Agricultural trade liberalization

Implications for irrigated agriculture

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Contents

List of boxes

List of tables

List of figures

Preface

The world depends on irrigation for 40 percent of its food supply. The new millennium has brought renewed efforts to halve by 2015 the twin menaces of humankind today: food insecurity and poverty. Despite the drastic fall of the population growth rate since the late 1960s, 79 million persons are currently added to the world population every year. Even by 2030 the annual addition will still be 67 million. Practically, all the increases will come from the developing countries. Parallel to food security runs the opportunity for an adequate nutrition that will guarantee the population's health. There are 842 million undernourished persons today worldwide (less than 2 700 kcal/person/year).

Irrigation accounts for 70 percent of the global water withdrawals, a percentage that jumps close to 85 percent when considering only the developing countries. However, agriculture is not particularly thrifty with a resource becoming scarce and the environmental costs of irrigation can be high (soil salinization, waterlogging, depletion of underground tables).

Agriculture is considered by many countries as a strategic sector given its role in fulfilling very basic needs while relaying on the availability and the sustained use of natural resources, particularly land and water. Thus, this sector has always been subject to a wide range of policy orientations and agreements between countries. Countries' challenges deal with finding the adapted policy arrangements leading to the balance allowing a sustainable use of water resources for agriculture, ensuring food security and protecting the environment.

Is liberalization going to modify significantly the policy options for facing these challenges? The likely impacts of international trade rules under negotiation within the World Trade Organization on the agriculture sector are being highly debated.

Within this context and given its mandate, IPTRID decided to initiate a specific study on the irrigation challenges faced by developing countries within the current reforms.

The aim of the present issue paper is to provide background information to feed such a debate, at academic and implementation levels. It addresses the likely impacts of liberalization on the role and status of irrigated agricultural production, on the viability of new investment in irrigation infrastructure through effects on commodity prices or shifts in production. It also looks at the capacity of small-scale irrigation farmers in responding to changes in the global market. For all these questions it appears that there are no simple or universal answers. Finally, it discusses the possible role for organizations dealing with the improvement of technical and institutional capacity in the irrigation sector in addressing the issues potentially arising from trade reform.

The literature review undertaken by the authors has shown that there is no clear position and hardly any specific study about the impact of trade reform on the irrigated sector. This issue paper presents a balance of the different views identified.

Comments and reactions are most welcome to continue the debate initiated in this paper. We also wish that the present document and the questions raised will generate further research and studies globally, dealing with the potential effects of trade reform at the international level, but also at national and local levels. Indeed, the present study has shown that the consequences of liberalization will depend on a wide range of factors being, for many of them, country specific. In addition, the necessity of understanding farming systems and being able to better anticipate farmers reactions to the change of given contextual factors requires the completion of local analysis.

List of acronyms

AMS	Aggregate Measure of Support
AoA	Agreement on Agriculture
DDA	Doha Development Agenda
ICID	International Commission on Irrigation and Drainage
IFPRI	International Food Policy Research Institute
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
IPTRID	International Programme for Technology and Research in Irrigation and Drainage
IWMI	International Water Management Institute
LDC	Least Developed Country
NGO	Non-governmental organization
OECD	Organization for Economic Co-operation and Development
SDT	Special and differential treatment
USAID	United States Agency for International Development
WTO	World Trade Organization

Summary

The present issue paper aims at providing background information for further identification of the challenges faced by irrigated agriculture within the context of trade liberalization, in different countries.

The following questions are addressed, based on a literature review:

- Will the implementation of balanced, multilateral trade reform under the World trade organization bring about changes in commodity prices, market access and product dumping on a scale that will significantly alter the current role and status of irrigated agricultural production?
- Will liberalization influence the viability of new investment in irrigation infrastructure through effects on commodity prices or shifts in production?
- Are small-scale irrigation farmers in a position to respond to changes in the global market?
- Can such farmers compete with large-scale farms in their own countries and in the North?
- What should be the response of agencies charged with the improvement of technical and institutional capacity in the irrigation sector to these and other issues potentially arising from trade reform?

The paper concludes by identifying possible role for organizations such as IPTRID to carry out or facilitate research for quantifying the opportunities and threats bearing on the irrigated production systems of individual nations as a consequence of trade liberalisation.

The paper is the fifth in a series of Issue Papers for the International Programme for Technology and Research in Irrigation and Drainage (IPTRID). The series aims to promote debate on important issues related to the development and sustained management of irrigated agriculture.

G.A. Cornish (consultant to IPTRID) and S. Fernandez (Technical Officer, IPTRID) prepared the paper. It was edited by Julian Plummer for IPTRID. The assistance of Carlos Garces (Programme Manager, IPTRID) and Jean Verdier (Deputy Programme Manager, IPTRID) in reviewing the paper is gratefully acknowledged.

Chapter 1
Introduction

There is extensive debate and literature focused on the probable consequences of future trade liberalization under the Doha Development Agenda (DDA) of the World Trade Organization (WTO). Much of the debate focuses on the potential effects of trade reform on issues of poverty, welfare and national economic growth and development. This position paper aims to provide a brief review of those larger themes before moving on to examine what the consequences of trade reform may be for the irrigated agriculture sector. Preparation of this position paper is prompted by the following types of question:

- Will the implementation of balanced, multilateral trade reform under the WTO bring about changes in commodity prices, market access and product dumping on a scale that will significantly alter the current role and status of irrigated agricultural production?
- Will liberalization influence the viability of new investment in irrigation infrastructure through effects on commodity prices or shifts on production?
- Are small-scale irrigation farmers in a position to respond to changes in the global market?
- Can such farmers compete with large-scale farms in their own countries and in the North?

What should be the response of agencies charged with improving the technical and institutional capacity in the irrigation sector to these and other issues potentially arising from trade reform?

Outcomes not clear

Any discussion of the impacts of trade reform on irrigation, or on the wider economy, has to take place within the following constraints:

- The DDA describes a lengthy period of negotiations between the member states of the WTO that began in November 2001. At its launch, the round was scheduled to be completed by January 2005 but this has been extended with no new end-date agreed (Sek, 2004). It remains unclear just what degree of trade liberalization will be achieved. Therefore, any formal modelling of consequences must consider a range of scenarios. Different lobby groups have widely differing views on the outcome and distribution of benefits arising from the implementation of the anticipated reforms and, as a consequence, very different analyses are presented in the literature.
- Whatever the levels of reform finally agreed, the consequences will be complex. Moreover, they will vary greatly between countries according to their level of economic and infrastructural development, their natural resource base, and the degree to which they currently benefit from bilateral or regional trade preferences. There will clearly not be a single outcome or consequence of the DDA for the global irrigated agriculture sector.

In short, the outcome of trade negotiations remains uncertain, the consequences or "likely outcomes" are disputed but it is clear that they will vary greatly between different states. Given the scale and complexity of the issues involved, the authors do not pretend to have arrived at a definitive or final "position", or to be in a position to bring comprehensive answers to

the types of question posed above. Rather, this paper is a first attempt to consider what the implications may be for irrigated agricultural production in different parts of the world. The review of literature upon which the paper is based shows that there has been almost no research or analysis to date that considers specifically the consequences of trade reform for irrigation.

The Doha Round and agricultural development – what the literature says

The Doha round differs from earlier trade negotiations prior to the establishment of the WTO, in two important respects:

- This round and its predecessor, the Uruguay Round starting in 1995, are the first to address trade in agricultural commodities (Anderson & Martin, 2005). Earlier trade negotiations under the General Agreement on Tariffs and Trade excluded the agriculture sector. As a consequence, global agricultural trade remains highly distorted through high levels of production and export subsidies, market protection and the existence of numerous bilateral and regional trading preferences.
- This round places a major emphasis on the role of international trade in the promotion of economic development and poverty alleviation, leading to its description as a development agenda.

Because of the key role of agriculture in the lives of millions of the world's rural poor, and the specific focus on development and poverty alleviation, development professionals and institutions have written at length on the likely outcomes. At its simplest, that literature can be divided into two groups. On the one hand, some writers predict substantial development and welfare benefits for most developing countries and countries in transition, with some affordable costs to agriculture in the developed world. On the other hand, some warn that the North will secure greater access to the markets of the South while continuing to subsidize producers and protecting their markets at home. The literature provides numerous case studies in support of both positions. However, because of the constraints referred to earlier, the literature on the DDA makes very few quantitative predictions of the outcome for different economic sectors. The sometimes conflicting views and future scenarios described in the broader development literature are set out in Chapter 3 of this paper.

It is striking that recent literature from the irrigation and water resources community is almost silent on the potential implications of trade reforms for irrigated agricultural production. The following references are the only ones the authors could identify that acknowledge the possible linkage between trade reform and the future economic, commercial and developmental environment in which irrigated agriculture will occur:

- The joint SIWI–IWMI (2004) report for the Commission on Sustainable Development identifies five key issues for policy debate, of which the fifth is the need to: "Identify unsustainable agricultural subsidies and trade barriers." Although identified as a key issue, along with water productivity, the uptake of technology, the consequences of changing food consumption patterns and the need to protect aquatic ecosystems, the report makes no further reference to trade issues. It does not describe their present impact on patterns of water use or set out possible future scenarios.

- There is a large body of literature on the theme of virtual water – the water consumed in the production of agricultural commodities that are subsequently traded. According to the recent report by the International Water Management Institute (IWMI) and the International Food Policy Research Institute (IFPRI) on virtual water trade and water use for cereals (de Fraiture *et al*., 2004), 1 724 million tonnes of grain were produced globally in 1995, but only 215 million tonnes (12 percent of production) were traded. Furthermore, traded produce represented only 7 percent of total irrigation water use for cereal production as the major grain exporters grow rainfed cereals. Thus, international trade represents a small fraction of total cereal production, and the role of trade as a future means of addressing regional water scarcity may be modest. It is national and international political and economic factors, such as concerns over food security, undue reliance on world markets and the need to develop rural infrastructure and economies, that determine resource allocations to irrigated agriculture rather than assessments of the relative productivity of water and virtual water trading. Although virtual water trading has received considerable academic coverage, it seems unlikely to become a key factor influencing levels of profitability and investment in irrigated production in the short to medium term. The reform of trade under the DDA may have greater impact on profitability and investment but it appears to have gone almost unassessed.

Finally, a group of IWMI researchers (C. de Fraiture, personal communication, 2005) has recently postulated a research project to analyse the effects of trade reform on agricultural water use using field studies in Morocco, Thailand and Viet Nam and computer simulation of past trends and future scenarios. However, the study has been postponed owing to the lack of certainty regarding the outcomes of the current round of trade negotiations and their impact on agricultural production.

Trade reform and the bigger picture

Trade reform, although argued by some to be an important precondition, cannot in isolation bring about sustained growth or increasing levels of prosperity in the agriculture sector of the developing world. Lack of investment in infrastructure (irrigation, transport, crop storage and processing), poor human resources development, and under-resourced research and extension capabilities, all militate against developing countries being able to take immediate advantage of any increased commodity prices and greater market access that trade reform may deliver. These weaknesses must be addressed in parallel with the reform of trading rules in order for the Doha Round to realize its potential as a "development agenda".

Figure 1 draws together the various factors that may influence the future of irrigated agriculture. The relative importance of the factors will vary according to the degree of economic development and the physical resource base of a given country. However, the figure illustrates that the reform of trade rules is only one factor among many. These other factors must also be borne in mind when considering the results of models that have been used to try and quantify possible future scenarios.

