainer and Asian trade expansion exceeding trade diversion. Asian incomes rise, particularly in China. Reducing domestic support of less-efficient, non-competitive domestic producers lowers the growing budget deficits in many APEC economies. These changes make food more affordable and increasingly available to consumers. For economies with subsidized consumer food prices, subsidy elimination leads to higher food prices, but, at the same time, a less distorted and more efficient allocation of resources across all sectors. Re-allocating resources to more efficient, competitive industries increases societal incomes and overall economic welfare. Rising incomes allow consumers to purchase even more of the lower priced food (as well as other products), further reducing the remaining food needs deficit. Economies with the largest impediments to an open global market will face the biggest changes under liberalization, but will also reap the largest economic welfare gains.

## **Factors to be considered:**

There are several issues of importance to be considered by policy makers which either arise from the above projection story or are not dealt with in the quantitative models surveyed.

Projections show a slow improvement in future food balances, but not all food needs are met. If the state of hunger is to be improved from a humanitarian standpoint, attention will have to be focused on how to fill the gap between food consumption and food need levels. Filling this gap will involve reducing poverty, improving food distribution systems, and increasing food production.

Poverty is a major cause of malnutrition and food insecurity. Society needs to increase people's ability to translate food needs into effective demand. A key food policy question, therefore, becomes how to alleviate poverty as well as how to increase food production.

Although population growth is slowing, it remains an important issue when considering future food demand. Accordingly, in addition to measures to increase food production, governments and national and international organizations need to consider how public policy decisions affect population growth rates.

The capacity to expand food production in APEC will vary greatly across the region, but will be constrained in some parts by limited supply of arable land and increased competing demand for land for other uses. Agriculture will be facing stiff competition for land and water resources from industrial and residential uses, further raising agricultural production costs. On the other hand, scope exists in different parts of the region to use available land and water resources more efficiently. The increased negative impact of environmental problems, such as soil degradation and desertification, will also constrain growth in production.

The world has not reached biological or physical limits to food production, but the production growth rate has been declining. The growth of grain yields, which has been a major factor in production growth, is also declining, reflecting factors relating to technology, investment, environment and production incentives. Scope also exists to expand the world's arable area in North America, Oceania and elsewhere which helps to ease pressure to raise yields. But with little or no scope to expand arable area in many APEC economies, especially in Asia APEC, tapping the full potential of existing technologies and creating new production technologies will also be a critical factor if output growth is to be sustained in those places. Moreover, there can be a long time lag before investments in technological innovations and in development of land, water and irrigation resources begin to show results. If investment in agricultural research, health, nutrition, education, and extension continues to be reduced, it would adversely affect the future world food situation. Such investment must either come through the public sector, or the public sector must ensure an environment conducive to private investment.

The food sector is particularly hard-hit by trade and marketing inefficiencies because many food products are highly perishable. Delays in moving products from

producers to consumers not only add to storage costs, but lead to spoilage and waste which further increase consumer costs and reduce producer incentives. Distances between consumers and producers are widening due to urbanization and trade expansion, thereby enhancing the requirement for more efficient systems for food distribution. This in turn calls for higher infrastructure investments in the region, not only to create new facilities, but also to rehabilitate the existing infrastructure system in transportation, communication, warehousing, forwarding services and other marketing related services.

As the world moves to a more open, global market economy, grain production is expected to shift to more efficient producers who increasingly produce for export. Several of these economies have recently taken steps to cut costs by reducing extremely high stock levels. If production becomes increasingly concentrated in a smaller number of economies, and if future grain stocks remain low, as expected, there could be some concern about the extent to which grain prices might fluctuate.

Agriculture has several characteristics in addition to agricultural production. Such external economies and diseconomies in agriculture can lead to desired production, consumption, and trade levels different from levels determined by the market mechanism alone. When externalities generate a desired solution different from a supply-demand market equilibrium, the public sector is frequently expected to play an important role in assigning costs and allocating benefits. These externalities may reach beyond national borders, and can entail trade-offs between neighboring economies or trading partners.

Population and food production pressures are increasing the strains on the global environment. Individuals, national governments, and national and international organizations need to devise methods to reduce negative environmental impacts on the planet without unduly reducing production or increasing food insecurity. Methods also need to be devised to promote and enhance positive agricultural impacts on the environment. There is also a possibility that, over the very long term, global environmental problems, such as green house effects, will have some impacts on food production. These effects could be positive or negative.

For many APEC economies, the structural adjustments in rural communities that accompany economic growth and trade liberalization involve resource movements out of agriculture. These movements have the potential to disrupt traditional societal norms and create welfare gains and losses for different sectors of the economy. These social and economic opportunity costs must be dealt with through the political process as economic growth continues and as APEC economies become more closely linked in the marketplace. Only when these costs, including all externalities, are incorporated, can the full costs of change in an economy be adequately compared with the benefits received from that change.

## **I. INTRODUCTION**

The Asia Pacific Economic Cooperation (APEC) Task Force on Food was established in 1995 to examine regional food issues and explore possible options for joint action. Four areas were identified for study: patterns of demand, production, and stocks;

processing and distribution; environmental linkages; and future supply and demand trends.

The Area 4 work plan objective is to assess future trends in food supply and demand in the APEC region in the medium and longer term using both quantitative and qualitative procedures. The approach taken in this study involved reviewing the rather extensive literature dealing with the future of world agriculture and focused on what this literature had to tell us about the future of food and agriculture in the APEC region.

One aspect of the study was the review of the quantitative studies available. This primarily focused on economic modeling based projection studies that attempted to generate explicit numeric answers about future food supply and demand levels. These studies were first evaluated to see if a consensus existed in the literature with respect to the future of world agriculture. The second stage of the quantitative model analysis focused on the degree of confidence one could have in these results. This is where questions of answer consensus and methodological appropriateness were raised. The qualitative part of the analysis focused on a review of the non-modeling, futurist based literature. This literature deals with the problems and public policy issues society will have to deal with in the medium to longer term future. These qualitative issues generally are not adequately dealt with in much of the modeling-based literature.

