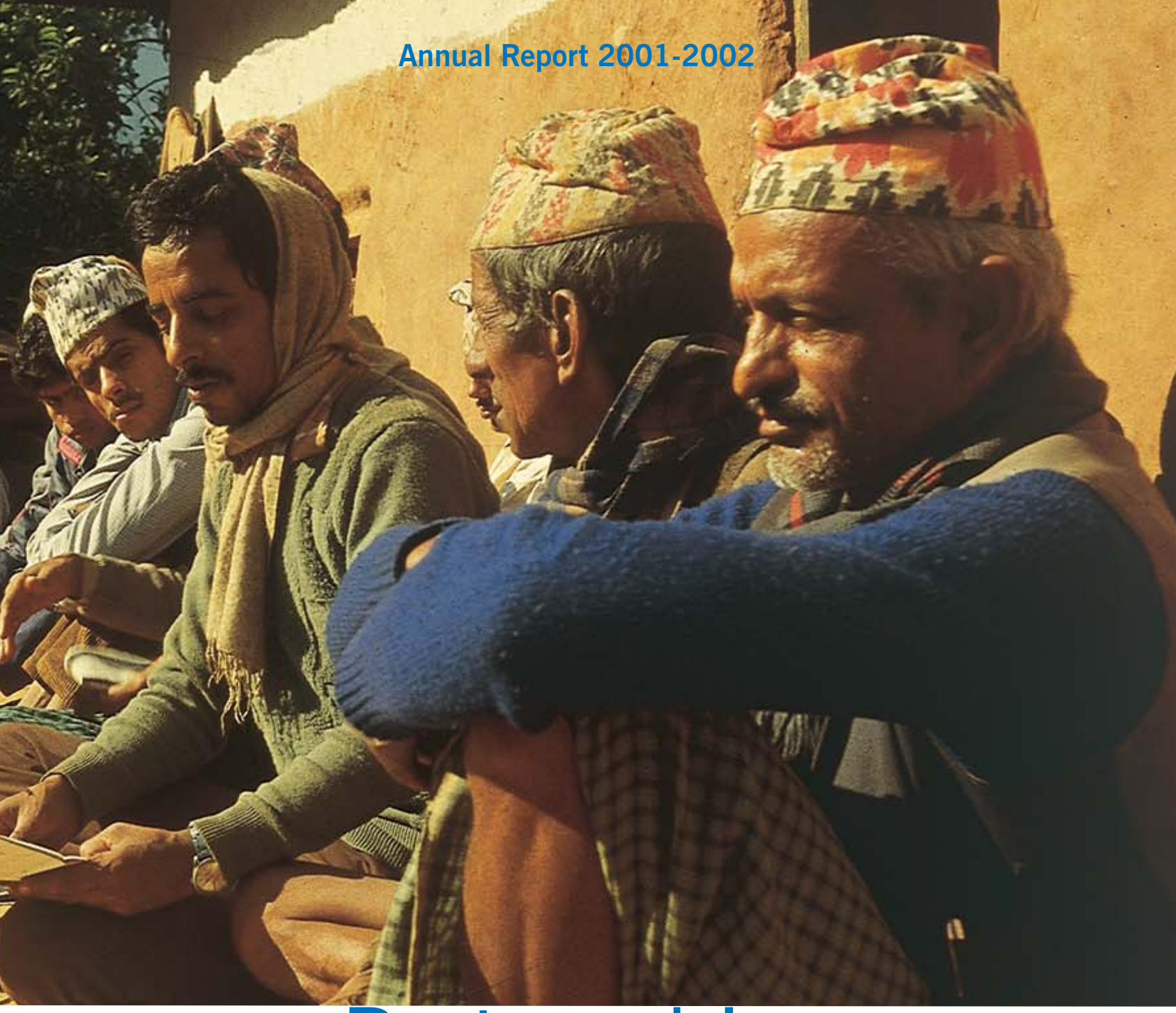
Annual Report 2001-2002



Partnerships for change

New initiatives. Research impacts and outputs. Partner perspectives.

IWMI
International
Water Management
Institute

CONTENTS

IWMI has doubled research capacity

Last year I wrote that IWMI was "on the move." We had prepared a new Strategic Plan in late 2000 and were starting to implement it. With pride, I can now report that the development of IWMI's programs and organization, as well as some key initiatives that IWMI has been instrumental in setting up, have started to pay off. We are grateful to our donors and partners who have made it possible for IWMI to increase its overall budget to over US$ 16 million for 2002—up from US$ 9.1 million in 2000. In terms of research capacity we will have more than doubled the number of researchers at IWMI over the period 2000 to 2002—up to over 100 researchers (about 70 of whom have international appointments).

Over half of researchers outside of headquarters

By the end of 2002, more than half of IWMI researchers will work outside of headquarters in Sri Lanka. The strongest growth of IWMI research staff has been in Africa—up from 1 in early 2000 to close to 30 by the end of the year. Most of these are located in Pretoria, South Africa, with a sizeable second group in Accra, Ghana. This growth is likely to continue in West Africa—and possibly East Africa, where we are investigating our potential in Ethiopia. Through the merger with the International Board for Soil Research and Management (IBSRAM) programs, and subsequent growth, there is also now a considerable IWMI presence in Southeast Asia, located in Bangkok, Thailand. A new residential program has started in 2001 in India, with its main office in Hyderabad, at the campus of the sister institute, the International Center for Research in the Semi-Arid Tropics (ICRISAT), and a second office in Anand, Gujarat. This program is still growing and expects to reach "full strength" in 2003. A smaller office opened in 2001 in Tashkent, Uzbekistan to support research in Central Asia. In 2002 we are investigating the feasibility of increasing our activities in China, and possibly opening a regional office there in 2003. Our long-standing operation in Pakistan, for many years IWMI's "other half," has been impacted by the security situation in the region since September 11. IWMI's overall strength in Pakistan has been reduced, but we still maintain a strong presence, with over 50 researchers and staff—ready to take up new opportunities when they arise.

Growth in programs through partnerships

IWMI is also making good progress in developing its thematic research programs, particularly through partnerships. In India, IWMI's program was established rapidly thanks to the cooperation with the Sir Ratan Tata Trust. Together Tata and IWMI established the IWMI-Tata Water Policy Program. The program focuses on bringing India's generally excellent specialized water research to bear on policy issues. In the first year of operation the focus was on groundwater management. One of the innovations pioneered in the program is a

Policy Briefing Series that focuses on actionable recommendations from research by IWMI and partners.

The integration of IBSRAM's and IWMI's programs that formally took place in April 2001, is gradually taking hold throughout the organization. While land management research has probably not yet taken its rightful place in the overall agenda, its importance is being recognized and internalized. Very important in this area is the major cooperation IWMI has with the Institut de Recherche pour le Développement (IRD) of France—close to a complete IRD research unit, led by Dr. Christian Vallentin, who has been seconded to IWMI. As of early 2003, 10 researchers will be posted to Thailand, Laos and Vietnam, carrying out research on integrated soil and water management at the catchment level. The work is part of the Management of Soil Erosion Consortium (MSEC), a regional network linking researchers in six Asian countries.

New initiatives

IWMI has launched a number of new initiatives—all of them in close cooperation with different groups of partners that provide a major impetus for IWMI's program and—I dare say—research on water and agriculture for development in general. First, at the request of the Center Directors at Centers' Week in October 2000, IWMI developed a new CGIAR Systemwide Initiative on Malaria and Agriculture (SIMA). The program, following exploratory activities in 2001, took off in 2002 and is now supported by Canada's International Development Research Centre, the United States Agency for International Development and the Government of the Netherlands.

The three key, linked activities on water and agriculture are: (1) The Dialogue on Water, Food and Environment; (2) The Comprehensive Assessment on Water and Agriculture; and (3) The CGIAR Challenge Program on Water and Food. The Dialogue, a program of 10 major international organizations in which IWMI represents agricultural research and hosts the Secretariat, was launched in August 2001. Following three design workshops, it is now establishing a series of 15-20 local-, basin- and national-level dialogues. The Comprehensive Assessment, the reconceived System Wide Initiative on Water Management (SWIM), has received a major grant from the Netherlands and has started a series of research projects. A first call for proposals for competitive research grants went out in June 2002. Finally, IWMI is the leading partner in the development of the CGIAR Challenge Program on Water and Food. IWMI's Board of Governors recognize the potential this program has to deliver major innovations, both in terms of content and management, to the way IWMI—and even the CGIAR—operates.

In short, IWMI is right in the middle of an exciting stage of the institution's development. We look forward to working closely with our many partners in making good those many promises that we see in our future.

Prof. Klaas Jan Beek
Chairman of the Board of Governors

The changing role of international research centers

Effective research for development requires new partnerships that take into account the changing strengths of research and extension organizations in developing countries and international research centers such as the Future Harvest Centers supported by the CGIAR. On the one hand, developed-country research institutes have access to a wealth of knowledge and technologies in advanced research areas such as functional genomics, or global water cycle change modeling. Research in some of these areas requires major investments and large consortia and consequently, the increased scale of research projects.

On the other hand, the growing number of highly trained scientists in many parts of the developing world and major research systems in some large developing countries have considerably increased the potential of many—but not all—developing countries to carry out high-quality research independently. The relevant research systems in large countries in the South now have larger budgets and larger numbers of capable scientists than the complete CGIAR system put together.

In this changing world, the role of the Future Harvest Centers changes from international research organizations that initiate and have primary responsibility for doing research in the developing world, to organizations that derive their added value primarily from brokering and facilitating international research networks. The international research centers link developed and developing country research institutes in complex multidisciplinary research programs with a strong focus on poverty alleviation and capacity building. This brokering role requires strategically drawing on the strengths of partners while still maintaining the capacity for world-class research within the system of international centers. The Future Harvest Centers should adapt themselves to playing different roles depending on the needs of our national partners: from (1) providing a two-way international window on the world for large, high-capacity countries such as Brazil, India or China, to (2) playing a major role in building capacity for research in countries with severely restricted internal capacities.

IWMI sees the proposal for a Water and Food Challenge Program not only as a means to significant increases in water productivity in agriculture—but also as a means to reorganize the way IWMI does business—maximizing the impact of our work through strategic multi-organization partnerships.

Impact on high-level water policy

Water is rising rapidly on the international agenda and IWMI has been playing a role at various levels. IWMI has provided support and Secretariat functions for the African Water Task Force that is preparing for the World Summit on Sustainable Development (WSSD) in Johannesburg in August. Together with the Food and Agriculture Ogranization of the United Nations and Ghana's Water Resources Commission, IWMI organized a ministerial

level conference in Accra, Ghana, opened by the President of Ghana and attended by seven African Ministers, as well as by over 200 delegates from over 40 African countries. Together with the United Nation's Economic and Social Commission for Asia and the Pacific and the Asian Development Bank, IWMI organized a Ministerial Round Table Dialogue in which ten Asian countries discussed water management issues and developed a joint statement on water management priorities. Finally, IWMI is the implementing agency for the WaterDome, an event that brings together all water-related actors and organizations at the WSSD.

Water has risen to the top of the WSSD agenda and delegates will be discussing various water-related goals—including one for water use in agriculture, proposed by Mr. Kofi Annan's water ambassador, the Prince of Orange. The Prince suggests that in order to meet the growing water needs of other sectors we must aim to "*achieve targets for reducing malnutrition and poverty without increasing water diverted to agriculture over the level of the year 2000*." The Challenge Program on Water and Food proposes to adopt this aim as the key quantitative target to measure its achievements.

Change management at IWMI

While the major attention of IWMI in 2001 was on developing new initiatives and establishing new regional offices, the key focus in 2002 is on a series of change management projects that have as their joint objective to make IWMI a modern, well-managed, flexible, networked organization. First has been the implementation of an on-line "time-writing" system, in January 2002, that records all time spent by all researchers on all projects and will allow a major improvement in project management. Second is a key project, which is a major reorganization of the human resources function. A series of personnel and system changes will put a strategic HR system in place that will be a major move in the direction of having a single HR system for all IWMI staff. Third is a quality-management project that is putting in place, step by step, a quality management system that is expected to be completed by late 2002. This should allow IWMI to obtain ISO certification by late 2003. Fourth, an Intranet project is at the frontline of putting more shared information and communication tools at the fingertips of all IWMI staff, in all offices. It is closely linked to, fifth, a database management project, and sixth, a knowledge sharing project.

Together, we firmly believe that this set of projects will drastically increase IWMI's effectiveness. It will also increase the opportunities for IWMI's staff and partners to benefit fully from career development and capacity building opportunities.

Finally, we do realize that increasing our research capacity is only one aspect of potentially increasing our impact. For 2003, our focus will be on how we can maximize IWMI's impact and how we update our Strategic Plan (2004–2008) towards that goal.

Prof. Frank Rijsberman
Director General

WATER WEEK:
Setting the Agenda for the Challenge Program on Water and Food

Eighty participants representing 30 research organizations working in water and agriculture met in November 2001 to define priority research needs related to water and agriculture and strengthen strategic partnerships. What emerged from the Water Week conference was a new approach to the challenge of increasing the productivity of water and the framework for the Challenge Program on Water and Food.

The Challenge Program on Water and Food was one of three proposed Challenge Programs selected by the CGIAR for development into a full proposal, following its submission in December 2001. The goal of this proposed new initiative is to increase the productivity of water for food and livelihoods, in a manner that is environmentally sustainable and socially acceptable.

Participants identified five main research themes which provide the basic structure for the Program: Improving Crop Water Productivity, Multiple Use of Upper Catchments, Aquatic Ecosystems and Fisheries, Integrated Basin Water Management Systems, and The Global and National Food and Water System. The research agenda for these five themes was established through five working groups that developed background papers through electronic consultation and a workshop of some 55 researchers in May 2002. The end result is a committed Challenge Program Consortium—composed of five CGIAR/Future Harvest Centers, six National Agricultural Research and Extension Systems, four Advanced Research Institutes and three International NGOs—and a complete proposal outlining the first phase of the Program.

Learn more about the Global Challenge Program at www.iwmi.org.

Incorporating New Land Management Expertise

IWMI officially integrated the work of the International Board for Soil Research and Management (IBSRAM) into its research program on April 1, 2001. This broadens the capacity of IWMI—adding substantial new expertise and resources, including sustainable land management research data, tools and projects, to the Institute's existing water resources management portfolio.

IBSRAM research projects and related staff now form part of the IWMI Regional Office for Southeast Asia, based in Bangkok. The merger brings to IWMI a network of new contacts at the farm and NARS level and extends its outreach to valuable research networks, complementing IWMI's research themes. These include the Management of Soil Erosion Consortium—linking researchers and stakeholders in water catchments in six Asian countries—and the Asialand Network, which brings farmers from Asian countries together with national and international researchers to find strategies for managing sloping lands.

IWMI's research has benefited from the addition of IBSRAM's expertise through the strengthening of its theme on sustainable land and water management for smallholders and an integrated land and water management approach across all five research themes. Some examples of new research that draws on IWMI's expanded capacity for land management include reuse of wastewater in urban and peri-urban agriculture, land and water management technologies and practices appropriate for smallholders, and sustainable catchment management.