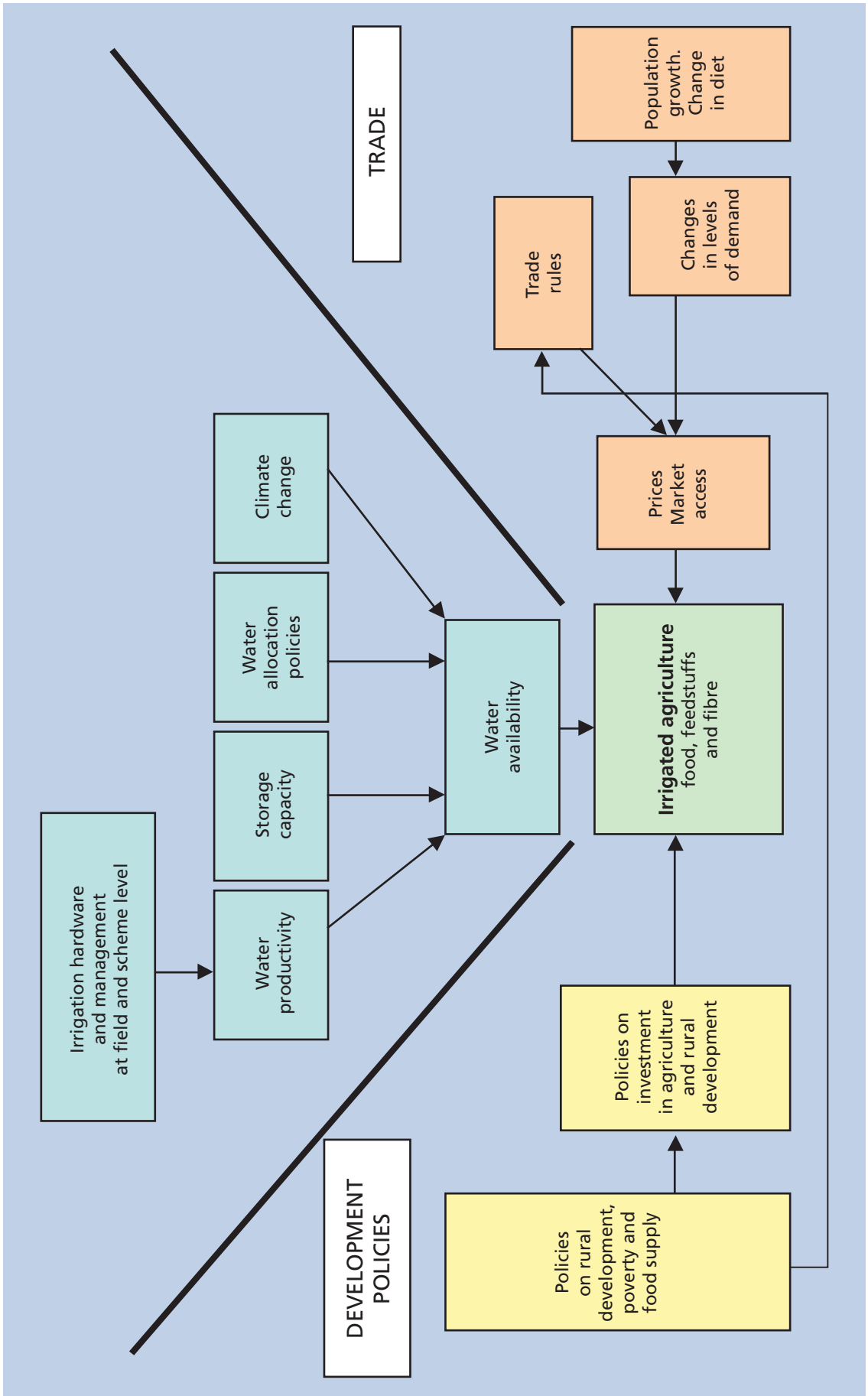


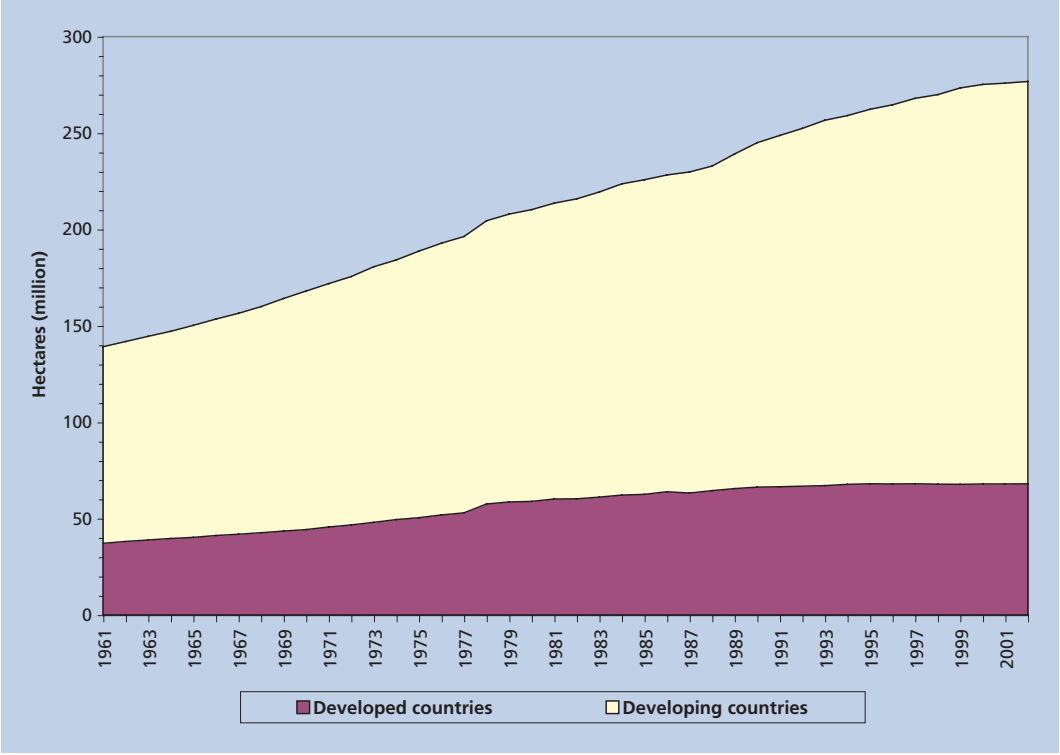
Figure 1
Policy, resource and trade issues bearing upon irrigated agricultural production

Chapter 2
Irrigation, agricultural commodity trade and future reform

Irrigation investment and development

Lending from four major donors – the World Bank, the Asian Development Bank, the United States Agency for International Development (USAID) and the Japanese Overseas Economic Cooperation Fund – for the development of new irrigated land and the improvement or rehabilitation of traditional systems peaked between the mid-1970s and early 1980s (Rosegrant, 1997). This investment led to the substantial growth in global irrigated agricultural area illustrated in Figure 2. Between 1960 and 2002, global irrigated area increased from 139 million ha to 277 million ha, with the great majority of the expansion (77 percent) taking place in the developing world. Although Figure 2 shows a relatively steady expansion in the absolute area under irrigation, Figure 3 shows how the annual percentage increase in area has fallen since the early 1990s. Figure 4 also illustrates how, although most of the expansion of irrigated area has taken place in the developing world, the irrigated area per head of population has declined owing to rapid population growth. In contrast, the area per head in the developed world has increased by more than one-third.

Figure 2
Increase in global irrigated area, 1961–2002



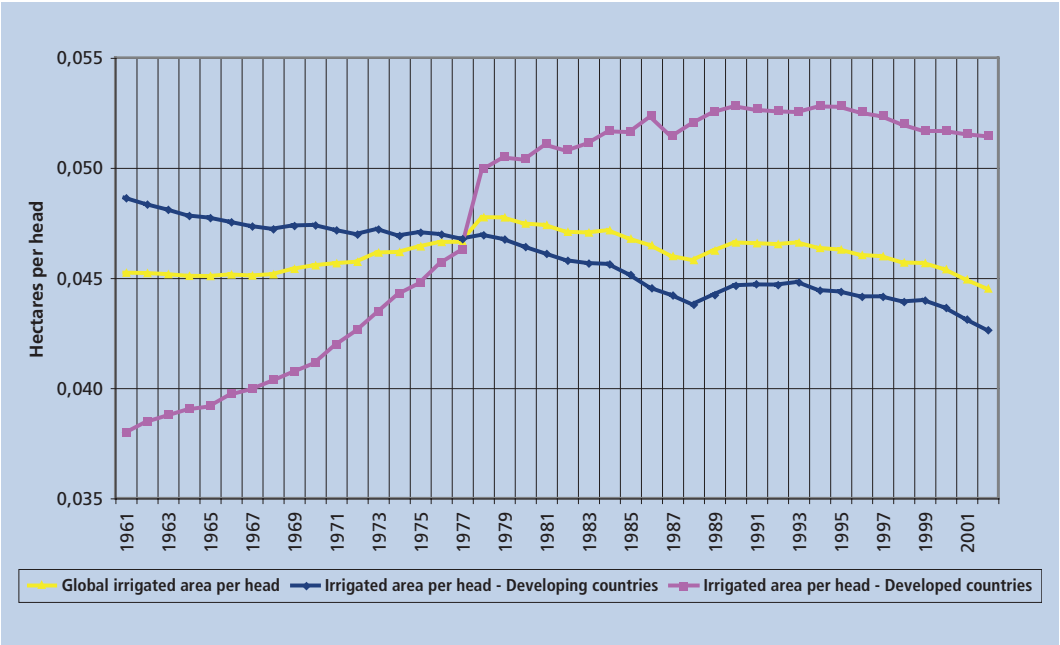
Source: FAOSTAT (2005)

Figure 3
Annual percentage increase in irrigated area, 1962–2002

Source: FAOSTAT (2005)

Notes:
1. The United States of America reported an increase of 3.68 million ha in 1978 leading to an 8.7-percent increase in area in the developed world.
2. The United States of America reduced its reported area by 1.06 million ha in 1987 resulting in a fall of 1 percent in irrigated area in the developed world.
3. Between 1989 and 1991, China, India and Pakistan together increased their reported area by 7.92 million ha.

Figure 4
Irrigated land area per head, 1961–2002



Source: FAOSTAT

The factors commonly cited as leading to the decline in investment in irrigation, either for the development of new areas or the modernization of existing schemes, include:

- A long-term decline in world food prices, reducing the economic return to investments in irrigation.
- Completion of most of the "lower-cost" and readily developed areas – expansion into other areas is now associated with much higher unit costs.

Disappointing technical and economic performance of some schemes, coupled with increasing competition for water resources and concerns about the social and environmental impact of irrigation schemes and the major dams required for their supply.

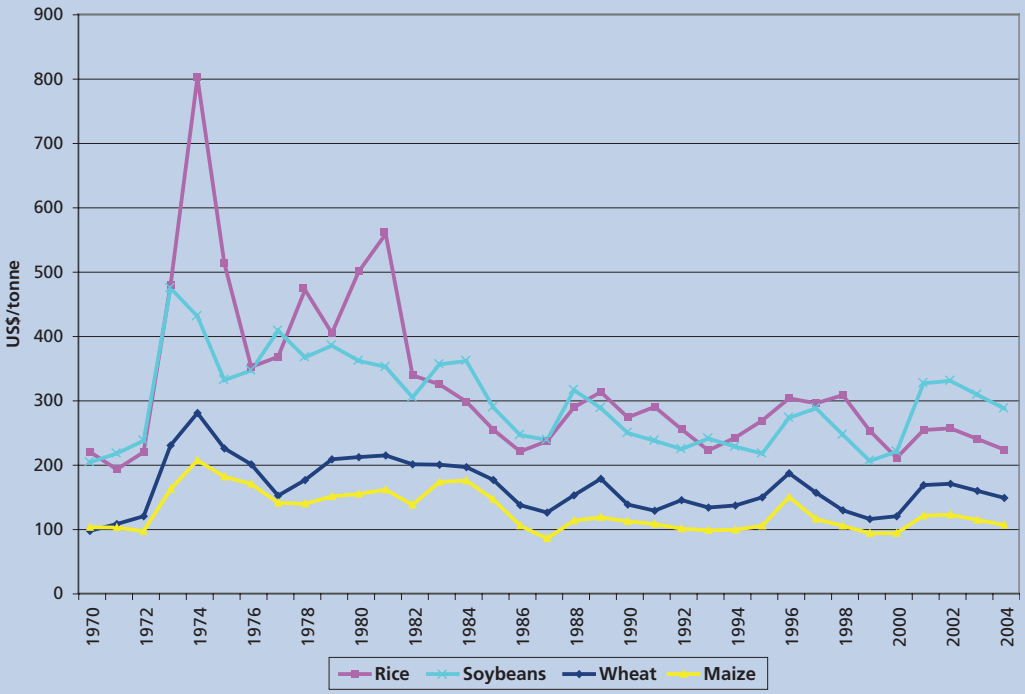
Agricultural commodity prices

The decline in world food and fibre prices merits particular attention in view of the possible effects of trade reform on prices. In a comprehensive review of the economic performance of irrigation schemes funded by the World Bank, Jones (1995) analysed the causes of the shortfall between the internal rate of return for 192 projects calculated at the time of project approval (before implementation) and at subsequent evaluation. The average economic internal rate of return at approval was 21 percent, but by the time of evaluation, it was only 15 percent, indicating that at least one-third of the expected benefits had not materialized. This analysis was based on projects implemented in the 20 years from 1965 to 1985. Forty percent of the difference in performance was explained by falls in the commodity price and unanticipated cropping intensity, and of these two factors, declining price played by far the greater role. Jones reported "Irrigation projects were hit harder by disappointing output prices than any other group of Bank-financed projects."