This report presents the consensus “story” about the future of APEC food and agriculture that exists in the quantitative studies, including those that explicitly address the question of the impact of APEC’s policy decisions. The report then raises several public policy issues that either arise out of these projection stories or come from the qualitative futures literature and are not adequately dealt with in the quantitative models reviewed. The concluding section reviews the modeling methodological issues that condition the quantitative projections presented at the beginning of the paper.

## **II. APEC OUTLOOK AND PROJECTION STUDIES**

Several organizations have recently completed comprehensive quantitative studies of the future of world and/or APEC agriculture and food supply and demand. These studies provide a view of the future trends in APEC food supply and demand. Recent literature looking at the future of world agriculture falls into three general categories: GATT Uruguay Round trade liberalization studies, post Uruguay Round projection studies, and APEC trade liberalization studies. Since most GATT Uruguay Round liberalization studies were conducted in the 1980's and early 1990's, the quantitative portion of this study focuses on the more recent projection studies and on APEC trade liberalization studies.

The long term world agricultural outlook has been the subject of recent studies by several groups of agricultural economists in international organizations (including the Food and Agriculture Organization of the United Nations, the World Bank ), national governments (including the Australia Department of Foreign Affairs and Trade; the Japan Ministry of Agriculture, Forestry and Fisheries; the United States Department of

Agriculture), and other institutions (including the International Food Policy Research Institute, the International Potato Center, Worldwatch Institute).

## **World Outlook**

Agricultural economists generally show a guarded optimism about the outlook for the global agriculture and food situation. Most projections show that agricultural production will keep pace with population growth and the increases in demand generated by rising incomes. Food consumption per capita will increase slightly as agricultural production grows at a slightly faster rate than agricultural consumption. As a result, real agricultural prices will fall slightly over the next 10 -20 years.

Some studies have considered more severe environmental and other restrictions constraining production growth and indicate rising real prices. For example, a study by Japan's Ministry of Agriculture, Forestry, and Fisheries (MAFF) considered two scenarios. In the first, crop yields increase at current rates. In the second, growth in crop yields would decline gradually towards half of the growth rate used in the first scenario, assuming yields might be constrained by such factors as environmental degradation and stagnant development of irrigation resources. Scenario two leads to a near doubling of international prices for grains and soybeans from 1992 to 2010. Brown projects rising real prices because major production shortfalls cause demand growth to outstrip supply.

While the global agricultural and food situation shows marginal improvements, regional problems will continue to persist. The developed countries, particularly the agricultural exporters, will continue along their historic growth path. With relatively slow population growth and relatively high incomes, domestic agricultural demand has stabilized, leaving agricultural growth dependent on growth in the international trade sector. The outlook for Asian economies will continue to be optimistic. They will continue to grow at higher than global average rates and the Asian food situation will continue to improve. South Asia's food situation, while improving, will continue to be vulnerable. Latin American economies are projected to recover from their recent economic downturn, with a resulting increase in both agricultural production and consumption. The economic and agriculture and food outlook for Sub-Saharan Africa remains pessimistic. Relatively low economic growth and continued high population growth constrain effective food demand and keep agricultural production and trade levels low. Africa remains vulnerable and malnutrition persists.

The major driving forces affecting world food demand are population and income growth. Food needs are primarily determined by population growth. UN population projections show a decline in the rate of growth of population, particularly in developed economies. Over 90 percent of the population increase will occur in developing countries.

By 2020, developing countries will contain about 80 percent of the world's population. Given its large base, the largest absolute increase in population will occur in Asia, but the most rapid population growth will be in Africa. Urban populations are growing more rapidly than populations in rural areas.



Continued population growth means that hunger and malnutrition will continue to be a primary concern in the future in some regions. These projections show global consumption per capita increasing somewhat. This does not mean that production will be sufficient to meet the world's food needs. Hunger and malnutrition will still exist. Undernourishment will continue to rapidly decrease in East Asia and, to a lesser degree, in South and Southeast Asia and Latin America and the Caribbean. Food insecurity will likely continue to be a problem in South Asia but chronic undernourishment problems will shift from South Asia to Sub-Saharan Africa. Child malnutrition is concentrated, but slowly declining, in South Asia and increasing rapidly in Sub-Saharan Africa. IFPRI projects that malnourished children in South Asia could decline by 20 million by 2020, but that projection still leaves 40 percent of South Asia's preschool children malnourished in 2020.

Food needs and food demands are different concepts. Food needs are translated into effective demand for food only when people have the income necessary to obtain the food required to meet their nutritional needs. Thus, income growth becomes a critical determinant of the demand for food in the marketplace. Projection models for the medium to long term do not sufficiently count food needs from people in low-income countries with food deficits, who lack food purchasing power and are in a state of hunger or under nutrition. They are economic models focusing on effective demand. From a humanitarian viewpoint, to obtain an estimate of food needs these effective demand based consumption projections would have to be revised upwards.

World economic growth is projected to increase about 3 percent annually over the next decade or so. Developed country growth rates are projected to continue growing at 1.5-2.0 percent annually. Africa and the former centrally planned economies are unlikely to show any significant growth in their economies over the next decade. Latin American growth will increase to the 3 percent annual range over the next decade, with Mexico resuming its previous growth path by the end of this decade.

Asian economies will continue on a relatively high growth path. East Asian growth will slow slightly from historic levels as their economies mature and Japan's recent slow growth performance will continue into the next decade then recover somewhat. China, South, and Southeast Asian economies economic growth rates are projected to be 5-6 percent annually well into the next decade. It is this continued good economic growth performance that allows Asian economies to make progress in reducing malnutrition and meeting their growing food needs.