New IWMI Office to Support Activities in Central Asia

IWMI established a new office in Tashkent, Uzbekistan to coordinate the growing research activities in Central Asia. The goal is to gain a better understanding of the specific needs of this region, which suffers from an alarming level of water scarcity.

The primary problems in Central Asia are institutional. There is a basic lack of well- coordinated laws, regulations and organizational structures, and overall water resources management governance. Most often, the water use strategies are insufficient or nonexistent. There is an urgent need to develop better water supply planning and procedures and to make management and operation of irrigation systems more effective and responsive to water-scarce situations.

In collaboration with a local partner—the Scientific Information Center of the Inter-State Commission for Water Coordination—IWMI is currently carrying out a pilot project in the Ferghana Valley, a water-stressed area at the intersection of Uzbekistan, Kyrgyzstan and Tajikistan that traditionally was home to extremely fertile lands. The aim of the project is to improve water resources management arrangements and identify roles and tasks for local water managers and farmers in the Ferghana Valley, while introducing participation of the key stakeholders.

Another project evaluating water conservation practices with local and regional partners (regional and local water users and water managers in four Central Asian countries—Uzbekistan, Kyrgyzstan, Kazakhstan, and Tajikistan), is underway.

Learning from Chinese Research

Upscaling alternate water-saving irrigation practices for rice can lead to an increase in water productivity of three to six times, according to a recently completed study in China.

IWMI, International Rice Research Institute (IRRI), the Zanghe Irrigation Administration Bureau, and the University of Wuhan recently completed a 3-year study in the Zanghe Irrigation System (ZIS) in the Hubei Province, China, on water-saving irrigation for rice. The ultimate goal of the study, funded by the Australian Centre for International Agricultural Research (ACIAR), was to develop irrigation-management strategies and techniques for rice-based systems that are high in water efficiency and productivity and can be implemented over large areas of China and other countries.

China has exerted significant effort in developing and applying water-saving irrigation practices in rice-irrigated areas in response to increased competition for water. The practice evaluated by the research is known as Alternate Wet-Dry Irrigation (AWDI). In the case of AWDI, irrigation savings take the form of deliberately allowing soil to dry out at various points in the growth cycle, thus reducing the amount of irrigation water applied.

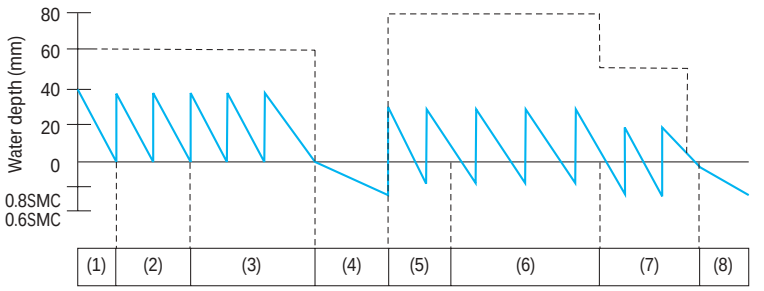
There is much to be gained from the Chinese research and investment in water-saving practices. However, not much has been done to quantify the impact of these practices at system and basin level—one of the key objectives in the collaborative IWMI study.

The study shows that at farm level, the water productivity per unit of irrigation water was much higher under AWDI than under traditional methods due to lower irrigation water input. Farmers tend to put much effort in making full use of irrigation water and rainfall. The study shows a drop at mezzo scale, which is due to considerable drainage outflow and the importance of other command users. However, when switching from a mezzo scale of about 300 ha to a basin scale covering the entire irrigation system, the water productivity per unit of irrigation turned out to be three to almost six times as high. The reason for this marked increase across scales is the recapture and reuse of irrigation water by the reservoirs.

A 4-year follow-up project entitled, "Growing more rice with less water" continues at the Zanghe site as well as at a new site at the Liuyuankou system in Kaifeng funded by the ACIAR.

For more information see: *Water-Saving Irrigation for Rice. Proceedings of an International Workshop Held in Wuhan, China, March 2001*. Edited by R. Barker, R. Loeve, Y. Li and T. P. Tuong.

Variations in water depth in Alternate Wet-Dry Irrigation



(1) Transplanting, (2) Revival of green, (3) Early and middle stages of tillering, (4) Late state of tillering, (5) Elongating and booting, (6) Heading and flowering, (7) Milk ripening, (8) Yellow ripening (SMC = Saturated Moisture Content)

A New Research Agenda on Wastewater Irrigation: Finding Realistic Approaches to Wastewater Reuse for Agriculture

Use of untreated wastewater in agriculture can be a threat to both people's health and the environment. Yet use of untreated wastewater provides food security to poor smallholders with few or no alternative water resources for irrigating their crops. Because of its high nutrient content some farmers even prefer wastewater as it reduces or sometimes eliminates the need for expensive chemical fertilizers.

IWMI's new research program on wastewater use in agriculture evaluates the extent of wastewater use and its implications on human health and environment. The aim is to provide innovative and inexpensive ways to maximize the benefits while minimizing the risks of wastewater reuse for people in low-income countries. Assessments of wastewater reuse in agriculture are currently being carried out in Ghana, India, Pakistan and Vietnam.

IWMI's initiative on wastewater analyzes the situation through different entry points, such as farmers, consumers, agronomists and local authorities. This multi-country study brings together researchers and agencies working in the sectors of wastewater, environmental pollution, urban planning and agriculture. An international workshop on wastewater irrigation is planned for November 2002 in Hyderabad, India.

For more information, see IWMI's resource area on wastewater reuse for agriculture: **www.iwmi.org/health.**

Managing Water to Meet the Needs of Traditional Agriculture

For centuries, people have been practicing flood-recession agriculture in the Senegal river valley. They grow sorghum and other crops in the clay depressions on the floodplain, which are annually inundated when the Senegal river swells during the rainy season. In 1987, with the construction of the Manantali Dam, this traditional means of farming was put at risk. Farmers are dependent on flows from the Manantali for 40 to 60% of the needed floodwaters.

The government has encouraged the farmers to transition to irrigated agriculture but many have stuck to their traditional practice. "The primary reason for this is that the residents of the floodplain are highly risk averse," says Pierrick Fraval, the IWMI researcher (seconded by the French Research Institute Cemagref) studying water management options for the area. "They will engage in activities that require very little labor and inputs, that will guarantee a minimum output to feed their families—i.e., flood recession agriculture—rather than in activities with high production and transaction costs, such as participation in the pump-based irrigation schemes set up in the valley, even though they are more productive and profitable."

Officials are now considering water management strategies that will allow them to recoup the investment and operating costs of the dam, such as hydropower. The danger is that the economic analysis will privilege uses with a greater economic return, such as hydropower and irrigated agriculture over lower-return flood recession agriculture, without taking into account the actual capabilities and livelihood strategies of all stakeholders. Says Fraval: "Our recommendation is managing the Manantali Dam so as to create a regular medium-sized flood. This would give the opportunity to tens of thousands of farmers to produce their cereals at a low cost without affecting hydropower production, as long as the objective is to reach a threshold and not maximization."

Conservation Farming Villages, the Philippines

The project started with ten farmers, to test and adapt technologies to conserve soil in erosion-prone areas. Now sucessful technologies are spreading by example.

Alley cropping prevents soil erosion by using rows of perennial crops to keep the soil in place, especially during the period after harvesting and before planting of annual crops when the soil is particularly vulnerable.

After the Mayor of Tanauan City declared the village of Maria Paz a model for sustainable agriculture, other farmers from neighboring villages came to see what the excitement was about. The village was taking part in the Asialand Project, previously led by the International Board for Soil Research and Management (IBSRAM), and taken over by IWMI when the Board's programs were merged into IWMI's.

Formerly, the farmers dealt with the erosion problem by collecting runaway top soil at the bottom of the slope and laboriously carrying it back up to their fields. Now they're switching to alley cropping, one of the soil-erosion-prevention technologies promoted by Asialand. In alley cropping, annual crops are planted in "alleys" between perennial crops such as coconut, heart of palm, mango and lemon grass, which serve to hold soil in place. "The model has been sucessful because we refined the technology with the active participation of the farmers," says Asialand coordinator Suraphol Chandrapatya. "At a certain point, the farmers began experimenting on their own—trying different combinations of crops until they found what worked best for them."

Before the project, villagers were more interested in finding off-farm employment. With the introduction of hedgerow cropping they are seeing their incomes from farming rise. Now the technology is spreading on its own, with the help of NGOs like CARE Philippines, which is introducing the technology in its project areas. Other conservation villages are being established in seven municipalities of the Camarines Sur Province of the Philippines.

Creating Research Synergies

Recent joint staff appointments with several sister CGIAR/Future Harvest Centers have given IWMI the opportunity to share knowledge and expertise and contribute to a common research agenda on water. Two IWMI-IFPRI researchers based in Colombo and Washington, D.C. are working together on a global food-water modeling team, which will integrate IFPRI's IMPACT model with IWMI's PODIUM model. This team, composed of researchers from both institutes combines expertise in water economics, trade, basin-level water resources and water needs for crop production. A jointly appointed IRRI-IWMI researcher, based in the Philippines, strengthens collaborative work between the two centers on water savings in rice cultivation. A long-standing joint appointment between IWMI and WARDA has been very productive, yielding specific recommendations for water management in the Senegal River Valley (see "Managing Water to Meet the Needs of Traditional Agriculture," on this page). There are plans to jointly appoint a researcher with ICARDA in 2002 to work with an inter-institute group on wastewater reuse for agriculture. The Institute is actively seeking to build such synergies with other organizations.

Expanding the Reach of IWMI's Research

In August 2001, IWMI launched its newly remodeled website. The website was redesigned to more accurately reflect IWMI's new strategy and structure and to make it an easy-to-use information resource for water and land resources management. The improved site features:

- **Easier access:** The site guide, text only version and other navigation features help users find the information they need faster.
- **More practical information:** The new Tools & Concepts and Resources Areas offer information on how users can apply IWMI research products to their work.
- **More publications:** In addition to IWMI Research Reports, the Institute's Working Paper Series and selected Conference Proceedings are now available on the website along with many other IWMI publications.
- **More languages:** The site now offers information for Mandarin, Russian and Spanish readers. Coming soon: Portuguese and Japanese.

Web report for 2001

- Total number of users of the website (www.iwmi.org): **729,697**
- Number of publications downloaded from the IWMI website: **129,390**
- Total number of users for the on-line version of PODIUM, IWMI's water and food security dialogue model: **839**

- Total number of on-line users for the World Water and Climate Atlas: **4,832**

Publications Update 2001

IWMI is moving increasingly towards electronic publishing—giving thousands of users access to our publications through the medium of the Internet and on CD-ROM. IWMI is still committed to making sure our outputs are available to all potential users, whether or not they have access to a computer.

Every year, the Institute distributes several thousand research reports and working papers to researchers and research libraries in developing countries, policy advisors and other relevant members of the development community.

- Total number of printed IWMI Research Reports distributed in 2001: **18,959**
- Total number of Working Papers distributed: **6,643**

Supporting Africa's Land and Water Priorities

The Institute's activities and office in Africa have expanded rapidly (from 2 to 20 staff) since the office opened in November 2000. The past year's milestones include: IWMI has been involved in the creation of the **African Water Task Force**, which brings together the leaders of regional institutions and agencies concerned with water to shape a shared agenda. The group's priority is to synthesize African positions and programs on water to be presented to the World Summit on Sustainable Development. IWMI provides strategic advice and secretariat functions to the Task Force. IWMI is a partner in the Soil Water Management Network (SWMNET) of **ASARECA,** the **African Agricultural Research Network**. IWMI has committed to providing intellectual and practical support to SWMNET by designing collaborative research projects as a part of IWMI's research priorities for Africa.

Examples of IWMI Contributions in Africa, 2001

- Support and input to development of draft cabinet policy paper on smallholder irrigation in South Africa
- Collaborated with Agricultural Research Council's Institute for Agricultural Engineering to develop a South African prototype treadle pump 'kit' (see "Everybody wants a Treadle Pump," page 13)
- Assessed impact of alternative irrigation regimes on water productivity and malaria vectors in rice irrigation schemes in Kenya
- Carried out an inventory and created a database of smallholder irrigation in Kenya; trained irrigation agency staff in its use as a basis for improved planning, management and monitoring of irrigation in the country (see "The Changing Face of Irrigation in Kenya," page 24)
- Decision support to municipal authorities and farmers in Ghana on nutrient recycling of solid waste, sludge and wastewater for urban and peri-urban agriculture
- Contributed to the Senegal Ministry of Agriculture's decision to improve and intensify recession agriculture through findings of RS/GIS study on crop yields and performance of flood recession agriculture in the Senegal river valley (see "Managing Water to Meet the Needs of Traditional Agriculture," page 8)

Improved Access to Irrigation: A Powerful Instrument for Reducing Rural Poverty

Despite the remarkable expansion in irrigated agriculture in Asia that brought dramatic increases in food production throughout the past three decades, there remain vast areas in established irrigation systems where productivity and incomes of farmers remain extremely low. Inadequate access to or lack of entitlement over resources needed for food and survival are some of the root causes of poverty in these areas. Poor irrigation management and lack of proactive policies that have led to inequitable water distribution are to blame in many cases.

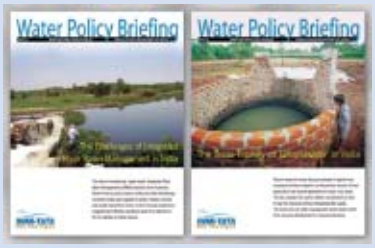
The IWMI project on Pro-poor Irrigation Intervention Strategies, supported by the Asian Development Bank (ADB), is identifying strategies for addressing these pockets of poverty within irrigation systems. The project, which was launched in 2001, is currently working with partners in Bangladesh, China, Indonesia, India, Pakistan and Vietnam.

The research is studying the extent to which irrigation development and past management practices have contributed to achieving the broader goal of socio-economic uplift of rural communities and the causes of underachievement. It will answer key questions, such as how irrigation investments have affected the lives of the poor in rural agricultural communities and how poverty and affluence coexist in irrigated agriculture. The overall goal of this study is to promote and catalyze equitable economic growth in rural areas through pro-poor institutional and policy reforms.

IWMI-TATA Water Policy Program: Putting Research Knowledge into Action

With support from the Sir Ratan Tata Trust, the IWMI-Tata Water Policy Program is building a coalition of Indian water resources researchers and institutes studying the pressing water scarcity issues facing communities in India today. To achieve its goals the program works through a number of vehicles such as policy publications and research papers, policy roundtables, consultations and workshops, and funding projects that encourage collaborative activities and cooperation across the Indian research community.

One important output of the Program is a periodical, *Water Policy Briefing*, which translates research and technical analyses on water resources into practical and actionable solutions, as a contribution to the policy discussion at the national, state and local levels.



In 2001, the IWMI-Tata India Program Office opened in Anand, Gujarat, and is already working on numerous projects. One of them is the **North Gujarat Sustainable Groundwater Initiative** in collaboration with the Gujarat Ecology Commission, the Institute for Rural Management (IRMA), Banas-kantha Dairy Co-operative Union and a number of local organizations.

