PROSPECTS FOR IRRIGATED AGRICULTURE:

HAS THE INTERNATIONAL CONSENSUS GOT IT RIGHT?

Jeremy Berkoff, Alternative Water Forum, Bradford, 1-2 May 2003

A. Is there an International Consensus?

The provisional objective for agricultural water use adopted at Kyoto was "*to achieve targets for decreasing malnourishment and rural poverty, without increasing global diversions of water to agriculture over the 2000 level*" (Third WWF 2003). This objective reflects a perceived need to preserve water for the environment. It is to be attained by integrated water resources management at a basin level and by trade in *"virtual water*", and implies that any increase in consumptive use would be limited to what is feasible from savings as a result of improved irrigation efficiencies.

The Kyoto objective differs markedly from that adopted three years earlier at The Hague. Then the vision for *"Water for Food and Rural Development"* (van Hofwegen & Svendsen 2000) argued that, if food needs are to be met, agricultural water supplies would need to rise by 15-20% between 1995-25 (*"even under favourable assumptions regarding improvements in irrigation efficiency and agronomic potential"*), and net irrigated area to expand by 22% (52 M ha). The overall Hague vision moderated these figures substantially (World Water Commission 2000) but still envisaged that irrigation withdrawals would rise by 6%, consumptive use by 9%, and net irrigated area by 5-10%. The anticipated increase in irrigation consumptive use (150 BCM) exceeded *total* use anticipated for municipalities (100 BCM), while an increase of 15-20% would have greatly exceeded consumptive use in both municipalities and industry combined.

The difference between Kyoto and The Hague is therefore far from trivial. What explains the difference? Amongst possible reasons, the most important seems to have been the rising influence of environmental advocates. At The Hague, separate sessions were held on *"Water for Food and Rural Development"* and *"Water and Nature*" and many environmentalists were unhappy with the outcome of the agricultural discussions. They believed that the potential of rainfed agriculture and for increasing water use efficiency in irrigation were both understated and that environmental degradation was felt mainly by the poor. At Kyoto these arguments seem to have won the day. Discussions were combined in a *"Dialogue on Water, Food and the Environment"* and concluded that between 30-50% of natural flows should be reserved for environmental purposes. This would essentially preclude additional diversions for agriculture.

Some dispute the Kyoto target. FAO, for instance, argues that irrigation diversions in developing countries must rise by 14% between 1997/99-2030 and net irrigated area by 20% (FAO 2003); and ICID's position paper for Kyoto reiterates the case for greater irrigation withdrawals and reservoir storage though less forcefully than at The Hague (ICID 2000, 2003). More interesting perhaps are the positions of IWMI and IFPRI. IWMI's base scenario at The Hague proposed the 15-20% increase (IWMI 2000), but at Kyoto IWMI provided the Secretariat for the *"Dialogue on Water, Food and the Environment"* and appears to have downplayed its earlier modelling work. IFPRI continues to utilise the IMPACT model but has revised its *"Business-as-Usual"* (BAU) scenario. Rather than an increase in irrigation diversions and a more than doubling in world grain prices by 2025, BAU now provides for minimal increase in withdrawals and declining prices (Rosegrant *et al* 2002). The main difference between the current BAU and the favoured *"Sustainable Water Use (SUS)"* scenario is that rainfed yields rise more rapidly under SUS permitting a 4% *reduction* in irrigation withdrawals while still meeting food requirements at even lower prices. Given the right policies, IFPRI thus believes that the Kyoto target can be exceeded.

Given these varied and changing perspectives, it is debatable whether there is such a thing as an international consensus. Moreover, to the extent that Kyoto represents such a consensus, the balance in my view has generally shifted in the right direction. A main concern with The Hague vision was that it could rationalise uneconomic expansion in irrigation (Berkoff 2001, 2002) but if irrigation diversions are to be limited to 2000 levels, this is no longer so much of an issue. Some new irrigation may replace that lost e.g. to urban expansion or salinisation; more efficient use may justify extension of some systems; and limiting groundwater extractions could shift water use to surface supplies. But existing surface schemes can in any case potentially take much more than is currently diverted and, all-in-all, Kyoto provides little support for irrigation expansion.

If there is no such thing as an international consensus, and the balance of the debate is shifting in the right direction, what is the point of a paper sub-titled *"has the international consensus got it right?"* One answer could be that FAO, ICID and others continue to advocate irrigation expansion so the case for constraining expansion still needs to be made. Another is that, though in terms of its main target Kyoto may have got it right, it remains useful to question the rationale on which this target is based. Assuming the case for limiting expansion is accepted, in the short time available I will briefly review three aspects of this rationale: (i) the role of food trade, (ii) implications for water management, and (iii) the impact of declining prices on rural poverty.