In reality, agricultural commodity prices have experienced both rises and falls in value since 1970 as Figures 5 and 6 illustrate. All of the commodities experienced a sharp rise in price between 1970 and 1974. In that five-year period, rice, cotton and sugar saw increases of 270 percent, 100 percent and 620 percent, respectively. Much of the apparent decline in agricultural commodity prices has been a gradual falling away from the peaks seen in the mid-1970s.

Quantifying the behaviour of agricultural commodity prices depends greatly on the selected start and end points for the analysis and the form of data used. Table 1 shows that, using the five-year average values for the periods 1970–74 and 2000–04, prices have fallen by between 6 percent and 58 percent. The recent FAO report on global agricultural commodity markets (FAO, 2004) asserts that much of the long-term decline in prices is driven by the growth in supply exceeding growth in demand. The same report acknowledges that short-term price volatility can also have a major impact on the profitability of production and the ability of small farmers to invest in improved production technologies. In the short term, prices may fluctuate by as much as 30 percent in a six-month period, driven by seasonal climatic variation, changes in global stocks, and geopolitical factors.

Figure 5
Prices for rice, wheat, soybeans and maize, 1970–2004



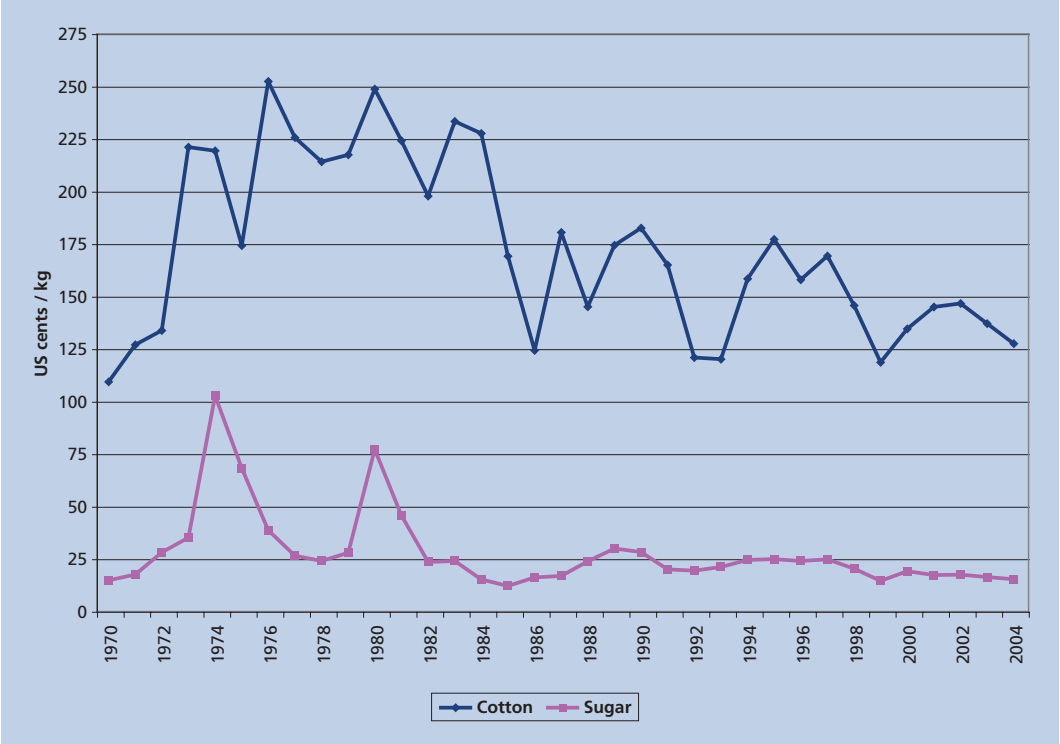
Source: Commodity Price Data, Development Prospects Group, World Bank

Note:
Prices adjusted to constant 1990 US$ values based on global manufactures unit value index.

Table 1: Percentage decline in world prices, 1980–2004

Crop	Units	Average price 1970–74 (constant 1990 prices)	Average Price 2000–04 (constant 1990 prices)	Percentage decline
Cotton	US cent/kg	161.43	137.48	15
Maize	US$/tonne	131.47	108.83	17
Rice	US$/tonne	380.02	234.27	38
Soybean	US$/tonne	310.15	292.00	6
Sugar	US cent/kg	39.06	16.51	58
Wheat	US$/tonne	164.39	150.62	8

Figure 6
Prices for cotton and sugar, 1970–2004



Source: Commodity Price Data, Development Prospects Group, World Bank

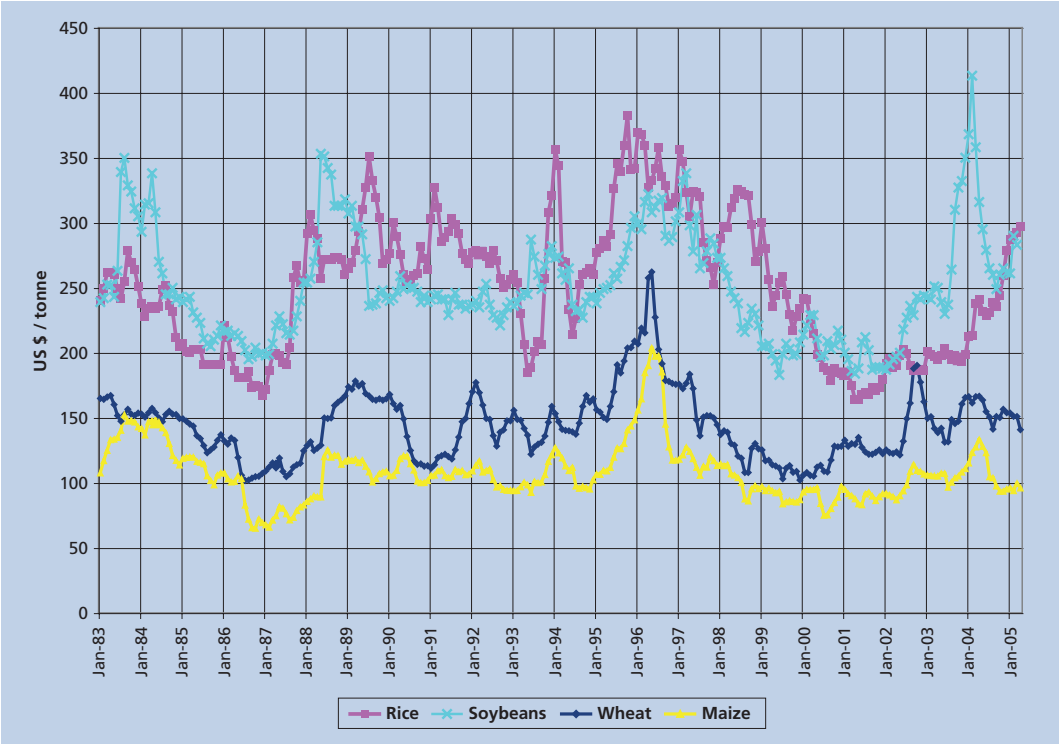
Note:
Prices adjusted to constant 1990 US$ values based on global manufactures unit value index.

Figure 7 illustrates monthly prices for rice, soybeans, wheat and maize since January 1983. Voituriez and Gérard (2001) have shown that the short-term volatility of agricultural commodities is comparable with that of financial assets and much higher than price fluctuations of manufactured goods.

Although a decline in commodity prices may have influenced the level of returns seen to past investment in irrigation infrastructure, economic return was not the primary factor driving governments and international financing institutions to make major investments in irrigation. The expansion of irrigated area (Figure 2) was driven by the need to expand food production at a rate exceeding the increase in global population, coupled with the goal of stimulating economic development through the "engine of agriculture". The fact that food prices have declined and per-capita food consumption has increased above a security threshold of 2 700 kcal/day in all but sub-Saharan Africa (FAO, 2003a) suggests that global agricultural production and trading systems have been successful in meeting the expressed demand for food and fibre as population numbers and economies have grown. Where hunger persists, this is a consequence of poverty, lack of purchasing power, and the absence of adequate supply and distribution systems, not an absolute scarcity of food. However, food production systems will need further development to feed the growing population and there is considerable disagreement about the potential effects of trade reform on existing distribution systems,

food security and levels of rural poverty (Oxfam, 2002 and 2005). This paper considers what the effect of trade liberalization may be on agricultural commodity prices and whether it may be on a scale to prompt international financing institutions and national governments to reverse the decline in investment in irrigated agricultural production.

Figure 7
Monthly world market prices for rice, soybeans, wheat and maize, 1983–2005



Source: Commodity Price Data, Development Prospects Group, World Bank

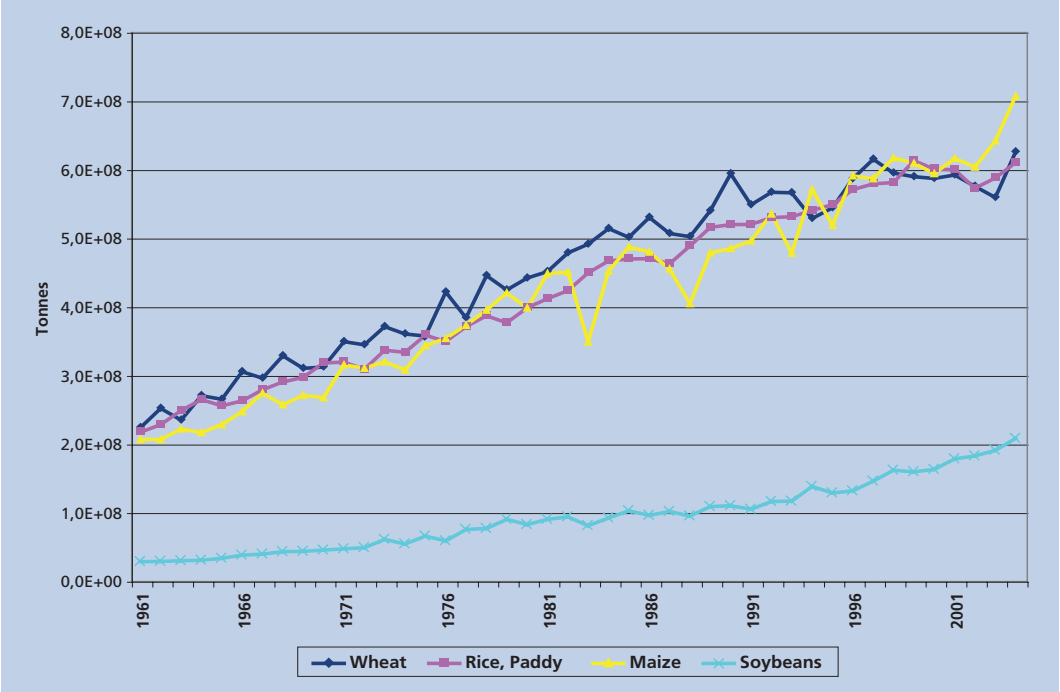
Food production systems are relatively unresponsive to changes in price, even though prices will influence their economic feasibility. The elasticities of food supply and demand are complex and non-linear. Newbery (1992) argues that the food supply in developing countries is responsive to investment in agricultural infrastructure (irrigation, roads, research and extension) rather than to price alone. In developed countries, supply has been determined more directly by policies that have protected the prices paid to producers.

Although trade liberalization may influence future commodity prices, this may not trigger any significant investment in new infrastructure with the purpose of increasing production. Furthermore, it may not call forth substantial additional production. However, if trade reform does lead to increases in commodity prices, as some predict it will, this may improve the economic returns to investment in modernizing existing infrastructure, aimed not at increasing gross production but at improving the productivity of land and water resources (which are limited and expected to become more constraining).

