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INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE

NEWS

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# Making real water savings to offset water scarcity

Nearly 1.4 billion people—more than one third of the population of developing countries—live in regions that will experience severe water scarcity by 2025. Slightly more than 1 billion people live in arid regions that will face absolute water scarcity. Around 350 million more, mostly in sub-Saharan Africa, will face economic water scarcity—where the potential water resources are sufficient to meet reasonable needs by 2025 but where they will need to develop water storage at considerable cost.

Water scarcity has become the single biggest threat to food security, human health, and natural ecosystems. So, with increasing competition for the limited and scarce water resources, there are demands to get the best use out of water. Furthermore, as growing populations demand more water for cities and industries, there is an increased awareness of the need for good quality water resources to maintain the environment.

As a large consumer of water, developments in irrigation have profound impacts on basin-wide water use and availability. Often, higher value is placed on water for industries, cities, and the environment than on that for agriculture, and irrigation is targeted as an inefficient user of resources. As water is reallocated to municipal and industrial uses, irrigated agriculture will have to produce more with less water.

## Steps to saving water

As a starting point, it is useful to consider two conditions in a river basin, "open" basins—where uncommitted utilizable outflow exists—and "closed" basins—where there is no uncommitted utilizable outflow. An open basin has outflows to the sea in excess of downstream environmental and economic requirements. Water can be saved by tapping these uncommitted outflows by improving the management of existing facilities or by developing new facilities.

In a closed basin, the situation is different—outflows from the basin to the sea are only those required to meet environmental and economic requirements. Any additional use that consumes water must be balanced by reductions in consumptive use elsewhere in the basin. Therefore, to make real water savings in closed basins we have to look for opportunities for reductions in nonbeneficial uses of water, or by shifting from less- to more-productive uses of water. But, changes in water use upstream may cause harm downstream. Consequently, it is increasingly important in water-scarce basins that local actions are undertaken in the context and knowledge of how these actions will affect water use in other parts of the basin.

## Improving the productivity of water in agriculture

Agriculture is the largest consumer of water accounting for 72 percent of the total withdrawals for the world at large. Many people believe that existing irrigation systems are so *inefficient* that most, if not all, future needs for water by all sectors could be met by increasing the efficiency of irrigation and transferring the water saved in irrigation to domestic, industrial, and environmental

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sectors. It is argued that this can be easily achieved by demand management and raising the price of water. The answer is not so simple. Even by improving irrigation efficiency, more water will be needed for irrigated agriculture.

To try to meet the increasing demands for water while maintaining food security, IIMI is focusing on improving the agricultural productivity of water without detriment to the environment. IIMI's basin-wide approach to water resources highlights the limitations of traditional views about how to improve water use efficiency. While the traditional approach often leads to water savings only on paper, applying the new basin-wide approach ascertains whether water savings are real. IIMI's research therefore, is designed to increase the productivity of water used in agriculture—*more crop per drop*.

To save water and grow more crops with less water it is necessary to look for opportunities to save water by reducing non-beneficial outflows and maximizing the consumption of uncommitted flows. In a river basin, there are four major outflow categories :

- beneficial depletion
- non-beneficial depletion
- uncommitted outflows
- committed water

In each category there are several opportunities to improve the productivity of water and these are summarized in the figure. Increasing the productivity, or value, per unit of water consumed from beneficial depletion is aimed at achieving higher agricultural productivity from the amount of water that is depleted by agriculture. As shown in the figure, in both open and closed basins, there are a number of opportunities to reduce the non-beneficial water depletion. Similarly, there are opportunities to tap uncommitted outflows as many facilities that utilize water resources are not managed efficiently, and utilizable outflows, in excess of downstream commitments, exist. Improved management of these facilities is an important aspect of making water savings. One option for increasing productivity of water is to reallocate water from lower- to higher-value uses as the productivity of water can be dramatically different between uses. However, reallocation of water can have serious legal, equity, and other social considerations that need to be addressed.

The actual choice of strategy for increasing water productivity is guided by economic and social factors. But, with competition and scarcity of water becoming ever more apparent, the economic value of water increasing, and the need to meet environmental river basin requirements also increasing, water savings are becoming critical in efforts to maintain and increase agricultural productivity. Achieving and sustaining high productivity of irrigated agriculture are central to our efforts to alleviate poverty and improve poor people's lives, especially in the water-scarce areas of the developing world.