B. Irrigated Agriculture and Food Trade

Irrigation covers some 20% of the world's arable area but accounts for 40-45% of cereal output[1]. According to IWMI between 1966-90 it contributed as much as 90% of the growth in grain output in developing countries (IWMI 2000). Irrigation also plays a critical role in agricultural diversification since water control can be a key to success in high value, water-sensitive crops. The view that irrigation has fed the world is thus not surprising: *"Without irrigation, increases in agricultural yields and outputs that have fed the world's growing population would not have been possible" (*Rosegrant *et al*, 2002). And not just feed itself. Calorie consumption per head has risen by 30% since 1961 and is now approaching an acceptable average world-wide level, even if too many in rich countries over-eat and too many in poor countries remain malnourished.

Without some irrigation expansion, many developing countries would have had difficulty in satisfying food requirements. But was expansion necessary on the scale that occurred? Returns to irrigation have typically fallen well short of expectations and many projects do not pass muster in economic terms (Berkoff 2002). That governments struggle to recover O&M costs, let alone capital costs in what is a highly capital-intensive activity, suggests that beneficiary farmers have received large subsidies and helps explain why so much grain has come from irrigation. Irrigation subsidies are considered to be trade-neutral and are not covered by the WTO discussions. Yet just as rich country farm subsidies distort incentives between developed and developing countries, so irrigation subsidies distort incentives between irrigated and rainfed farmers within countries.

As far as I am aware, the IMPACT model is the only world food model that incorporates response functions that distinguish irrigated and rainfed areas (Rosegrant *et al* 2002). As already stated, IFPRI conclude that food needs could be met under the BAU and SUS scenarios together with further declines in world prices. But under a third *"Water Crisis (CRI)"* scenario, yields (and areas) would rise by less, leading to much higher grain prices (Table 1).

Table 1. Projected World Average Yields and Prices (1995 and 2025)

	Base Year 1995	Projected: 2025 BAU	 SUS	 CRI
Average Yields: t/ha				
Irrigated	3.48	4.89	4.80	4.69
Rainfed	2.18	2.83	3.02	2.64
Total	2.58	3.48	3.57	3.26
Mean Prices US$/ton				
Rice	285	221	215	397

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[1] Statistical data quoted in this paper have been derived largely from the invaluable FAOSTAT database operated by the FAO's World Agricultural Information Centre. Price data come from World Bank sources.

Wheat	133	119	111	241
Maize	103	104	98	224

Source: Rosegrant, Cai and Cline 2002

BAU - business-as-usual scenario; CRI - water crisis scenario; SUS - sustainable water use scenario

But is it reasonable that yields could be *lower* under CRI than BAU or SUS if simultaneously prices are *twice* as high? This would only be possible if price incentives were overwhelmed by physical constraints on yields, and this seems neither likely nor to accord with past experience:

- Growth in yields has slowed significantly in recent decades. While IRRI and IFPRI attribute this to physical causes (Pingali & Rosegrant 2000), it must surely also have been a response to declining grain prices. Indeed, if yields *had* risen faster than they did, output would have been even higher and prices would had to fall even more. Would this have been feasible given that prices fell by 50%+ over 30 years? Surely yields would be expected to find their level in relation to prices within a general equilibrium context at levels below the physical potential?

- Yield differences between countries are much greater than between the scenarios given in Table 1 and this may provide some insight into why yields are what they are. Rainfed wheat and maize yields in Europe are perhaps the highest in the world. No doubt European farmers use advanced technologies but would they do so to the same extent if faced by uncertain rainfall in the absence of price guarantees and subsidies that can account for up to 50% of their income? Would paddy yields in Japan be anything like as high if prices were at world levels? Conversely, remarkable increases in output typically occurred in developing countries when they adopted market reforms, indicating that given the right conditions farmers in these countries also respond actively to financial incentives.

- Following the initial increase, yield growth in these countries typically slowed and significant yield variations between countries remain. Why? A possible reason is that export-equivalent prices are much lower than import-equivalent prices. As a country tilts into surplus, prices tend to collapse, depressing output in the succeeding year in a feedback loop. That so many countries remain broadly self-sufficient, trading only at the margin in response to climatic variability, may be no accident. If so, yield variation between countries may be inherent since they are a function of the relative size of the irrigated and rainfed areas and of the domestic market. Such differences can still be described in technical/managerial terms but their general levels would be determined by the feedback loop. And even if governments also promote self-sufficiency, the feedback mechanism would greatly assist achieving such an objective.

