Beyond More Crop per Drop

Water Management for Food and the Environment

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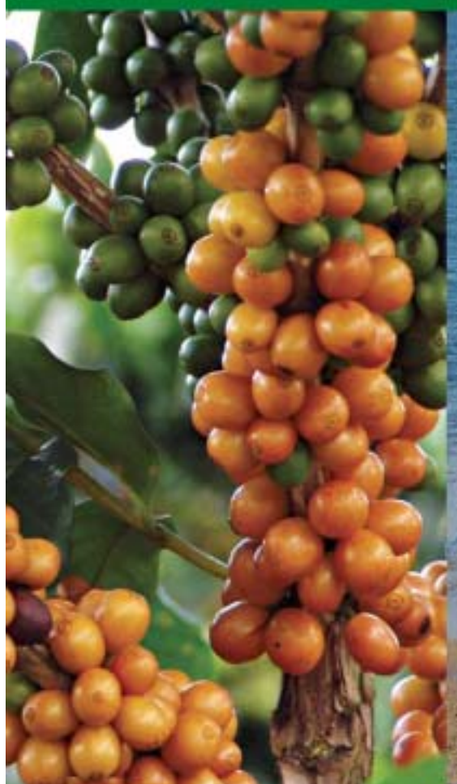
IWMI International Water Management Institute

SIWI SEI Ramsar Comprehensive Assessment of Water Management in Agriculture INWEPF ICID+CIID CGIAR Challenge Program on WATER & FOOD IUCN



Setting the Stage

The Water for Food and Environment Challenge

Frank Rijsberman, Director General IWMI
Photograph by Sanjini de Silva, IWMI

Why is so much water used for "irrigation"? Can we not reduce this to satisfy the needs of rapidly growing cities and safeguard the environment? Obviously, people need water for more than drinking, washing and other domestic needs alone. Few people realize how much more. As much as seventy times more water is required to grow a person's food than is required for domestic needs. Even more water is required to maintain the ecosystem services without which our lifestyle is not sustainable. That frames the challenge on water for food and environment: finding water for expanding cities, often taken from agriculture; growing food for a growing population; providing jobs for the rural poor while sustaining the environment.

If we fail in this challenge poor people will pay the price. Poor urban people are most affected by low access to safe and affordable drinking water and sanitation. For poor rural people, inadequate access to safe and affordable water is crucial for domestic use as well as for their livelihoods. Degraded natural resources affect all people, but particularly the poor, in cities as well as rural areas. Is it possible to overcome this challenge? We believe it is. Communities in hundreds of "bright spots" demonstrate that technologies are available and effective if used appropriately. It requires a shift in how natural resources are managed. Many river basins, particularly in Asia, are already "closed", i.e. there is no additional water available for development that does not take away water already being used by someone else.

Water and land need to be managed at basin and landscape scale - re-allocating water among users. The value to society generated by these multiple, interlinked uses of water needs to increase. This is often possible. If we understand the complex ways water is used and re-used as it flows through a closed river basin, we will be able to increase water productivity. At the same time in Africa, particularly, the available infrastructure to overcome rainfall variability is still so inadequate that investment remains a top priority.

Frank Rijsberman
Director General, International Water Management Institute
Beacon, Water, Food and Environment Theme

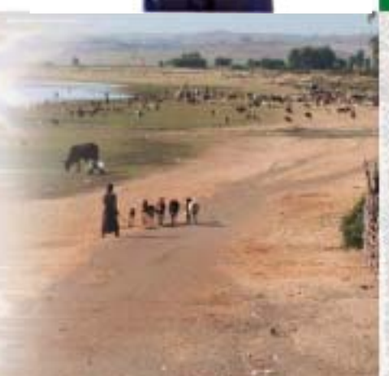
Highlights

1. Poor access to reliable, safe and affordable water for food and livelihoods is a poverty trap for 70% of the world's poor people, i.e. the 800 million poor people that live in rural Africa and Asia.
2. People require, on average, seventy times more water to grow their food than for their domestic use.
3. Plants use between 500 liters (in highly efficient irrigated areas) and 4,000 liters of water (in low productivity rainfed systems) to produce one kilogram of staple food grains such as rice or wheat.
4. Many rivers in the arid and semi-arid regions of the world no longer reach the sea. These river basins are closed or closing, with all water used before it reaches the mouth of the river. Developing water resources in closed basins is robbing Peter to pay Paul. When basins close, the pressure to transfer water from other basins rises.
5. The value of water in agriculture is measured in cents while the value of water for domestic use or industry is measured in dollars. The consequence is that urban people out-compete farmers for water everywhere. Water is moving out of agriculture to satisfy the rapidly growing urban and industrial demand in developing countries.
6. Agriculture competes for water with nature. All water in the hydrological cycle has an environmental function. Every shift of rainfall, river or groundwater from ecosystems to rainfed or irrigated agriculture represents a trade-off between other ecosystem services and food or livelihood benefits.

Photograph by Sanjini de Silva, IWMI

A Story from the Awash Basin

Nhigist has trouble keeping the cows and the goats together. The cows want to walk down to the river, but the goats are trying to walk back to the village. She yells and runs after the goats; now they turn around. The houses are at the top of a steep hill and the river is at the bottom. Her father is already working on the land halfway down the hill. He is preparing the land for the next season. They grow tef, mostly, to make Ethiopian bread and some beans. That is all that will grow if you do not have access to irrigation water. And Nhigist looks after their cows and goats and those animals of her uncle, who lives next door. There are about 200 people in their village, situated just on the edge of a small dam, built for irrigation. The water for the irrigation is used downstream in the village of Godino – not far from Debre Zeit. That is why the dam and canal are called the Godino irrigation system. A few people in the village can use the water from the reservoir by taking some water out of the irrigation canal, as it leaves the reservoir, but most people in the village depend on rainfall to grow their crops.