Increasing urbanization and rising income in developing countries are leading to more diverse diets. People are eating more livestock products, decreasing the proportion of direct consumption of cereals, and eating more fruits, vegetables, and processed foods. Asians are eating more poultry and pork. This increase in meat consumption leads to an increase in demand for feed (feed grains and oilseeds and products).

Grain consumption is shifting proportionately from rice, coarse grains for food use, and tubers to wheat-based foods, particularly in urban areas where high female labor force participation leaves less time for food preparation. IFPRI projects rice demand to grow at half the rate of wheat and maize.

These differential rates of regional population and income growth will generate an increase in both demand and import demand for food and agricultural products. This increase is large enough in the developing economies to more than offset the declines in demand and import demand in developed and transition economies.

Growth in aggregate agricultural production will continue, but at a slower rate than in the past. Alexandratos projects agricultural production growth to be about 1.8 percent annually to 2010, down from the 2.0 percent annual growth rate seen in 1980-1992 and the 2.3 percent annual growth rate of the 1970's. World grain production growth is projected to keep pace with demand growth. Livestock production, particularly in developing economies, is projected to continue its recent strong growth. This increasing livestock production will generate increased demand for feed grains.

Most of the projected increase in crop production comes from increasing yields. The consensus is that there is only a limited scope for expanding agricultural crop areas. The major exceptions are Latin America and Africa, where some area expansion is still economically and technically feasible. With Brown as a major dissenter, there is general agreement that there is still scope to increase yields based on existing technologies and on adoption of new technologies already in the pipeline. A major concern is that governments and international organizations need to maintain (or increase) commitments to sustainable agricultural growth through investments in research on new production increasing technologies, extension, irrigation and water development, human capital development, and improving rural infrastructure, while controlling negative environmental impacts. Given the long lead times needed, these investments need to be made now to forestall a future downturn in productivity growth.

The rapid changes in diet, driven by increasing globalization, rising incomes, and reduced barriers to trade will increase trade in agricultural and food products. These trends are expected to continue. Projections show an increased Asian reliance on meat imports, and an increase in feed to support an expanding livestock production sector. Trade will increase between the developed country agricultural exporters and developing country agricultural importers. This increased reliance on trade will be particularly true for Asian economies.

With the Uruguay Round induced dismantling of barriers to trade moving the global economy closer to an open market economy, we will see an increased reliance on markets and an increase in agricultural and food imports. This increased market orientation will also increase the agricultural and food exports of those APEC countries with a comparative advantage in agricultural production and exportable surpluses--Australia, Canada, New Zealand, and the United States.

**Divergent Result:** Brown argues that there is little backlog of unused agricultural yield raising technology and that fertilizer application has reached its limit in major producing countries and will not be a significant source of future yield increases. Rates of increase in cropping land and irrigation are limited, rangeland carrying capacity has been exceeded, and industrialization and urban encroachment on farm land impose severe constraints in some countries. Past increases in food production have led to land

degradation. Fish production has reached biological limits. National government attempts to expand food production have failed. These supply constraints coupled with demand growth, particularly China's growing demand for grain imports, will trigger price shocks and increased hunger and starvation in other regions.

Brown focuses on China, forecasting declines in land and water availability for grain production. He projects China needing more than 200 million metric tons of grain imports per year by 2030. This is about the current volume of global international trade in grain and implies that China would be getting half its grain consumption from imports by 2030. He forecasts that the rest of the world would be unable to supply such demand growth. This puts significant upward pressure on international grain prices over the next few decades.

Brown's analysis is not based on a formal economic model. It does not incorporate behavioral responses to his projected price increases. Production and consumption shifts in response to his large price shock are minimal and no significant response is anticipated from China's producers, consumers, or government. This is a major weakness in his analysis.

Brown's assumption of almost 50 percent reduction in grain land is not consistent with historical experience nor with land reclamation now underway in China. ERS argues that Chinese current yields are lower than officially reported because cropland is under reported. Thus, Chinese yields are not as close to technical limits as Brown assumes. Brown also assumes that China will follow the East Asia model with urbanization in China encroaching on arable land area as it has in East Asia. This argument is flawed by his assumption that grain area and arable land are the same. Decline in arable land in South Korea and Japan has not been dramatic.

Brown's argument is focused primarily on China's grains economy, which represents over half of total food calories consumed in China. Other analysts see efficiency gains in Chinese livestock and poultry feed conversion rates, which would reduce feed grain demand.

The other projection studies show rising Chinese grain imports, but not to the extent Brown projects. These other studies show exportable surplus in traditional exporting countries sufficient to meet Chinese import demand without causing real price increases.

## **APEC Liberalization**

As with the projection studies, there is a common APEC liberalization story, at the qualitative level. The economic theory behind all these models is essentially the same, thus they should tell similar stories. Most economists are familiar with the Heckscher-Olin trade model and the two-country, one-commodity export supply-import demand model. These theoretical models can be used to determine the expected qualitative results that these empirical models should all generate.

APEC economies have begun to reduce trade barriers and increase their reliance on markets to efficiently allocate resources to meet the increasing demands for a larger variety of food products. Nevertheless, trade barriers remain relatively large in East Asia, particularly in the agriculture and processed foods sectors. The trade liberalization studies on the APEC region show Asia as the biggest gainer and that Asian trade expansion would exceed trade diversion. Asian incomes rise, particularly in China. Reducing domestic support of less-efficient, non-competitive domestic producers lowers the growing budget deficits in many APEC economies. These changes make food more affordable and increasingly available to consumers. For economies with subsidized consumer food prices, subsidy elimination leads to higher food prices, but, at the same time, a less distorted and more efficient allocation of resources across all sectors. Re-allocating resources to more efficient, competitive industries increases societal incomes and overall economic welfare. Rising incomes allow consumers to purchase even more of the lower priced food (as well as other products), further reducing the remaining food needs deficit. Economies with the largest impediments to an open global market will face the biggest changes under liberalization, but will also reap the largest economic welfare gains.