- Given the pattern of self-sufficiency, the volume of trade in grains has actually *fallen* since the early 1980s. On *a priori* grounds, given rapidly falling world prices and large differences in land and water endowments, trade might be expected to increase in favour of those with a comparative advantage. Whole industries have shifted in response to comparable trends, and trade in high value agriculture has boomed, yet trade in grains has failed to grow despite being confidently predicted by many, a confidence reiterated at Kyoto. Farmers often have no where else to go so that falling grain prices do not typically lead to major reductions in grain areas, at least in developing countries. But farmers are also cautious in the face of risk and uncertainty, and can reduce inputs and revert to quasi-subsistence. Responses to low prices are therefore primarily evidenced in terms of yields. It is not that farmers are ignorant of the virtues of fertiliser and chemicals. It is simply that they cannot take the risk of using them, especially if faced with the possibility of an export-induced price collapse.

These arguments throw doubt on the elasticity assumptions of the IFPRI model. They suggest that *physical* yields could have risen faster than they did but that this was precluded by self-regulating economic forces. No doubt governments intervene to promote self-sufficiency, and to tax or protect farm incomes depending on circumstance. Moreover some countries have to import or can profitably export at export-equivalent prices. Others offset world prices leading to *"uneconomic"* surpluses. Yet others need to import at times of drought or war. Trade is an essential component of the world food economy. But if feed-back loops between supply, demand and prices are stronger than assumed by IFPRI, then self-regulating responses may be relatively more important and trade and government programs less important than implied by the model.

These arguments suggests that if countries such as India or China had developed less irrigation, they could still have maintained broad self-sufficiency since rainfed and pre-existing irrigated yields would have adjusted to achieve this result. Besides being uneconomic, past development of irrigation may thus have contributed little to strategic food objectives. And, as in the past, there may be less need for increases in the trade in food grains than anticipated again at Kyoto.

C. Irrigated Agriculture and Water Management

It is not only investments in new irrigation that have often proved disappointing. Programmes aiming to improve irrigation performance, whether on-farm investments, system modernisation or institutional reform, have also frequently been of doubtful value, especially in regions where irrigation has been over-developed. Efficiency in a basin context is often much higher than at scheme level (Frederiksen *et al* 1990, Seckler *et al* 1998). If no water reaches the sea or another sink, the only *additional* source of water lies in reducing unproductive losses and the potential for this may be limited. On the North China plain, for instance, apart from flood flows and ecological releases, little water reaches the sea from a vast area that contains 7.5% of the world's population. Re-use of drainage is pervasive, field losses recharge groundwater, and basin level efficiency is high by any standards. It is a paradox that enhanced local irrigation efficiency (canal lining, sprinklers, drip etc.) can *increase* the fraction consumed in irrigation since the irrigated area expands to absorb the water *"saved"* and return flows fall (Frederiksen 1996). Only if diversions are rigorously reduced in parallel with water-saving investments can more water be diverted to M&I or ecological uses, and this can be politically and administratively very difficult.

Even at system level, irrigation is typically more efficient than commonly supposed. In contrast to M&I, most surface irrigation must be *designed* for some water stress even in water-abundant areas. In arid areas, stress may be inherent in the design (e.g. warabundi in NW India and Pakistan, Albinson & Perry 2000). In more water rich areas, stress is confined to dry years (e.g. average needs say three years in four) or the dry season (a low design intensity) or dry spells. But the fact that *ex ante* a system is designed for stress is neither here nor there *ex post* to the farmer -- he *wants* to crop as much of his land as possible whatever the intentions of the designer, and in a dry spell he is *desperate* to save his crop. Access to groundwater offsets stress, helping to explain widespread over-extraction. The farmer without access to groundwater must compete for surface water even if this leads to damage to the system and/or deprives those who live downstream.

Irrigation expansion in a closing water system adds substantially to this inherent stress. On the North China plain, for instance, 20% of the developed area never receives water and this rises to 50% in a dry year (World Bank 2001). Stress is thus ubiquitous, though this was not the design intention as in the case of the warabandi systems of NW India. As a result, existing irrigation can essentially take all the water available (in Elston's terminology, irrigation is *"user of last resort"*, Elston 1999). In such contexts, it makes little sense to estimate irrigation demand since it is environmental needs, not those for irrigation, that must be assessed and protected. This was essentially what was advocated at Kyoto although it begs the question of how much should or can be reserved for the environment in the face of farmers desperate for all the water that they can get.

