Water for food and environment: The need for dialogue

Growing water scarcity threatens the food supply of nearly three billion people, as well as the health and productivity of major wetlands and other ecosystems around the world. Increasing scarcity, competition and arguments over water in the first quarter of the 21st century will dramatically change the way we value and use water and the way we mobilise and manage water resources. Innovative ways of using this precious commodity have to be found to protect ecosystems and ensure food for the billions on this planet.

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Farmers in the Chistian area of Pakistan, where irrigation agriculture is dominating.

The debate on the use of water is sharply divided. Agricultural scientists say that farm water use, especially irrigation, must be increased 15 to 20 percent in the coming 25 years to maintain food security and reduce hunger and rural poverty for a growing world population. Environmental scientists, on the other hand, say that water use will need to be reduced by at least 10 percent to protect the rivers, lakes and wetlands on which millions of people depend for their livelihoods and to satisfy the growing demands of cities and industry. Many of these ecosystems have already been eliminated or severely damaged over the last decades.

Currently, some 450 million people in 29 countries face water shortage problems. The entire Mediterranean region, including parts of southern Europe, North Africa and Middle East, Pakistan, parts of India and China, most of Sub-Sahara Africa and major regions in North and South America, especially the western United States, will face severe water shortages in the coming years. Northern Europe also faces serious problems. By 2025, about 2.7 billion people, nearly one-third of the expected world's population, will live in regions facing severe water scarcity. Asia and sub-Saharan Africa, containing the most heavily populated and poorest regions of the world, will be most severely affected. If current trends continue, the shortage of water will extend well beyond the semiarid and arid regions. Expanding demand for water will drain some of the world's major rivers, leaving them dry throughout most of the year. Urban centres will experience severe water shortages. But the rural poor will suffer the most serious consequences. Many already lack access to potable water and to the quantity and quality of water needed to grow food and generate income.

The protection of rivers and lakes is also vital. Many people, especially in poor rural communities, depend directly on the food, timber and fish these ecosystems provide. Moreover, ecosystems play an important role in the regulation and provision of water. Abstraction of more water and the conversion into agricultural land will destroy many of these ecosystems and threaten the communities that depend on them. In many developing countries, irrigation today accounts for 80 to 90 percent of the water consumed for human purposes, so that the debate among agriculturists and environmentalists on how to manage water for agriculture is of paramount importance to the very poor.

It is clear to both sides of the debate – agriculturalists and environmentalists – that more irrigation cannot be the only solution. Water infrastructure built in recent decades is decaying or becoming obsolete, mainly through silting up of reservoirs and crumbling of irrigation networks. Groundwater levels are falling and soils are rendered infertile by salinisation. Surface and groundwater is polluted through excessive use of pesticides and fertilisers. For instance, estimates from China indicate that loss of agricultural production due to pollution amounts to roughly 160 million US$ per year. At the same time, even though local communities may be in harmony with their environment, the traditional use of ecosystems is unlikely to feed the billions of people in 2025.

The key question is: how will we collectively use the available water to provide food security, environmental security, health, and livelihoods to a growing world population, in harmony with nature and water users such as industry?

Limitations to increasing irrigation efficiency

A common perception is that increasing efficiency in agriculture is the solution to the water crisis. Irrigation efficiency at the level of the farmer's field, technically defined as the amount of water used by the crop compared with the total amount diverted for irrigation, is indeed often very low – as little as 30 to 40 percent for flood irrigation. Since it is technically possible to increase efficiency at field level to 80 or 90 percent, for drip irrigation but even for well managed flood irrigation on laser-leveled land, the tempting conclusion appears to be that agriculture could do with something close to half the water it is now getting. That would appear to solve »the water crisis«.

»We need a Blue Revolution in agriculture that focuses on increasing productivity per unit of water … more crop per drop.« (Kofi Annan)

Unfortunately, this is a widespread misperception. To illustrate this point consider the Chistian area, located in Pakistan's Punjab, in a landscape heavily dominated by irrigated agriculture. To get an idea of how efficiently water was used, IWMI – the International Water Management Institute – performed a water accounting exercise (*Molden et al., 2001*). During the 1993/94 agricultural year, 740 million cubic meters (MCM) of water entered the area from irrigation deliveries, rain and groundwater (504 MCM from irrigation diversions, 143 MCM as rain, and 73 MCM as net groundwater abstraction).

Crop evapotranspiration was 595 MCM, while evaporation from cities was about 50 MCM. Even though individual farmers may have irrigation efficiencies as low as 30 to 40 percent in the Chistian, human use at a basin level, dominated by crop agriculture, consumed 90 percent of the supplies, evidently quite »efficient«.