Photograph by Frank Rijsberman, IWMI

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The rapidly expanding requirements of water for food production, both in rainfed and irrigated agriculture, have entailed very large water withdrawals, significant modification of flow regimes, and degradation of water quality—all with major implications for ecosystem health. Water, food, and the environment form a nexus, an inextricable web. Actions targeted at the local level and at a range of larger scales are needed in order to reconcile the tradeoffs associated with increased food production imperatives and growing recognition of intrinsic environmental and biodiversity value as well as the amenities provided by robustly functioning ecosystems.

The Water, Food, and Environment (WFE) Theme of the 4th World Water Forum aims to bring together a range of stakeholders to address the linkages between concepts and actions, and between actions and outcomes. Discussion and debate based on real evidence from basins around the world is needed to build consensus on the way forward.

Photograph by Sanjini de Silva, IWMI
Water is key for both food and the environment.

This Document

This document has been produced for the 4th World Water Forum to provide 'KEY MESSAGES' which reflect valuable information, insight and opportunity for action within the framework of the water-food-environment nexus. The document is based on the knowledge and experience of IWMI and a diversity of partners. The formulation of many of the messages and supporting evidence is derived from initial results of the wide-ranging study undertaken by the Comprehensive Assessment of Water Management in Agriculture.

The main aim is to present opportunities in the water-food-environment nexus, in terms of specific interventions or intervention packages that have large potential net benefits for society.

The document begins by SETTING THE STAGE by providing some key facts about the current water situation and issues to be considered for the future. The main body of the document focuses on presenting KEY MESSAGES which are clustered into three main categories:

1. CONTEXT MESSAGES - these tell important facts and ideas about the current and future water situation and its connection to agriculture and the environment
2. DRIVER MESSAGES - these messages highlight and explain relevant external forces, pressures, global situations and contributing factors to the water situation (current and future) and that influence (and will influence) the water-food-environment relationship
3. ACTION MESSAGES - these messages reflect the overall theme of the 4th World Water Forum in which we attempt to identify, explain and promote ACTIONS which can contribute to overcoming water- food-environment issues and challenges.

A Story from the Krishna Basin

It is 5 a.m and the sun begins to rise over Sardana's village in the heart of the Krishna basin, in Andhra Pradesh, India. The Krishna basin extends over an area of 260 thousand square kilometers, and straddles three states. With eight percent of the total geographical area of the country, it is India's fourth largest river system.

Sardana wakes before the sun fully rises over the village in which she and her family live. Her husband and three children are still sleeping. She must get water for the household's cooking and washing purposes. If she is late there are long lines at the nearby well and the pump produces ever less water as the groundwater table keeps falling.
As she busies herself with the morning chores, Sardana reflects on how differently things are in her village from when she was a girl. Getting water was much easier, when even shallow wells had clean water. The river then was often spilling beyond its banks but now is easily crossed. And the water is black. It cannot be healthy to touch it -and drinking it is out of the question. Ever since the big dam was built upstream the river has been tamed – and the city has polluted what was left of it.
Soon her husband will rise and head out to the fields where he grows rice and bananas. It is his turn for irrigation today. She will take her daughter to the vegetable plots where she is paying to irrigate with the black water pumped out of the river.

Photograph by Sanjini de Silva, IWMI

What is the situation with water resources now and for the future?

Is the world running out of water? Not really. The world water crisis has more to do with managing water resources badly than with a lack of resources. We need to understand the nature of water scarcity to take the appropriate action. Water poverty, or water insecurity, is the lack of access to safe and affordable water to satisfy a person's needs for drinking, washing and their livelihoods. When a large number of people in an area are water insecure for a significant period of time there is water scarcity. Water scarcity can be physical, economic or institutional. We also need to understand how much water we have. Discussions of water availability tend to include only the "renewable water resources" - that is only some 40% of the total rainfall worldwide. The other 60% is crucial for both food production and the environment.

Photographs by Sanjini de Silva, IWMI

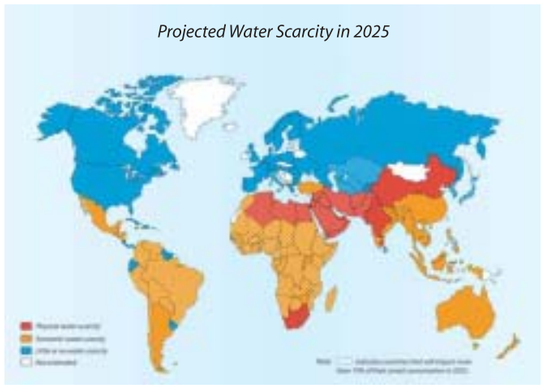
1. Nature of water scarcity: inequitable access contributes as much, or more, to water poverty as does scarcity in resources.

i. Physical water scarcity, where the resources cannot satisfy the demands, dominates water poverty in the arid areas of the Middle East, North Africa and the dry parts of Asia.

ii. Economic water scarcity, where lack of water infrastructure is more important than the lack of resources, affects the overwhelming majority of water-poor farmers in Sub-Saharan Africa and many others in parts of Asia.

iii. Institutional water scarcity, where water resources and infrastructure may be available, but people are water-poor because they are tail-enders, or landless farmers, or do not have rights to land or water, affects poor rural people anywhere, even in the heart of well-endowed irrigation systems.