For more information on the IWMI-Tata Water Policy Program and to download the *Water Policy Briefings:* **www.iwmi.org/iwmi-tata.**

Strategies for Managing Water Resources

Since 1999, IWMI and partners have been conducting a 3-year regional study to identify the physical, socioeconomic and institutional conditions that affect the management of scarce water resources available for agriculture. The study involved investigations in selected river basins in five countries in Asia: China, Indonesia, Nepal, Philippines and Sri Lanka.

In most of the selected river basins, not only is there no possibility of further increases in irrigated area but irrigation water is being increasingly diverted for other uses, and water is becoming the single most important constraint to any increase in food production.

A broad recognition among the participating countries of the importance of reexamining their policies, institutions and strategies for the water sector has led to rapid and positive results. Four study teams of the involved countries are currently pursuing the development and implementation of Action Plans.

Research Partners

- Chinese Academy of Agricultural Sciences
- The Center for Irrigation, Land and Water Resources and Development Studies, Indonesia
- Department of Irrigation, Nepal
- Institute of Agriculture and Animal Science, Nepal
- Central Luzon State University, Philippines
- Water Resources Development Division, Sri Lanka
- Kasetsart University, Thailand
- National Water Resources Committee of the Prime Minister's Office, Bangkok, Thailand

Poverty-Focused Smallholder Management

Across the developing world, people living in poor communities are finding innovative ways of dealing with drought, access to water, contamination and depletion of groundwater and other water-management challenges. But the benefits of these "home-grown" solutions are rarely scientifically verified and do not often travel beyond their original village or community.

IWMI research in India and Nepal, supported by the U.K.'s Department of International Development (DfID), is identifying and evaluating promising water harvesting and small-scale irrigation technologies for possible wider application.

In 2001, the work focused on three innovations: the revival of traditional water-retaining structures, *paals*, in Rajasthan; the on-farm rainwater harvesting technique, the 5% recharge pit, in West Bengal, India; and the low-cost drip irrigation kits gaining popularity in western Nepal.

The *Paal* Revolution

Paals are traditional water-retaining structures, specifically constructed for agricultural purposes, across seasonal watercourses (or *nala*s) in areas where average annual rainfall is 400-600 mm. *Paals* help retain water on the field and spread it over a larger area in the catchment, thereby increasing the soil moisture availability and also contributing to groundwater recharge.

These structures had fallen into disuse after many farmers migrated during the Indo-Pakistan separation in the late 1940s. In the early 1990s, the NGO PRADAN spearheaded the revival and improvement of *paals*.

The direct benefits we've been able to substantiate from the use of this technology are an extended growing season—farmers are now able to grow three crops where earlier only one crop was possible—and a significant increase in agricultural production. We have also seen evidence that the *paals* are helping to raise groundwater levels, with a proportional decrease in pumping costs for farmers.

by Shrinivas Badiger, Postdoctoral Scientist

The communities in the Kanpur Mewan watershed, (Alwar District, Rajasthan) where *paal* revival was taken up seem to be experiencing a general socioeconomic uplift; farmers are now able to send their children to school, and are able to invest in improved seeds, fertilizers, tractors and diesel pumps; there's an increase in the number of wells for irrigation and drinking; more houses have been built, and electrified.

Gender Performance Indicator for Irrigation

A new tool to fill the gap between good intentions and no action

While women constitute a considerable portion of the farm decision makers in many parts of the world, they continue to be excluded from irrigation decision-making bodies. "The slow pace of reform can be partly explained by the lack of appropriate methodologies and conceptual tools that policy makers and change agents can use to diagnose gender issues in irrigation schemes and take action" states Barbara van Koppen in a recently published IWMI Research Report, *A Gender Performance Indicator for Irrigation: Concepts, Tools and Applications*.

With sponsorship from The Ford Foundation, the Swedish International Development Agency (SIDA) and the Government of the Netherlands, IWMI researchers have developed an analysis tool to fill this gap: The Gender Performance Indicator for Irrigation (GPII).

The GPII measures inclusion/exclusion at three levels.

- Women's and men's access to water and irrigated land at farm level
- Inclusion in irrigators' networks in which rules for infrastructure construction, operation and maintenance are set and reinforced
- Eligibility and election for leadership positions and women's capacity to function well in these roles

The GPII is easy to apply and capable of differentiating between women who function as the primary farm decision makers and women who participate in farming only as unpaid family labor, a distinction that is most often overlooked in the conceptualization of gender and irrigation. The GPII helps avoid efforts to include women who do not consider or address women's actual needs.

By applying the GPII, effective gender policies can be set to ensure optimal productivity for both men and women. The next step is to disseminate the tool to irrigation policy makers, interventionists and researchers worldwide for the benefit of poor women and their dependents.

A Gender Perfomance Indicator for Irrigation is available on the CD-ROM version of the Annual Report or at **www.iwmi.org/pubs.**

Improving Domestic Water Supply in Water-Scarce Villages

In large areas of South Asia, the Middle East and East Africa, groundwater is not a safe source of drinking water due to high arsenic, fluoride, iron or salt levels. Here, irrigation water may be the only available source of drinking water—either direct from canals, from community storage tanks or as seepage water. With funding from the Canadian International Development Agency, a 3-year study by IWMI and the McGill University Center for Drainage and Water Management has provided a better understanding of the links between irrigation and domestic water supply in water-scarce areas.

The study, which was conducted in the Hakra 6/R irrigation district in Pakistan, found that while direct irrigation water does not meet World Health Organization guidelines for drinking water, seepage water from irrigation canals does. The availability of this water is dependant on irrigation management; during the annual 1–2 month canal closure, this source quickly dries up. But the most surprising finding of the study is that it is water availability, not quality, that emerges as the key factor in reducing childhood diarrhea and malnutrition (see "Irrigation as a Source of Drinking Water: Is Safe Use Possible ?" page 32).

The research team also worked with villagers to identify and test a number of interventions to improve domestic water quality and sanitation—narrow-necked water storage pitchers, chlorination and the construction of a waste-disposal scheme. All three interventions had a positive impact on target villages. However, the study showed that other factors, such as availability of water, sanitation, and hygiene behavior are essential to obtain the health benefits of better-quality water.

Learn more about domestic use of irrigation water at **www.iwmi.org/health**.

Training-Workshop Highlights from Southeast Asia

New opportunities for knowledge-sharing with North Korean scientists

At the request of the Swiss Agency for Development and Cooperation (SDC), IWMI's Southeast Asia Office is conducting a series of training workshops on sustainable land and water management for North Korean policy makers, scientists and extension officials. In November 2001, the Office worked with the International Training Center for Agricultural Development, Thailand to train researchers from North Korea's Academy of Agricultural Science in land use planning. The training was a follow-up to a session for policy makers in April 2000. More workshops are planned for 2002–2003.

Introducing new tools

With support from the French Ministry of Foreign Affairs (Regional Delegation for ASEAN), IWMI and the Institut de Recherche pour le Développement (IRD) were able to share cutting-edge land/water modeling and data-analysis technologies through two regional training workshops in 2001. The workshops were aimed at partners in the Management of Soil Erosion Consortium (MSEC), a network of scientists and research institutions in six Asian countries. The first workshop, which was held in October in Vientiane, Lao PDR, introduced techniques for modeling soil erosion at the catchment scale. Participants in the second workshop, held in Bangkok, Thailand in November, learned how to process hydro-meteorological data. Proceedings and training materials from both workshops are available on CD-ROM.

See **www.iwmi.org/MSEC** for more information.

Everybody Wants a Treadle Pump

M.Sc. student Caryn Seago working with IWMI's Africa Regional office designed a treadle pump to meet the needs of South Africa's small-scale farmers. Her design won second prize in the World Bank's Contest for Innovative Ideas and Technologies in 2001.

The pump is easy-to-use and affordable. It can be manufactured out of standard plastic components, which can be sourced in most African villages. Repair and servicing can also be done by rural entrepreneurs. The price of the pump is targeted at Rand 600, around 15% of the cost of the diesel pumps currently in use in South Africa.

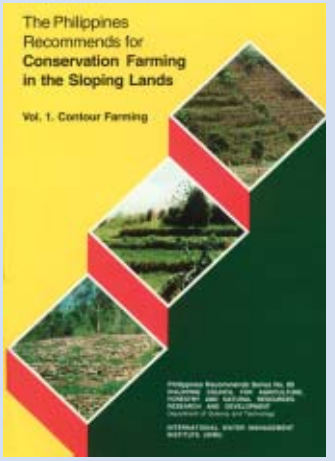
In South Africa, farmers are interested in using treadle pumps to improve local food security and reduce the burden of carrying water in buckets to irrigate their plots. "During the field evaluations in rural communities, many people were interested in the pump," says Caryn Seago.

IWMI research has shown that treadle pumps can help increase crop yields and incomes. In the long run, treadle pump-adopter households are likely to perform better in terms of savings and capital accumulation; investment in agriculture, and education; and the spread of these pumps in a community improves wage rates and employment opportunities for the landless.

IWMI's partner in the project, the Agricultural Research Council's Institute for Agricultural Engineering provides a testing service for all treadle pumps in South Africa. It will examine alternative manufacturing strategies and credit options to enable purchase on a large scale. In 2002, demonstration and marketing will begin. IWMI will monitor the progress and impact of this effort and propose recommendations and adjustments.

A New Resource for Conservation of Sloping

The Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), with support from IWMI, has produced a new guide for extension and development workers involved in the conservation of sloping lands. The publication, part of the Philippines Recommends series, offers practical information and techniques for contour farming.



These practices use physical and vegetative barriers along contours to reduce the quantity and speed of water runoff, thereby preventing soil erosion. "This publication hopes to provide our tillers in the sloping lands a system that can help them achieve maximum productivity," says Patricio S. Faylon, PCCARD's Executive Director.

PCCARD is an active partner in the Asialand Network and the Managing Soil Erosion Consortium (MSEC). These networks, coordinated by IWMI, link institutions and researchers across Asia that are dedicated to finding solutions to the growing problem of soil erosion in the region.

For more information, see **www.iwmi.org/smallholder.**

Capacity Building Activities

Increasing the Institute's Firepower

In the past two years, IWMI has added 20 young researchers (14 Post Docs and 6 Associate Experts) to its ranks. In 2001, two rounds of recruitment resulted in the hiring of 9 Post-doctoral Researchers from 8 countries (including: Bangladesh, China, India, Japan, Nepal, Sierra Leone, UK, USA). A further recruitment round is planned for 2002. The Institute is currently supporting 10 Ph.D. students from the South through its Ph.D. Scholarship Program and providing limited support to 8 Ph.D. students doing research in IWMI projects.

The Institute held 18 workshops in 2001, at local, national and international levels. It also offered 9 formal training courses to researchers and water and land management professionals in Asia and Africa.

Partnerships for a Better Water Future

IWMI is involved—as a leader, facilitator and partner—in several new international research and capacity-building initiatives, which aim to provide knowledge that will help the development community and developing country partners better target their water strategies—to increase food security and protect the environment. These are the Dialogue on Water, Food and Environment; the Comprehensive Assessment of Water Management in Agriculture; and the proposed CGIAR Challenge Program on Water and Food.

"IWMI believes that strong partnerships which bring together all players in the development chain—from research to capacity building and education to implementation of development projects and strategies—are the best way to reduce poverty and address challenges, such as water scarcity, conflict between irrigation and environment, and lack of access to water for the poor" says IWMI Director General, Frank Rijsberman.

These three initiatives call on a diverse array of organizations and individual expertise to answer three crucial questions for the world's water future:

How much water do we really need for food security? (The Comprehensive Assessment)

How can we grow more food with less water? (The Challenge Program)

How can we comanage water for food and nature? (The Dialogue)

The three initiatives work together: The Comprehensive Assessment identifies opportunities and determines the scope for increasing the productivity of water in agriculture; the Challenge Program acts on these findings—developing concrete solutions and promoting the changes needed to realize increases in productivity; and the Dialogue helps validate and disseminate research results and determine research priorities from a stakeholder perspective. The collaboration between the initiatives is enhanced through benchmark river basins, which form a physical link between the three programs.

"In general, I find an ideal partnership to be with one who shares resources and responsibilities equally and is prepared to share credit equally, as well. I would call a partnership successful if and when each partner looks eagerly to the other for further collaborative work."

Sunil Kumar Ambast, Senior Scientist, Division of Irrigation and Drainage Engineering, Central Soil Salinity Institute, (CSSRI), India. Collaborating with IWMI on farmers' decision-making process for water allocation and distribution at farm level in water scarce-areas.

Comprehensive Assessment on Water Management in Agriculture

The Comprehensive Assessment taps the considerable scientific weight of the CGIAR's Future Harvest agricultural research system and a number of other key partners such as the FAO. The goal is to create a research base on all aspects of water management in agriculture—for donors, countries and poor communities investing in solutions related to water and agriculture. A range of partners—universities, local research organizations, and advanced scientific institutes—join the team to bring local knowledge, and environmental, health and other agricultural expertise to the program.

The Assessment will examine the costs and benefits of water management in agriculture over the past 50 years, look at the current situation and provide data and tools that decision makers can use to make more informed choices on water management in the future. “IWMI’s water and land resources research reveals only part of the picture,” says David Molden, IWMI principal researcher and Chair of the Comprehensive Assessment Steering Committee. “It is complemented by the work of partners in the other Future Harvest Centers. They are developing drought and salt-tolerant plant varieties, practical and low-cost methods to sustain soil-fertility in poor areas, ways to manage forests to more effectively catch and distribute water, and strategies where fisheries and irrigation work together. These and other research-based solutions allow us to see what is really possible in terms of effective utilization of our water resources.”

Read more about Comprehensive Assessment activities, access publications and concept notes and learn about guidelines for proposals at *www.iwmi.org/assessment*

Core Partners

CIAT–Centro Internacional de Agricultura Tropical, **CIFOR**–Center for International Forestry Research, **CIMMYT**–Centro Internacional de Mejoramiento de Maiz y Trigo, **CIP**–Centro Internacional de la Papa, **FAO**–Food and Agriculture Organization of the United Nations, **ICARDA**– International Center for Agricultural Research in the Dry Areas, **ICLARM**–the World Fish Center, **ICRAF**–International Centre for Research in Agroforestry, **ICRISAT**–International Crops Research Institute for the Semi-Arid Tropics, **IFPRI**–International Food Policy Research Institute, **IHE**– International Institute for Infrastructural, Hydraulic and Environmental Engineering, **IITA**– International Institute of Tropical Agriculture, **ILRI**–International Livestock Research Institute, **IPGRI**–International Plant Genetic Resources Institute, **IRRI**–International Rice Research Institute, **IWMI**–International Water Management Institute, **SEI**–Stockholm Environment Institute and **WARDA**–West Africa Rice Development Association

CGIAR Challenge Program on Water and Food

The proposed CGIAR Challenge Program on Water and Food will be a research, extension and capacity building program that will significantly increase the productivity of water used for agriculture. The program’s interlocking goals are to allow more food to be produced with the same amount of water that is used in agriculture today, even as populations expand over the coming 20 years, and to do this in a way that decreases malnourishment and rural poverty, improves people’s health and maintains environmental sustainability.