Farmer response to scarcity, whether due to system design or to dry conditions, is comparable to a response to price. Farmers compete for what they can get and outcomes tend towards optimality (the hidden hand of Adam Smith). Of course headenders and the powerful misuse water, facilities deteriorate, operators are corrupt or lazy, but the struggle for water *when it is scarce* means that little water is wasted *when it has value*. That water may be wasted when it is abundant (after it rains, during a flood) is neither here nor there, and to argue from average measures of water use efficiency can be very misleading. Price signals that respond to continuously changing rainfall and other factors are almost impossible to establish in huge complex schemes with vast numbers of farmers, whereas the *"hidden hand of scarcity"* operates with immediate and pervasive effect. Indeed, except if supplies are fully controlled, piped and metered, scarcity management is almost invariably more effective than a water price in promoting efficient use in surface systems.

Sunk costs and relatively efficient water use in response to stress suggest that, provided recurrent, opportunity and externality costs are covered, it seldom makes sense to abandon existing schemes. And, though programmes to improve irrigation performance are often disappointing, sunk costs can add powerfully to the justification for additional storage and inter-basin transfers such as the South-North transfer scheme in China (Berkoff 2003). Farmers can only respond to scarcity if they receive some water. It is true that large water short systems tend to support low return crops at the margin since shortages, uncertainty and risk are concentrated in vulnerable tail-end areas. Nonetheless, augmenting supplies to water-short systems has an immediate output response, besides greatly facilitating allocations to high value and environmental uses. It can also ease the rural transition in countries going through rapid and unsettling change. In closing water systems, construction of large-scale water infrastructure might thus often be a more effective strategy than the small scale, on-farm, and institutional programmes that are currently favoured.

D. Declining Prices and Rural Poverty

The feedback loop between water scarcity and water use is comparable to the loop between world prices and crop yields. Both imply that self-adjusting responses to incentives are more important than commonly supposed. And just as farmers can respond to water scarcity only if they receive some water, so they can respond to price only if they can sell their produce at some level that at least pays for how they value labour. If not, they have the option of opting out of the market altogether and reverting to quasi-subsistence agriculture. Something like this may well be happening in sub-Saharan Africa and other poor areas in response to persistent price declines.

Grains account for 70% or more of cropped area in developing countries and, depending on the role of irrigation, typically predominate in both irrigated and -- to an even greater extent -- in rainfed agriculture. In countries with significant irrigated areas, rainfed farmers thus compete directly with irrigated farmers, being discriminated against in a number of ways. They failed, for instance, to obtain much benefit from green revolution technologies that were adapted to irrigated conditions and have received far fewer subsidies, not only directly in irrigation but also in respect of other services and inputs. On the other hand, they are equally exposed to declining prices and to most crop taxation. In a sense they are more exposed since they tend to be dispersed in less accessible regions so that distribution and marketing costs tend to be higher. And it is above all declining prices that threaten farm incomes. This is so in both irrigated and rainfed agriculture, and affects countries with little irrigation as much as those with a significant irrigated area.

Productivity increases and slowing growth in demand no doubt explain much of the decline in world grain prices. Subsidies have, however, also played a part. If all the trade distortions under discussion at the WTO were to be abolished, USDA estimate that world prices of wheat would rise by 18%, of rice by 10% and of other grains by 15%, and that this would result in an annual gain of US$56 billion in world welfare as conventionally defined (Burfisher *ed*. 2001, USDA 2001). Benefits would *inter alia* accrue to competitive exporters, many in developing countries. The Doha round was dominated by arguments in favour of a level playing field in agriculture in which developing countries are thought to have a broad comparative advantage. (Irrigation subsidies are outside the WTO's remit being considered trade neutral -- to the extent that self-sufficiency is due to self-regulating economic forces, the impact of irrigation subsidies within a country would in any case be reflected more in relative yields than in domestic price levels).