Key producers and traders of agricultural commodities

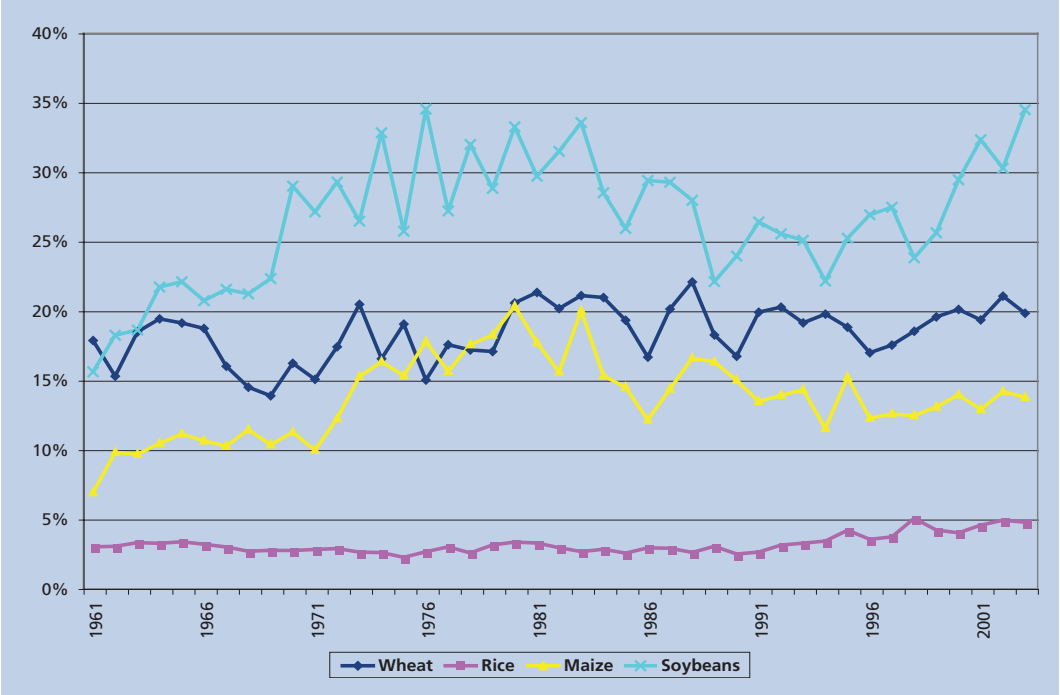
To understand whether or not the reform of agricultural trade under the DDA will have a significant effect on the future development and vigour of irrigated agriculture, it is necessary to have a picture not only of the trends in commodity prices but also of the present levels of production and the volume of agricultural commodities traded between countries.

Figure 8
Global production (in tonnes) of agricultural commodities, 1961–2004



Source: FAOSTAT (last updated 20 December 2004)

Figure 9
Percent of global production entering world trade, 1961–2003



Source: FAOSTAT (last updated 7 December 2004)

Table 2: Production of and trade in key irrigated agricultural commodities, 1995–2002

Crop	Main producers (% of global production)	Fraction of production under irrigation	Main exporters (% of global export)	Main importers (% of global imports)	% of global production in trade
Maize	United States of America (40%) China (20%) Brazil (6%) Mexico (3%) France (3%) **72%** *Total average global production: 590 million tonnes*	United States of America 17% China 46% Brazil 0% Mexico 50% France 28%	United States of America (61%) Argentina (12%) France (10%) China (7%) Hungary (2%) **92%** *Total average global exports: 81 million tonnes*	Japan (20%) Republic of Korea (11%) Taiwan Province of China (7%) Mexico (6%) Spain (4%) 48%	14%
Rice (milled equivalent)	China (33%) India (22%) Indonesia (9%) Bangladesh (6%) Viet Nam (5%) Thailand (4%) **79%** *Total average global production: 388 million tonnes*	China 98% India 56% Indonesia 91% Bangladesh 89% Viet Nam 69% Thailand 39%	Thailand (26%) Viet Nam (14%) India (13%) United States of America (12%) Pakistan (7%) China (7%) Uruguay (3%) **82%** *Total average global exports: 25 million tonnes*	Indonesia (10%) Philippines (5%) Bangladesh (4%) Iran (4%) Nigeria (4%) Brazil (4%) 31%	6%
Soybeans	United States of America (46%) Brazil (20%) Argentina (12%) China (10%) India (4%) **92%** *Total average global production: 155 million tonnes*	United States of America 9% Brazil 0% Argentina 33% China 50% India 13%	United States of America (59%) Brazil (22%) Argentina (8%) Paraguay (4%) Netherlands (3%) **95%** *Total average global exports: 43 million tonnes*	China (19%) Netherlands (12%) Japan (11%) Germany (8%) Mexico (8%) 58%	6%

Table 2: Production of and trade in key irrigated agricultural commodities, 1995–2002 *(continued)*

Crop	Main producers (% of global production)	Fraction of production under irrigation	Main exporters (% of global export)	Main importers (% of global imports)	% of global production in trade
Sugar (raw equivalent)	Brazil (14%) India (14%) China (6%) United States of America (6%) Thailand (4%) Australia (4%) **48%** *Total average global production: 131 million tonnes*	Not available	Brazil (22%) Australia (10%) Thailand (9%) Cuba (7%) France (7%) Germany (4%) **59%** *Total average global exports: 42 million tonnes*	Russian Federation (12%) United States of America (6%) Japan (4%) Republic of Korea (4%) United Kingdom (4%) Indonesia (4%) 34%	32%
Wheat	China (18%) India (12%) United States of America (10%) Russian Federation (6%) France (6%) Canada (4%) **57%** *Total average global production: 570 million tonnes*	China 78% India 82% United States of America 13% Russian Federation 16% France 26% Canada n/a	United States of America (22%) France (14%) Canada (13%) Australia (12%) Argentina (7%) Germany (5%) **73%** *Total average global exports: 131 million tonnes*	Brazil (6%) Italy (6%) Japan (5%) Egypt (4%) Iran (4%) Algeria (4%) 28%	23%
Cotton (lint)	China (24%) United States of America (20%) India (10%) Pakistan (9%) Uzbekistan (6%) **69%** *Total average global production: 19 million tonnes*	Not available	United States of America (29%) Uzbekistan (15%) Australia (11%) Greece (4%) Argentina (4%) **62%** *Total average global exports: 6 million tonnes*	Indonesia (9%) Turkey (6%) Thailand (6%) China (6%) Republic of Korea (6%) 33%	32%

Data on the annual production and trade of all principal agricultural commodities are available in the FAO database at: http://faostat.fao.org/. However, no distinction is made between irrigated and rainfed production. The only recent, comprehensive data set that distinguishes between irrigated and rainfed production appears to be that prepared by Rosegrant, Cai and Cline (2002), used in the forecasting model IMPACT-WATER (International Model for Policy analysis of Agricultural Commodities and Trade). Data from both these sources have been combined to provide the information on global food and cotton production and trade in Table 2 and Figures 8 and 9.

Production of all six commodities listed in Table 2 is dominated by the United States of America, China and India. These three nations produce 60 percent of the world's maize and soybeans, 55 percent of its rice, 26 percent of its sugar, 40 percent of its wheat and 54 percent of its cotton lint. The production and export of these crops is focused on a relatively small number of major players – three-quarters of the world's maize production occurs in just seven countries, and 90 percent of maize exports come from just four countries. Eighty percent of the world's rice production and export derives from just eight countries. The production and export of sugar (beet and cane) is slightly more widely distributed – 22 countries produce 80 percent of global sugar output and as many as 15 countries contribute to 80 percent of exports. However, the picture is generally one of production and export concentrated in a small number of countries. On the other hand, food and fibre imports are spread far more widely among countries in both the developed and developing world. Developing countries have generally increased the fraction of their food supply met by imports over time. Food production has not kept pace with the growth in demand. FAOSTAT (2005) shows that the net cereal imports of developing countries increased from 36 million tonnes in 1976 to 87 million tonnes in 2003, a two-and-a-halffold increase.

The amount of production occurring under irrigated rather than rainfed conditions varies greatly between countries and commodities. Overall, Rosegrant, Cai and Cline (2002), using 1995 data, report that only 31 percent of the world's cereal growing area, including rice production, is irrigated, producing 42 percent of world cereal production. With the exception of rice, Table 2 shows that a very high percentage of the traded cereals are grown under rainfed conditions.

Figure 8 shows that cereal production has expanded at a relatively constant rate, almost tripling in the 44-year period since 1961. Although global production has increased dramatically, Figure 9 shows that, while there have been considerable year-on-year fluctuations in the percentage of world production going to export, there has been only a modest overall increase in the fraction of cereal production that is traded. This increase has been 1.5–2 percent for wheat and rice and 4.5 percent for maize. These data underscore the fact that trade in cereals and other staple food commodities is a trade in surpluses, accounting for only a small fraction, generally less than 20 percent, of global production and consumption – they are residual markets. The majority of food production is not traded but feeds the national population where it is grown.

There is no significant correlation between the fluctuations in world prices seen in Figure 5 and the levels of global production. By its nature, agricultural production is slow to respond to price fluctuations owing to production lags and the existence of food stocks. Production is driven more by longer-term predictions of demand and consequent investment in and uptake of crop production technologies, rather than by rapidly changing market prices. Global production

has increased despite the long-term fall in commodity prices, but the anticipated returns from investments in irrigation infrastructure have been less than originally anticipated.

Rosegrant, Cai and Cline (2002) show that developing countries are already net importers of cereals and that, under a "business as usual" scenario, net imports will increase from 107 million tonnes to 245 million tonnes by 2025 (the estimate of 107 million tonnes does not concur with FAOSTAT data of 87 million tonnes imported in 2003 – confirmation of the inconsistency of international data sets). This is in large part driven by future water scarcity constraining their ability to expand national food production. The same model predicts that under "business as usual", i.e. no significant changes driven by trade liberalization or other factors, irrigated cereal areas in the developing world will expand by just 3.1 million ha, a 7-percent expansion in 20 years.

The major IFPRI study based on IMPACT-WATER and reported by Rosegrant, Cai and Cline (2002) does not explicitly model the impact of trade reform under the DDA. However, the fact that the model was not used to simulate the effects of trade reform may imply that the modellers did not consider that such reform would bring about substantial change.

Predicting how this current picture of irrigated and rainfed production, export and import may change as a consequence of trade reform is not simple, not least because the precise nature of such reform remains undefined. Therefore, it is necessary to review the key elements of the DDA in terms of broader economic and social welfare, before commenting upon their consequences for the irrigation sector.

The Doha Development Agenda

In considering the implications of trade liberalization for irrigation, it is essential to have some understanding of the factors that influence current trading relationships and of the negotiations under the DDA that aim to bring about reform. However, the topic is complex, the literature offers a relatively polarized range of views and interpretations of past performance and future outcomes, and the quantification of reform remains undefined. Therefore, the following is only a summary of the key issues.

Because agricultural trade has only been the subject of multilateral trade negotiations since the Uruguay Trade Round (1986–1994), agriculture remains one of the most distorted sectors of international trade (World Bank, 2003). The Doha Trade Round, launched in November 2001 in Doha, Qatar, sets out "three pillars" of agricultural trade reform, which follow on from the Agreement on Agriculture (AoA) negotiated during the Uruguay Round of trade negotiations (WTO, 2001). Agriculture is not the only sector addressed in the Doha Round of negotiations, but it is of fundamental importance. Other aspects of the round include market access for non-agricultural products (notably textiles), trade in services, and trade-related aspects of intellectual property rights. The three pillars with specific bearing on agricultural trade commit member states to:

- substantial improvements in market access;
- reductions in, with a view to phasing out, all forms of export subsidies;
- substantial reductions in trade-distorting domestic support.

The Doha Ministerial Declaration also confirms that "special and differential treatment for developing countries shall be an integral part of all elements of the negotiations" (WTO, 2001).

Improved market access

Negotiations on improved market access address the barriers used by nations to protect their domestic producers from competition from cheaper imports through the imposition of import tariffs or other non-tariff barriers that prevent the free trade of goods between countries. Tariffs are a tax charged on the purchase of an imported good that raises the price paid by the purchaser. Non-tariff barriers include import or export quotas and bans and the use of product quality and sanitary regulations to exclude certain products. The Uruguay Round AoA established a process of "tariffication" – the conversion of non-tariff barriers to an equivalent agreed or "bound" tariff that was then to be reduced by an average of 36 percent by 2000 for developed nations and by 20 percent by 2004 for developing nations. In addition to these average tariff reductions, tariff-rate quotas were also introduced whereby a country agrees to import a certain quota of a commodity at a low tariff, with imports beyond this quota attracting a much higher tariff.

Negotiations under the DDA seek to make greater and more equitable progress in the reduction of market protection measures, recognizing that earlier reform under the AoA has often disadvantaged developing nations that have made greater concessions. Many have pointed out the imbalance in the reform process to date (Oxfam, 2002). However, agreeing the detail of further tariff reductions is proving difficult.