The Program is proposed by an 18-member consortium, composed of five CGIAR/Future Harvest Research Centers, six National Agricultural Research and Extension Systems (NARES), four advanced research institutes (ARIs) and three international nongovernmental organizations (NGOs). The Consortium Partners have clearly defined roles, which take advantage of their specific strengths. Future Harvest Centers lead thematic research groups, which will serve as a focal point for synthesizing results from the various countries and regions and for bringing out generic conclusions. NARES lead benchmark basin work—collaborating closely with local communities, community-based organizations, universities and government agencies. They will provide a link to regional and locally defined priorities and help drive implementation. NGOs will expand the outreach of the Program and help desseminate research findings. ARIs will ensure a strong link for this research to the global change research agenda.

The Program also introduces new approaches to how agricultural research for development is organized and managed. It proposes a new quality of partnership. Some 75 percent of the total program funding is organized around a process for open, competitive grant financing—a formula designed to open the field to many new partners—and to allocate at least 33 percent of funding for each project to national agricultural research organizations.

Read the CGIAR Challenge Program on Water and Food Proposal and Background Papers at *www.iwmi.org/challenge-program*

Consortium Partners

CGIAR/Future Harvest Centers

CIAT–Centro Internacional de Agricultura Tropical, **IFPRI**–International Food Policy Research Institute, **IRRI**–International Rice Research Institute, **IWMI**–International Water Management Institute, **ICLARM**–The World Fish Center

National Agricultural Research and Extension Systems

ARC– Agricultural Research Council, South Africa, **EMBRAPA**–The Brazilian Agricultural Research Corporation, **AREEO**–Agricultural Research, Education and Extension Organization, Iran, **NWRC**–National Water Research Center, Egypt**ICAR**–Indian Council of Agricultural Research, **YRCC**–Yellow River Conservancy Commission, China

Advanced Research Institutes

CSIRO–Commonwealth Scientific and Industrial Research Organization, Australia, **IRD**–Institut de Recherche pour le Développement, France, **JIRCAS**–Japan International Research Center for Agricultural Sciences, University of California, Davis, USA

International NGOs

CARE International, **SEI**–Stockholm Environment Institute, **WRI**–World Resources Institute

The Dialogue on Water, Food and Environment

The Dialogue on Water, Food and Environment brings together partners from communities that have often been seen to be in conflict—those focused on water for food and those whose concern is water for environment. The initiative, originating from the World Water Vision and Framework for Action process, aims to reduce the gap between these widely differing visions of how water should be managed and developed.

The convening partners include international organizations working in water, agriculture, health and environment. Says Dialogue Secretariat Director, Hans Wolter, "To meet food security and environmental goals in a climate of growing water scarcity, we have to work together to find acceptable water management strategies. We can no longer afford to consider agricultural or environmental objectives in isolation."

The Dialogue is based around three main activities: Cross-sectoral dialogues at national- and basin-level, aimed at developing shared values related to water for food and environmental security; building a water-food-environment knowledge base from research provided by programs, such as the Comprehensive Assessment, FAO's Long-Term Forecasting Program, the UN's World Water Assessment Programme, IUCN's Freshwater Programme, the Millennium Ecosystem Assessment, the CBD/Ramsar River Basin Initiative, and the Text Delivery Service of the International Commission on Irrigation and Drainage (ICID); and local-action activities that aim to provide an information exchange and best-practice identification platform, linking thousands of local, NGO and bilateral projects and activities into the formal knowledge base.

Learn more about the Global Dialogue on Water, Food and Environment at *www.iwmi.org/dialogue*

Consortium Partners

FAO–Food and Agriculture Organization of the United Nations, **ICID**–International Commission on Irrigation and Drainage, **IFAP**–International Federation of Agricultural Producers, **IWMI**–International Water Management Institute, **UNEP**–United Nations Environmental Programme, **WWF**–Word Wide Fund for Nature, **IUCN**–World Conservation Union, **WHO**–World Health Organization

Systemwide Initiative on Malaria and Agriculture

The new CGIAR Systemwide Initiative on Malaria and Agriculture (SIMA) brings together malaria researchers, agricultural researchers and affected communities to find solutions to the malaria problem. This partnership adds a new dimension to the fight against malaria—finding ways of discouraging malaria vector mosquitoes from breeding and spreading the disease through better land, water and farming practices.

The SIMA network extends from agricultural and health research to malaria control, agricultural extension and training, agricultural policy development, education and community-based action organizations. The creation of SIMA was led by IWMI during 2001. It started with a consultation with sister Future Harvest Centers (CIP, ICIPE, IITA, ILRI, IPGRI, WARDA), health sector actors and malaria programs (WHO, Roll Back Malaria) and 37 government agencies, national programs and NARES partners in the developing world—primarily Africa.

This coalition set the SIMA research agenda through an on-line consultation with some 200 participants. "SIMA is a very good example of how knowledge-sharing communities can help create an international agenda in a cost-effective, rapid and practical way" says SIMA Coordinator Clifford Mutero. Two workshops, supported by Canada's International Development Research Centre (IDRC) and the United States Agency for International Development (USAID), in Nairobi and Ibadan helped finalize the research agenda.

SIMA is a dynamic initiative: Partners and collaborators continue to join SIMA as it develops. For more information about SIMA or on participating in the Initiative, see *www.iwmi.org/sima*

"The ideal partner is the one who is sufficiently different from you to allow a relation that is not based on the competition mode. But the objectives of your ideal partner must not differ from yours at the point to make you give up your own objectives. "

Dr. Christian Valentin, Director of the Research Unit on Soil Erosion and Land Use Change, Institut de Recherche pour le Développement (IRD), France. One out of eight colleagues posted in Thailand, Laos, and Vietnam, as part of the Managing Soil Erosion Consortium, coordinated by IWMI.

Core Partners

CARE International, **CIP**–Centro Internacional de la Papa, **DBL**–Danish Bilharziasis Laboratory, **FAO**–Food and Agricultural Organization of the United Nations, **ICIPE**–International Center of Insect Physiology and Ecology, **IDRC**–International Development Research Centre, **IITA**–International Institute of Tropical Agriculture, **ILRI**–International Livestock Research Institute, **IPGRI**–International Plant Genetic Resources Institute, **ISNAR**–International Service for National Agricultural Research, **IWMI**–International Water Management Institute, NRI–Natural Resources Institute, University of Greenwich, United Kingdom, **PEEM WHO/FAO/UNEP/UNCHS** Panel of Experts on Environmental Management for Vector Control, Department of International Health, University of Copenhagen, Denmark, **UNEP** Chemicals, Chemicals Division of the United Nations Environmental Programme

New IWMI Resource Center to Expand Collaboration with the Global Water Partnership

As of 5 November 2001, IWMI has been selected as the home of the third Resource Center for the Global Water Partnership (GWP), making it the only Resource Center located in a developing country. Under a 3-year program of collaboration, IWMI will work with GWP's regional and country partners to identify key constraints to improved and sustainable management of water resources in developing countries.

The GWP—an independent network open to national governments, research and nonprofit organizations, private companies, and other institutional stakeholders involved in water resources management—facilitates the exchange of knowledge and experience on integrated water resources management.

IWMI considers GWP and its network to be an important mechanism for bringing its knowledge to users and has actively supported GWP, particularly in the South Asian region through IWMI's regional offices in Pakistan and Sri Lanka. The establishment of this Resource Center provides a valuable opportunity to expand IWMI's collaboration with the GWP.

The new Resource Center based at IWMI in Sri Lanka builds on the ongoing work of the Institute and contributes directly to the efforts of GWP in carrying out its mission. In particular, it will support four main GWP objectives: Establishing partnerships and mobilizing political will, building strategic alliances for action, promoting good practice in international water resource management, and developing and promoting regional actions.

Since the inception, the Resource Center has been involved in various activities such as:

Developing links with the Yellow River Conservancy Commission (YRCC) with the objective of introducing stakeholders to the China Technical Advisory Committee.

Supporting the launching of the South Africa Country Water Partnership including partial organization of a national workshop on Water and Poverty in South Africa

Establishing contacts with stakeholders for an Eastern Africa Water Partnership

Drafting a 'ToolBox Implementation Plan' on Integrated Water Resources for Asia

Providing input to the Task Force on Dialogue for Water and Governance; groundwork for launching the first dialogues in Southeast Asia

Learn more about the IWMI-based GWP Resource Center at *www.cgiar.org/iwmi/gwp/index.htm.*

Intensified IWMI/IPTRID Partnership to Alleviate Poverty among Smallholder Farmers

Based on their complementary missions and strengths, IWMI and the International Program for Technology and Research in Irrigation and Drainage (IPTRID) have agreed to forge a closer partnership with the objective of enhancing the value of their technical and information-sharing activities.

On 1 July 2001, IWMI and IPTRID joined forces in a 3-year program for Research on Irrigation and Drainage, funded by the Government of the Netherlands.

The work includes providing strategic research input to national programs on investment, performance evaluation, and capacity and institution building in the area of smallholder water management. This includes work in water harvesting, low-cost drip irrigation, treadle pumps, and other innovative approaches that show promise for alleviating poverty among smallholder farmers.

Currently, IWMI is contributing substantially to the IPTRID program on benchmarking irrigation performance, assisting in program design, helping national partners with the benchmarking program, and maintaining of an electronic database on the performance of irrigation systems (see *www.iwmi.org/agriculture).* IWMI will also provide content to IPTRID in the area of institutional aspects of irrigation, including Water User Associations, Irrigation Management Turnover and Participatory Irrigation Management.

IPTRID is a partnership between international research institutions, multi- and bilateral donors and six major international institutions—the Food and Agricultural Organization of the United Nations, the Global Water Partnership, IWMI, the International Commission on Irrigation and Drainage, the United Nations Development Programme and the World Bank.

"IWMI, as an international and nonprofit research institute, has many advantages to cooperate with developing countries. IWMI can summarize the successful experiences on water management through cooperative projects and disseminate these outputs to the developing countries. IWMI can exchange information and ideas through cooperation, and understand the trend in water management and present suggestions to the decision makers and water managers."

Dong Bin, Ph.D. Student, Department of Irrigation and Drainage, Wuhan University, Wuhan, Hubei, China. Collaborating with IWMI on evaluating water-saving practices in rice irrigation.

University Partnerships: Linking Foreign and National Students for Mutual Learning

Dr. Robert C. Abaido and Dr. Charles Quansah from the Departments of Environmental Studies and Crop Science, respectively, at Kwame Nkrumah University of Science and Technology (KNUST) are part of an ongoing partnership with IWMI's field office in Kumasi, Ghana. KNUST has been hosting the office in Kumasi since its beginnings (under IBSRAM). Here's what they had to say about university partnerships and, in particular, their collaboration with IWMI.

IWMI: *Taking the catchword "Institutional Strengthening," what comes to your mind in the context of our collaboration?*

Quansah: Many things. The overall goals of our university are teaching research and development. Our IWMI partnership provides the prerequisites for achieving these goals through the provision of equipment and chemicals for our laboratory, funds for our joint field research by lecturers and students, and input given by IWMI staff through part-time teaching at our Department and so forth.

IWMI: *From your personal perspective, what did you gain through your collaboration with IWMI?*

Quansah: I find that training, for example in participatory research methods, has enhanced my working relationship with farmers in terms of technology development and transfer and generally broadened my scope of research and expertise.

Abaido: Our partnership has also helped us to establish contacts and collaboration with international institutions and experts in both our fields and other disciplines. Through participation in national and international conferences and seminars I have been able to enhance my recognition on the international research scene. For the University, it has been a means to advertise the expertise of the departments and lecturers internationally. Consequently, we now have a range of joint conference papers as well as joint papers in international journals. I also find it noteworthy that IWMI supports graduate students attending international meetings to present their results. This often gives them a valuable boost as does linking foreign and national students for mutual cross-fertilization.

IWMI: *Cross-fertilization is a good key word. Also we benefited a lot from the various disciplines the universities offer. For us it is lucky having an office hosted by KNUST. However, what could be improved?*

Quansah: A major constraint is the availability and maintenance of sustained communication media (especially e-mail) for effective networking and information access. This would also facilitate the active participation of all partners in decision making. Here, still more shortcuts are needed linking international and national activities.

Partnership Challenges: The Importance of Developing a Shared Language

Partnerships can be positive and productive collaborations that strengthen the organizations involved. Through knowledge-sharing, and working from common objectives, the chance of successful implementation of research results can be enhanced and arriving at mutual goals made more efficient. But for partnerships to be sucessful, partners have to learn to communicate.

Dr. Christian Valentin is an IWMI Principal Researcher seconded by the Institut de Recherche pour le Développement (IRD), France. As part of a small team living and working in Lao PDR on catchment management, Valentin has the opportunity to collaborate closely with a number of different partners, such as farmers and other stakeholders in the catchment, local government agencies, university students from Lao and other countries, and national researchers. According to Valentin, many of the constraints and problems related to partnerships can be solved through improved communication.

"One obstacle that has to be overcome is semantics. IWMI, like other Centers of the CGIAR, uses, and must use, the language of international donors, which differs from the language of the scientific discipline—with the possible exception of political economy. It is thus necessary to familiarize oneself with the latest watchwords."

Problems of communication are not solely related to the interaction between donors and researchers. The importance of mutual understanding becomes an issue between researchers and other stakeholders, such as farmers and locals (villagers). Initiating cooperation is highly dependent on dialogue and a shared language.

"Even though everyone has a perception of the problems and of the possible solutions, the words used by the farmers are not those of the university researcher, and vice versa. One must take the time, therefore, and make the effort to understand each other. This is one of the reasons why my colleagues and I stay in the village we work in rather than come back every night to Louang Phabang (northern Laos). It is one of the advantages of working with Lao students that because most of them are from farming families, they are the best to interpret between the two worlds."

According to Christian Valentin, interaction is also key to the successful implementation of research results, which should already be facilitated prior to research. Not only among the main partners but also at every level, from the farmers, or their representatives, to the most "academic researchers." "It is only if partnerships enable the existence of a real continuum between the various stakeholders that the societal issues can irrigate research (without play on words…) and that, conversely, research is likely to bring some answers."

A Partnership can be a Real Eye Opener

To Ph.D. student Dong Bin from Wuhan University, China, collaborating with IWMI over the past 3 years has provided an important link to the "real world" outside the university.

Since 1991, IWMI has been working with Chinese researchers, policy makers and water managers to address water management issues vital to China's future. The collaboration has been highly beneficial on both sides. As the world's biggest rice-growing country and one that is experiencing increasing water scarcity, China has some of the leading scientists in research on water saving in rice-based irrigation systems. Wuhan University is one of IWMI's major partners in China, with collaboration dating back to 1991.