Not all WTO reforms in developing countries would raise prices: abolition of tariffs, for instance, would reduce domestic prices. However, many tariffs are not applied being retained only as a precaution against world price disturbances (USDA 2001) and, as countries have liberalised their markets and exchange systems, domestic prices have in practice increasingly been determined in relation to competitive border prices. If so, any increase in world prices arising from a WTO agreement would be translated directly into higher domestic prices. There is thus an apparent contradiction between those who argue in the interests of developing countries for WTO reforms that would *inter alia* lead to higher world prices, and those such as IFPRI who argue for further price declines on the grounds that the poor typically allocate a relatively high proportion of their expenditure to the purchase of grains.

The World Bank advocates targeted subsidies rather than generalised price interventions. This supports the WTO approach, with an appropriate share of any welfare gains in principle allocated to meet distributional objectives. Targeted subsidies are, however, often difficult and expensive for the government to deliver. This helps explain why so many countries have found it more practical to intervene through price and trade controls despite their adverse impact on national welfare. Moreover, countries that initiated reforms when world prices were relatively high were often able to combine heightened incentives to the farmer with continued consumer subsidies. But as world prices fall and incomes rise, the balance of the argument shifted. The case for subsidised food weakens and that for higher prices to augment total welfare and raise farm incomes strengthens. The speed and extent of these shifts varies greatly from country to country while those that came later to the reform process have in many ways been at a disadvantage:

- In rapidly growing, densely populated countries such as China, the price of grains to the urban poor decreases in relevance while the gap between urban and rural incomes becomes increasingly sensitive. Even in China's rural areas, following the success of the initial reforms in the early 1980s, grain prices as a factor in many farm incomes is of declining importance being offset by such factors as agricultural diversification, village & township enterprises, and remittances from the cities. Nevertheless, many poor farmers remain highly dependent on grain sales for their livelihoods, especially in poor rainfed areas and where irrigation water is scarce. Moreover, the issue in these regions is not just how to preserve rural incomes but also how to manage a rural transition that is unsettling and potentially destructive. Higher domestic grain prices could contribute significantly to this objective.

- In countries that have developed less rapidly, such as India, these shifts are proceeding at a slower pace. Urban food prices may remain a sensitive issue, and the landless rural poor in densely populated areas a major concern. Moreover, marginal farmers themselves must often sell at harvest only to have to purchase grains subsequently during the dry season. Higher grain prices may thus have mixed effects in rural areas, supporting the incomes of surplus farmers and creating wealth, while penalising the landless and in some respects the marginal farmer. Overall, however, though the balance of the arguments may currently remain ambiguous, the trends are in the same direction as in more rapidly expanding economies.

- In most of Africa, and in some other poor countries, opportunities outside agriculture remain constrained and economic growth remains limited. In contrast to much of Asia, irrigation is normally of little significance and, given its costs and poor returns, and competing demands

> for investment resources, this is unlikely to change. Again in contrast to Asia, most farmers in sub-Saharan Africa have access to land and, with notable exceptions, the rural landless are of lesser concern. But opportunities for breaking out of subsistence agriculture have become increasingly constrained by declining world prices and liberalised markets. Farmers uniquely among economic agents have the option of withdrawing from the market (all others must *at least* earn enough to buy food), leaving them poor and vulnerable to climatic events but helping them to survive. As communications improve, food aid can also carry them through a drought. Coming late to development, African agriculture has faced low world prices which, it can be argued, have increasingly locked farmers into the combination of quasi-subsistence and aid dependence that characterises so much of the continent.

As an increasing share of the world's absolute poor become concentrated in rural Africa, and as the gap between rural and urban incomes become an increasingly sensitive issue in successful countries, distributional arguments in favour of lower prices become less convincing and the balance of distributional arguments shifts in favour of higher grain prices. Whether the balance has yet shifted sufficiently to be conclusive is unclear. Yet this does suggest, at the very least, that the price increases resulting from the proposed WTO reforms would be desirable. But whether they would be sufficient to raise rural Africa out of poverty may be doubted. The increases anticipated by USDA are not that great and could well be more than offset by technical advances biased in favour of the rich (e.g. GM technologies). Moreover, it seems increasingly unlikely that these reforms will in practice be agreed in the foreseeable future.

Perhaps, instead, as some have advocated (Koning 2002), a case can be made for *protecting* domestic grain farmers in some developing countries e.g. by tariffs, especially in Africa and perhaps more widely. Such policies would no doubt contravene the rationale for liberalised policies and be inconsistent with the WTO proposals as they currently stand. But such protection could be adapted to the circumstance appropriate to each country and, if the arguments developed in this paper have merit, would be one way of tackling the African malaise. Protection is out of fashion but nevertheless I believe it should be given careful consideration.

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