The APEC trade liberalization shock can be represented by the elimination of commodity trade barriers in each country. These barriers are expressed as a set of price wedges that go to zero. Since these barriers differ across countries and across sectors, eliminating them changes relative prices. These changes in relative prices cause changes in relative consumption (quantities demanded), changes in relative factor allocations across sectors, and thus changes in production (quantity supplied). The changes in prices and quantities generate changes in income, in trade levels, and in demand for factors of production, which in turn leads to changes in savings and investment and thus to further income, price, and trade changes.

The partial-equilibrium, single-commodity, two-country market story is that lower trade barriers in the importing country will lower price in the importing country, thereby lowering quantity supplied and raising quantity demanded in the importing country. This, in turn, generates a higher imported demand quantity. In the exporting country, this liberalization of the importers market raises price in exporting country, thereby raising quantity supplied and lowering quantity demanded in exporting country. This, in turn, generates a higher export supply quantity in the exporting country and a higher income in the exporting country.

The theory also indicates that the biggest changes will occur where the shocks (trade barriers) are the biggest and where the elasticities are the largest. The model used in these studies generate this behavior. Trade barriers in East Asia are relatively large in the agriculture and processed foods sectors.

The APEC trade liberalization story is then a story of comparative advantage. Since the trade theory used assumes a factor endowment based comparative advantage, we can expect that economies will produce and export goods utilizing their relatively abundant factors of production and import those goods requiring their relatively scarce factors of production. Reducing trade barriers increases world trade levels and more efficiently allocates factors of production, allowing world output of goods and services to rise. Global income also rises.

**Divergent Result:** Young & Huff conclude liberalization *among APEC members only* increases APEC welfare more than when APEC members grant MFN to the rest of the world. They do agree that a better solution is full global liberalization. They argue that APEC MFN liberalization opens APEC markets to competition from the rest of the world while keeping the rest of the world markets closed to APEC exports. Their divergent results are probably due to their model not allowing the more dynamic and longer term economic effects to come into play (fixed investment allocations do not allow resource reallocation, resource expansion, income growth, or changes in trade balances). Their results contain most of the trade diversion effects and only some of the offsetting trade creating effects.

**Asia APEC Results:** Assuming reduction of the relatively large barriers in East Asia, markets open to lower-cost goods from other economies. This is particularly true for agricultural commodities and processed foods. Imports of these goods rise. Asian agricultural sectors will face lower price imports and lower incomes, and shift resources to other sectors of their economies, where they have a comparative advantage. Asian trade expansion exceeds trade diversion. Asian incomes rise. The projection length of the models is long enough to show how the dynamic effects of open markets operate. Asia itself is the biggest gainer from APEC liberalization. China is a potentially large market, particularly if its trade barriers are lowered. Its income increases, benefitting the rest of APEC (but primarily China). Rising incomes in Asia, particularly East Asia and China, leads to upgraded diets and a shift toward meat and livestock (East Asia and China) and feed grain imports (China).

**North America and Oceania Results:** North America and Oceania have a comparative advantage in agriculture and food products. Increased demand in the Asian market, as well as lowering APEC trade barriers, increases Australia, Canada, New Zealand, and U.S. production and exports. Their income rises. Particularly for the United States, Asia becomes a more important region. Increased U.S. agricultural exports to Asian markets comes about through a diversion of exports from the rest of the world to Asia. Opening North America and Oceania non-agricultural markets to developing Asian economies increases their exports, generating the increased income necessary to allow them to import North America and Oceania agriculture and food products.

### III. FACTORS TO BE CONSIDERED

There are several issues of importance to be considered by policy makers which either arise from the above projection stories or come from the qualitative futures literature and are not adequately dealt with in the quantitative models reviewed.

#### Food Needs

Projections show a slow improvement in the future food situation, but do not show all food needs being met. Food needs and food demand are different concepts and

projection models for the medium to long term do not sufficiently count food needs from people in low-income countries with food deficits, who lack food purchasing power and are in a state of hunger or undernutrition. If this state is to be improved from a humanitarian viewpoint, attention will have to be focused on how to fill the gap between food consumption and food need levels. Filling this gap will involve reducing poverty, improving food distribution systems, and increasing food production.

An alternative approach for evaluating long-run food demand focuses on food needs instead of the effective (market) demand concept used in most economic models. Such an approach starts with population projections and estimates of per-capita food consumption levels required to eradicate hunger and undernutrition to calculate future food needs. Crosson and Anderson used this approach to project a world grain food needs increase of 97 percent between the late-1980's and 2030. Developing countries projected grain food needs increased by 169 percent (wheat, 190 percent; rice, 105 percent; and coarse grain, 216 percent). Developed countries projected grain food needs increased by 18 percent.

An FAO study projected plant-derived energy requirements based on population growth and on the changing population age structure. They found that 2050 energy requirements will be double present levels in developing countries (developed countries, 2 percent increase).

Eliminating chronic undernutrition in Asia would require a 14 percent increase in energy requirements and achieving a well-balanced diet in Asia would require a further 21 percent increase in plant-derived energy. Combining population growth and food needs factors indicate developing countries would have to increase plant-derived energy by 174 percent (Asia, 100 percent increase).

## **Poverty**

Poverty is a major cause of malnutrition and food shortage. Society needs to increase peoples' ability to translate food needs into effective demand. A key food policy question becomes how to alleviate poverty as well as how to increase food production. Policies which promote economic growth, as well as policies promoting skills development, improved health and education, or improved access to land, capital, and new technologies, all contribute to reducing poverty. Expanding income and employment would make it easier for people to buy the food they need. The increased demand will increase market prices and induce an increased quantity of food produced and supplied to the market.

National income may increase with economic growth and trade liberalization, but not all sectors benefit equally. Especially in Asian economies, income gaps may widen between rural and urban areas and between agriculture and other industries, exacerbating rural poverty, rural depopulation, and urban overcrowding. In those Asian economies with large rural populations and high population densities, rural decline involves great social costs. According to a World Bank report, the past economic growth in East Asia has substantially reduced poverty. However, there has been an increase in income disparity

and a concentration of poverty among specific groups in those economies. The report particularly specified rural areas for the higher incidence of poverty and warned that agricultural households faced a higher risk of poverty than any other occupational group.