Of the three aspects of intervention currently "distorting" agricultural trade (market access, production subsidies and export subsidies), many commentators agree that increasing market access through reduction of tariffs and removal of quotas offers the greatest opportunity for trade benefits. However, even after the establishment of the "July Framework Agreement" by the General Council of the WTO in July 2004 (which attempts to reconcile the disparate concerns of rich and poor nations by setting out a "framework" for continued negotiations), there remains considerable uncertainty over what the final nature and extent of market access reform will be.

Reducing export subsidies

Export subsidies are paid by governments to their domestic producers when the world market price of a commodity is lower than the local cost of production. International trade rules have prohibited their use on non-agricultural products since 1955, but they continue to be used to a limited extent for agricultural products. Their effect is to protect local producers, allowing them to produce and export a product without making a loss. Where they are used by a major exporter they also contribute to world prices lowering. A parallel mechanism that has similar effects is the provision of export credit, which reduces the cost of the export process. The use of export subsidies and export credits has been scaled back (World Bank, 2003; Green and Morrison, 2004). However, the subsidizing of domestic producers continues on a massive scale in many developed nations (see below) and has a similar trade distorting effect through the reduction of production costs and consequent lowering of world market prices. Unlike the protection of market prices using tariffs, which is common in the markets of both

developed and developing nations, production and export subsidies are mainly confined to the developed nations. The OECD (2002) reports that about 90 percent of export subsidies notified to the WTO are on products exported from the European Union.

Trade-distorting domestic support

Support to domestic producers can be in the form of: border tariff protection, which maintains the local price of products above world market price; direct subsidies to growers to meet part of the costs of production; or wider support to the agriculture sector including research and infrastructure. The WTO groups and reports the first two types of domestic support – price support and direct subsidy in a single measure – the Aggregate Measure of Support (AMS). The Organisation for Economic Co-operation and Development (OECD) uses the term Producer Support Estimate to report the same measure. In 2004, the total level of support to producers within the OECD was reported to be US$279 000 million (OECD, 2005). To set this level of domestic subsidy in context, it is approximately five times greater than present OECD official development assistance. Oxfam (2002) argues that the high levels of direct subsidy, although only one-third of the total AMS, result in the United States of America and European Union exporting products at prices well below their true production costs. For example, the export price of wheat represents only 50 percent of the production costs, and maize exports from the United States of America represent 80 percent of the true cost of production. The OECD reports that levels of production support for cereals have declined since 1988, but they are still far beyond any level of support that developing countries can offer to their growers.

The United States of America dominates the export markets for maize, wheat and soybeans, with the European Union significantly influencing the wheat market and their low export prices contribute to driving down the world market price for these commodities. Box 1 provides a summary of information taken from the World Bank's annual Global Economic Prospects report for 2003, describing the effects of domestic subsides on world trade and prices for selected commodities.

The Uruguay Round AoA acknowledged that different forms of domestic support and tariff protection of markets can influence world markets to varying degrees (Box 1). In view of this, subsidies have been categorized into three boxes:

Amber box Subsidies deemed to be trade-distorting and, therefore, subject to reduction to below a minimum, so-called "de minimis". For developed countries, total amber subsidies must be no more than 5 percent of the value of agricultural production. For developing nations, the minimum is 10 percent.

Blue box Subsidies that are exempt from reduction or limitation as they are part of programmes that limit rather than promote further production.

Green box Subsidies considered to have "no or at least minimal trade-distorting effects on production". These include direct income support to farmers that are not related to the production of a particular commodity or price threshold. Support for environmental protection and rural development programmes falls within this box.

Box no. 1: Production subsidies and market protection influence the market

Sugar: In 2002–04, prices for sugar received by producers and those paid by consumers were in OECD countries, on average, about twice the level of border prices. Owing to falling domestic demand, partly caused by the increased use of artificial sweeteners, producers such as the United States of America and the European Union, highly supporting their production, have become net exporters. This contributes to lower world market price, which is below the production costs of some of the most efficient producers. The World Bank's trade model predicts that removal of all tariffs, producer support and preferential market access would increase the world price by 40 percent while prices in the protected OECD producer countries would fall by as much as 65 percent in Japan, 40 percent in the European Union and 25 percent in the United States of America. However, abolition of preferential access to markets for many African, Caribbean and Pacific countries could actually depress rather than increase their production.

Wheat: The European Union provided US$9 500 million of producer support to wheat growers in 1999/2001, equivalent to "a protection rate of almost 50 percent".

Cotton: Domestic producer support in the United States of America, Greece and Spain resulted in national prices that were, respectively, 91, 144 and 184 percent higher than the world market price in 2001/02. Again, predictive models indicate that full liberalization in all commodity sectors – more far-reaching reform than is envisaged under the DDA – would increase the world price by 13 percent. Cotton production in the United States of America and the European Union would fall by 6.7 percent and 70 percent, respectively.

Rice: Tariff and equivalent non-tariff protection averages about 40 percent but can be as high as 200 percent. The World Bank estimates that full liberalization would lead to an increase of 33 percent in world market prices, mainly benefiting producers in Cambodia, China and Viet Nam. However, Oxfam's recent briefing paper on WTO negotiations and rice (Oxfam, 2005) warns that equitable reform may not be achieved and that beneficial impacts may not be spread so widely.

Source: World Bank 2003

Special and differential treatment

The Doha Ministerial Declaration reaffirms that provisions for special and differential treatment (SDT), which enable developing countries to take account of their development needs including food security and rural development, should be an integral part of WTO agreements. However, making such provision concrete and specific has proved difficult. Developing countries made more than 85 proposals for SDT in 2002 (World Bank, 2003) but none was agreed upon.

Provisions may fall into one of three areas:

- Preferential access to developed-country markets, i.e. at tariffs lower than most favoured nation status. This access is granted without a reciprocal commitment from the developing countries.
- Exemptions or deferrals from some WTO rules allowing developing countries more time to implement a given policy.
- Technical assistance to help implement WTO mandates.

Ruffer and Swinebank (2003) stress that the lack of a clear definition of what constitutes a developing country within the WTO membership hinders the application of SDT. Countries may declare themselves as developed or developing without reference to any quantitative criteria. In January 2002, almost three-quarters of the 144 member states of the WTO declared themselves to be developing countries. However, only 30 of these come from the group of Least Developed Countries (LDCs) as recognized by the United Nations Conference on Trade and Development. A further 22 countries are classed as net food importers. The developed nations would prefer to offer SDT to this smaller group of about 50 nations, but poor developing counties that lie just outside the definition of LDC see this as unfair discrimination. Furthermore, there are challenges as to what constitutes a net food-importing nation. As a consequence, progress on negotiating the substance of SDT in any given context is often protracted.

The merits and drawbacks of SDT are debated vigorously in the literature. For this paper, it is sufficient to recognize that the complexity and lack of definition around SDT adds to the uncertainties accompanying any attempt to comment upon the outcome of trade reform on the irrigated agriculture sector of different nations.

The DDA and improved national welfare

On either side of the debate over trade liberalization, there appears to be agreement that if the "right" balance is struck, there could be substantial welfare benefits for many people in the developing world. The World Bank (2003) describes an illustrative programme of trade reform, addressing both agriculture and manufacturing sectors, in which developing countries see additional income of US$350 000 million by 2015 while the developed world sees an additional US$170 000 million. Oxfam (2002), in offering a critique of trade reform does not challenge these headline figures or the claim that trade can "work for the poor". The concerns of many in the non-governmental organization (NGO) development community are about the spread of these benefits and issues of equity, balance and the need for safeguards and protection for those groups that will face hardship and potential loss of livelihood as a consequence of changing terms of trade (Save the Children, 2002).

FAO (2003b) points out that the benefits anticipated with the initial formulation of the AoA under the Uruguay Round in 1994 did not materialize. More importantly, the same document raises the obvious question: if the gains from free trade are so universal and clear cut, why is there so much protectionism and protracted negotiation over trade reform? Three potential explanations are put forward:

- Trade theory can demonstrate that, for large countries, there is an optimum tariff above zero at which their gains are greater than their losses.
- The analogy of the infant industry is used to argue that small firms, and indeed small countries, need some initial protection to allow them to grow to a size where they can compete head-on with larger organizations that enjoy economies of scale and other benefits such as better market knowledge, and greater research and development capacity.
- There is the political influence of national groups that gain from market protection and production subsidy, coupled with national governments' need to raise revenue from border taxes where other tax bases are weak.

The FAO report concludes that the gap between trade theory and real world practice is caused by the failure of theoretical assumptions about perfect competition and "frictionless exchange" to hold true in practice. It is important to bear this in mind when considering the outputs of theoretical trade models in the following chapter.

Chapter 3
Modelling the effects of trade liberalization

Predicting the effects of what remains an unspecified degree of trade reform on the existing patterns of food and fibre production and trade is not straightforward. However, some attempt must be made to assess the direction and scale of changes that may be brought about as a consequence of trade liberalization. In recent years, economists and resource managers have used partial and general equilibrium models to model the response of sectors or entire economies to change. General equilibrium models model an entire economy at a national, regional or even global level, while partial equilibrium models model a particular sector such as energy, transport or food supply. Their practical implementation has only become possible in the past 20 years because of advances in computer hardware and software, and their development and use remains a specialist area. Such models must simplify reality in order to model a sector or entire economy effectively. The diversity of consumers (rural/urban, wealthy/poor) is commonly reduced to a single representative "national household", and the range of sectors and commodities that exist within an economy are aggregated according to the purpose of the model. Regional and global models commonly group numerous individual countries into a smaller number of representative blocks.

Despite their simplifications and the approximations used in modelling economic transactions, their exponents argue that, when well constructed, such models can generate data that are useful in informing policy debate by indicating the direction and relative magnitude of changes that a given level of change may bring about.

This paper presents selected quantitative output from two recent models of trade reform as a basis for considering the scale of change that may come about in commodity prices and the volume of commodities traded, and for exploring what the implications may be for irrigated production in a number of states. This can be no more than a first review using deductive reasoning and data generated for other ends. Nevertheless, it serves to flag up trends and key issues and may highlight the need for greater awareness of the issues associated with trade reform in the thinking of irrigation policy-makers.

The models and modelled scenarios

Data are presented from two models. The first, larger general equilibrium model, LINKAGE, was developed at the OECD Development Centre but has been most recently used by the World Bank to assess the outcome of further global trade reform under the DDA. A technical specification of the model is provided by van der Mensbrugghe (2005). The model uses the most recent version of the GTAP database (Version 6), which divides the world into 87 countries or regions and identifies 57 economic sectors. This data set provides data for the base year of 2001. The LINKAGE model aggregates these data down to 27 regions and 25 economic sectors, of which 13 relate to food and agriculture. Although the model explicitly models the supply of capital, labour and land, it takes no account of water as an agricultural production factor.

The second model is the partial equilibrium model, IMPACT (International Model for Policy Analysis of Agricultural Commodities and Trade), developed by the IFPRI and described by Rosegrant, Cai and Cline (2002). It models trade in 16 agricultural commodities between 36 countries and aggregate regions.

The World Bank has modelled six different possible scenarios reflecting different degrees of reform that may be agreed during the Doha Round, modelling the effects of these through to 2015 (Anderson & Martin, 2005). The scenario considered a "most likely outcome" assumes the elimination of all export subsidies and the following reductions in the 2001 applied levels of domestic support (AMS): 28 percent in the United States of America, 16 percent in the European Union, 18 percent in Norway, and 10 percent in Australia. Reductions in applied tariffs are taken to vary between 45 and 75 percent for developed nations and between 35 and 60 percent for developing nations, with the greater cuts applied to higher tariffs. It is assumed that there is zero tariff reduction in LDCs. In addition to the reduction in subsidies and tariffs on agricultural produce, access to non-agricultural markets is increased through a 50-percent reduction in tariffs for developed countries, a 33-percent reduction for developing countries, and no change for LDCs. These changes are assumed to be phased in during the five-year period from 2005 to 2010.

The IFPRI sectoral model, addressing only the consequences of trade reform in the agriculture sector and ignoring possible cross-linkages with other sectors, modelled five scenarios and makes no suggestion as to which may be "likeliest" outcome. Each scenario projects the outcome through to 2020 with the changes phased in rapidly between 2005 and 2006. The scenarios are summarized in Table 3.

Table 3: Trade liberalization scenarios modelled in the IFPRI IMPACT model

Scenario	Description
1. Baseline	No change from the present (2002) trading arrangements.
2. Full liberalization	All differences between domestic and international prices are removed in all countries.
3. Developed country liberalization	All differences between domestic and international prices are removed for developed countries but developing countries retain present levels of market protection.
4. Developing country liberalization	Developed countries retain existing levels of protection and all WTO developing countries see all market protection removed.
5. Fifty-percent liberalization	All countries see a 50-percent reduction in their present levels of market protection.