Projected Water Scarcity in 2025



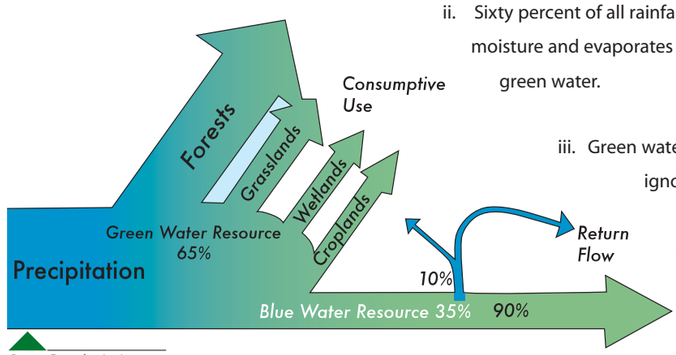
Source: IWMI

2. The myopic focus of water resources management on blue water alone needs to be replaced by an approach to manage the complete water-cycle, including green and blue water.

i. Traditionally, what is defined as renewable water resources is only the rainfall that runs off into rivers and recharges the groundwater; this is only 40% of total rainfall - we call this the blue water.

ii. Sixty percent of all rainfall never reaches a river or aquifer; it replenishes the soil moisture and evaporates from the soil or is transpired by plants - we call this the green water.

iii. Green water cannot be piped or drunk, and is therefore safely ignored by urban water managers. But green water is crucial to plants, both in ecosystems and in agriculture, and needs to be managed carefully.



Source: Comprehensive Assessment

This finger diagram gives a visual representation of the amount of water from rainfall that goes to different types of water resources and uses, as discussed in points i and ii above.

Photographs by Sanjini de Silva, IWMI

Top photo of a river in Brazil represents blue water while green water is represented by the plants growing in a garden in South Africa in bottom photo.

iv. Management of water for food and environment should take into account the complete hydrological cycle, including all rainfall and evapotranspiration, that is, both green and blue water.

World map of Green and Blue water dependence in food production

Source: Johan Rockström

v. The traditional split between rainfed and irrigated agriculture has become obsolete. It should be replaced by water management for agriculture, accounting for the complete spectrum from pure rainfed, via rainwater harvesting, to supplemental or deficit, to full irrigation.

A Story from the Awash Basin

Carrying water up to the house is probably the hardest work Nhigist and her mother Ataman have to do. They walk down with blue plastic Jeri cans to the bottom of the dam and fill them with water by dipping them on the side into the stream. That can fill them up to about two thirds. The last bit Nhigist fills with an empty can. The water looks brown, but after it has been standing in the house for a few hours the mud settles and it can be used for cooking and washing. But the full plastic bottle is so heavy that Nhigist can barely carry it back up to the house. Even her mother is bending down deep under the weight. No wonder her mother gets so angry with her brothers when they spill water. When you have to carry every drop up the hill you think twice before you wash yourself. Water is really scarce.

Ataman's father always says that if they only could get water out of the reservoir, like their cousins who live in Godino, to irrigate their crops then they could also grow wheat, vegetables even. But the small dawn at the bottom of the hill has been built a long time ago, before Nhigist was born, by engineers from far, far away; from Cuba.

Photograph by Frank Rijsberman, IWMI

A Story from the Krishna Basin

Dinesh, Sardana's huband, is up. He is worried that the water will not come to their land today. In the twenty years since he has farmed here, the competition for water seems to grow every year. New dams have been built upstream. The city has paid to take water from the reservoir that also irrigates his land. And the bananas and sugarcane that have replaced much of the rice in the area are thirsty crops. As a result, the water he gets from the irrigation canal has reduced and has become more uncertain. Some years back he has therefore started to buy groundwater from a neighbour with a well, but as the groundwater levels fall and the government increases the price of electricity and diesel, this water is becoming more and more expensive, when he can get it at all. There are rumours that the government plans to double the electricity prices – already there is service for only a number of hours per day. He has participated in several protest marches in the capital when earlier state governments had plans to increase the price of electricity that much; Dinesh is convinced that would be the end of farming in this area as he knows it. Water is becoming really scarce.

Photograph by Dave Trouba, SIWI

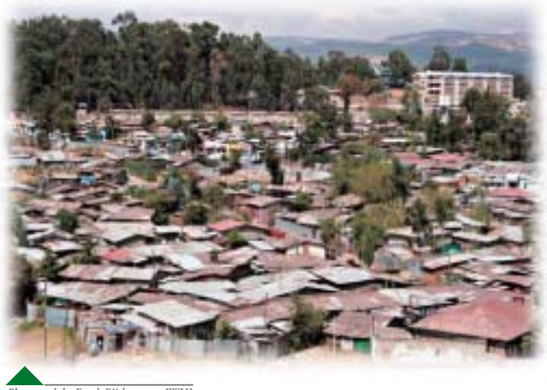
Factors driving the water-food-environment nexus

Some factors outside the water sector, and out of the control of water managers or users, are nevertheless likely to have a major influence on the water-food-environment nexus. We call these factors "drivers". The three key drivers we see are: population growth and economic development; world trade negotiations related to agriculture; and climate change.

