Genomics and Water Management?

Water for agriculture gets squeezed-poor farmers first

As populations rise, incomes rise, and countries industrialize—the demand for water in urban areas in developing countries will rise very strongly in the coming decades. At the same time increased environmental awareness will place more and more emphasis on maintaining a healthy environment for people and for nature. The large-scale development of river and groundwater resources is less acceptable now than it was in the1960-1990 period, when the large majority of the world's 45,000 large dams was built. Additionally, water infrastructure built in recent decades is becoming obsolete—for example through silting up of reservoirs, and crumbling irrigation networks—and there appears to be a decreasing willingness to fund rehabilitation and replacement of this infrastructure. Groundwater levels are falling in key aquifers that have contributed substantially to food security in recent years through provision of water-on-demand to millions of farmers who tapped them directly through tube wells. In all these developments, as resources become more scarce, the poor and vulnerable are hit first and suffer the most.

Water for agriculture is being squeezed as this resource is moved out of the farming sector and diverted to urban areas. Groundwater sources are drying up, and the willingness to develop new resources has declined for financial as well as environmental reasons. The consequences of this situation are visible, for instance, in Pakistan, home to the world's largest irrigation system and today, to increasingly serious droughts. Agriculture has grown used to cheap and plentiful water in irrigated areas. As the human population tripled in the 20th century, water use multiplied sixfold, mostly for agriculture. Agricultural productivity has risen sharply in recent decades due to higher-yielding crop varieties and increased fertilizer use. This increase was also due to major investments in water resources infrastructure and to massive energy subsidies for pumping groundwater, that are less likely to be repeated in the coming decades.

Against this background, the question appears to be: **How will we find sufficient water to provide food security, health and livelihoods to a growing world population— in harmony with other water users and the environment?** This is truly a global challenge, that should perhaps be reformulated as follows:

How can we grow the food we need with the water available?

To grow enough food and provide sustainable livelihoods to poor people with the available water will require a considerable overhaul of the way agriculture is practiced. The dominant

agricultural philosophy that views land as the scarce resource and aims to maximize crop yields per unit of land through better varieties—while removing nutrients and water as constraints[1]—needs to be replaced. It should be replaced by a philosophy that views land, water, nutrients and genetic resources as an integrated set of scarce resources that need to be managed by the stakeholders.[2]

For water and land resources management there are three priorities:

1. To implement better water and land resources management practices in agriculture, forestry and fisheries.
2. To increase the understanding between agriculture and other water users, particularly environmental uses.
3. To reduce agriculture's water use and dependence.

We are proposing major initiatives, involving the CGIAR in a central role, to address these priorities.

Comprehensive assessment of water management in agriculture

There are many ways in which water can be managed better, ranging from better technology such as laser-land-leveling or drip irrigation to better involvement of users in planning and management of resources. Collectively these are known as 'integrated water resources management' and most of IWMI's work deals with specific aspects of this. Particularly in upper catchment areas and on hillsides, but not limited to these areas, better water management should to be intertwined with better land management, for example through integrated watershed or catchment management approaches.

While it is clear that water and land resources management in currently cultivated systems can be improved, it is not clear by how much irrigated areas should be expanded in the coming decades. Irrigated agriculture—'old style', large-scale publicly funded irrigation systems—has gained an ambiguous reputation with parts of society. The willingness to invest in new systems has declined. Others, particularly in the irrigation and drainage community, hold it self-evident that considerable expansion of irrigated areas is necessary and unavoidable to achieve food security and reduce hunger and poverty in rural areas.

IWMI has initiated a major research program to assess the benefits and costs of the investments in water management for agriculture in the past and to assess future options.[3]

---

[1]Achieved through higher-yielding varieties, cheap fertilizer and essentially free water.

[2]This is, of course, nothing more or less than a plea for integrated natural resources management.

[3]The *Comprehensive Assessment of Water Management in Agriculture,* reformed from the former System-Wide Initiative on Water Management (SWIM) and therefore also referred to as SWIM-2.

This program is designed to involve CGIAR institutes and other partners in an international effort to provide credible and authoritative knowledge—international public goods—to the agriculture and environment communities. This research is embedded in a wider program that will foster dialogue among the agricultural and environment communities, particularly, at national and basin levels.

Dialogue on Water, Food and Environment

Bridging the gaps in perception on the desirable directions in water management for agriculture will reduce conflicts among users and increase the resources available for broadly supported investments. To this end, a broad consortium is being established that will catalyze a process of cross-sectoral *dialogue on water for food and environmental security*.[4] IWMI has taken the initiative for this exercise and will host the Dialogue Secretariat. A sponsor group chaired by the Netherlands government has been established to support the exercise. Significant resources from outside the CGIAR are expected to be available for the program and its components such as the Comprehensive Assessment. The Dialogue will be formally launched in August 2001 at the Stockholm Water Symposium.

The global challenge for water and agriculture

But there is a broader global challenge that goes considerably beyond the implementation of improved water and land management practices in agriculture, forestry and fisheries. That is the challenge of addressing water and land resources management practices in conjunction with (1) breeding plants that are more drought-resistant and have a higher yield per unit of water and (2) the management of soil fertility.

The CGIAR system is uniquely positioned to address this challenge. The crop centers combine the expertise to address drought resistance and water productivity—even though concentrating on these multiple traits will mean a relative shift in focus. It will require a considerable paradigm shift to think in terms of *yield per unit of water* as a significant complement to *yield per unit of land*. Key areas of a major research programe that addresses this water and agriculture challenge, to be addressed in a coordinated framework, can be grouped as follows:

1. Increasing the drought-stress tolerance of key irrigated and rain-fed food and cash crops through breeding and biotechnology, thereby adapting agriculture to increased climatic variability due to anthropogenic climate change.
2. Increasing the water productivity of key food and cash crops through breeding and biotechnology.

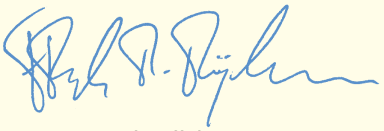
[4]Initially consisting of the Food and Agriculture Organization (FAO); Global Water Partnership (GWP); International Commisison on Irrigation and Drainage (ICID); IUCN, The World Conservation Union; International Water Management Institute (IWMI); United Nations Environment Programme (UNEP); World Health Organization (WHO); and World Water Council (WWC).

3. Improving soil water and soil fertility management to sustainably increase crop yields, particularly in rain-fed agriculture.
4. Improving integrated water resources management at the basin level to increase water productivity and (re-)allocate water resources to a sustainable mix of high-value uses, from crops to forestry, to fisheries, the environment and domestic and industrial use, and reduce conflicts among users.
5. Integrated natural resources management with full involvement of all stakeholders and explicit sustainability and poverty alleviation objectives.

The potential of genomics for water and agriculture

The overall objective of the global challenge program on water and agriculture could be to sustainably increase global food production by 40% while reducing the renewable water resources used in agriculture by 10–20% in the next 25 years. This would imply a reduced use of water for agriculture over current projections by some 600-700 cubic kilometers—of the same order as the additional water required for domestic and industrial purposes.

Improved water resources management practices by themselves are unlikely to achieve this goal. In fact, the largest potential for a breakthrough may come from the advances in genomics that allow the manipulation of the multiple genes that govern drought-tolerance and water productivity in plants.



Frank Rijsberman
Director General