The scenarios described in Table 3 do not attempt to capture the complexities of different tariff regimes or current preferential trade agreements in the way that the LINKAGE model does. They are simplifications intended to generate results indicating the potential magnitude and direction of change. Like the LINKAGE model, the IMPACT model does not take account of water availability as a factor of production. The IFPRI subsequently extended the IMPACT model to include a water simulation model based on water supply and demand in 69 major basins (Rosegrant, Cai & Cline, 2002). However, there is no reported use of this larger, IMPACT-WATER model to model the outcome of trade reform on irrigated and rainfed agriculture. This larger model has only been used to examine the effects of different economic and technical interventions relating to the development and management of water resources.

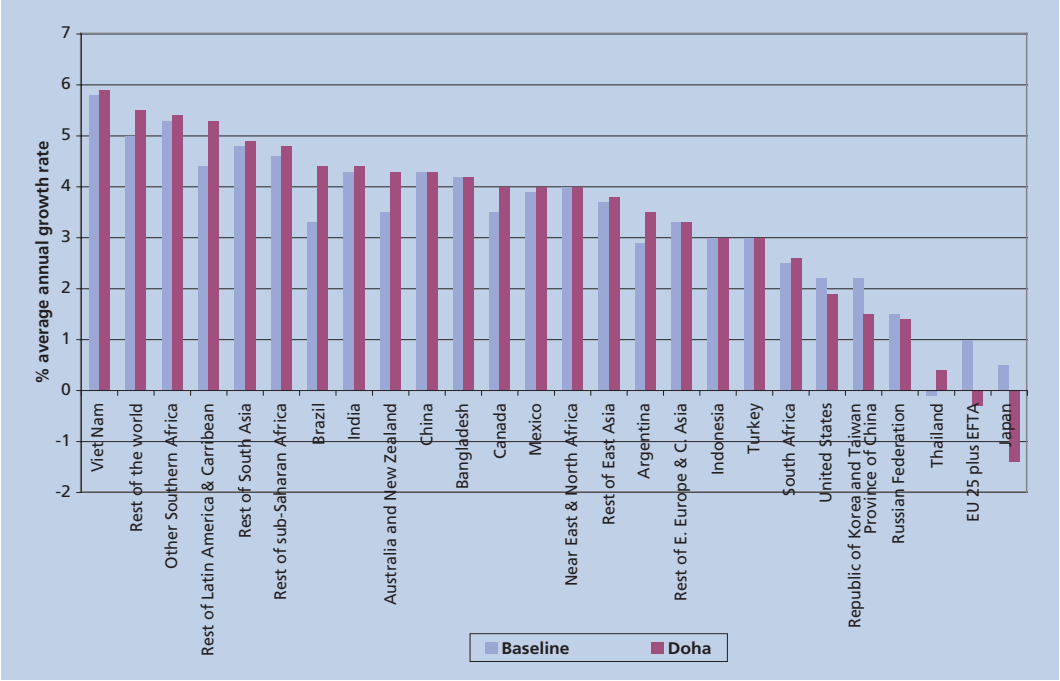
Model results

The above models were developed to evaluate broader questions concerning the distribution and scale of effects arising from different types and extent of trade reform. It was not their purpose to depict the effects of reform on the irrigation sector. Nevertheless, the results provide an indication of the scale of changes and the differences between regions that may result from differing degrees of reform, including an attempt to simulate the "most likely reform scenario".

Agricultural output

Figure 10 indicates that the levels of reform it may be realistic to expect from the present trade round will generally have only a modest positive effect on rates of overall agricultural growth, including both livestock and crop production. Latin America and the Caribbean, and Australia and New Zealand stand out as benefiting more than other regions. However, even here the increase in the rate of agricultural growth as a consequence of the modelled levels of reform is only 0.8–1 percent.

Figure 10
Average annual growth in agricultural output under "business as usual" and possible Doha trade reform between 2004 and 2015



Source: Anderson & Martin (2005)

Those nations and regions showing the greatest additional growth in their agricultural sector, arising from trade reform are, without exception, members of the Cairns group of nations[1]. These nations are characterised by having low existing levels of market protection and domestic support. In part of these countries large commercial estates operate in parallel with small-scale, semi subsistence agriculture (Mazoyer & Roudart, 2004). The former have access to well-developed agricultural infrastructure, and this sector may have the opportunity to expand the area under irrigated production (see below). The commercial agricultural sector of these nations would see particular benefits from the reduction of tariffs and subsidies but the smallholder sector will be less well placed to reap these benefits.

FAO (2003a) reports that only 26 percent of the potential irrigated area of Latin America has currently been developed. Under "business as usual", this is predicted to expand to 32 percent by 2030. The enhanced rates of agricultural growth occurring in that region under trade reform may lead to greater development of its irrigation potential. However, it must be recognized that one of the key beneficiaries of agricultural trade reform in this region will be the livestock sector rather than crop production (Rosegrant & Meijer, 2002).

The United States of America, Republic of Korea, and Taiwan Province of China see a reduction in their annual rates of growth, and the European Union and Japan experience shrinkage of their agriculture sectors as the current high levels of subsidy are reduced. Although the United States of America has a highly protected agriculture sector (Tables 3 and 4), the effect of the modelled reform scenarios is not as marked as that seen in the European Union and Japan. It is also notable that Thailand, the world's leading exporter of rice, would see the reversal of a predicted 0.1-percent annual reduction in its agriculture sector to a 0.4-percent annual growth.

Reporting the IFPRI IMPACT model, Rosegrant and Meijer (2002) do not provide information on the overall changes in agricultural output arising from their different liberalization scenarios.

Trade volumes

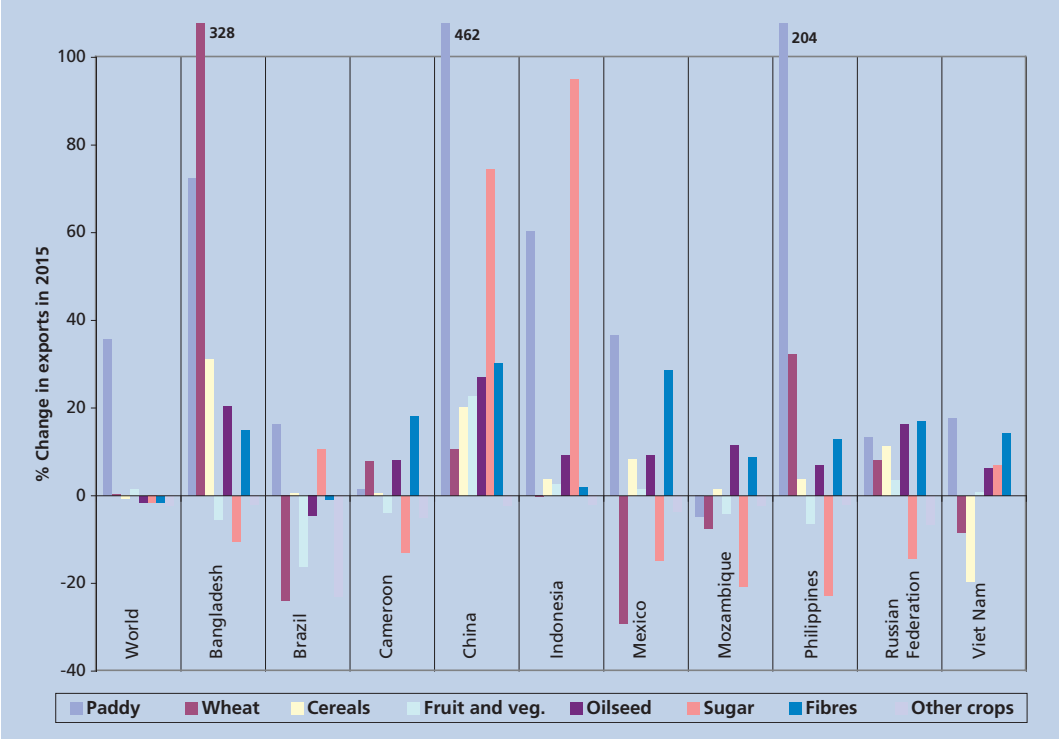
Figures 11 and 12 indicate that the greatest changes in traded volumes will affect rice, the world's major irrigated cereal. Globally, the volume of rice entering trade may rise by 35 percent, accompanied by an 8-percent rise in export prices.

The results suggest that changes in the volume of trade of other primary agricultural commodities, at a global level, will be no more than one or two percentage points. However, the model indicates a potential reduction in global trade, except in the case of wheat and fruit and vegetables. By contrast, the output for the "full liberalization" scenario (not shown) shows an increase in global trade of primary agricultural commodities with the volume of rice traded increasing by as much as 223 percent (Anderson, unpublished data). However, such full liberalization of trade seems unlikely to occur in the foreseeable future. Furthermore, it must be recalled from Table 2 that only 6 percent of the global rice crop is currently traded, so an increase of 35 percent does not imply a major increase in the quantity of rice traded. A reduction in global trade may well come about as a consequence of reduced production in the European Union and the United States of America as the current levels of production subsidy are reduced and agricultural commodity prices within those countries fall.

[1] The Cairns group comprises: Argentina, Australia, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Guatemala, Indonesia, Malaysia, New Zealand, Paraguay, the Philippines, South Africa, Thailand and Uruguay.

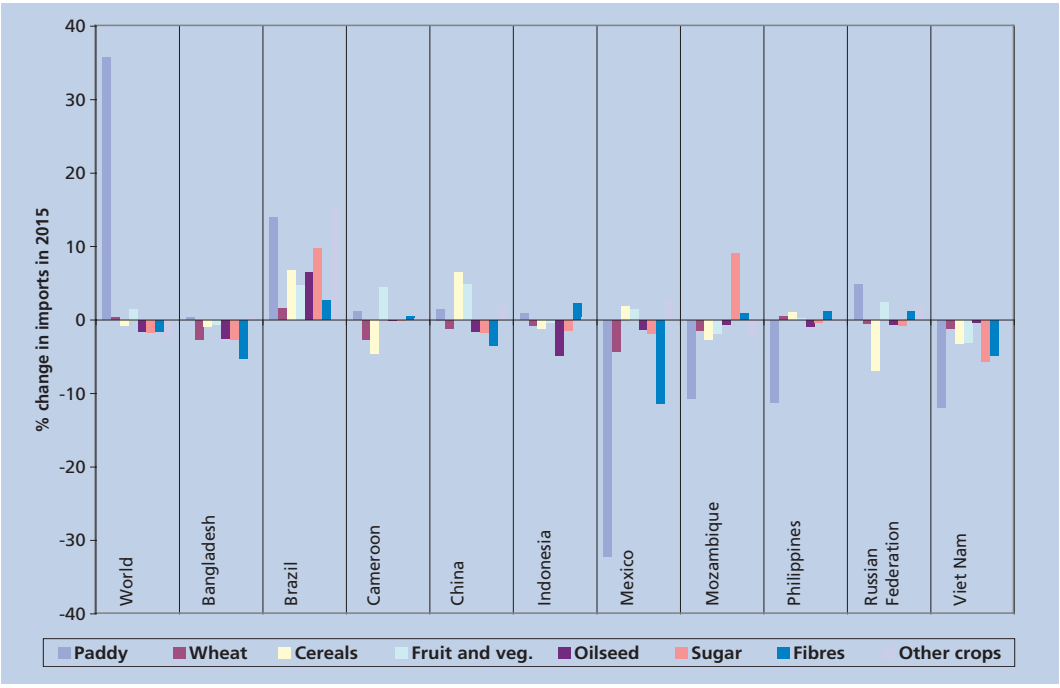
The outcome for some of the individual countries is shown in Table 4, where the modelled percentage changes in import and export quantities are related to recent trade records.

Figure 11
Percentage change in crop export quantities relative to "business as usual" for selected countries in 2015 under possible Doha trade reform



Source: Anderson (unpublished data)

Figure 12
Percentage change in crop import quantities relative to "business as usual" for selected countries in 2015 under possible Doha trade reform



Source: Anderson (unpublished data)

Table 4: LINKAGE model results for rice and wheat trade by 2015 in the context of present production and trade

	Average annual production 1995–2002	Average annual exports 1995–2002	Average annual imports 1995–2002	Change in exports by 2015	Change in imports by 2015
	(tonnes)			(%)	
Bangladesh					
Rice	21 562 484	396	860 091	72.4	0.3
Wheat	1 612 254	223	1 692 511	328	-2.6
China					
Rice	126 587 045	1 805 630	502 697	462	1.5
Wheat	105 433 875	720 346	3 329 635	10.7	-1.1
Indonesia					
Rice	33 705 485	5 368	2 184 856	60.4	0.9
Wheat	n/a	43 096	3 873 611	-0.3	-0.7
Philippines					
Rice	7 674 482	216	997 196	203	-11.3
Wheat	n/a	15 068	2 430 377	32.3	0.5
Viet Nam					
Rice	19 885 663	3 422 959	7 551	17.6	-11.9
Wheat	n/a	13 325	594 677	-8.4	-1.1

Source: FAOSTAT and Anderson (unpublished data)

Note:
Rice = milled equivalent.