## **Population**

The principal factor determining food needs is population growth. In addition to looking for ways to increase food production, governments and national and international organizations need to consider how public policy decisions affect population growth rates.

## **Resource Constraints**

The Earth has finite land resources, and in APEC most of the potentially cultivable land is already being used. In addition, in some areas agriculture is facing increased competition for land from urbanization and industrialization. Adding to the cultivable land base can only be done at the expense of rapidly rising development costs for land and water and increasingly negative environmental impacts.

Water resources are increasingly constrained by limited supply and increased competing demands. Economic growth generally is accompanied by a shift in demand for water from agricultural to industrial and residential uses. Projections indicate that developing country urban populations will double between 1990 and 2010 and triple by 2025. Agriculture will be facing stiff competition for water resources, further raising agricultural costs of production.

A 1990 World Bank/UNDP study found scope for an additional 110 million hectares of irrigated land in developing countries (69 million hectares in Asia). However, rising development costs and moving irrigation development into increasingly marginal areas have caused rates of return on new irrigation infrastructures to fall. Such a trend will likely make agricultural irrigation development increasingly uneconomic. At present, irrigation is expanding at a 1.4 percent annual rate, but this is expected to drop to 1 percent by 2010 as the number of large-scale irrigation projects financed by public funds is decreased.

A further problem is that existing irrigation facilities are aging and becoming difficult to manage. The World Bank/UNDP report estimates that over half the world's existing irrigation facilities need to be replaced or modernized. This alone imposes a major investment burden over the next 10-20 years.

## **Investing in Productivity Growth**

There is a consensus that the world has not reached the biological and physical limits of world food production. However, the rate of food production growth has begun to decline. With area expansion at near limits, future productivity increases are critical for

further production increases. Tapping the full potential of existing technologies and creating new production technologies becomes critical for future productivity growth.

In the past, technological innovation has enabled food production growth to outpace population growth, with an accompanying decrease in real prices. If yield increases comparable to those of the past 30 years could be achieved in the future, adequate production could be maintained, but most analysts conclude that we cannot count on yield increases as dramatic as those achieved during the green revolution. However, there continues to be large disparities between experiment station yields and field yields. Thus, yields can further increase with current technologies. Some improvement is also expected from the development and dissemination of new technologies, but emphasis is shifting to establishing management techniques that will make it possible to achieve sustainable high production levels.

Due to the long time lag before investments in technological innovations or in development of land and water resources begin to show results, quantitative analyses with time frames of about 10-15 years tend to make little allowance for future trends in investment levels. After significant growth during the 1960's and 1970's, public agricultural research investments slowed in the 1980's and remained stagnant in the 1990's. Commitments to agriculture by international financing organizations were halved between 1986 and 1993, while bilateral assistance declined 20 percent. The ratio of public research expenditure to agricultural GDP now averages only about 0.5 percent for most developing countries and ranges from 2 to 4 percent for developed countries. In addition, investments in irrigation development have slowed considerably since the 1960's. Internationally funded irrigation development has also declined. World Bank lending for irrigation halved from US\$2 billion in 1980 to US\$1 billion in 1993. One positive change is the increase in agriculture and food research and development expenditures from the private sector, but it is difficult to gather accurate data on these investments.

If investment in development of land and water resources, agricultural research, health, nutrition, education, and extension continues to be reduced, it would adversely affect the future world food situation. Such investment must either come through the public sector, or the public sector must ensure an environment conducive to private investment.

## **Distribution**

The food sector is particularly hard-hit by trade and marketing inefficiencies because many food products are highly perishable. Delays in moving products from producers to consumers not only add to storage costs but lead to spoilage and waste which further increase consumer costs and reduce producer incentives. Distances between consumers and producers are widening due to urbanization and trade expansion, thereby enhancing the requirement for more efficient systems for food distribution. This in turn calls for higher infrastructure investments in the region, not only to create new facilities, but also to rehabilitate the existing infrastructure system in transportation, communication, warehousing, forwarding services and other marketing related services.



For example, reducing post-harvest losses by improving the storage, distribution, and processing infrastructure in developing APEC economies can help relieve food shortages. Problems involving the availability of factors of production and the development of effective systems for disseminating technology also exist and limit production to suboptimal levels. Governments, and national and international organizations can make public investments or policy decisions that help create an environment conducive to improving economic markets and the agricultural infrastructure required for efficient and optimal allocation of productive resources and consumer products, as well as help create alternative rural jobs.

### **Grain Market Instabilities and Short Term Fluctuations**

As the world moves toward a more open global market economy, projections show grain production shifting to more efficient producers who will increasingly produce for export markets. Both developed and developing economies in Asia are projected to become increasingly large grain importers.

After peaking at 466 million tons in 1986, world grain carryover stocks have declined continuously, falling to 246 million tons in 1996. Ending stocks held by the United States, which once played a major role in stabilizing world grain markets have declined rapidly (from 200 million tons in 1986 to 41 million tons in 1996). Other economies, such as the European Union, are also expected to reduce government grain inventories as a way to reduce one burden on public finances.

If the future grain production becomes concentrated in the United States, Canada, Australia, China, Europe, the former Soviet Union, India, Brazil, Argentina, and a few other countries, some people believe that international markets may become more unstable in the face of crop variation, policy changes, interruption of shipments by natural disasters or accidents, halted shipments due to pest or disease outbreak in major producer regions, or disrupted transport routes cut by regional conflicts, accidents, or disasters. However, others would argue that the market opening which would drive such increased concentration would actually make markets more stable and better able to deal with temporary localized disruptions.