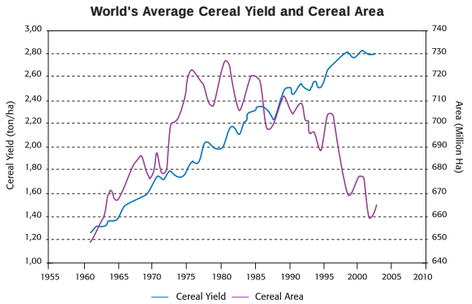
1. Population growth and economic development, with a fixed resource base, is the key driver of increasing water scarcity in Africa and Asia.

i. Increases in the world population in coming decades, concentrated in the developing countries where water is already scarce, will significantly exacerbate the current water crisis in a business as usual scenario, increasing the need for action.

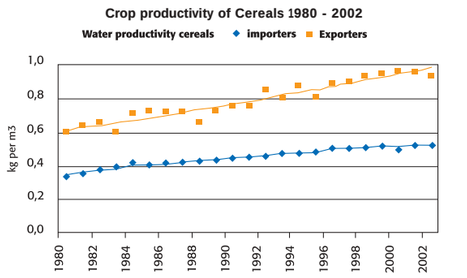
ii. The current rapid economic growth in Asia leads to a more water-intensive lifestyle, for example through changing diets such as increased meat consumption.



Photograph by Frank Rijsberman, IWMI
A crowded slum area has grown in Addis Ababa in Ethiopia



Source: IWMI

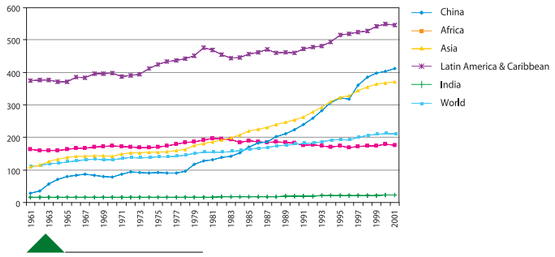


Source: IWMI

Food Item	Water requirement m^3/kg (avg.)
Beef (grain fed)	15 or more
Lamb	10
Poultry	6
Cereals	0.4-3
Cirtrus fruits	1
Palm oil	2
Pulses, roots and tubers	1

Source: SIWI based on several sources

Table showing the water requirement in m^3/kg (avg.) for various food items highlights that meat items require greater amounts of water compared to other food items.



Source: Comprehensive Assessment (CA)

Graph above shows the increase in meat consumption over a time period for the world and for different regions.

2. The world trade negotiations are expected to have a very significant impact on the demand for water resources to grow food and fiber.

i. The world trading patterns in food and fiber products are greatly affected by the agricultural subsidies and tariffs that are currently the subject of intense WTO negotiation.

ii. If the WTO negotiations have the effect desired by developing countries, i.e. greater access to the markets of OECD countries for their agricultural products, then the additional water required to grow these products in developing countries presuming the more stringent export food quality criteria can be met - is potentially very large.

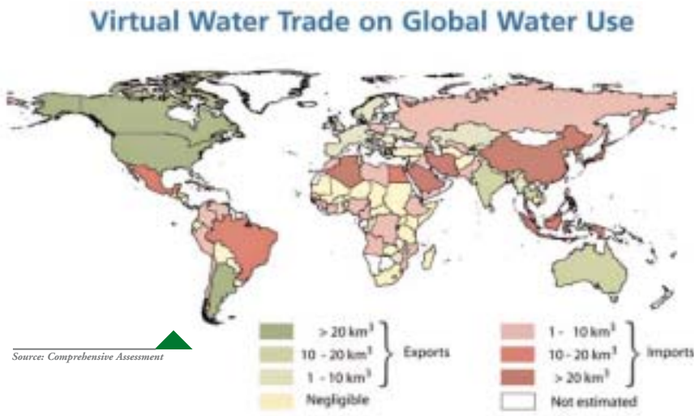
Photograph by Sanjini de Silva, IWMI
Bags of grain in a market in Ghana

3. Climate change will increase climate variability while the capacity to deal even with the current climate variability is very low.

i. Climate change is expected to increase climatic variability. Adapting to these changes will require adequate storage infrastructure and delivery systems for water resources.

ii. Adapting to current climate variability will prepare us for future changes. Due to the difficulty in obtaining localized forecasts of the impacts of climate change, it is not prudent to wait for accurate predictions as the basis for action.

Source: IWMI



Source: Comprehensive Assessment

A Story from the Awash Basin

Nhigist's father will go visit her older brother today. Nhigist is excited, she has asked whether she can come, but it is a long walk down the mountain and her father said no. One time she had a ride on a truck and then the ride back up the mountains took only half an hour, but for Nhigist's family, walking down with the donkeys and back up is a trip that takes more than a day.

Her brother, Regassa, left their village a few months ago. He is now working on a huge farm that grows flowers at the bottom of the Godino irrigation system. The farm is all new, the flowers are grown in green houses, the temperature and the water are controlled by computers. The one time that Nhigist visited Regassa she could not believe her eyes – this was another world, so close to her village but also so far away. In her village, it seems that nothing important has changed since even her grandmother can remember. But Regassa is cutting flowers that go into a truck straight to the airport. Her father says that Regassa is going to be rich. Last time he came home he brought almost all the clothes her family is now wearing. Regassa says that his boss at the farm predicts that soon there will be farms like his on all land between there and Godino.