Table 1: Water productivity and yield growth rates for a scenario meeting goals of food and environmental security

	Irrigated	Rainfed
Recent Annual Growth Rates (%) in Yield	1.0 %	0.5 %
Business as Usual Scenarios		
– Growth in Yield	1.0 %	0.5 %
– Growth in Water Productivity	0.6 %	0.5 %
– Growth in Water Productivity (25 years)	20 %	15 %
Food and Environmental Security Scenario		
– Growth in Yield	1.3 %	1.0 %
– Growth in Water Productivity	1.8 %	1.2 %
– Growth in Water Productivity (25 years)	60 %	35 %

From this larger, basin perspective, farmers are very effective in converting water into crop production. In fact, groundwater was mined during the year, and very little water was available for environmental purposes such as flushing salts, or for ecosystems. The farmers in the Chistian as a group are, if anything, too efficient! Certainly increasing the efficiency, and leaving even less for other uses, is not recommended.

How can there be such a big discrepancy between field and basin level irrigation efficiency? The answer is that unless fresh water is »lost« irretrievably to the ocean or a saline aquifer, it is often re-used. Water running into a drain is reused downstream. Water seeping into shallow groundwater is pumped up by a neighbour. Water leaking from irrigation canals feed shallow wells used for drinking. Water released for irrigating rice is used by coconut trees downstream of the irrigation area, etc.

However, while efficiency is very high in the Chistian, productivity is very low. Wheat yields are on the order of only 2 tons per hectare, while rice yields are on the order of 1.4 tons per hectare. In terms of kilograms and dollars per cubic meter, water productivity is on the low end of the spectrum when comparing to other systems worldwide. For wheat this converts to 0.6 kg/m^3 of water. IWMI has found a range of water productivity of wheat from 0.6 to about 1.5 kg/m^3 worldwide. The gross value of production for the rice-wheat cropping system per cubic meter of evapotranspiration is on the order of US$ 0.07, at the low end of the spectrum (*Sakthivadivel et al, 1999*). For 40 systems, IWMI determined a range of water productivity calculated in this way from 0.05 to about 0.80 US$ per cubic meter.

Where water is limiting, there is a clear need to shift from an exclusive focus on productivity of land resources, yield in tons per hectare, to a view that focuses on productivity of water resources. Yields ought also to be measured in tons per cubic meter of water, and in a broad sense, including all benefits derived from water used – including environmental uses.

Productivity of water – how will it help?

»We need a Blue Revolution in agriculture that focuses on increasing productivity per unit of water – more crop per drop« reported Mr. Kofi Annan, Secretary General of the United Nations, Report to the Millennium Conference, in October, 2000. Why is getting more crop per drop so important? The answer is simple – growing more food with less water alleviates scarcity, contributes to achieving food security, and puts less strain on nature. Reducing water withdrawn by agriculture contributes by freeing up more water for nature, for drinking, and industrial uses. Can this be done and still provide food security and improved rural livelihoods?

The results of a global calculation using the IWMI's Podium Model (*IWMI, 2000, and http://www.iwmi.org*) show what it would require. In this scenario[1], there is a moderate expansion of 3 percent of the harvested area, and 10 percent of irrigated area. But withdrawals for irrigation have been assumed to decrease by about 10 percent. The only way that enough food can be grown in this situation is by increases in water productivity on rainfed and irrigated land. For the period of 2000 to 2025, we have estimated that an annual growth rate of about 1.8 percent or roughly a 60 percent increase for the period, on irrigated land, and 1.0 percent, or a 30 percent increase on rainfed land in water productivity would be required (see Table 1). This marked change in water productivity from business-as-usual scenarios is the global scale challenge to solving the water-food-environment dilemma.

> How can we use the available water to provide food security, environmental security, health and livelihoods to a growing population?

Can water productivity be increased?

The billion dollar question is, of course, whether such an increase is feasible. Increases on rainfed land can be achieved by several means, for instance:

- improved drought tolerant or water productive plant varieties,
- better nutrient management,
- improved soil-water management practices, including increased irrigation efficiency; and
- supplemental irrigation to fill in the water gaps within the growing season.

It is estimated that in arid areas, 50 percent of rainfall evaporates back to the atmosphere without contributing to crop productivity (*Rockstrom, 1999*). Capturing this water before it evaporates, through improved crop properties such as fast growing roots, or improved tillage practices seems to offer potential. Drought tolerant crops, while not necessarily lifting the yield ceiling, can improve water productivity. Much of the recent increases in maize yield, for instance, have been due to increased drought tolerance. The new CIMMYT (International maize and Wheat Improvement Centre) drought tolerant maize reportedly could increase yields of drought-

The Dialogue on Water, Food and Environment

To contribute to resolving the dilemma between agricultural production and environmental protection, a group of the world's most influential nature protection, irrigation and food security organisations has created an international scientific and policy coalition – the Dialogue on Water, Food and Environment.

The group consists of the Food and Agriculture Organization (FAO); the Global Water Partnership (GWP); the International Commission on Irrigation and Drainage (ICID); the International Federation of Agricultural Producers (IFAP); the World Conservation Union (IUCN); the International Water Management Institute (IWMI); the United Nations Environment Programme (UNEP); the World Health Organization (WHO); the World Water Council (WWC) and the World Wide Fund for Nature (WWF).