For more information on the subject of this article contact: David Molden, Leader, Performance and Impact Assessment Program, IIMI. E-mail: d.molden@cgiar.org

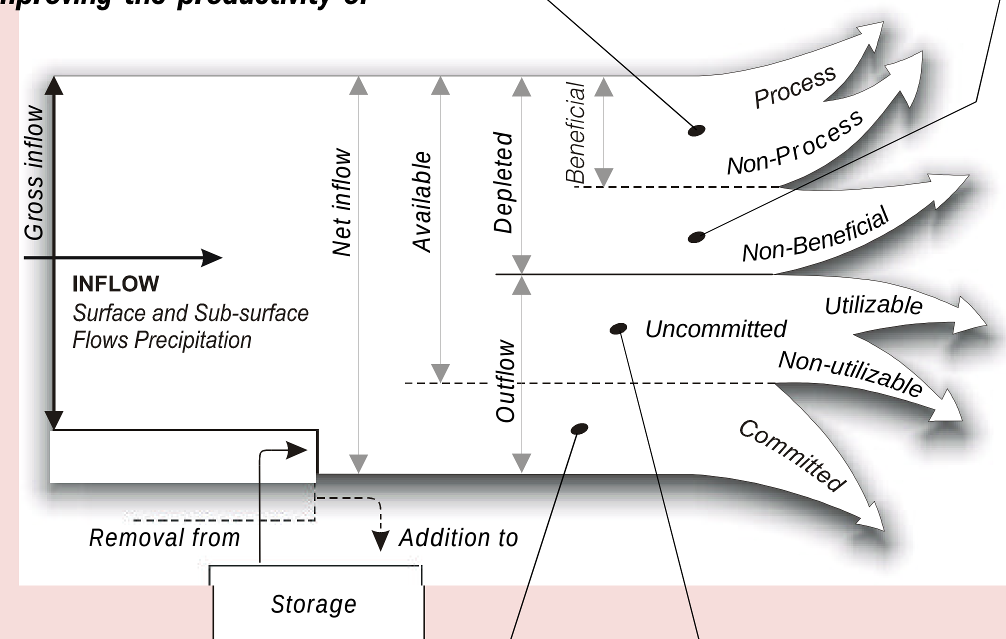
### Increasing the productivity per unit of water consumed

- *Changing crop varieties*—developing new crop varieties can provide increased yields for each unit of water consumed, or the same yields with fewer units of water consumed.
- *Crop substitution*—switching from high- to less-water-consuming crops, or switching to crops with higher economic or physical productivity per unit of water consumed.
- *Deficit, supplemental, or precision irrigation* —with sufficient water control, higher productivity can be achieved using irrigation strategies that increase the returns per unit of water consumed.
- *Reallocating water between sectors* —from lower-to higher-value uses.

### Reducing non-beneficial depletion

- Reduction of non-beneficial evaporation by reducing…
  - evaporation from water applied to irrigated fields through specific irrigation technologies such as drip irrigation, or agronomic practices such as mulching, or changing crop planting dates to match periods of less evaporative demand.
  - evaporation from fallow land, decreasing area of free water surfaces, decreasing vegetation, and controlling weeds.
  - water flows to sinks by interventions that reduce deep percolation or surface runoff.
  - flows through saline soils, or through saline groundwater to reduce pollution caused by the movement of salts into irrigation return flows.
  - saline or otherwise polluted water by shunting it directly to sinks to avoid the need to dilute it with freshwater.
  - reuse of return flows.

**Figure. Opportunities for improving the productivity of water in a river basin.**




### Reallocating water between uses

- *Reallocation of water from lower- to higher-value uses* . Because downstream commitments may change however, reallocation of water can have serious legal, equity, and other social considerations that must be addressed.

### Tapping uncommitted outflows

- *Improving the management of existing facilities* to obtain more beneficial use from existing water supplies. A number of policy, design, management, and institutional interventions may allow for an expansion of irrigated area, increased cropping intensity, or increased yields within the service areas.
- *Adding storage facilities* and releasing water during drier periods. Storage takes many forms including impoundment in reservoirs, groundwater aquifers, and in small tanks and ponds on farmers' fields.
- *Reuse of return flows* through gravity and pump diversions to increase irrigated area.