Photograph by Frank Rijsberman, IWMI

A Story from the Krishna Basin

The population of Sardana's village, and those around it, has probably doubled since she was young. People have no space left to build houses, the home gardens are getting smaller and smaller and the farms are getting smaller too. Sardana is lucky that she has her vegetabe plot and that she can get water there, even though it is expensive and it is wastewater. Given a choice, she would not eat vegetables grown with that water either. But she has to have vegetables. When she was young, people in this area were strictly vegetarian, now people are eating eggs and every wedding has to have at least one or two non-veg dishes. Even her own children claim to like chicken! Well, not in her house, not for her – but she cannot help but wonder how that will change when her children are grown up. It has been hard enough to make a living for her family and to put her children to school. She is very proud of her son Shilp, who is now at university. But the last few years there seem to be more and more serious droughts. Two years ago her husband Disnesh was so desparate when the drought made his crop fail that he threatened to commit suicide. And now people talk about climate change – more and more droughts apparently. She is glad Shilp will not be a farmer but she will still have to find good husbands for her daughters. She does not have the money yet to let them marry anyone but other poor farmers from the village.

Photograph by Sanjini de Silva, IWMI

Action Message

Increasing Blue Water productivity

~ Getting the most out of our renewable water resources ~

ACTIONS:

For most regions of the world, increasing water productivity in agriculture, both irrigated and rainfed systems, rather than allocating more water, holds the greatest potential to improve food security and reduce poverty at the lowest environmental cost. This will require a combination of agronomic, socio-economic and institutional interventions. Low-productivity rainfed agriculture requires 4000 tonnes of green water to produce a tonne of cereal grains, often course grains. Irrigation systems in Africa and Asia typically require 2000 tonnes of water to produce a tonne of cereal grains such as rice or wheat. In the best irrigation systems it takes only 500 tonnes. That is the promise - and the challenge for the sector.

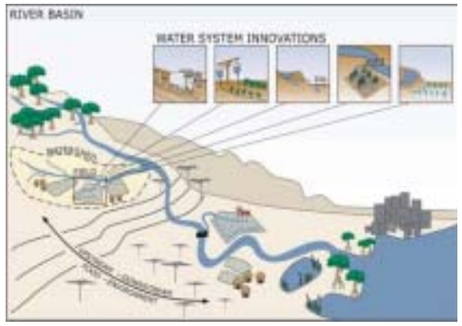
Photograph by Frank Rijsberman, IWMI

Improving irrigation management

Irrigation system management can be improved to provide more reliable water supply to farmers through storage and improved operation of reservoirs, better distribution of water with improved control structures as well as more responsive management. More reliable water supply allows farmers to invest in better on-farm water management such as better land leveling, zero tillage, or pressure irrigation. Improved management usually requires improved institutions as well as improved technologies. Governments rarely manage to operate and maintain irrigation systems successfully on their own. Farmer participation increases success rates. Schemes have to be financially self-sufficient on operation and maintenance and farmers can, and do, pay for well-performing systems.

Multiple use systems: single systems for domestic use, agriculture, aquaculture, agroforestry and livestock.

Rural people often do not distinguish between water for domestic or livelihood purposes. However, water projects and water experts usually still focus on a single purpose. Increased value can be captured by designing, planning and managing projects that enable multiple uses in an integrated manner.



Source: MUS project
Diagram showing a multiple use system for water.

Enhancing the safe and productive use of wastewater in irrigated agriculture

Growing water demands of rapidly expanding urban areas also create the opportunity to re-use the equally growing wastewater flows. Making an asset out of wastewater for peri-urban small-scale farmers may make sanitation affordable for poor urban dwellers. Development of appropriate treatment systems to make the waste water biologically safe, while keeping the nutrients that replace fertilizer for farmers, is the challenge. Potential benefits include improved health in urban slums, livelihoods for peri-urban farmers, improved nutrition (vegetables) for the urban poor, and reduced pollution.

Wastewater is being increasingly used in agriculture and can be a valuable asset for productive use if it can be properly treated.

Photograph by Sanjiwi de Silva IWMI

Adapting farming practices to increased water scarcity

When water is relatively abundant, and its cost to farmers is negligible, farmers are not motivated to conserve water. As water moves out of agriculture to cities, and population densities increase in rural areas, the scarcity and value of water increases. Farmers can, and will, respond to increased scarcity, or higher cost such as pumping cost at greater depth at realistic energy prices, by using water more effectively.

FACTS AND FIGURES

Irrigation efficiency is often confusing due to different definitions used at different scales. In addition, increasing irrigation efficiency is not necessarily good for anything. Water productivity links the water consumed with the outputs produced. Just as "crop yield" is the productivity of land, often measured as ton per hectare, water productivity of the same crop is measured as the "crop per drop", for instance as kilograms of rice or wheat per cubic meter of water used. When a farmer produces rice, vegetables, as well as fish from his farmpond, then the combined water productivity has to be expressed in monetary units. Water use efficiency is often defined in a similar manner as water productivity and is thus the same thing.

DEBATES

- **Good governance and IWRM are also important factors in water productivity.** While technical solutions are needed to increase blue water productivity it is widely recognized that good governance, integrated water resources management (IWRM), and strong supporting policies are also important requirements to improve the productivity of systems
- **Increasing water productivity is necessary but not sufficient.** In practice, local gains in water productivity can provide an excellent incentive to farmers to intensify or expand cultivated areas. Along with water productivity enhancement on-farm, however, must come rules for allocating scarce resources to make sure that water released from agriculture is used to meet other purposes such as ecological restoration.