If production becomes increasingly concentrated in a smaller number of economies, and if future grain stocks remain low, as expected, there could be some concern about the extent to which grain prices might fluctuate.

### **Externalities**

Agriculture has several characteristics in addition to agricultural production. Such agricultural externalities consist of both external economies and diseconomies. Economies include agriculture's role in preserving the land and environment and creating local employment. Diseconomies include contamination of groundwater through overuse of fertilizer and soil erosion due to cultivation of marginal land. The existence of these externalities means that an equilibrium established by market mechanisms will not

necessarily represent an optimal welfare allocation of resources. For example, the socially desirable level of agricultural activities should be greater than the equilibrium level if agriculture has net external economies and smaller if it has net external diseconomies.

From the viewpoint of international trade, the existence of externalities in agriculture in the exporter and importer economies may mean that comparative advantage does not always lead to the optimum balance in terms of economic welfare. For example, take the case in which agriculture has net external diseconomies for an exporter and net external economies for an importer. As long as they do not internalize these externalities, trade will increase as agricultural production expands in the exporting country and contracts in the importing country. In this case, liberalization of trade may result in welfare losses to both economies.

These externalities, particularly environmentally based ones, are very difficult to incorporate within the framework of quantitative analysis. If externalities were correctly evaluated, they would likely lead to desired levels of production, consumption, and trade different from the supply-demand equilibrium levels determined by the market mechanism alone. Thus, besides a measurement issue, a costs burden issue exists. When externalities generate a desired solution different from the efficiency-based market supply-demand equilibrium solution, the public sector is frequently expected to play an important role in assigning costs and allocating benefits. These externalities may reach beyond national borders, and can entail trade-offs between neighboring economies or trading partners.

## **Environment**

Increased population pressures and increased food production pressures are increasing the strains on the global environment. The negative environmental impacts of increasing fertilizer, herbicide, and pesticide use; soil degradation from overcropping, deforestation, overgrazing, erosion, and salinization; desertification; and the use of marginal lands are raising the costs of production and placing constraints on sustainable expansion of production. Global problems such as green house effects might also have an adverse impact on food production.

The Intergovernmental Panel on Climate Change (IPCC, 1995) has projected that, on the whole, global production would not be greatly affected, although this conclusion does not allow for changes in pest distribution and increased climatic variability. The effects on food production will be positive in some areas and negative in others.

Many of these changes are gradual, taking many years for their cumulative effects to adversely effect agricultural production significantly. This very-long-term nature of environmental impacts coupled with the difficulties in systematically incorporating them into the structure of quantitative global models means that the full implications of environmental diseconomies may not be fully incorporated into the world agricultural projections discussed earlier. Individuals, national governments, and national and international organizations need to devise methods to reduce the negative environmental impacts on the planet without unduly reducing production or increasing food insecurity.

Not all of agriculture's environmental impacts are negative. External environmental economies also exist. Sustainable agriculture conservation practices can help preserve the environmental benefits of agriculture. Bromley classifies environmental benefits of agriculture under three headings: providing amenities, providing habitats, and fostering ecological processes. Japan classifies the environmental benefits of agriculture and rural communities in enhancing the public welfare through their roles in conservation of water, soil, air, flora and fauna, as well as their contribution to local communities, education, and traditional culture.

Well managed agricultural land can contribute to social welfare in many ways. For example, Japan identifies the following special functions for agriculture: physical and chemical functions (developing water resources, preventing floods and soil erosion), biological functions (purifying air and water, preserving ecosystems, protecting wildlife species), amenity and cultural functions (preserving scenery, buffering microclimates, enhancing health and recreation). Other economies would have different lists, but all could enumerate such benefits in various degrees.

When the contributions of Japan's agriculture and rural areas to the public welfare were calculated using the contingent valuation method (CVM), the annual flow was estimated at 4 trillion Yen (Nomura Research Institute, 1996). Since annual agricultural production amounts to 12 trillion Yen (1994), this figure indicates that agriculture in Japan has very large external economies relative to the value of its production. The study also concludes that paddy fields contribute greatly to the prevention of natural disasters affecting the land.

Both the negative and the positive impacts of agriculture on the environment need to be addressed in any study of agriculture's future. The APEC Task Force on Food Area III document presents a more detailed discussion of environmental linkages to agriculture.

## **Rural Communities**

One role of agriculture has been to provide rural employment and the economic base for the maintenance of rural communities. Other industries play similar roles, but agriculture is somewhat unique. It provides permanent residences in rural areas where there are few other job opportunities.

Rural communities tend to have a relatively strong family orientation as well as a relatively strong sense of community. Agriculture predominantly involves family-operated farms. In the major agricultural exporting economies of Australia, Canada, New Zealand, and the United States these family-operated farms are relatively large and commercial in nature. In Japan, Korea, and Chinese Taipei, rural communities are formed with small family-operated farms structured around paddy rice cultivation. China can be divided into a southern and coastal rice-growing region and a northeast and inland grazing and upland farming region. In both cases, production is primarily based on small family farms. ASEAN economies are dual agricultural economies, with small, family-operated rice and maize farming existing alongside corporate plantations growing tropical crops such as

bananas, pineapples, and coconuts. In ASEAN rice and maize producing areas, rural communities similar to those in East Asia exist.

These rural communities, formed around an agricultural core and its supporting service sector, serve many purposes. Even while providing a continuing source of labor for urban economic growth, they provide a social safety net for a significant part of some economies' population in times of economic hardship, help maintain a sense of social stability, and serve as a repository for traditional values and lifestyles. This social stability role is particularly important for those economies where the agricultural workforce makes up a high proportion of the total workforce, as in the ASEAN economies.

The structure of rural communities is changing, particularly in economies with a limited land base and a rapidly growing urban sector which is expanding into rural areas. Agricultural land is relatively expensive in highly-populated Asian countries. For example; land in the Philippines costs several times as much as it does in Australia, while per-capita GDP is one-twentieth. Because agriculture requires a greater land area for production than other industries, the difficulty of expanding the scale of operations under these conditions impedes efforts to raise total agricultural productivity. At the same time, economic growth and trade liberalization increase industrial sector productivity.