# BOOK REVIEW

***Expanding the Frontiers of Irrigation Management Research—****Results of Research and Development at the International Irrigation Management Institute, 1984 to 1995.* Douglas J. Merrey. International Irrigation Management Institute, Colombo, Sri Lanka. 1997.

The purpose of this book is to consolidate into one accessible document, an overview of IIMI's research results in the first 10 years from the institute's inception late in 1984, to the end of 1995. The primary audiences for the book are researchers in water resources and irrigation management. Policy makers and water resources managers will find sections of the book interesting and thought-provoking. Douglas Merrey, presently Deputy Director General-Designate of IIMI, is eminently suited to be the author of this book. Except for a brief period in 1996, Dr. Merrey has been on the staff of IIMI since 1985 and he has a well-deserved reputation as a researcher, research manager, and communicator, and has made significant contributions to IIMI's programs and projects.

During IIMI's first 6 years, most of the institute's funding came from bilateral sources for applied research and institutional strengthening activities in specific countries. Consequently, development and institutional strengthening received a higher priority than global research. After joining the CGIAR in 1991, the priorities shifted towards strategic research. The book, by documenting research results during IIMI's first decade, sets the stage for the second decade. It is clear from the book that IIMI has produced interesting and useful research results.

The book organizes the presentation of the research results in the format of the new program structure introduced in 1995, devoting one chapter to each of the four programs and a separate chapter describing IIMI's achievements in Training and Institutional Strengthening. A concluding chapter considers some of the limitations in the research outputs to date as a basis for suggesting improvements in the future, and making some suggestions for future research and institutional strengthening initiatives.

The book demonstrates that IIMI has made important contributions not only to the global understanding of irrigation, but also more broadly to water resources management and irrigated agriculture. First, its documentation in a number of countries of the large gaps between the reality of irrigation performance, the potential or expected performance, and assumed performance has been very valuable. Second, the results of its work on the performance of Pakistan's mega-irrigation systems have enormous implications for the future of irrigated agriculture in that country, and possibly in other semiarid and arid countries with large water-scarce irrigation systems. It has documented not only the high degree of unreliability and inequity of surface water deliveries on distributaries and minors (previously assumed to perform as designed), but has shown the relationship between this unreliability and inequity and the increasingly serious threat of salinity and sodicity. Similarly, its work on design and performance of irrigation systems in West Africa, its work on management transfer, its documentation of gover-nance and institutional problems, and its use of participatory methodologies in research and policy analysis are all important contributions that can be used to make future improvements.

This exceedingly useful book is essential reading for irrigation researchers, policy makers, planners, and water resource system managers, and multilateral financing agencies and bilateral donors who have invested—and who are still investing—enormous amounts in irrigation systems in the developing countries. It is sure to engender appreciation of the contributions of IIMI in its first decade of existence and to enhance support for IIMI's work in the future.

P. S. Rao, Formerly, Professor of Water Management, Anna University, Madras, India.

# VISITORS

- *Nicola Riddell* joined IIMI in August for a 3-month term as a consultant in agricultural economics. Nicola completed her Ph.D. studies at the University of Strathclyde, Scotland earlier this year where she worked on the socioeconomic impacts of the irrigation management transfer in the Delta region of Senegal. At IIMI, she is working on water pricing, water accounting, and support systems for local management of irrigation systems.

- *Wim Bastiaanssen*, an IIMI Fellow working at the International Institute for Aerospace Survey and Earth Sciences (ITC), the Netherlands, came to IIMI for 2 weeks for discussions on the use of remote sensing in assessing the performance of irrigation and water resources management.

# NEW STAFF

## Wilfried Hundertmark

Wilfried joined IIMI in July 1998. He received his Ph.D. in 1990 from the Christian-Albrechts University, Kiel, Germany where he worked on applied modeling of system performance characteristics of drained agricultural soils. Before joining IIMI, Wilfried worked at GFA-Agrar, Hamburg where he was a staff member since 1995. Between 1991 and 1995 he worked for GTZ in Muscat, Oman as an irrigation expert in the Ministry of Agriculture and Fisheries. At IIMI, Wilfried is located in West Africa at WARDA's headquarters in Bouake, Côte d'Ivoire where he is involved in land and water use characterization, and the management of large- and small-scale irrigation systems.