A small Secretariat for the Dialogue will be hosted by IWMI, on behalf of the group, in Colombo, Sri Lanka. The Dialogue process, launched in August 2001 at the Stockholm Water Symposium, is scheduled to for five years with intermediate results planned for the 3rd World Water Forum in March 2003 (Kyoto, Japan) and final results for the 4th World Water Forum in 2006 (Montreal, Canada).

The Dialogue aims to involve as many people and organisations as possible to find that answer. Water is everyone's business, especially since one use of water has repercussions for another. Upstream irrigation impacts downstream fisheries and pollution can dramatically reduce tourism activities downstream. The Dialogue has set itself a five-year target to develop a consensus between the agricultural and environmental groups – on how water can be managed to feed the world and preserve the environment in the coming decades. The Dialogue group will mobilise world class water and environmental research to present practical policy options for governments who are bound by the dual imperative of feeding their populations and protecting natural ecosystems.

The objective of the Dialogue on Water, Food and Environment is to »improve water resources management for agricultural production and environmental security to reduce poverty and hunger and to improve human health«. To achieve this ultimate objective, the Dialogue process will focus on building bridges between agricultural and environmental communities, on water resources issues, by improving the linkages between the sectoral approaches that dominate policymaking and implementation, particularly at national level. (www.iwmi.org/dialogue.htm)

In the Zhang He reservoir, in the Yangtze River basin in China, water is increasingly used for urban and industrial water uses.

affected maize by 30 percent. CIMMYT also reports important progress on drought-tolerant wheat. Similar good news appears possible for some other crops. IRRI – the International Rice Research Institute in the Philippines – has also developed salinity tolerant rice that allows growing of rice in areas where water quality does not allow cultivation of conventional lowland rice.

Advances have also been made in the development and introduction of practices that increase water productivity through soil-water management (e.g. zero tillage or conservation tillage, dry seeding, bed planting, permanent beds). The area under conservation tillage in South Asia is reported to be significant and rapidly growing. And supplying a small amount of water through supplemental irrigation at a time of stress can greatly contribute to productivity.

In many areas, potential productivity is not realised and this is in part due to poor irrigation management. Considering the productivity of water in more than 40 irrigation systems worldwide, Sakthivadivel et al (1999) demonstrated a 10-fold difference in the gross value of output per unit of water consumed by evapotranspiration. Some of this difference is due to the price of grain versus high valued crops, and certainly not all agriculture can be devoted to high valued crops. But even among grain producing areas, the differences are large. There are many examples of improvements in water productivity through better water management in specific areas – often propelled by water scarcity. Israel, pioneer and forerunner in drip irrigation technology, was forced to increase water productivity due to physical scarcity. In California, increased emphasis on improving water productivity is also driven by environmental concerns: the need to leave a reasonable part of the overall resources to support ecosystems.

Another example comes from China, where water is moving out of agriculture. The Zhang He reservoir, situated in the Yangtze River basin, was constructed primarily for irrigated agriculture. Over time, reservoir water also met increasing demands from higher valued urban and industrial water uses. This is the situation many agriculturalists worry about – that water will be taken from agriculture to be used for other uses. But in the Zhang He irrigation system, water managers – farmers, irrigation service providers, and water resource managers – were able to shift large amounts of water out of agriculture to meet these other needs without the feared major impacts on agriculture. Production levels remained stable over the time period in spite of this massive shift of water out of agriculture (Table 2). The increase in water productivity can only partly be explained by yield growth which nearly doubled over a thirty year period. This is compared to a near trebling of water productivity attributed to the Zhang He supply. Growing more rice with less water – improving the productivity of water – was made possible through on-farm water saving irrigation practices, ample recycling through the melons-on-the-vine system of reservoirs, pricing water, and strong institutions to back these approaches (*Hong et al., 2001 and IWMI, 2000b*).

In short, there are many pieces to the puzzle that are available, and much promising work remains to be done, but in the short term the key constraints are likely to have more to do with policies and institutions rather than with science and technology. The lack of agreement among different stakeholders in the water arena is threatening to slow down funding for water projects, almost regardless of their value to society. Large water projects are perceived to be necessary by some and a threat to the environment by others – without much dialogue on the real and perceived costs and benefits to all stakeholders. While the work of the World Commission on Dams – recently completed – was a valiant effort to bring the stakeholders together, it also clearly demonstrated how much remains to be done.

Table 2: Changes in land and water productivity in Zhang He irrigation district 1966 – 1998

Period	Annual irrigated area (10^3 ha)	Rice crop production (10^3 tons)	Rice yield (t/ha)	Rice water productivity (kg/m^3 water supply)
1966 – 78	139	561	4.04	0.65
1979 – 88	135	905	6.72	1.17
1989 – 98	118	920	7.80	2.24