Bangladesh is the world's fourth largest producer of rice but it exports almost none of its production. Therefore, the 72-percent increase in exports shown in Figure 11 is of no significance. In the same way, the large percentage increase in wheat exports does not imply any important change in production capacity, given that current exports are negligible. What is more significant is the predicted reduction in imports (Figure 12) of all but two of the modelled agricultural commodities (rice and other crops), which signals increased levels of national production. However, the small scale of this increase must be understood. The predicted 2.6-percent fall in wheat imports is equivalent to 44 000 tonnes. Rosegrant, Cai and Cline (2002) report that Bangladesh harvested 280 000 ha of irrigated and 372 000 ha of rainfed wheat in 1995, with average yields of 2.53 tonnes/ha and 1.45 tonnes/ha, respectively. To grow the additional 44 000 tonnes calls for a yield increase of 4 percent between 1995 and 2015. Even at the low annual increases in yield of about 0.72 percent predicted for the period 2002–2025 (Rosegrant, personal communication, 2005) this will not call for any substantial additional investment in Bangladesh's food productions systems.

The predicted changes in China's future production of and trade in rice and wheat are of greater significance. China currently exports 1.4 percent of its rice production. The predicted 462-percent increase in export volume represents an increase of 6.5 million tonnes, with exports rising to 6.6 percent of current annual production. China would need to raise the productivity of irrigated rice from a current national average of about 4.1 tonnes/ha to 4.3 tonnes/ha (a 5-percent increase in productivity) or expand the area under production by as much as 1.5 million ha. However, neither of the models takes account of water as a factor of production. Given China's increasing water scarcity, it may be questioned whether China will be able to export such an increased quantity of rice. The expansion in wheat exports is less dramatic. The combined increase in exports and reduction in imports is equivalent to about 114 000 tonnes, or just 0.1 percent of current production, 78 percent of which is irrigated. This minor change will not call forth substantial new investment in irrigation infrastructure and management. However, it may again be questioned whether even this modest increase in wheat exports will be forthcoming if water is a constraint. This example serves to illustrate that the effects of trade reform on irrigation may often be overshadowed by other, more influential factors, with growing water scarcity often a primary constraint.

Changes in Indonesia's pattern of import and export are minor. Although there is a predicted 60-percent increase in exports, this is an increase from an extremely small base.

The Philippines shows an 11-percent reduction in rice imports, equivalent to about 100 000 tonnes (based on current imports). Based on the harvested areas and production reported by Rosegrant, Cai and Cline (2002) for 1995, production of this additional quantity would require only a 1.5-percent increase in current yields between 2005 and 2015.

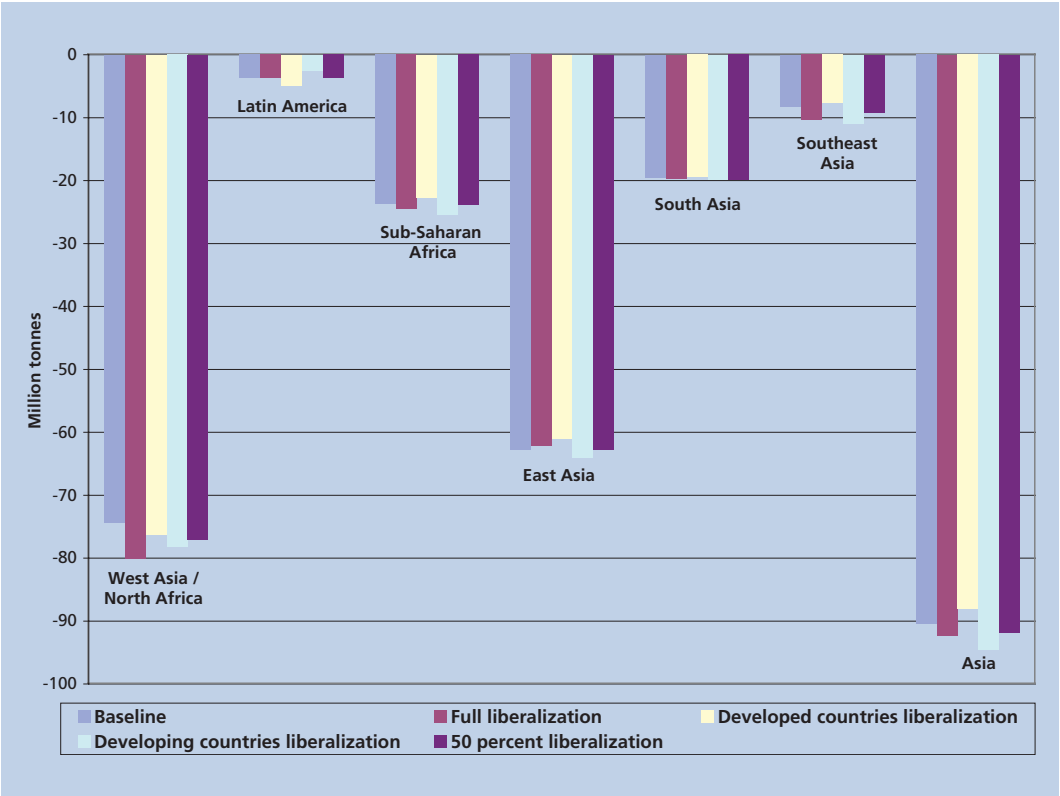
Viet Nam is currently the world's second largest exporter of rice after Thailand, exporting 17 percent of its national production. Increasing this current level of exports by almost 18 percent is equivalent to additional exports of 616 000 tonnes – a yield increase of 3.6 percent given the present harvest area and yields. If yields remained static, this would require an additional 192 000 ha of irrigated paddy – a 5-percent increase in the current harvested area.

None of these changes is particularly large. Under the scenario considered to reflect the most likely outcome of the Doha Round, the LINKAGE model presents a picture of only slightly enhanced rates of agricultural growth in most of the developing world and a 35-percent increase in the volume of rice traded. However, even this increase in the volume traded seems unlikely to call for a dramatic increase in harvested areas or yields beyond the long-term yield improvements of about 0.7 percent/year. A striking feature of Figures 11 and 12 is the variation in outcome seen between both countries and crops in the effects of trade liberalization on import and export volumes. For example, while the Philippines sees a drop of 23 percent in sugar exports, relative to the baseline, Indonesia is predicted to see an increase of 95 percent. The difference arises from different existing trade agreements and preferences, and how these may be modified by liberalization.

Figure 13 shows the results from the IMPACT model. Again, relative to the baseline scenario, the percentage changes in net imports are small. In this model, even full liberalization brings

about relatively small changes, but this scenario can be considered highly unlikely. If the 50-percent liberalization scenario is the best approximation to that which may be negotiated, the model suggests that overall cereal imports in the seven regions shown will increase by 5.5 million tonnes while exports from the developed world (not shown) will increase by 4.2 million tonnes. These figures are a small fraction of the 270 million tonnes of cereal currently traded annually and an even smaller fraction of global cereal production, which is about 2 100 million tonnes. On the basis of these figures, it appears that trade liberalization will not trigger major changes in the global distribution of cereal production. However, it is significant that rice, the major irrigated cereal, shows by far the greatest percentage change in traded quantity. The results also indicate that there is no single conclusion or outcome that applies to all countries. Rather, every country must be considered individually, taking account of its natural resource base, degree of economic development, present levels of food security, and existing trade agreements.

Figure 13
Net cereal trade in 2020 under different trade liberalization scenarios, modelled by IMPACT

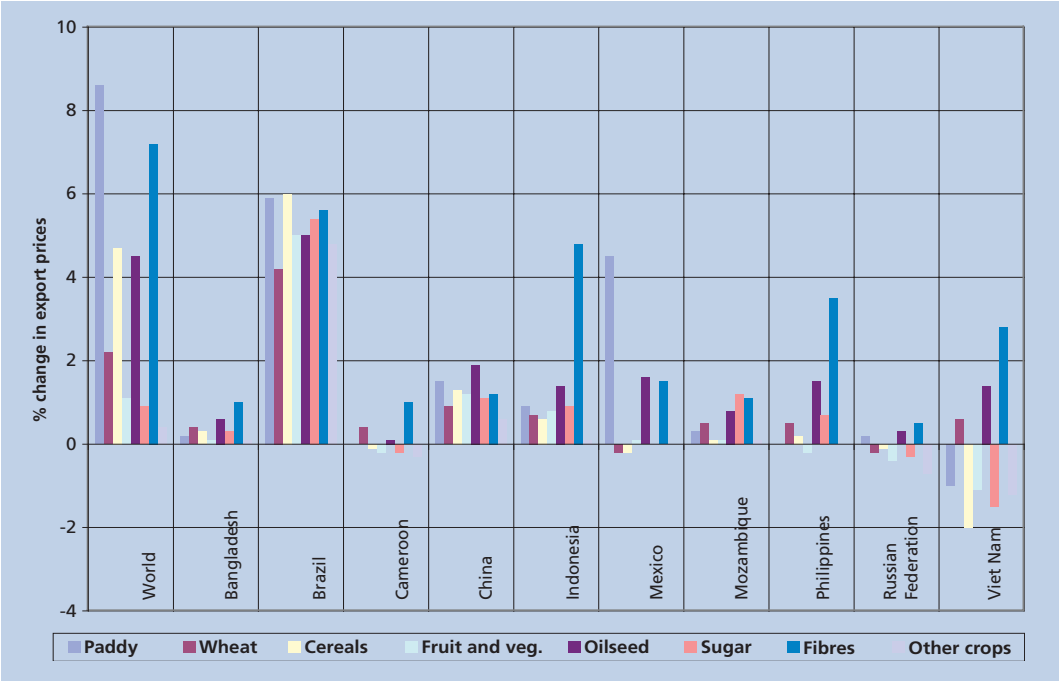


Source: Rosegrant and Meijer (2002)

Commodity prices

Although there is no single pattern of movement in terms of the quantities of agricultural produce imported and exported, Figures 14 and 15 show a more consistent picture regarding agricultural commodity prices, predicting their overall increase on the world market.

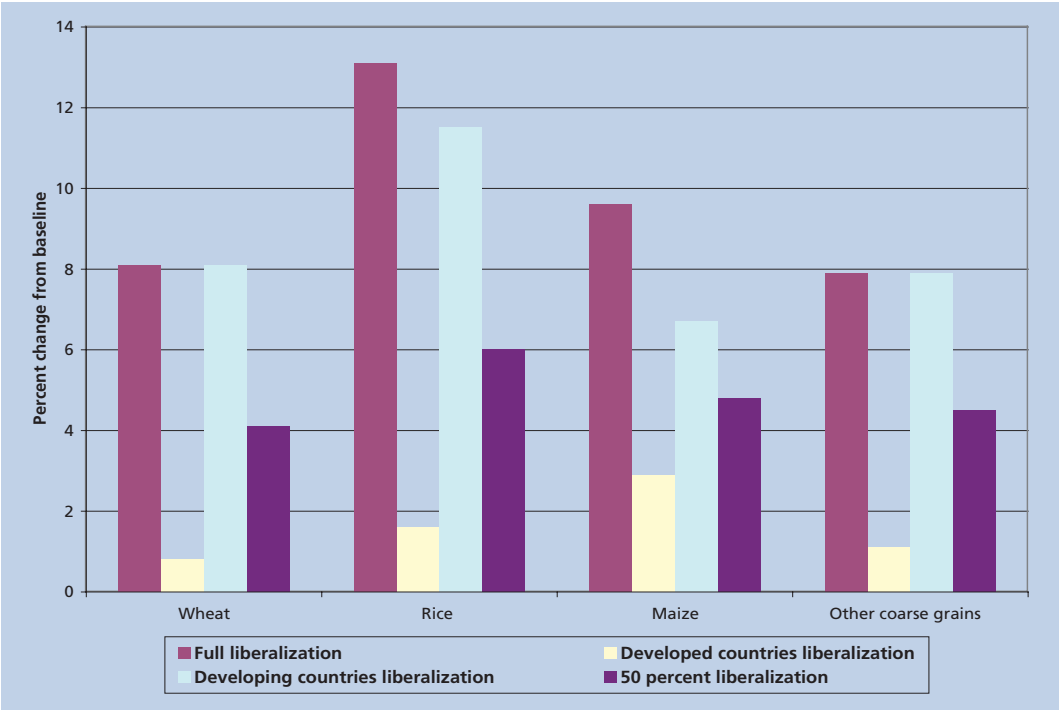
Figure 14
Percentage change in export prices relative to "business as usual" for selected countries in 2015 under possible Doha trade reform



Source: Anderson (unpublished data)

Note:
Export price = price of the commodity at dockside including cost of freight and insurance to the port of export.