From 1991 to 1994 IWMI and Wuhan worked on performing an in-depth study of local management and financing of irrigation. Currently, IWMI's research with Wuhan focuses on the evaluation of alternate wet-dry irrigation, a water-saving practice for paddy rice. Ph.D. student Dong Bin has worked with IWMI researchers at the field site in the Zanghe irrigation system and over the past 3 years has spent 3 to 4 months annually at IWMI headquarters in Sri Lanka. He considers the exchange valuable and believes it has added immensely to his research.

"Working in the field with IWMI is very different from working in a university environment," says Dong Bin. "For instance, some water-flow measuring structures in the study site were damaged by the local farmers because they thought those structures would reduce the water discharge, and influence the irrigation and drainage. So, before constructing those structures, I found we needed to consult the farmers first to find out the maximum and normal water discharge of the irrigation canals or drainage canals, and then design the size of those structures." Learning the hard way has been one of the major contributions and useful experiences for Dong Bin's collaboration with IWMI—facing the challenges of field research and finding ways to improve and make research more efficient.

Generally, it is Bin's experience that visiting the study site regularly is key to a good partnership and vital for establishing trust and good communication. While partners have different understandings and approaches to collaboration, partnership relations could always be strengthened through improved communication.

Increasing Productivity of Water: A Requirement for Food and Environmental Security

David Molden, Frank Rijsberman, Yutaka Matsuno and Upali Amarasinghe

Working Paper 1 of the Dialogue on Water, Food and Environment, 2001. The complete article is available on the CD-ROM version of this Annual Report or at www.iwmi.org/dialogue.

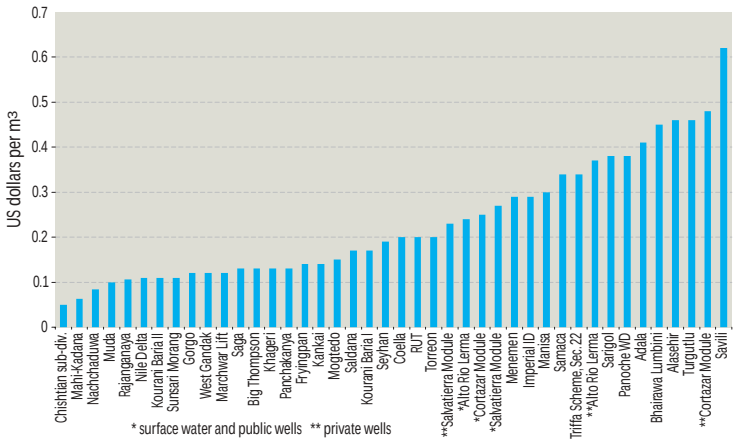
Research Program:
Comprehensive Assessment of Water Management in Agriculture

How much irrigation we really need is probably the most important, yet unresolved, question in the water for food and environmental security arena. Over time, as the value of water rises, there is more pressure to move water out of agriculture into higher-valued urban and industrial uses. In many cases, both agriculture and nature are the residual users—getting water after the needs of uses that are higher-valued are met. Thus, the area of water stress and conflict that is likely to intensify the most is not between cities and agriculture but rather between nature and agriculture.

Increasing the productivity of water in agriculture is a critical consideration because, simply stated, the more we produce with the same amount of water, the less the water is needed to meet future irrigation demands and the more water that is available for the environment and other uses. This includes improving productivity of water in both rain-fed and irrigated areas.

The purpose of this article is to demonstrate why the productivity of water is necessary for food and environmental security. We show that more food can be produced with less water, thus leaving water available for other environmental uses. The key opportunities to improve water productivity are to increase productivity on irrigated lands and to use water to supplement rainfall in marginal areas. To achieve maximum benefit from these changes, our approach to water management must also change. What is needed is a form of comanagement that can balance the water demands of agriculture and those of the environment, instead of considering the needs of each sector in isolation.

Differences in the productivity of water in 42 irrigation systems



Considering the productivity in 42 irrigation systems worldwide, IWMI research demonstrated a tenfold difference in the productivity of water (measured as gross value of output per unit of water consumed). Some of this difference is due to the price of grain versus high-valued crops, but the large differences seen even among grain-producing areas suggest there is a large scope to improve the productivity of water in many areas.

The challenges for water management as outlined in this paper are:

Improving the productivity of water on existing irrigated lands through water-saving practices or by increasing the productivity of water consumed by the agricultural process. Within irrigation there is tremendous scope for improving the productivity of water.

Improving the productivity of water in areas that are primarily rain-fed through supplemental irrigation. There are a number of water harvesting, groundwater use, storage and water application practices being developed that have potential to raise the productivity of water in these areas. Many of these practices are particularly suitable for use by smallholder farmers and can go a long way in the fight against poverty.

Comanaging water for agriculture and nature. We feel that there are ample opportunities for the comanagement of water for food and nature. Supplies that have already been exploited through water resources development can be used to meet ecosystem and agricultural requirements.

In irrigated agriculture, improving the productivity of water can be defined as the physical output per unit of water depleted—meaning that water is rendered unavailable for uses further downstream. It can be expressed in kg of yield/m^3 of water. In many areas, the potential productivity of water is not realized and this is, in large part, due to poor irrigation management. Without stable irrigation deliveries, farmers cannot take advantage of production potential.

Another appealing option is to increase the productivity from rain-fed agriculture through water harvesting and supplemental irrigation. Giving one irrigation turn at the right time can tremendously increase land yield and the productivity of water. In marginal areas—where rainfall is not reliable for full production, and access to full irrigation is difficult or expensive—supplemental irrigation may hold an important key to the productivity of water.

One of the challenges of water management is to shift from managing water to meet one need—water for environment or water for agriculture—to integrated water resources management, i.e., managing water resources to meet a variety of needs.

The Changing Face of Irrigation in Kenya

Hurbert G. Blank, Clifford M. Mutero and Hammond Murrary-Rust, editors.

The complete article is available on the CD-ROM version of this Annual Report or at www.iwmi.org/pubs.

Research Theme:
Integrated Water Management for Agriculture

The rapid changes in the political economy of Kenya are having a direct impact on the nature of irrigation and the benefits that accrue from investing in modern irrigation technologies. IWMI research in Kenya evaluated the past and present trends in Kenyan irrigation for clues to the future of irrigation in that country and in neighboring countries in Eastern and Southern Africa that are likely to experience many of the same trends over the next decades. The research was carried out in collaboration with ICIPE, ICRAF, ICRISAT, ILRI, Kenyan universities, KARI, an NGO, ASARECA Soil and Water Management Network and Sokoine University, Tanzania.

The outcome of this work is a series of papers addressing topics in three broad categories: basin issues, community management issues and the potential impacts of changes. The main users of the report are expected to be natural resource researchers, donors and other development professionals with specific interests in water issues.

Part 1: Setting the context

Paper 1 of this book reviews the past development and current trends in smallholder irrigation linked to changes in irrigation technology for water lifting and water distribution, together with the rapidly changing institutional environment in Kenya. Paper 2 describes the new irrigation technologies being introduced in Kenya and indicates their rate of adoption in the past decade.

Part 2: Smallholder irrigation in the basin context

The five papers in this section look at the need to consider smallholder irrigation in the context of river basins. Paper 3 looks at the role of GIS in inventorying smallholder irrigation systems, identifying their location, their size, their demand for water, crops grown and the number of people involved. Paper 4 examines issues relating to smallholder irrigation arising from a series of three workshops held in different parts of Kenya in 1999 and 2000 that helped in the inventory procedure for smallholder irrigation. Paper 5 looks at a case study where increased intensification of smallholder irrigation has led to conflict between upstream and downstream users. Paper 6 looks at the impact of poor upstream land management on sedimentation, maintenance, and flood damage to downstream irrigation systems, and raises issues of impacts of irrigation development on nutrient discharge into rivers and lakes. Paper 7 looks at competition for water between livestock and irrigation in the drier parts of the country.

Part 3: Community management issues in smallholder irrigation

The four papers in this section look at issues of community management related to smallholder irrigation. Paper 8 looks historically at the evolution of approaches to small-scale irrigation management in Kenya. Paper 9 examines the case of a large rice producing system where smallholders are taking over operation and maintenance of the system, and have to cope with significant management and other problems. Paper 10 examines what management inputs are required at the community level to deal with health risks associated with irrigation, notably those associated with vectors such as malarial mosquitoes. Paper 11 looks at opportunities for integrated pest management and the specific needs by smallholder irrigators producing high-valued crops.

Part 4: Potential impacts of changes in smallholder irrigation

Two papers address a set of issues that look at the overall need to maintain equity of access to resources, poverty alleviation and income generation. Paper 12 looks at some of the economic and social consequences of commercialization in the smallholder irrigation sector, its impact on household incomes, and its impact on access to water if there is unequal access to new irrigation technologies. Paper 13 addresses policy issues for government that will be required to support the expansion of profitable commercial smallholder irrigation while at the same time ensuring that water rights, equity and poverty issues are not ignored.

Part 5: Regional relevance

The final paper looks at the relevance and importance of the Kenyan example to other countries in the region. Commercialization has taken off rapidly in Kenya, and other countries will soon follow suit. By addressing some of the same issues in other countries it is hoped that the Kenyan experience will prove useful in the development of sustainable smallholder irrigation throughout the region.

Research and Development Priorities for Urban and Peri-Urban Agriculture

Pay Drechel and Dagmar Kunze

Published in *Waste Composting for Urban and Peri-Urban Agriculture: Closing the Rural-Urban Nutrient Cycle in Sub-Saharan Africa*, 2001. The complete article is available on the CD-ROM version of this Annual Report.

Research Theme:
Sustainable Smallholder Land & Water Management Systems

A number of issues related to urban and peri-urban agriculture (UPA) and its resource base will arise in the near future. This paper looks at a variety of aspects related to UPA and waste management. The paper highlights:

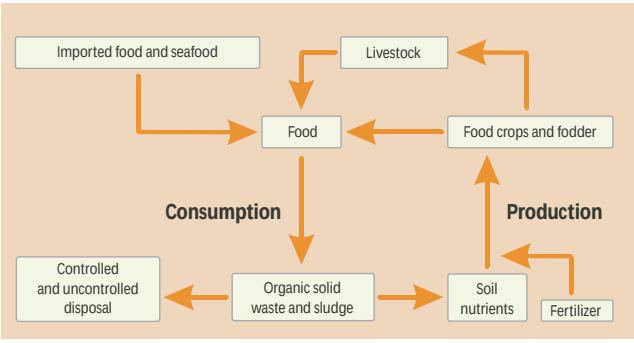
- Issues related to environment and public health
- Scientific knowledge gaps in soil fertility management and nutrient recycling
- Issues that are felt to be important topics from the farmers' point of view
- Decision making in policy, planning and economics

Some priorities concern "development," i.e., they focus on areas for projects or technical assistance at the field level. Priorities for "research," on the other hand, look at knowledge gaps that hinder ongoing development activities or future technical cooperation. At the same time, research will build up a basis for decision makers in policy and planning.

Environment and public health are of obvious concern in relation to (peri-) urban agriculture. Risks may be caused through the use of wastewater, pesticides, recycled waste-stream products (compost from sewage, manure, etc.) and by handling through marketing. Hence, priorities center on four areas of sanitation: infrastructure, water, soil, and food and nutrition.

Soil fertility aspects are of major concern to research with respect to sustainable soil management, maintaining agricultural production and environmental protection against soil contamination. There is a need to understand nutrient flows in existing (peri-)urban farming systems, to quantify the amounts and value of urban waste materials available and assess their agricultural potential, to develop and test appropriate waste-processing technologies and to improve research uptake in governmental and nongovernmental institutions.

Urban areas as huge "nutrient banks"



Farmers' points of view on issues in UPA development primarily concern land availability and tenure, credit availability, agrochemicals,

transport of organic manures/compost, water availability/accessibility and quality, market entry, and an insufficient number of extension officials trained in UPA.

Policy, planning and economics issues can constrain urban agriculture and organic waste recycling. Some issues for particular attention include increasing public awareness, improving implementation of bylaws, promoting institutional capacity building, improving infrastructure, identifying feasible and appropriate technologies and enhancing investment in UPA and waste management/recycling programs.

It has to be noted that necessary improvements in urban living, regarding agriculture as well as waste management, can only be made if decision makers are willing to take the first steps. Many activities discussed here depend on the outcome of a number of general decisions, which have to be taken at the policy level.

For agriculture, one of the major decisions to be made at policy and planning levels is the appropriate consideration of UPA by the municipal authorities. In most cities in western Africa, this process is still in its development stage, leaving the status of urban and peri-urban agriculturists, who are often squatters, unclear. These farmers are not only denied any official status, but are refused any governmental service as well. However, there are also encouraging examples of support.

Regarding waste management, one of the major decisions to be taken at the level of policy and planning is the allocation of sites for waste deposits and treatment, and the organization and financing of waste collection. Moreover, the control of illegal dumping or “hijacking” of trucks carrying night soil needs attention. The free accessibility of “composted waste” from illegal waste dumps undermines not only sanitation but also any controlled and environmentally safe compost production.

Wells and Welfare in the Ganga Basin: Public Policy and Private Initiative

Tushaar Shah

IWMI Research Report 54, 2001. The complete article is available on the CD-ROM version of this Annual Report or at www.iwmi.org/pubs.

Research Theme:
Sustainable Groundwater Management

Eastern India is home to some 88 million, or nearly a third of India's rural poor. Although its industrial economy has stagnated, the region offers vast scope for accelerated development of irrigated agriculture based on groundwater wells. While much of South Asia suffers from acute overexploitation of groundwater resources, eastern India has over one-fourth of the country's usable groundwater resources, and less than one-fifth of it is developed. Stimulating groundwater development in the region is not only central to creating livelihoods and welfare for its poor but also to addressing its syndrome of extensive waterlogging and flood-proneness.

This report analyzes how public policies designed to promote groundwater development over the past 50 years have failed in their promise, and how initiative by private agents can generate the social welfare the region needs so direly. The report outlines a five-pronged strategy for attacking eastern India's rural poverty through fuller utilization of its groundwater resources:

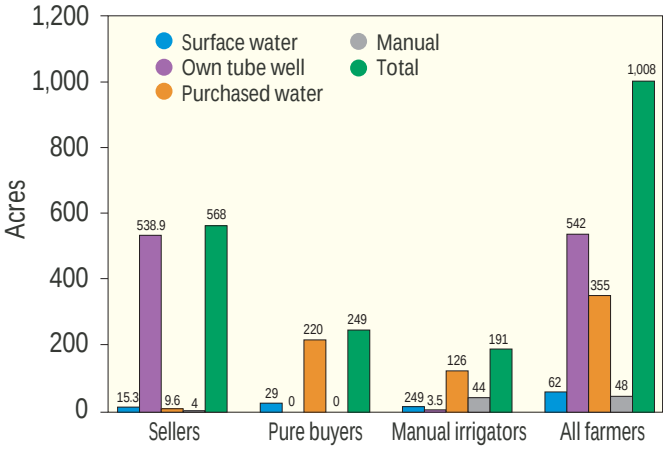
- Discontinue minor government irrigation programs; instead focus on private tube wells as the primary mode for groundwater development.
- Improve the electricity-supply environment for agriculture by reintroducing metered tariff, decentralized retailing of electricity and the use of prepaid electricity cards.