Thus, a widening income gap develops between agriculture and industry, and production factors (particularly labor) leave agriculture at an increasing rate, leading to a decline of agricultural production.

Many rural communities are becoming more urban-like as other industries move their production to rural areas to be close to relatively low-cost, productive workers, and reduce their capital expenditures. This industrialization of rural communities is gradually changing the face of the traditional rural community in varying degrees. Many rural communities are becoming less rural as more community members take off-farm jobs.

More farmers are becoming part-time farmers with most of their income derived from off-farm employment. As this industrialization and urbanization progresses, the commodity structure of agriculture in these rural communities changes. In addition, the potential for conflicts over use of natural resources, such as land and water, increases as farmers compete with industry and urban residents. With rising incomes and more away-from-home work, diets change, thereby changing the structure of demand for agricultural products. Production of traditional products will continue to contract as production of fresh vegetables, fresh fruits, and dairy products expand. Thus in many economies you observe an aging, shrinking population of traditional, full-time farmers and an expanding, younger population of part-time farmers producing a different mix of products. This latter group values the amenities of a rural community, but, also, wants to participate in the benefits of the economy's non-agriculture based economic growth.

In more isolated rural communities, in particular, the labor which flows out of agriculture to industry tends to be weighted toward the best workers unless significant off-farm employment is generated in rural areas so that part-time farming becomes an option. The resulting decline in the quality and quantity of agricultural labor further exacerbates the decline of agricultural production unless the means are found to help remaining

farmers take advantage of economies of scale, a difficult problem in many areas where land is highly partitioned. The end result of this rural-urban gap, the so-called “rural problems”, are a major challenge facing many APEC economies. In some economies, cities are poorly prepared to accept these new migrants, and urban poverty substitutes for rural poverty. Southeast Asian economies, in particular, are facing problems with growing urban slums due to the large-scale migration of poor rural dwellers to large cities. In others, as in the case of Japan and Korea, migration leads to serious depopulation and aging of rural communities.

For many APEC economies, the structural adjustments in rural communities accompanying economic growth and trade liberalization involve the movement of resources (particularly human resources) from agriculture to other sectors of the economy. These adjustments are not always smooth or without cost. They have the potential to disrupt traditional societal norms and create welfare gains and losses for the different sectors of the economy. Various problems arise under certain geographical, historical, or demographic conditions. These social and economic opportunity costs must be dealt with through the political process as economic growth continues and as APEC economies become more closely linked through global markets. Only when these costs, including all externalities, are incorporated, can the full costs of change in an economy be compared with the benefits received from change.

#### **IV. MODELING AND METHODOLOGICAL ISSUES**

##### **APEC Outlook and Projection Studies**

These projection studies are generally model based. About half are econometrically estimated and half are simulation models. All are annual, partial equilibrium, supply-demand, agricultural sector models. The databases supporting these models contain time series data. About a third are explicitly identified as dynamic models. All models, either explicitly in equation estimation and exogenous variable projection or implicitly in assumption specification in static models, assume past trends continue into the future unless explicit shocks or changed structural assumptions are specified. Most models incorporate exogenous population growth (usually UN projections), income growth, and explicit assumptions about future crop yield growth. The country/region and commodity coverage differs across the models. Most only cover grains-oilseed-livestock sectors.

The more formal, model-based projections also incorporate expert judgement into the final results. Most of these studies are done by economic modelers within a larger organization of agricultural economists. Initial model results are reviewed by country and commodity specialists and the resulting feedback leads to further refine development of model structure, model parameters, and exogenous shift factors. Thus, while the projections are model based, they also incorporate expert judgement into a final hybrid set of results. If the more qualitative, futurist issues aren't already explicitly included in the

model equation structure, it is through this melding of expert judgement and initial quantitative results that their influences become felt.

**Methodological Critiques:** The projection models used are neither documented nor validated in the results-oriented manuscripts. Without documentation and validation information, it becomes harder to evaluate the quality of the resulting projections. Goodness-of-fit type criteria cannot be used in the evaluation process. Therefore, one must rely on judgement as to the quality of the agricultural economists making the projections, on whether the economic theory underlying these types of economic models is appropriate, on whether the results are internally consistent, and on whether the economic story coming out of a set of projections is consistent with both our and other modelers' *a priori* world view.

Most of these models are relatively large and a severe manuscript length constraint means that only a few results can be reported. Given modelers differing interests and priorities, the reported variables aren't the same in any two studies. Thus cross model comparisons are limited to areas of overlapping interests. Even then, definition differences make data comparisons hard.

One analyst makes projection to 2005; another 2005 and 2010; a third 2006, 2011, and 2016; and a fourth only 2020. Projection differences could be due to fundamental differences in world view or to different time horizons. Not enough information is presented to differentiate.

Limited information on model structure and exogenous assumptions also makes it difficult to evaluate why results differ. We can look for areas of consensus and disagreement, but, unless differences are large or the same 2 variable is explicitly discussed in different studies, we can't explain the differences or choose one projection set as superior to another.

Projections of future behavior add a time dimension to the analysis. With a static model, dynamics and trend factors are built into predicted future levels of exogenous variables, equation specification, and parameter values to make the model represent the state of the economy in the future. However, static models, while incorporating changes in the levels of exogenous variables, seldom make substantive changes in equation specification or parameter magnitudes to reflect the changed structure of the future economy. Dynamic models usually involve solving for a market equilibrium solution for each point in time (usually annually). Dynamics are incorporated as a recursive lag structure with variable levels in one time period, in part, dependent on the variable levels of the previous periods. Lags are usually simple, seldom exceeding one-period, and few in number. With short-term and few lags, these models contain limited dynamics.