Water Productivity (WP) Definitions:

WP-field: The amount of crop output in physical terms (crop yield in kilogram) or monetary terms (crop yield times its price in financial or economic terms) divided by the amount of water consumed (evaporated from the soil or transpired by the plant, the evapotranspiration) - in other words, the crop per drop.

WP-basin: At the basin level, water productivity needs to be understood in the widest possible sense, including crop, livestock and fishery yields, ecosystem services as well as social impacts such as on health, together with the systems of resource governance that assure an equitable distribution of these benefits.

Increasing water productivity is therefore equivalent to obtaining more value from each drop of water.

Improving water productivity by 40% on rainfed and irrigated lands could reduce the need for additional withdrawals for irrigation over the next 25 years to zero.

Typical water productivity figures for staple cereal crops (rice and wheat):

Typical low performing irrigation system	- 0.5 kg per cubic meter
State-of-the-art irrigation system in Asia	- 2.0 kg per cubic meter
Rainfed systems in Sub-Saharan Africa	- 0.2 kg per cubic meter
Rainfed systems in Europe/North-America	- 2.0kg per cubic meter

A Story from the Awash Basin

Nighist would like to go to school, but her father says she is needed to herd the animals. All the girls need to work on the farm and around the house. Her two brothers do go to school. Her cousins who live in Godino do go to school and she has asked her father why she cannot go. Her father says that all family members have to help to grow tef and look after the animals, or they will all go hungry. The land is steep and not very fertile and gives them only just enough to survive. Her father says only water for irrigation can help him grow more and let her go to school; he is often angry that he cannot get the water that sits in the reservoir, so close to his land.

On the other side of the hill, in the neigbouring village people also do not have irrigation, but they have built terraces – rainwater harvesting they call it – and they are growing wheat without irrigation. Nighist wonders how that is done. She would love to learn how to grow other things than tef on their farm and she wonders if you can learn that in school. Her mother is growing some vegetables next to the house, but if the rain stops these often die. There must be ways to get water to the house that are less difficult than carrying it on your back.

Photograph by Frank Rijsberman, IWMI

A Story from the Krishna Basin

As water is getting scarce and more expensive, both Dinesh and Sardana have tried to use less. Dinesh has tried a new way of growing rice, called System of Rice Intensification. It means transplanting the rice plants early and letting them grow individually rather than as a small clump, then letting the soil fall dry and wetting it again. It is a lot of extra work. The first year he tried it produced more rice, but Dinesh does not have time to do all the weeding and finding reliable labor is hard. He is not sure whether to continue with it.

Sardana has had more success trying to use a drip irrigation kit for her vegetables, but that only works next to the house where they have clean water – on her wastewater irrigated plot the drip lines would be clogged too quickly. Still, on her small vegetable plot next to the house Sardana grew beautiful vegetables and they could go to the market earlier than most people and got a good price. Dinesh is considering whether to change some of his banana to other fruit trees and use drip irrigation. But it is hard to know which fruits will get a good price and for several years there would be very little income.

Photograph by Frank Rijsberman, IWMI

Action Message

Increasing Green Water productivity

~ Making the most of soil moisture ~

ACTIONS:

Rainfed agriculture and natural ecosystems have in common that they both depend on the 60% of the rainfall that does not make it into rivers or aquifers, but is stored directly in the soil as "soil moisture" - the green water. Increasing the productivity of green water used in rainfed agriculture has great potential to reduce the area needed for agriculture. Agricultural production of staple crops in Africa, has, over the last 40 years, increased almost exclusively by area expansion, at the cost of large areas of natural ecosystems. To enable sustainable increases in food production in Africa, agricultural intensification is absolutely necessary. Increasing the productivity of green water used in rainfed agriculture - particularly by adding a limited amount of blue water (from rivers or aquifers) through supplemental irrigation has great potential.

Photograph by Sanjini de Silva, IWMI
By carving out channels in the soil in her garden in South Africa Tshepo Khumbane is able to capture and distribute rainwater to the plants she is growing.

FACTS AND FIGURES

- Green water is represented by the 60% of rainfall that does not end up in rivers or aquifers.
- Green water exists as soil moisture until it is evaporated from wet soils or transpired through plants.
- Approximately 75% of the poor depend on rainfed agriculture for their livelihoods
- In Sub-Saharan Africa > 90% of population depends on rainfed agriculture which generates between 30-40% of GDP
- Water productivities of 5000 m^3 water/tonne grain, are common in rainfed systems in semi-arid regions such as SSA and parts of Asia.
- The untapped potential of rainfed systems is approximately the equivalent of doubling yields.

Rainwater harvesting

Capturing a larger share of rainfall close to where it falls not only increases the water available to plants and people in that location, but also prevents soil erosion. Rainwater harvesting can focus on: (1) capturing water for domestic use, e.g. by collection of rain falling on rooftops in cisterns; or (2) replenishing green water, e.g. through stone bunds on the contour line; or (3) increasing blue water available locally, e.g. through small check dams that either increase recharge to the groundwater or store water in small reservoirs. Rainwater harvesting has been used successfully by hundreds of thousands of communities, particularly in India, to increase water for domestic, agriculture and ecosystem uses. It has brought rivers back to life. But practised on a large scale in upper watersheds, it will reduce water available further downstream.