- Initiate planned interventions to improve the energy efficiency of agricultural pumping sets.
- Introduce small diesel pumps and manual irrigation technologies for vegetable growers and marginal farmers.
- Remove the pump subsidies while also opening up the imports of Chinese pumps; if doing this is not feasible or practical, follow the next best alternative of redesigning the pump-subsidy schemes à la Uttar Pradesh's Free Boring Scheme.

The analysis shows that the story of groundwater-based livelihood creation in eastern India is one of failed public initiatives and successful adaptive responses by private agents. The public and community tube-well program initiated by the government and supported by many donors has, in retrospect, not been successful at promoting groundwater development. The Rural Electrification Program, funded by the World Bank, could have stimulated groundwater irrigation; however, the 1980s saw progressive "de-electrification" of eastern India's countryside, and a rapid decline in electricity use in the region's agriculture. Finally, while the public-sector financial institutions channeled massive resources to support groundwater development in western and southern India, where overexploitation of the resources has been reaching critical proportions, eastern India, with its unutilized groundwater potential, has not received its fair share of institutional credit.

In the face of such public-policy failures, it is not surprising that groundwater development in the Ganga basin has been far slower than elsewhere in the subcontinent. The redeeming aspect has been adaptive responses of private actors who, in eastern Uttar Pradesh and north Bihar, have stimulated private groundwater development and catalyzed a belated Green Revolution. Here, the failure of the Public Tube Well program was overshadowed by the rise of pervasive pump-irrigation markets; and the impact of rural "de-electrification" was offset by the rapid dieselization of groundwater irrigation. An alternative to the high fuel cost of diesel-pump irrigation too was promoted—not by the government—but by the International Development Enterprises, a private NGO, which promoted treadle-pump irrigation as a technology for the poor. Finally, a hassle-ridden Free Boring Scheme was transformed into an instrument of small farmer development by spontaneous "dealer dynamic" in eastern Uttar Pradesh and north Bihar. The moral of the story is clear: tube-well-induced agrarian dynamism that we find in eastern Uttar Pradesh and north Bihar in recent years can spread to all of eastern India and Nepal terai if public policy makers learn correct lessons from the experience of these two subregions. In future, the best role for public policy lies in catalyzing and supporting private action.

Contribution of water markets in eastern UP agriculture: Survey of 380 farmers



A survey done for this research reveals that surface water makes a surprisingly small contribution to smallholder irrigation in the area studied. After personally owned tube wells, the largest water provider to smallholders is water purchased from pump irrigators.

Valuing Water in Irrigated Agriculture and Reservoir Fisheries: A Multiple-Use Irrigation System in Sri Lanka

Mary E. Renwick

IWMI Research Report 51, 2001. The complete article is available on the CD-ROM version of this Annual Report or at www.iwmi.org/pubs

Research Theme:
Water Resources, Institutions & Policies

Although irrigation water is often used for other purposes like domestic use, fisheries, livestock, wildlife habitat and environmental enhancement, the importance of nonagricultural uses of water in relation to the economic development and quality of life for the rural poor has often been ignored. Failure to recognize the nonagricultural uses of water has important implications for irrigation project management, water rights and the economic appraisal of the irrigation projects themselves. Decision makers often lack information on the relative economic contributions of water in irrigation and nonirrigation uses. This report addresses this problem. It examines the relative economic contributions of irrigated agriculture and reservoir fisheries in the Kirindi Oya irrigation system, located in southeastern Sri Lanka.

The evaluation technique used

The total economic valuation (TEV) framework provides a systematic approach for assessing the combined economic values of all the goods and services—both market- and nonmarket-related—produced by a resource-based system. This report takes the first step in the TEV approach by focusing on economic valuation of two important market-related uses of the Kirindi Oya Irrigation and Settlement Project (KOISP) water—irrigated agriculture and reservoir fisheries.

Agriculture

Economic returns to water measure the value of water in its current use. They equal the total value of marketed and nonmarketed production less all cash and noncash production costs. The average per-hectare economic return to water, or value of water, for KOISP is Rs 16,748 (US$239). The estimated total annual value of water in irrigated paddy production is US$3.1 million per year for the KOISP. This represents the economic contribution of water in paddy production to the local economy. To estimate the total economic contribution of water to the local economy would require estimates of the value of water in all its other uses.

Economic gains associated with improvements in water management to achieve higher levels of cropping intensity were also estimated. If an irrigation intensity of 200 percent (2 crops per year) could be achieved with the same water resources, economic returns to water would increase to approximately US$4 million, representing an annual economic gain of about US$888,000 to the local economy. The increase in agricultural productivity and concomitant economic gains associated with higher irrigation intensities will work towards alleviating poverty among the poorest households in the Kirindi Oya area. Realizing these economic gains will require significant changes in water management. Due to increased water recycling these changes may influence the quantity and quality of water in the reservoirs where the fisheries are located.

Fisheries

Out of the five reservoirs in the KOISP, three—Lunugamwehera, Wirawila and Yoda Wewa—where commercial fishing exists, were chosen to better understand both the current economic contribution of inland fisheries in the KOISP area and the potential trade-offs. The combined total annual yield from the three reservoirs studied was approximately 2,000 metric tons. Economic returns were estimated to measure the net contribution of fisheries to the local economy. Economic returns equal the value of the total catch less all cash and noncash costs associated with fishery operations. The total annual net economic contribution of all five commercially important fisheries in the KOISP is estimated to be about US$544,000–US$566,000 per year.

Fisheries represent an important economic contribution of the KOISP, adding approximately 18 percent of the value of the KOISP's annual paddy production over the 1989–97 baseline period. At present, fisheries are not recognized in water management and allocation decisions. These results demonstrate the importance of recognizing and assessing the value of water in nonirrigation uses. They also highlight the importance of fisheries as a potential poverty-alleviation tool.

Further research is needed to better understand the relationship between reservoir levels and biological productivity of the fisheries, between water recycling, concentration of potentially toxic chemicals, bioaccumulation of these chemicals in fish and the potential health implications associated with local consumption patterns of fish and to identify the alternative water management strategies required to meet the target of 200 percent irrigation intensity.

Irrigation as a Source of Drinking Water: Is Safe Use Possible?

Wim van der Hoek, Flemming Konradsen, Jeroen H. J. Ensink, Muhammad Mudasser and Peter K. Jensen

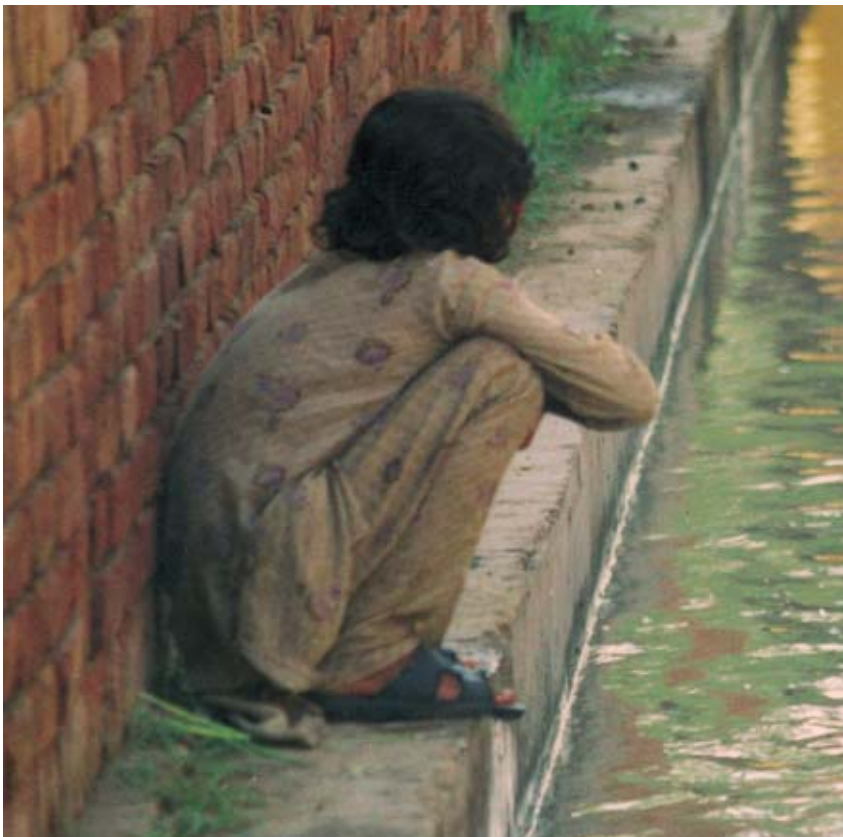
Published in *Tropical Medicine and International Health,* Vol. 6, No. 1, pp. 46-54, January 2001. The complete article is available on the CD-ROM version of this Annual Report.

Research Theme:
Water, Health & Environment

In arid and semiarid countries there are often large areas where groundwater is brackish and where people have to rely on irrigation water for all uses, including domestic uses.

An alternative to drawing drinking water directly from irrigation canals or village water reservoirs is to use the water that has seeped from the irrigation canals and irrigated fields. This water forms a small layer of freshwater on top of the brackish groundwater. The objective of the IWMI study was to assess whether the use of irrigation seepage water for drinking results in less diarrhea than direct use of irrigation water and how irrigation water management would impact on health. The study was conducted in an irrigated area in the southern Punjab, Pakistan.

In large areas of Pakistan where groundwater is too saline for human use, villagers divert canal irrigation water into small community reservoirs—called *diggis*—to meet their domestic needs. This water is carried home by hand or is supplied to the household by means of PVC pipes and manual or motor-driven pumps. In addition to using water directly from these reservoirs, people tap small pockets of potable groundwater formed by seepage from canals and fields. In this case, the sandy soils act as a filter—removing fecal contaminants.



Availability of this cleaner water depends on how much and how often irrigation water is released into the canals. For a period of four to eight weeks, during the annual canal closure, people rely on water stored in the local *diggi* or in household storage tanks. Several villages in the study area

have piped water-supply schemes, but the sand filters that the schemes rely on for water treatment are dysfunctional due to lack of funds for maintenance and, in effect, the villagers are being supplied with untreated irrigation water.

The year-long study recorded drinking water sources used and diarrhea episodes for each day for all individuals of 200 households in 10 villages. Surveys collected information on hygiene behavior, sanitary facilities and socioeconomic status.

The study found that seepage water was of much better quality than surface water but that this did not translate into less diarrhea. This could only be partially explained by the generally poor quality of water in the in-house storage vessels—reflecting considerable in-house contamination of drinking water. Risk factors for diarrhea were absence of a water connection and water storage facility, lack of a toilet, low standard of hygiene and low socioeconomic status. The association between water quality and diarrhea varied by the level of water availability and the presence or absence of a toilet.

Among people having a high quantity of water available and a toilet, the rate of incidence of diarrhoea was higher when surface water was used for drinking than when seepage water was used (relative risk 1.68; 95% CI 1.31-2.15). For people with less water available the direction of the association between water quality and diarrhea was different (relative risk 0.80; 95% CI 0.69-0.93). This indicates that good-quality drinking water provides additional health benefits only when sufficient quantities of water and a toilet are available. In a multivariate analysis no association was found between water quality and diarrhea but there was a significant effect of water quantity on diarrhea that was, to a large extent, mediated through sanitation and hygiene behavior.

Increasing the availability of water in the house by having a household connection and a storage facility is the most important factor associated with reduced diarrhea in this area. Safe use of canal irrigation water seems possible if households can pump seepage water to a large storage tank in their house and have a continuous water supply for sanitation and hygiene. Clearly, irrigation water management has an impact on health and on bridging the gap between the irrigation and drinking water supply sectors, which could provide important health benefits by considering the domestic water availability when managing irrigation water.

This research has been conducted with financial support from CIDA.

Donors - 2001

During 2001, IWMI's funding support was provided by the following governments, development banks, agencies and foundations:

- **African Development Bank**
- **Asian Development Bank**
- **Australia**
- **Belgium**
- **Canada**
- **CARE/Nepal**
- **CGIAR/CIAT**
- **Denmark**
- **Food and Agriculture Organization**
- **Ford Foundation**
- **France**
- **Germany**
- **IDRC, Canada**
- **IFPRI**
- **Ireland**
- **Japan**
- **The Netherlands**
- **Norway**
- **Sir Ratan Tata Trust**
- **Sweden**
- **Switzerland**
- **Taiwan**
- **UNESCO**
- **United Kingdom**
- **USA**
- **World Bank**

The Governments of Ghana, India, Iran, Nepal, Pakistan, South Africa and Sri Lanka provided program support for IWMI-related activities in those countries.

Board of Governors - 2001

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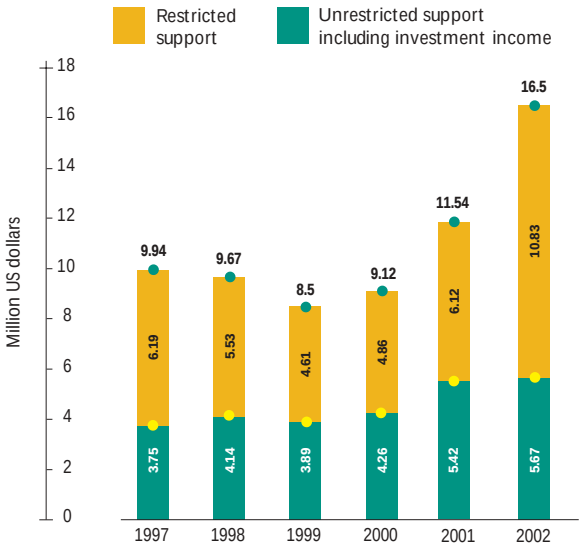
Financial Statement

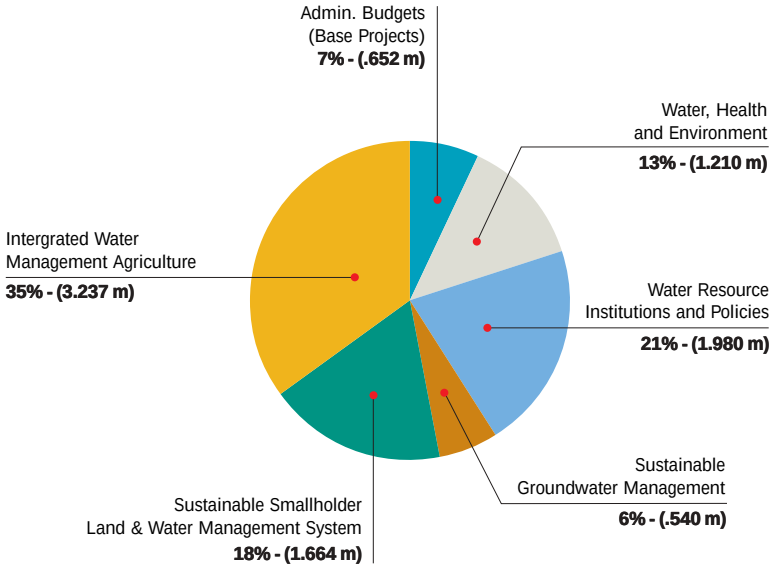
In 2001, the net assets of the Institute recorded an increase of U$95,000 compared to the increase of net assets of $319,000 in 2000.