## Izhar Hunzai

Izhar Hunzai joined IIMI in September 1998 as Project Development Officer. Izhar received his masters degrees in International Relations from the University of Karachi, Pakistan in 1983, and from Cornell University, USA in 1990 where he studied International Agriculture and Rural Development. Izhar comes to IIMI from the Aga Khan Development Network (AKDN) which he joined in 1984. Izhar worked in the Network's rural support program in several capacities and, from 1996 onwards, as Chief Executive Officer of the Aga Khan Cultural Service. At IIMI, Izhar is responsible for developing research project proposals with research staff and partners for submission to donors.

## Barbara C. M. Van Koppen

Barbara joined IIMI in September 1998. Barbara received her M.Sc. in Gender in Agriculture from the Wageningen Agricultural University in 1982. From 1988 to 1990 she was coordinator of a project in Burkina Faso concerned with formulating policy and strategy for women's integration in water user organizations in small-scale irrigation schemes, and training-of-trainers programs. From 1990, Barbara was a lecturer at the Department of Irrigation and Soil and Water Conservation, Wageningen Agricultural University. During this time she conducted research into poverty alleviation, gender, and water rights for her Ph.D. and undertook several consultancies and short overseas assignments in Tanzania, Niger, Tunisia, Indonesia, and India. At IIMI, Barbara leads the gender program.

## Philippus "Flip" Wester

"Flip" Wester joined IIMI in July this year. He received his M.Sc. in January 1994 in tropical land and water use from the Wageningen Agricultural University. During his studies he conducted research in Senegal on the effects of state disengagement on locally managed irrigation systems, and irrigation management and system performance in the Kabul River Canal system in Pakistan. Between 1994 and 1995, Flip worked as a researcher with the International Institute for Land Reclamation and Improvement (ILRI) and, from October 1995 to April 1998, he was employed as a Dutch Associate Expert with the Bangladesh Water Development Board's Systems Rehabilitation Project. At IIMI, Flip is working on the institutional aspects of river basin management.

# BOOKSHOP

## New Research Reports

- Sakthivadivel, R., Nihal Fernando, and Jeffrey D. Brewer. 1997. *Rehabilitation planning for small tanks in cascades: A methodology based on rapid assessment.* Research Report 13.
- Rock, Michael, C. J. Perry, and D. Seckler. 1997. *Water as an economic good: A solution, or a problem?* Research Report 14.
- Wim, H. Kloezen, Carlos, Garcés-Restrepo, and Sam H. Johnson III. 1997. *Impact assessment of irrigation management transfer in the Alto Rio Lerma Irrigation District, Mexico.* Research Report 15.
- Sam H. Johnson III. 1997. *Irrigation management transfer in Mexico: A strategy to achieve irrigation district sustainability.* Research Report 16.
- Bandaragoda, D. J. 1998. *Design and practice of water allocation rules: Lessons from warabandi in Pakistan's Punjab.* Research Report 17.
- Upali, A. Amarasinghe, R. Sakthivadivel, and Hammond Murray-Rust. 1998. *Impact assessment of rehabilitation intervention in the Gal Oya Left Bank.* Research Report 18.
- Seckler, David, Upali Amarasinghe, David Molden, Radhika de Silva, and Randolph Barker. 1998. *World water demand and supply, 1990 to 2025: Scenarios and issues.* Research Report. 19.
- Molden, David., R. Sakthivadivel, Christopher J. Perry, Charlotte de Fraiture, and Wim H. Kloezen. 1998. *Indicators for comparing performance of irrigated agricultural systems.* Research Report 20.
- Bandaragoda, D. J. 1998. *Need for institutional impact assessment in planning irrigation system modernization.* Research Report 21.
- Wim H. Kloezen, and Carlos Garcés-Restrepo. 1988. *Assessing irrigation performance with comparative indicators: The case of the Alto Rio Lerma Irrigation District, Mexico.* Research Report 22.