Photograph by Dominique Perera, IWMI
Rain water harvesting in Ruhuna Basin, Sri Lanka

Supplemental and micro irrigation

Supplemental irrigation with about 100mm of water, provided during crucial drought spells, can double rainfed yields from about 1 to 2 tonne of cereals per hectare, increasing water productivity to 0.5 kg per cubic meter of water consumed. There are many technologies for supplemental irrigation that range from farm ponds to micro-irrigation with shallow groundwater pumped with treadle pumps.

Photograph by Frank Rijsberman, IWMI

Increased infiltration and reduced runoff through land and water conservation

Improving productivity of rainfed systems through improved land management techniques and agricultural production systems. Use of terracing, contouring and micro-basins are important measures in maximizing rainfall infiltration into the soil to increase yields, especially for farmers in Sub-Saharan Africa, Latin America and South Asia. Conservation or zero tillage - where crop residue is used as mulch - is a promising technology.

DEBATES

- **Some experts believe rainfed systems do not hold more potential.** Skeptics point out that rainfed agriculture has been the focus of research for many years, that ideas have been in place for a long time, yet gains are not forthcoming, and thus rainfed systems do not hold as much promise as claimed.
- **Others believe that evidence exists for greater potential and poverty reduction from new approaches to enhancing rainfed agricultural systems.** New pro-poor small-scale, low-cost approaches such as treadle pumps, water bags, and water harvesting are proving to be the key to unlocking rain-fed potential and reducing poverty on marginal rainfed lands.
- **Dependence on approaches to enhancing rainfed agriculture involves high risk due to climate variability, particularly affecting small and poor farmers.** Thus investing in water resources development and management to increase the coping ability with rainfall variability, through methods ranging from building dams to drought-proofing crops are crucial.
- **Not just technologies are needed.** Socio-economic and institutional interventions are also needed to achieve greater gains in use of green water. There is a need for distributed expertise and decentralization.

Table of Summary adoption and impact of agricultural sustainability technologies and practices on 286 projects on 57 countries. From: Pretty et al. 2004

FAO farm system category	Number of farmers adopting	Number of hectares under sustainable agriculture	Average % increase in crop yields
1. Smallholder irrigated	179,287	365,740	174.6 (±45.7)
2. Wetland rice	8,711,236	7,007,564	22.3 (±2.8)
3. Smallholder rainfed humid	1,704,958	1,081,071	101.2 (±9.0)
4. Smallholder rainfed highland	401,699	725,535	107.3 (±14.7)
5. Smallholder rainfed dry/cold	604,804	737,896	99.2 (±12.5)
6. Dualistic mixed	537,311	26,846,750	76.5 (±12.6)
7. Coastal artisanal	220,000	160,000	62.0 (±20.0
8. Urban - bases and kithen garden	207,479	36,147	146.0 (±32.9)
All projects	12,566,774	36,960,703	83.4 (±5.4)

Notes: Yield data from 405 crop project combination; reported as % increase (thus a 100% increase is a doubling of yields)
Standard errors in brackets

Source: IWMI

A Story from the Awash Basin

Nighist's uncle has visited the village on the other side of the hill. During lunch he is explaining what he has seen. He claims that the people in the other village can get twice as much tef as they do – and without irrigation. Soil and water conservation he calls it. Terracing the land, stopping the erosion with stone bunds and leaving the stubble on the field – conservation tillage, they call that. By capturing more of the rainfall and keeping it in the soil the plants grow better.

Nhigist is excited when she hears her uncle tell it. It can be done because people do it so close to her own house, with nothing but their own hands. She does wonder what her animals would eat, though, because the stubble is a large part of what they eat. Her father is more skeptical. He believes the government should build another dam and give them irrigation – just like their cousins in Godino have. He believes that will allow them to grow a second crop and grow vegetables, just as in Godino.

Photograph by Frank Rijsberman, IWMI

A Story from the Krishna Basin

Sardana and Dinesh have always had access to irrigation water, but they have family living further upstream in the basin that farm on rainfed land. That has never been very profitable. They grew coarse grains such as sorghum, some chickpeas and then had some animals. But in recent years their family has been involved in rainwater harvesting – building small checkdams particularly. That has made a big difference. It allows them to irrigate their crops at least several times whenever there is a dry spell. Now they have switched to more profitable crops – and because land is cheaper there, they are doing quite well. Thousands of such checkdams have been built all over the upstream part of the basin. Dinesh wonders if that has anything to do with the hard time they have filling the reservoir from which he gets his irrigation water.

Photograph by Dave Trouba, SIWI

Action Message

Increasing access to water resources

~ Investing in water resources developments that are crucial to achieving MDGs in Africa ~

ACTIONS:

In Asia, massive investments in water resources development, in dams and irrigated schemes by governments and in wells by private sector farmers, have successfully alleviated poverty. In Africa, failed irrigation projects in the 70s and 80s that cost as much as US$ 25 thousand per hectare have led to unwillingness to invest. Modern irrigation systems built in Africa in the 90s though, with costs ranging from only 4 thousand for upgrading to 6 thousand US$ per hectare for new development have proven successful with returns on investment of 10% or higher. Rice-based schemes (where productivity is at least 3 to 4 tonnes per hectare) and mixed cereal-horticulture schemes have proven to be viable. Irrigated horticulture is proving highly profitable and a fast expanding sector, driven by private sector investments.