In 2001, the total revenue amounted to $11.54 million. Unrestricted income amounted to $5.42 million.

Income 1997 – 2002



Research Expenditure by Program - 2001



RESTRICTED RESEARCH CONTRACTS OVER $50,000 AWARDED IN 2001

Sustaining the rice-wheat production systems in Asia (ADB)—$93,000 over 3 years

To promote water management techniques for sustainable productivity in rice-wheat system at the field, the farm and the watercourse command levels.

Studies in pro-poor interventions in the irrigation sector in Asia (ADB)—$1,000,000 over 2.5 years

To promote and catalyze equitable economic growth in rural areas through pro-poor irrigation interventions in the participating DMCs (including Bangladesh, People's Republic of China, India, Indonesia, Pakistan, and Vietnam). To determine what can realistically be done to improve the returns to poor farmers in low-productivity irrigated areas, in the context of improving the overall performance and sustainability of the established irrigation schemes.

SWNM/MSEC (Management of Soil Erosion Consortium) (ADB)—$593,263 over 1.5 years

To use a catchment approach to managing soil erosion in Asia—combining biophysical research with socio-economic research. The project builds on the contact, data and insights of the ASIALAND Network on the Management of Sloping Lands.

Growing more rice with less water: Increasing water productivity in rice-based cropping systems (ACIAR)—A$908,357 over 4 years

To promote water management techniques in rice-based irrigation systems that sustain the environment and allow crop production to be maintained or increased in the face of growing demands and competing uses of water.

Water productivity and sustainable agriculture: Improving the performance of wastewater irrigation in peri-urban areas (GTZ)—DM300,000 over 1 year

To optimize and sustain the overall benefits of wastewater irrigation in peri-urban areas in arid and semi-arid regions, including reduction of health and environmental risks—while promoting poverty redution and greater social and gender equity among beneficiaries.

Wastewater reuse in agriculture in Vietnam:Water management, environment, and human health aspects (Danida)—$481,000 over 4 years

To optimize and sustain the overall benefits of wastewater irrigation in peri-urban areas in Vietnam, including reduction of health and environmental risks.

International Programme for Technology and Research Irrigation and Drainage (IPTRID) (FAO) —$900,000 over 2.5 years

To share accumulated experience and generating new knowledge for the future: A collaborative research and knowledge-networking project between IPTRID and IWMI

IWMI-Tata Water Policy Program (Sir Ratan Tata Trust)—Indian Rupees 45,000,000 over 4 years

To analyze India's groundwater economy and its socio-ecology, especially from the view-point of food production, livelihoods of the poor, and environmental effects; to examine demand and supply side approaches to sustainable management of groundwater resource; and to develop and effectively communicate practical strategies and policies to promote sustainable groundwater management based on the research program.

Peri-urban agriculture, Ghana (IDRC)—$242,699 over 2 years

To improve the rural-urban nutrient cycle through peri-urban agriculture by collaborating with many national partners and to set up a regional consortium for research and capacity building.

Impact Assessment of Intrastructure Development on Poverty Alleviation (JBIC)—$169,798 over 10 months

To make an assessment of the economic impact of infrastructure development by using the concept of transient and chronic poverty—taking irrigation projects as a case study on the impact assessment.

Integrated Nutrient Management (MULTI DONORS)—$173,282 over 1.25 years

To find ways to better manage acid and infertile soils, with particular attention to phosphorus management.

Global Dialogue on Water, food and Environment (the Netherlands)—Dutch Guilders 2,500,000 over 2.5 years

To improve water resources management for agricultural production and environmental security to reduce poverty and hunger and to improve human health.

Global Water Partnership (GWP) Resource Center (SIDA)—$1,629,030 over 3 years

To establish partnerships and mobilise political will; to build strategic alliances for action; to promote good practice in IWRM; and to develop and promote regional actions.

Asialand Network on Management of Sloping Lands for Sustainable Agriculture-Phase 4 (SDC)—$209,489 over 5 months

To find ways of managing of sloping lands for sustainable agriculture in Asia through a network of seven countries.

Asialand Network on Management of Sloping Lands for Sustainable Agriculture-Phase 5 (SDC)—$1,000,000 over 3 years

To implement research findings, to analyze impact, and to support extension.

Integrated Water Management Ferghana Valley (Switzerland)—$200,000 over 6 months

To organize water management in Ferghana Valley on three levels along hydraulic boundaries with the following allocation of responsibilities: BWO Syr-Darya, Canal Water Organizations and Water Users Associations.

UNRESTRICTED, RESTRICTED—2001

	Donor	Grants 2001 US$'000	Grants 2000 US$'000
Unrestricted	Australia	264	190
	Belgium	77	61
	Canada	323	203
	China		10
	Denmark	347	362
	France	51	
	Germany	140	196
	India	37	38
	Ireland	312	
	Japan	139	215
	Netherlands	453	480
	Norway	110	116
	Sweden	269	279
	Switzerland	390	243
	USAID	805	690
	World Bank	1,170	825
	Subtotal (Unrestricted)	**4,887**	**3,908**
Other Revenue	Investment income	393	287
	Sundry income	137	65
	Subtotal (Other Revenue)	**530**	**352**
	Total (Unrestricted Resources)	**5,417**	**4,260**
Agreed Agenda – Restricted			
	African Development Bank	92	120
	Asian Development Bank	1,116	508
	Australia/Australian Centre for International Agricultural Research	130	135
	Canada	32	59
	Care/Nepal	5	1
	CGIAR/CIAT	109	
	Denmark	119	18
	Food and Agriculture Organization	118	
	Ford Foundation	66	179
	France	364	156
	Germany	292	420
	International Development Research Centre (IDRC)	165	34
	International Food Policy Research Institute (IFPRI)	40	
	Iran	102	112
	Japan	723	755
	Netherlands	509	261
	Other (Multi-Integrated Nutrient Management)	97	
	Pakistan		25
	Peru		30
	Sir Ratan Tata Trust	94	
	South Africa	92	137
	Sri Lanka	36	14
	Sweden	174	134
	Switzerland	396	91
	Taiwan	40	34
	UNESCO	9	6
	United Kingdom	284	239
	USAID	243	97
	WAPDA	44	112
	World Bank	630	910
	World Bank – Pakistan		269
	Total (Restricted Resources)	**6,121**	**4,856**
	Total Grants	**11,538**	**9,116**

STATEMENT OF FINANCIAL POSITION, DECEMBER 31, 2001 AND 2000

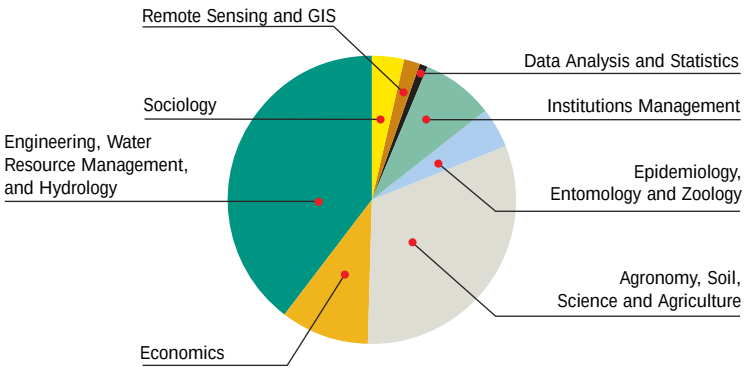
	2001 US$'000	2000 US$'000
Assets		
Current Assets		
Cash and cash equivalents	4,106	4,980
Accounts receivable:		
Donors	1,587	1,188
Employees	219	120
Others	327	113
Inventories	32	30
Prepaid expenses	269	155
Noncurrent Assets	**6,540**	**6,586**
Property and equipment, net	1,974	1,207
Other Assets	1,390	1,338
Total Assets	**9,904**	**9,131**
Liabilities and Net Assets		
Current Liabilities		
Accounts payable		
Donors	2,036	1,598
Employees	197	208
Others	507	347
Accruals	133	114
Total Current Liabilities	**2,873**	**2,267**
Long-Term Liabilities		
Accounts payable		
Employees	898	826
Total Long-Term Liabilities	**898**	**826**
Total Liabilities	**3,771**	**3,093**
Net Assets		
Unrestricted		
Appropriated	3,304	3,300
Unappropriated	2,829	2,738
	6,133	**6,038**
Restricted	–	–
Total Net Assets	**6,133**	**6,038**
Total Liabilities and Net Assets	**9,904**	**9,131**

Institute Staff Overview

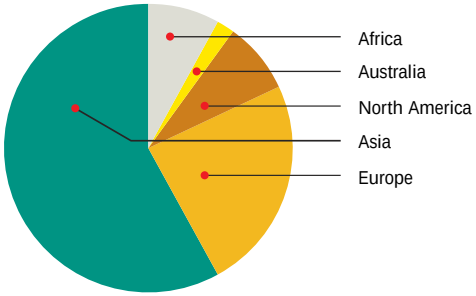
A complete list of IWMI staff is available on the CD-ROM version of the Annual Report or at www.iwmi.org

In 2001, the Institute had 110 research staff, of whom 50 were internationally recruited. The Institute also had 5 associate staff (seconded by donor organizations) and postdoctoral fellows. IWMI's total staff numbered 302.

IWMI Research Staff
(by Discipline - 2001)



IWMI Research Staff
(by Nationality - 2001)



An introduction to New Research Staff who joined IWMI in 2001

Dr. Arlene Inocencio, Researcher/Economist—Arlene is from the Phillipines, and is based at IWMI'S Regional Office in South Africa since October 2001. At IWMI she is working on a research program to identify how to make small-scale irrigated agriculture in Southern Africa economically viable and more profitable. Arlene holds a Ph.D. in Economics from the University of the Philippines. For the last 5 years she was a researcher at the Philippines Institute for Development Research and has also worked at the International Rice Research Institute (IRRI), Los Banos as a Senior Research Assistant.

Dr. D.M. Gunawardena joined IWMI in January as a Research Associate attached to the H&E Program. He holds a Ph.D in Epidemiology from the University of Colombo (1999). Prior to joining IWMI he worked as Regional Malaria Officer attached to the Ministry of Health. He also worked as Research Assistant at the Malaria Research Unit of the Faculty of Medicine, University of Colombo.

Dr. Eric Biltonen, Postdoctoral Scientist /Economist—A US national, Eric is based at IWMI-Southeast Asia Regional Office in Thailand. He started at IWMI in May 2001. Eric is a part of the team implementing IWMI's research project on Pro-poor Intervention Strategies in Irrigated Agriculture in Asia. He holds a Ph.D. in Agricultural and Resource Economics from the Colorado State University in the US. His Ph.D. research focused on evaluation of flood management strategies for the Red river basin in Vietnam.

Dr. Felino P. Lansigan, Senior Regional Researcher—Felino Lansigan from the Philippines works at IWMI's Regional Office in Southeast Asia from November 2001. He joins IWMI during his sabbatical from the University of the Philippines Los Banos, Philippines. He holds a Ph.D. in Hydrology & Water Resources from the Colorado State University.

Dr. Francois Molle, Principal Researcher/Water Resources Management is from France and was seconded to IWMI's Asia Regional Office in Colombo by IRD in France, from August 2001. Francois has worked in Thailand for the last 7 years, where he was based at the Kasertsart University. He has done extensive work on many facets of water resources management of the Chao Phraya basin.

Dr. Hans Wolter, Principal Researcher/Director of Dialogue Secretariat—Hans Wolter, a German national, took up this position from the 1st of October 2001. He ensures the progress of the dialogue process, supports fund-raising activities, manages the communications program and supports the development of national and local dialogues in 15-20 countries. He was Director of the Land and Water Division of FAO and a member of the ACC-Subcommittee on Water, of the United Nations and the Task Force of the World Water Development Report. Hans holds a Ph.D. in Water Resource Planning and Irrigation from the Technical University, Hanover. The Dialogue is an international research initiative of 10 international organizations including the FAO, WHO, World Conservation Union (IUCN), IWMI, International Commission on Irrigation and Drainage (ICID), World Wildlife fund and others.

Dr. Hugh Turral, Senior Researcher/Water Resources Management is from Australia, and has been at IWMI's Asia Regional Office, Sri Lanka, from September 2001. Hugh is working on several large new initiatives IWMI is developing on Dialogue on Water, Food and Environment and Comprehensive Assessment of Water Management in Agriculture as well as on RS/GIS work. He holds a Ph.D. in Civil and Environmental Engineering from the Melbourne University, Australia, and is currently a Research Fellow at the University of Melbourne. Hugh is also Secretary of the technical working group on integrated land and water management, ICID.

Dr. Liqa Raschid–Sally, Senior Regional Researcher is based at IWMI's Asia Regional Office. She holds a Ph.D. in Environmental Engineering from the Institute National des Science Appliquees de Toulouse, France. Prior to joining IWMI, she worked as a consultant with the Health and Environment Programme from 1999 to 2001.

Mr. Olivier Briet, Associate Expert in the Theme–Water, Health & Environment is based at the Asia Regional Office of IMWI. Before joining IWMI he worked at WARDA as an Associate Professional Officer in Entomology/Ecology for the Netherlands Minister for Development Cooperation (DGIS). Prior to this, he worked as a Consultant for the World Health Organization (WHO).

Dr. Peter G. McCornick, Senior Researcher/Water Resources Management—An American and British national, Peter was seconded to USAID Washington to provide inputs to USAID's Water Team, starting September 2001. Peter has extensive international experience in water resources management and institutional strengthening projects. Before joining IWMI, he was working in cooperation with the Minstry of Water and Irrigation, Amman, Jordan to develop an integrated water reuse plan for the Amman-Zarqa basin. He holds a Ph.D. in Agricultural Engineering from the Colorado State University, USA.

Dr. Robert Simmons, Postdoctoral Scientist is from the UK and is based at the IWMI Southeast Asia Regional Office in Thailand since May 2001. Rob is currently focusing on research related to soil and crop heavy metal contamination to minimize the risks to human health and the environment. He holds a Ph.D. in Geography/Soil Science from the University of Kent at Canterbury. Prior to joining IWMI he worked in Thailand on heavy metal pollution in soils and rice plants at the Department of Agriculture of Thailand.

Dr. Sarath Abaywardana—Senior Regional Researcher is a former Technical Director at Unilever Ceylon Limited and has been seconded to work at IMWI's Asia Regional Office since December 2001. Dr. Abaywardana holds a Ph.D. in Chemical Engineering from the University of London. At IWMI, he supports the development of the Sri Lanka National Water Partnership, liaises between Unilever and IWMI on activities of the WWF3 CEO Panel project.

Dr. Stephanie Buechler, Postdoctoral Scientist/Sociologist—An American national, Stephanie Buechler is based in Hyderabad, India from 1 October 2001. At IWMI Stephanie manages collaborations with other partner institutions and assists the research leader in achieving planned outputs, outcomes and impacts at the program level in India. She holds a M.P.A. in Public Affairs from Cornell University and has obtained her Ph.D. in Sociology from Binghamton University in the United States. She carried out her doctoral research on wastewater irrigation in Mexico.