- Levine, G., D. Garcia, A. Cruz, C. Garcés-Restrepo, and S. Johnson III. 1998. *Performance of two transferred modules in the Lagunera Region: Water relations.* Research Report 23.
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- Vermillion, D., and Carlos Garcés-Restrepo. 1998. *Impacts of Colombia's current irrigation management transfer program.* Research Report 25 (forthcoming).
- W. K. B. Elkaduwa, and R. Sakthivadivel. 1998. *Use of historical data as a decision support tool in watershed management.* Research Report 26 (forthcoming).
- Bastiaanssen, W. G. M, D. J. Molden, S. Thiruvengadachari, A. A. M. F. R. Smit, L. Mutuwatte, and G. Jayasinghe. 1998 *Performance evaluation of the Bhakra irrigation system, India: Using advanced information technologies.* Research Report 27 (forthcoming).

## Spanish Editions

- Wim H. Kloezen, Carlos Garcés-Restrepo, y Sam H. Johnson III. 1998. *Los Impactos de la Transferencia del Manejo del Riego en el Distrito de Riego Alto Rio Lerma, Mexico.* Informe de Investigación 15-Es.
- Wim H. Kloezen, y Carlos Garces-Restrepo. 1998. *Evaluación del Desempeño del Riego con Indicadores Comparativos: El Caso del Distrito de Riego Alto Río Lerma, México.* Informe de Investigación 22-Es (forthcoming).
- Johnson III, Sam H. 1998. *La transferencia del manejo de la irrigación en México: Una estrategia para lograr la sostenibilidad de los distritos de riego.* Informe de Investigación 16-Es (forthcoming).

## SWIM Papers

- David Molden. *Accounting for water use and productivity.* SWIM Paper 1.
- Kijne, Jacob, W., S. A. Prathapar, M. C. S. Wopereis, and K. L. Sahrawat. *How to manage salinity in irrigated lands: A selective review with particular reference to irrigation in developing countries.* SWIM Paper 2.
- I. R. Calder. *Water resources and land use issues.* SWIM Paper 3.
- Batchelor, C. J. Cain, F. Farquharson, and J. Roberts. *Improving water utilization from a catchment perspective.* SWIM Paper 4 (forthcoming).

## Books

- Bastiaanssen, W. G. M. 1998. *Remote sensing in water resources management: The state of the art.*
- Horst, Lucas. *The dilemmas of water division: Consideration and criteria for irrigation system design* (forthcoming).
- Merrey, Douglas J., and Shirish Baviskar (Eds.). *Gender analysis and reform of irrigation management: Concept, cases, and gaps in knowledge* (forthcoming).

# CONJECTURES AND REFUTATIONS

Water resources management should be devolved to the highest necessary level, not the lowest possible level (as advocated in the International Conference on Water and the Environment Development Issues for the 21st Century, Dublin, Ireland, January 1992). Sound and sustainable water resources management involves—at a minimum—the following tasks:

- Data collection and dissemination stream flows; soil and vegetative status in catchment areas; soil information in potential agricultural/irrigated areas; water quality status.
- Planning analysis of water availability in time and space; present and future demand; location of potential development areas for irrigation, drainage, and flood control; impacts on other users/uses; flood zoning under alternative scenarios.
- Design and optimization of alternative configurations of new or improved irrigation, drainage, and flood control facilities.
- Construction oversight and/or execution of irrigation, drainage and flood control facility construction, major rehabilitation, extension, and improvement.
- Operation oversight and/or execution of operation of water facilities—dams, hydropower, flood control, irrigation, and drainage.
- Maintenance oversight and/or execution of work to ensure that all facilities work in accordance with design specifications.
- Regulatory setting and enforcing standards for design, and operation and maintenance of facilities, including: water quality standards, minimum/maximum flow regimes, safety of dams, water rights administration among projects and sectors, and pollution control.

It has been noted above that as river basin resources reach full commitment, the interactions at the basin level become critical: consumption increases in one area *must* be offset by consumption decreases in another; poorer quality effluent in an upstream area directly impacts on downstream entitlements. Other issues—flood zoning, safety and operation of dams—must of course, always be regulated and administered at the basin level.

Thus, the nature of management required is moving progressively upwards, and indeed, the level of effort and strength of institutions is probably declining precisely as this is happening. The movement to privatization and turnover, which is predominantly of relevance to subsets of two of the items listed above (operation and maintenance), is generally diverting attention from the need for management at the highest necessary level, and debilitating the necessary institutions in the process.

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