These are structural models used primarily for policy analysis. They incorporate both fundamental economic market structure and public policy decision rules. They are usually used to develop a base solution where the assumption is that current market and policy behavior operates. This solution is compared to an alternative solution where this *ceteris paribus* assumption is relaxed and something is changed. The emphasis is on how the two solutions differ. The "what if" nature of the question means that variable levels in the

alternative solution are much less important than the change in variable levels between the two solutions. Using these models for projection (or shorter-run forecasting) requires focusing on the variable values of a single model solution, i.e., "what will be the answer."

For policy analysis or shorter-term forecasting, you evaluate relatively small changes from a base solution. This analysis is best done with relatively short-run elasticities (parameters). For longer-term projections, where more things are allowed to change, the model needs to use relatively long-run elasticities. Long-run elasticities are more elastic, allowing larger changes in quantities relative to price than is the case with shorter-run elasticities. If the models used to produce these projections were developed primarily to do policy analysis, then projections may underestimate quantity changes and overestimate price changes. In addition, too little consideration is given in these models to factors difficult to quantify but likely to emerge as issues over the longer term, such as environmental and global resource problems.

These are also partial equilibrium models, where many variables are held constant that would vary in the long run. The feedbacks into the agricultural sector from changes in that part of the global economy not modeled are most likely not fully accounted for in the projections. They are either ignored under the *ceteris paribus* assumption or estimated outside and prior to the modeling process and then incorporated as exogenous shocks to model parameters or to exogenous variable levels.

In spite of all these concerns, these projections should be treated as reasonable projections of what might happen in the future. They all are based on a common theoretical view of how the global agricultural economy operates. This is the economist's view that supply and demand market fundamentals underlie economic behavior. At the qualitative level there seems general agreement about the exogenous forces driving these models (population growth, income growth, changes in technology, etc.).

With Brown's being the exception, a common global food and agriculture story -- at the qualitative level at least -- emerges from all the myriad of detailed projections in these studies. These projections are not the work of one or two agricultural economists working in isolation. Besides being experts, most of these modelers work in large organizations where their analyses are reviewed by country and commodity specialists. They are also aware of the models and projections of other modelers. Conscious attempts were made to refine models and results by incorporating feedback from these subject matter experts and other modelers. If these projections were derived via a Delphi process, we would say that a significant number of experts reached consensus in arriving at the projection summary reported above.

### **APEC Liberalization Studies**

The reviewed APEC trade liberalization studies are CGE model based, with similar model structures but different simplifying assumptions. All are static (except McKibbin), multi-region, multi-sector, price and income sensitive supply-demand equilibrium models. Since liberalization goals were to be achieved only by 2010/2020, these models simulate longer run behavior and allow the sort of changes in the world economy that would occur

over this relatively long time horizon to work themselves out. Supply-demand equilibrium levels are determined by more than just income and relative prices. These models allow for: (1) factor movement between sectors, (2) production functions containing intermediate goods in addition to land, labor, and capital, (3) productivity growth (through savings and investment) and changes in economies of scale, and usually (4) income growth as production increases. Macroeconomic policy is generally constant or exogenous. Capital and labor are not allowed to flow between regions. A region's total trade balance is held constant, allowing sectoral trade adjustments only. Balance of payment or balance of trade adjustments due to policy changes are absorbed by exchange rate changes. Results are reported as differences between a base solution without APEC trade liberalization and an alternative solution that includes changes resulting from APEC trade liberalization. The models differ with respect to how broadly APEC trade liberalization is defined: APEC preferential liberalization, APEC liberalization with MFN, or APEC liberalization with MFN and rest-of-world reciprocity.

**Methodological Critique:** Some things held constant in the model structure are likely to change in a time horizon that extends from now to 2010/2020: for example, trade balances, macroeconomic policies, total investment, cross-country factor flows, and income growth.

As with projection models, the studies report no evidence of model “goodness-of-fit” beyond saying that equation specification (i.e., model structure) is based on generally accepted “good” economic theory. Validation arguments are implicit and of the “take my word for this, I know what I’m doing” variety.

Reported results focus only on the difference between alternative scenarios. However, this “difference” answer may not be sufficient to convince decision makers that a model generates “good” results. Clients are more interested in what is happening in the “real world” than what is happening in the “model”.

They want to know “What will happen?” *and* “What will happen if...?”. If levels are wrong, it is harder for subject matter specialists and lay audiences to relate model results to real world behavior.

Large models contain many endogenous variables and generate many results. Many are not reported. Not all results are evaluated, nor are all reasonable. In models where “everything affects everything else” (lots of simultaneity in the equation set), all results need to be reasonable. Reporting only selected results is understandable when you have a short manuscript. However, if no attempt is made to report on model validation, providing only a small subset of results makes reader evaluation of model quality difficult.

The results reported in these studies presumably are the most relevant and important variables. In more than a few cases, magnitudes seem out of an expected range. Most likely, full model results have not been carefully evaluated by authors and, therefore, needed model “fine tuning” has not been done. One likely reason is that authors focus on solution “differences”.



More so even than projection studies, no two models consider the same variables important. Estimating the impact of APEC liberalization on the world economy is a complex problem. Many variables can change. Different analysts focus on different aspects of the issue. These differences make it harder to use consensus as a supportive argument for the validity of the results generated by one or more of the studies.

### **Concluding Methodological Comments**

No two quantitative studies report exactly comparable numbers (or have comparable structures). For questions about any specific region, sector, or variable, you will likely only have a small sample of answers. Comfort and confidence in an answer will have to come from the general sense of the common story underlying all these studies. Confidence cannot come from rigorously validated models and closely comparable answers. An annotated bibliography is available that extracts the most relevant agricultural answers from the quantitative studies. These quantitative studies only tell part of the story about the future of APEC agriculture. For a more complete picture of the future of APEC agriculture numerous more qualitative issues must be incorporated into any quantitative story. Only by merging quantitative and qualitative analyses can we even begin to get a clear sense of how the future will unfold.

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