Dr. Vladimir Smakhtin, Principal Researcher/Eco-Hydrologist—A South African national originally from Russia, Vladimir Smakhtin is based at IWMI's Asia Regional Office, Sri Lanka from October 2001. His inputs help develop IWMI's activities in the field of natural resources management in the context of irrigated agricultural development, and provide expertise on ecological flow requirements to wetlands. He has experience in catchment hydrology and water resources and is currently a Senior Scientist—Hydrology and Water Resources at CSIR, Division of Water, Environment and Forestry Technology, Water Management Programme, Pretoria, South Africa. He holds a Ph.D. in Hydrology and Water Resources from the Water Problems Institute of the USSR Academy of Sciences, Moscow, Russia.

Dr. Zhongping Zhu, Senior Researcher/Water Resources Management—A Chinese national, Zhongping Zhu is based at IWMI's Asia Regional Office, Sri Lanka from October 2001. Zhongping is a member of the Theme–Integrated Water Resources for Agriculture. For the last 9 years he has worked in Egypt on the Nile Basin. Prior to this, he was one of the developers of the WEAP river basin management model at the Stockholm. Environment Institute in Boston. He holds a Ph.D. in Water Resources and Environmental Engineering from the John Hopkins University, USA.

Publications

A complete listing of publications for 2001—including books, monographs and conference papers—and access to IWMI Research Reports, Working Papers and Journal Articles is available on the CD-ROM version of the Annual Report or at www.iwmi.org/pubs

IWMI Research Report Series:

1. **Sakthivadivel, R.; Amarasinghe, U. A.; Thiruvengadachari, S. 2001.** Using remote sensing techniques to evaluate lining efficacy of watercourses. Colombo, Sri Lanka: IWMI. v, 29p. (IWMI research report 46)
2. **Van Der Hoek, W.; Sakthivadivel, R.; Renshaw, M.; Silver, J. B.; Birley, M. H.; Konradsen, F. 2001.** Alternate wet/dry irrigation in rice cultivation: A practical way to save water and control malaria and Japanese encephalitis? Colombo, Sri Lanka: IWMI. v, 30p. (IWMI research report 47)
3. **Jayatilaka, C. J.; Sakthivadivel, R.; Shinogi, Y.; Makin, I. W.; Witharana, P. 2001.** Predicting water availability in irrigation tank cascade systems: The cascade water balance model. Colombo, Sri Lanka: IWMI. v, 41p. (IWMI research report 48)
4. **Molden, D.; Sakthivadivel, R.; Habib, Z. 2001.** Basin-level use and productivity of water: Examples from South Asia. Colombo, Sri Lanka: IWMI. v, 24p. (IWMI research report 49)
5. **Kite, G.; Droogers, P.; Murray-rust, H.; De Voogt, K. 2001.** Modeling scenarios for water allocation in the Gediz Basin, Turkey. Colombo, Sri Lanka: IWMI. v, 29p. (IWMI research report 50)
6. **Renwick, M. E. 2001.** Valuing water in irrigated agriculture and reservoir fisheries: A multiple-use irrigation system in Sri Lanka. Colombo, Sri Lanka: IWMI. v, 34p. (IWMI research report 51)
7. **Perry, C. J. 2001.** Charging for irrigation water: The issues and options, with a case study from Iran. Colombo, Sri Lanka: IWMI. v, 17p. (IWMI research report 52)
8. **Droogers, P.; Kite, G. 2001.** Estimating productivity of water at different spatial scales using simulation modeling. Colombo, Sri Lanka: IWMI. v, 16p. (IWMI research report 53)
9. **Shah, T. 2001.** Wells and welfare in the Ganga Basin: Public policy and private initiative in Eastern Uttar Pradesh, India. Colombo, Sri Lanka: IWMI. v, 43p. (IWMI research report 54)
10. **Sakthivadivel, R.; Loeve, R.; Amarasinghe, U. A.; Hemakumara, M. 2001.** Water scarcity and managing seasonal water crisis: Lessons from the Kirindi Oya Project in Sri Lanka. Colombo, Sri Lanka: IWMI. v, 29p. (IWMI research report 55)
11. **Molden, D. J.; Sakthivadivel, R.; Keller, J. 2001.** Hydronomic zones for developing basin water conservation strategies. Colombo, Sri Lanka: IWMI. v, 30p. (IWMI research report 56)
12. **Amerasinghe, F. P.; Konradsen, F.; Van Der Hoek, W.; Amerasinghe, P. H.; Gunawardena, J. P. W.; Fonseka, K. T.; Jayasinghe, G. 2001.** Small irrigation tanks as a source of malaria mosquito vectors: A study in north-central Sri Lanka. Colombo, Sri Lanka: IWMI. v, 28p. (IWMI research report 57)

Working Papers:

1. **Harmancioglu, N.; Alpaslan, N.; Boelee, E. 2001.** Irrigation, health and environment: A review of literature from Turkey. Colombo, Sri Lanka: IWMI. iii, 61p. (IWMI working paper 6)
2. **Van Der Molen, I. 2001.** An assessment of female participation in minor irrigation systems of Sri Lanka. Colombo, Sri Lanka: IWMI. ix, 53p. (IWMI working paper 8)
3. **Van Koppen, B.; Nagar, R. K.; Vasavada, S. 2001.** Gender and irrigation in India: The Women's Irrigation Group of Jambar, South Gujarat. Colombo, Sri lanka: IWMI. v, 9p. (IWMI working paper 10)
4. **Saini, H.; Van Koppen, B. 2001.** Gender in lift irrigation schemes in East Gujarat, India. Colombo, Sri Lanka: IWMI. v, 17p. (IWMI working paper 11)
5. **Van Koppen, B.; Van Etten, J.; Bajracharya, P.; Tuladhar, A. 2001.** Women irrigators and leaders in the West Gandak Scheme, Nepal. Colombo, Sri Lanka: IWMI. vii, 28p. (IWMI working paper 15)
6. **Memon, Y.; Talpur, M.; Murray-rust, H. 2001.** Capacity building for participatory irrigation management in Sind Province of Pakistan. Lahore, Pakistan: IWMI. iii, 27p. (IWMI working paper 16 / Pakistan country series no.5)
7. **Stimie, C.; Richters, E.; Thompson, H.; Perret, S.; Matete, M.; Abdallah, K.; Kau, J.; Mulibana, E. 2001.** Hydro-institutional mapping in the Steelpoort river basin, South Africa. Colombo, Sri Lanka: IWMI. xii, 85p. (IWMI working paper 17 / South Africa working paper no.6)

8. **Thompson, H.; Stimie, C. M.; Richters, E.; Perret, S. 2001.** Policies, legislation and organizations related to water in South Africa, with special reference to the Olifants river basin. Colombo, Sri Lanka: IWMI. xi, 81p. (IWMI working paper 18 / South Africa working paper no.7)

9. **Droogers, P.; Seckler, D.; Makin, I. 2001.** Estimating the potential of rain-fed agriculture. Colombo, Sri Lanka: IWMI. v, 14p. (IWMI working paper 20)

10. **Klinkenberg, E. (Ed.) 2001.** Malaria risk mapping in Sri Lanka - Results from the Uda Walawe area: Proceedings of a workshop held in Embilipitiya, Sri Lanka, 29th March 2001. Colombo, Sri Lanka: IWMI. iii, 46p. (IWMI working paper 21)

11. **Khan, A. R. 2001.** Searching evidence for climatic change: Analysis of hydro-meteorological time series in the Upper Indus Basin. Lahore, Pakistan: IWMI. iv, 31p. (IWMI working paper 23)

12. **Nielsen, M.; Hoogvorst, A.; Konradsen, F.; Mudasser, M.; Van Der Hoek, W. 2001.** Childhood diarrhea and hygiene: Mothers' perceptions and practices in the Punjab, Pakistan. Colombo, Sri Lanka: IWMI. v, 21p. (IWMI working paper 25)

13. **Hussain, I.; Raschid, L.; Hanjra, M.; Marikar, F.; Van Der Hoek, W. 2001.** A framework for analyzing socioeconomic, health and environmental impacts of wastewater use in agriculture in developing countries. Colombo, Sri Lanka: IWMI. vii, 23p. (IWMI working paper 26)

14. **Hemakumara, M.; Barker, R.; Droogers, P. (Eds.) 2001.** Ruhuna benchmark basin activities: Proceedings of the inaugural meeting held at Peacock Beach Hotel, Hambantota, Sri Lanka, 15 June 2001. Colombo, Sri Lanka: IWMI. vi, 71p. (IWMI working paper 27)

15. **Freisem, C.; Scheumann, W. 2001.** Institutional arrangements for land drainage in developing countries. Colombo, Sri Lanka. IWMI. v, 67p. (WWorking paper 28).

16. **Klinkenberg, E. (Ed.) 2001.** Malaria risk mapping in Sri Lanka: Implications for its use in control - Proceedings of a workshop held at the International Water Management Institute, Colombo, 25 May 2001. Colombo, Sri Lanka: IWMI. iv, 51p. (IWMI working paper 29)

17. **Raschid-Sally, L.; Van Der Hoek, W.; Ranawaka, M. (Eds.) 2001.** Wastewater reuse in agriculture in Vietnam: Water management, environment and human health aspects. Proceedings of a workshop held in Hanoi, Vietnam, 14 March 2001. Colombo, Sri Lanka: IWMI. vii, 48p. (IWMI working paper 30)

18. **Sakthivadivel,R.; Aloysius, N.; Matsuno, Y. 2001.** Assessment of performance and impact of irrigation and water resources systems in Taiwan and Sri Lanka. Colombo, Sri Lanka: IWMI. xii, 33p. (Working paper 31)

19. **Molden, D.; Amarasinghe, U.; Hussain, I. 2001.** Water for rural development: Background paper on water for rural development prepared for the World Bank. Colombo, Sri Lanka: IWMI. v, 89p. (IWMI working paper 32)

Journal Articles:

1. **Abernethy, C. L.; Jinapala, K.; Makin, I. W. 2001.** Assessing the opinions of users of water projects. *Irrigation and Drainage*, 50(3):173-193.

2. **Abernethy, C. L.; Sally, M. H. 1999; 2001.** Experiences of some government-sponsored organisations of irrigators in Niger and Burkina Faso, West Africa. Erfahrungen mit einigen staatlich geforderten Selbstverwaltungsorganisationen von Bewasserungslandwirten in Niger und Burkina-Faso, West Afrika. *Journal of Applied Irrigation Science*, 35(2):177-205.

3. **Bakker, M. ; Matsuno, Y. 2001.** A framework for valuing ecological services of irrigation water. *Irrigation and Drainage Systems*, 15(2):99-115

4. **Bandaragoda, D. J. 2001.** Pakistan efforts in institutional reforms for participatory water resources management. *Journal of Applied Irrigation Science*, 36(1):57-71.

5. **Bastiaanssen, W. G. M.; Bandara, K. M. P. S. 2001.** Evaporative depletion assessments for irrigated watersheds in Sri Lanka. *Irrigation Science*, 21(1):1-15.

6. **Bhattarai, M.; Hammig, M. 2001.** Institutions and the environmental kuznets curve for deforestation: A crosscountry analysis for Latin America, Africa and Asia. *World Development*, 29(6):995-1010.

7. **Droogers, P.; Torabi, M.; Akbari, M.; Pazira, E. 2001.** Field-scale modeling to explore salinity problems in irrigated agriculture. *Irrigation and Drainage*, 50(2):77-90.

8. **Duran, L. S.; Batac, J. H.; Drechsel, P. 2001.** Planning in a changing environment: The case of Marilao in the Philippines. *Urban Agriculture Magazine*, 4:40-42.

9. **Faergue, J.; Magid, J.; Penning De Vries, F. W. T. 2001.** Urban nutrient balance for Bangkok. *Ecological Modelling*, 139:63-74.

10. **Farah, H. O.; Bastiaanssen, W. G. M. 2001.** Impact of spatial variations of land surface parameters on regional evaporation: A case study with remote sensing data. *Hydrological Processes*, 15:1585-1607

11. **Jensen, P. K.; AalbµK, B.; Aslam, R.; Dalsgaard, A. 2001.** Specificity for field enumeration of Escherichia coli in tropical surface waters. *Journal of Microbiological Methods*, 45:135-141.

12. **Kikuchi, M.; Merrey, D. J.; Dassenaike, L. 2001.** Compensation of irrigation professionals: Three Asian irrigation agencies. *Irrigation and Drainage*, 50(1):65-74.

13. **Meinzen-dick, R. S. ; Van Der Hoek, W. 2001.** Multiple uses of water in irrigated areas. *Irrigation and Drainage Systems*, 15(2):93-98 (H 29539)

14. **Meinzen-dick, R. ; Bakker, M. 2001.** Water rights and multiple water uses. *Irrigation and Drainage Systems*, 15(2):129-148 (H 29541)

15. **Perry, C. 2001.** Water at any price?: Issues and options in charging for irrigation water. *Irrigation and Drainage*, 50(1):1-7.

16. **Perry, C. 2001.** World Commission on Dams: Implications for food and irrigation. *Irrigation and Drainage*, 50(2):101-107.

17. **Renault, D. 2001.** Re-engineering irrigation management and system operations. *Agricultural Water Management*, 47(3):211-226.

18. **Renault, D.; Khan, A. H.; Hemakumara, M. H.; Memon, M. A. 2001.** Assessing sensitivity factors of irrigation delivery structures. *Journal of Irrigation and Drainage,* 127(6):346-354.

19. **Rijsberman, F. 2001.** Water for food and environment: The need for dialogue. *Entwicklung + läendlicher raum*, No. 5:8-11.

20. **Sarwar, A.; Bastiaanssen, W. G. M. 2001.** Long-term effects of irrigation water conservation on crop production and environment in semiarid areas. *Journal of Irrigation and Drainage Engineering*, 127(6):331-338.

21. **Sarwar, A.; Bastiaanssen, W. G. M.; Feddes, R. A. 2001.** Irrigation water distribution and long-term effects on crop and environment. *Agricultural Water Management*, 50:125-140.

22. **Shah, T.; Molden, D.; Sakthivadivel, R.; Seckler, D. 2001.** The global groundwater situation: Opportunities and challenges. *Economic and Political Weekly*, 36(43):4142-4150.

23. **Shah, T.; Van Koppen, B.; Merry, D.; De Lange, M.; Samad, M. 2001.** Farmer management of irrigation systems: Can Africa's smallholder black farmers do it? *NewsReach*, pp.1-6.

24. **Shah, T.; Van Koppen, B.; Merrey, D.; De Lange, M.; Samad, M. 2001.** Institutional alternatives in African smallholder irrigation. *IHDP Update*, 1(1):7-9.

25. **Van Der Hoek, W.; Konradsen, F.; Ensink, J. H. J.; Mudasser, M.; Jensen, P. K. 2001.** Irrigation water as a source of drinking water: Is safe use possible? *0*, 6(1):46-54.

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