Figure 15
Percentage change in world prices relative to "business as usual" for selected cereals in 2020 under four different liberalization scenarios



Source: Rosegrant and Meijer (2002)

However, as Figure 14 shows, the percentage change in export prices for individual countries and commodities varies considerably, reflecting the different existing levels of market protection between countries and commodities. Both models indicate that rice is likely to see the greatest increase in price, of 6–8 percent, but with substantial variation between countries.

With the exception of rice, the predicted increases in price are less than 5 percent. The question is whether this small price increase would be able to provide an incentive for food-importing developing countries to increase their national production (either rainfed or irrigated) in order to reduce their expenditure of foreign exchange on food imports.

Chapter 4
Implications for irrigation

The preceding chapters have illustrated the short-term variability in commodity prices that overlies a long-term decline in price. The proportion of global food production that is traded has remained relatively constant at a low level, indicating that countries have generally sustained a constant level of national food production per capita despite a doubling of world population since 1961. Leaving aside the uncertainties that remain around the scale and extent of reform that will occur under the Doha Round, economic models indicate that the effects of reform must be considered on a country-by-country and a commodity-by-commodity basis. Notwithstanding this last point, the general picture can be summarized as follows (although these broad generalizations mask significant national and regional variations):

- Investment in irrigation infrastructure and the expansion of global irrigated area peaked in the late 1970s and early 1980s. The gross area continues to expand but at a reduced rate.
- Global food production has increased steadily in the past 40 years, keeping slightly ahead of the rate of population increase.
- Food exports are dominated by a small number of major producers (the United States of America, China, and India) and, with the exception of rice, the bulk of cereals traded between nations are rainfed.
- A much greater number of countries import food to satisfy national demand.
- The greater part of the world's irrigated food production is consumed nationally and not traded.
- Trade in cereals is primarily a trade of surplus production – it is a residual market. On average, just 15 percent of the cereals listed in Table 2 enter trade.
- The growth in imports into developing countries has exceeded the rate of growth of their domestic production.
- Agricultural commodity prices peaked in the early to mid-1970s and fell sharply in the early 1980s. Since then, they have remained relatively constant (although there has been considerable short-term fluctuation, and there has been a slow long-term decline in agricultural commodity prices).
- Agricultural trade is one of the most protected sectors within the world economy as it has remained outside earlier rounds of trade reform.
- Commodity prices and patterns of production and trade are influenced by a complex array of factors, some of them lying outside the agriculture sector, overlain by numerous regional trade agreements and bilateral, preferential trade arrangements.
- There is little if any documented debate regarding the possible consequences of trade reform for the irrigated agriculture sector.

Chapter 3 has indicated that the effects of trade liberalization are likely to be:

- Commodity prices are expected to rise commonly by no more than 2 to 4 percent on the global markets although given the high number of factors influencing prices, their inter-correlation and the feed-back loops phenomena, considerable national variation and short term fluctuations may considerably influence this change.
- Rice may see a greater world price increase, possibly by as much as 8 percent.

- Globally, with the exception of rice, the quantity of cereals, fibres and other crops traded will remain unchanged or see a slight reduction. However, there will be some changes in the amounts supplied by individual nations onto the world market.
- The quantity of rice traded globally may increase by as much as 35 percent (an increase of 8.75 million tonnes based on present global exports), but the model predicting this does not take account of potential water supply constraints.
- Trade reform will bring only a very small incremental increase in the annual rate of growth of most developing nations' agriculture sectors. The greatest benefits in terms of sectoral growth may accrue to the members of the Cairns Group of nations.
- Latin America stands out as one region where they may be as much as 1 percent additional increase in annual growth, and it is a region that has only exploited 25 percent of its irrigation potential.
- Although it has only been possible to obtain LINKAGE model outputs for a small group of countries, these show how different but neighbouring counties may face quite different outcomes. For example, Indonesia may see a 95-percent increase in sugar exports while the Philippines reduces sugar exports by 23 percent. At present, both countries produce about 2 million tonnes of sugar equivalent. The difference in outcome is the result of differences in existing trade agreements and levels of preferential access.

This review has been unable to identify either case studies or other forms of research that examine the effects of forthcoming trade reform specifically on irrigated agriculture. This appears to be a gap as such information is essential to inform the policy decisions of national planners and international funding organizations. In the absence of such research, this issue paper puts forward the following initial comments in the hope of stimulating research and debate.

Trade influences the majority of the world's irrigation farmers indirectly as a consequence of price. There are only a few nations that supply the bulk of traded grains and other products, and the majority of that is rainfed. Increases in domestic and international commodity prices that would reverse the static or declining prices are incentives to upgrade production. However, they will not be sufficient on their own. Regional and national agricultural development policies will also be needed, taking account of land and water resources availability and many other factors (Mazoyer & Roudart, 2004). Decisions on how to promote the development and improvement of irrigated production or rainfed systems, or a combination of these, must be taken on a case-by-case basis.

Trade liberalization is unlikely to stimulate a return to the levels of investment in irrigation seen in the 1970s. Economics and trade are only two of the many factors that bear upon the role and priority given to irrigated agriculture within a nation's development at a given moment, as Figure 1 illustrates. In the past 30 years, food and fibre production systems have kept pace with increases in demand driven by population growth and economic development. Demand will continue to increase, requiring improvements in the productivity of rainfed and irrigated production systems as there is limited scope to increase the area under production. Several recent, forward-looking reports on water for food conclude that a key objective in the coming decades will be to increase water productivity through improved land and water management in both rainfed and irrigated production systems (Molden & de Fraiture, 2004; SIWI–IWMI, 2004; Rosegrant, 1997).

Theoretically, liberalization of trade may contribute to modify the economic prospects for irrigators in many developing countries through increasing the prices they receive and opening markets in both developed and developing countries that were previously closed. This would reshape agricultural production strategies following added value and natural resources availability criteria, as observed in some water scarce countries for example. However, as many have pointed out (Rodrik, 2002; Oxfam, 2002), trade reform in isolation will not permit many irrigators in the developing world to reap these potential benefits. Irrigators need functioning and flexible water delivery systems and drainage networks, and all farmers need roads and crop storage and processing infrastructure if they are to engage in trade effectively. Access to credit, market information, agricultural equipment and inputs, and effective extension advice continues to be essential if the opportunities that liberalization may offer are to be realized. True market liberalization may limit the degree to which governments can plan and fund the provision of these services.

The introduction to this paper set out five broad questions that it is logical to ask concerning the effects of trade reform on irrigated agriculture, particularly within the developing nations of the world. It is clear that there are no simple or universal answers to these questions. However, an attempt must be made to give some response to those questions, even if only to recognize that there is a knowledge gap that remains to be filled.

1. *Will the implementation of balanced, multilateral trade reform under the WTO bring about changes in commodity prices, market access and product dumping on a scale that will significantly alter the current role and status of irrigated agricultural production?*
   As the results of predictive models reviewed in Chapter 3 demonstrate, there is no single answer to this question for there is substantial variation in the outcomes seen between different nations and different commodities. This review of literature has found neither national nor regional assessments that identify the question as one requiring a response. It appears that policy-makers are not anticipating changes on a scale that will overshadow other concerns relating to water and food production that include the need to sustain increases in food production, the demand for improved land and water productivity, and the need for institutional reform that can facilitate and sustain the required improvements. However, one fact arising from this review that merits further attention from irrigation water managers and researchers is the predicted increase of 35 percent in global rice trade. Given the recent interest in the theoretical debate around virtual water trading, there appears to be an opportunity for those same researchers to extend that work and engage with the thornier, real-world complexities of trade reform and its implications for the irrigation sector in different regions.

2. *Will liberalization influence the viability of new investment in irrigation infrastructure through effects on commodity prices or shifts on production?*
   The impact of liberalization on international commodity prices is not clear-cut, in terms of levels and volatility.

   There is evidence of developing nations that have reduced their own market protection, under programmes of structural reform and undercut national producers, often leading to increasing levels of poverty. Oxfam (2005) cites examples of such undercutting from

Nicaragua, Haiti, Cambodia and Ghana. Although globally commodity prices might rise, individual nations that currently protect their national growers may have to remove this protection. However, the provisions of SDT negotiations may reduce such effects in future, depending upon the outcome of negotiations. Oxfam (2002) highlights the case of Cambodia that may see its rainfed rice farmers undercut by lower-priced, but unsubsidized, irrigated, rice imported from Thailand and Viet Nam. For the Cambodian farmers, liberalization of their market does not lead to higher prices for their produce. Trade liberalization will inevitably lead to both winners and losers. The large global models such as the World Bank's LINKAGE model that generates headline figures such as US$350 000 million additional annual income in developing countries by 2015 (World Bank, 2003) do not identify who the losers may be and in which nations and sectors they may be found.

A rise in world market prices may serve as a general incentive and justification for nations to invest in improving the productivity of irrigated and rainfed production. However, there is an obvious need for more detailed study of the scenarios likely to be faced by individual nations and the resource constraints, costs and benefits that may determine whether new investments in irrigated agricultural production are likely to be socially and economically attractive.

Since the end of the 1970s, the LDCs have increased their imports regularly and, since the 1980s, their exports have decreased. The effect of subsidy removal alone in changing these trends is the subject of discussion. Some consider that liberalization tends to bring prices into line with the lowest offers from surplus exporters (Mazoyer & Roudart, 2004). Some key problems limiting development will not be solved by subsidy removal anyway (Griffon, 2003). Differences in productivity in open economies partly explain the flows of agricultural products. Liberalization is about putting agriculture sectors with very different levels of productivity in competition with one another.

Water management is one production factor that explains such productivity differences. The more developed countries have a highly educated labour force, adapted technologies, the capacity to innovate, and financing for investment. None of these endowments are innate endowments; they are dynamic, achieved through policy.

3. *Are small-scale irrigation farmers in a position to respond to changes in the global market?*

   And:

4. *Can such farmers compete with large-scale farms in their own countries and in the North?*

   The point has already been made that trade reform in isolation without parallel investment in irrigation, marketing and wider rural infrastructure may leave many small-scale farmers unable to access newly opened markets and facing increased competition in their own national market from imports and better-equipped commercial farms. The need for policy decisions that permit the development of economically and resource efficient farming systems, while also protecting and enhancing the livelihood of small farmers, is not confined to the arena of trade reform. There will remain a need for capacity

development and the facilitation of adapted technology uptake to enable farmers to benefit from the market changes that will come about. At a strategic level government agencies and policy makers may require improved institutional capacity to formulate effective policies that address the needs of rural development, food supply and natural resource management.

It is likely that trade reform will bring the issues of economic efficiency in its widest sense and the protection of the livelihoods of the rural poor into sharper focus for many developing countries. In turn, this may identify one of the future roles for agencies charged with the support of agricultural development and specifically irrigation – the subject of the last question that was posed.

5. *What should be the response of agencies charged with improving the technical and institutional capacity in the irrigation sector to these and other issues potentially arising from trade reform?*
   This paper has shown that there has been very little public debate of the consequences of trade reform for the irrigated agriculture sector. More general discussion of the implications for agriculture and food security is taking place, but much of it focuses on economic and development theory (Green & Morrison, 2004; FAO, 2003b; Hoekman, English & Mattoo, 2002). There is little if any analysis of the implications for specific sectors and countries, possibly because the scale and extent of reform is unknown. However, this seems an insufficient reason. There appears to be a place for agencies such as the International Programme for Technology and Research in Irrigation and Drainage (IPTRID), the International Commission on Irrigation and Drainage (ICID) and the IWMI to carry out or facilitate the research that can begin to quantify the opportunities and threats bearing on the irrigated production systems of individual nations as a consequence of trade liberalization. Such research will require effective collaboration between the disciplines of trade and development economics and water resource and irrigation planners to move towards better quantification of the issues touched upon in this paper.

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