Photograph by Dave Trouba, SIWI
A well in Dehli, Gujurat, India

FACTS AND FIGURES

- Analysis of 346 irrigation investment projects completed in the last 40 years show that successful projects in Asia and Africa have similar costs of around 4 to 6 thousand US$ per hectare.
- Dependance on government for O&M has been a major reason for poor irrigation performance. Financial autonomy, with costs for O&M recovered from users, benefits the poor, as better performing schemes enable the poor to produce more.
- Modern, productive and well managed irrigation systems have a high rate of success, measured as returns to investment of 10% or better.
- Peri-urban agriculture supplies more than 90% of the vegetables consumed in African cities.
- Over 20 million peri-urban farmers are engaged in wastewater agriculture.

Coping with climate variability requires investment in water storage, through large and small dams.

Scale matters. A 10% larger water resources development project is shown to have 7% lower unit costs and 3% higher returns on investment. But few large-scale government-run projects are successful and well-designed large dams therefore need to be combined with small irrigation systems well-managed by empowered farmers in decentralized systems.

Photograph by Frank Rijsberman, IWMI
Narmada Dam, India

Farmers are the private sector and will invest in water and land development, management and conservation wherever this is a viable business proposition.

Farmers need to be recognized as the key private sector actors; they are the primary investors in groundwater development and small scale irrigation in Asia and Africa. More than half the irrigated area in Africa is privately financed and managed. At farm level irrigated agriculture is a complete private sector enterprise. Smallholder farmers invest in water control when they have access to profitable markets, technology and investment resources, as shown by their fast response to opportunities in (peri)urban agriculture as well as horticulture for export.

Returns to agricultural water investment increase with access to markets and when combined with hydropower, livestock, aquaculture or drinking water.

Multi-functional investments offer scope for increased returns. While multiple-use of water comes naturally to smallholders and the rural poor, governments, donors and NGOs are still often focused and organized around single objectives. In the Nile basin the water demands of livestock (for drinking and feed/fodder) are as high as or higher than those of people (for drinking and crop-based agriculture). Links are both through prevention of natural resource degradation (overgrazing, soil erosion, pollution of water sources) as well as increased water productivity for fodder production (rainfed or irrigated). Low-intensity fisheries and aquaculture in reservoirs or farm ponds can contribute as much as 20% of the value of the crops grown to overall output. High intensity aquaculture has much higher water productivity than most crops and in many closed basins competes for scarce water resources.

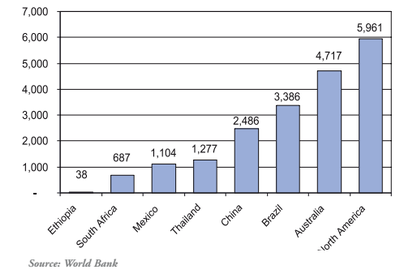
Making an asset out of wastewater holds the promise to make sanitation affordable for poor people.

Meeting the MDG on sanitation for Africa requires innovative approaches. Reduction in the African burden of diarrhea of 25 million DALYs per year may become more affordable when the wastewater is treated as a valuable resource. When wastewater is treated it will be re-used. Safe re-use in peri-urban agriculture has such a high value that it may help make sanitation affordable. Technologies are available but remain largely untested. This is a major challenge and opportunity for research that is a high-potential investment opportunity and could well be an option for developed countries with a looming water stress situation in the near future.

DEBATES

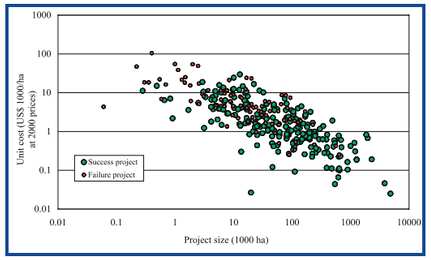
- **Need for more water development: are dams bad?** Dams are not "good" or "bad" - large dams can be good and small dams can be bad. The point is to distinguish between good dams - that have positive returns on investment when all impacts are accounted for and benefits shared equitably - and bad dams.
- **Should farmers pay for water?** Where irrigation schemes do not raise the cost for O&M, farmers pay the price in poorly performing systems. Well performing systems enable farmers to pay. Farmer involvement, and empowered farmers, are the key to breaking this gridlock.
- **Is re-using wastewater irresponsible?** It happens anyway: over 20 million peri-urban farmers are engaged in wastewater agriculture. The point is to make that safer while maintaining the livelihood benefits. The promise, and the challenge, is in linking the approaches to (eco-)sanitation with the re-use for agriculture.

Reservoir Storage per Capita (m3/cap), 2003



Source: World Bank

Unit Costs versus Project Size - whole sample, 1967-1996



Source: Africa Investment Study, IWMI and partners

A Story from the Awash Basin

Nighist's father still remembers when the Cubans were building the dam next to his land, almost 30 years ago, when he was a boy. Everybody in the village was excited; they believed that there would be another dam that would give them access to water as well. But for almost 30 years now, no other dam has been built anywhere in the area that he knows. He has family members in many parts of Ethiopia but it is the same for almost all people living in the rural areas. They have to rely on rainfall, which is good in some years, bad in others and sometimes stops for several weeks in the middle of the rainy season, killing their crop. Hunger is always just around the corner. He knows of people who have built small dams themselves, or with the help of some foreign groups, and people who have built their own wells. But you need a good place for a dam, or groundwater close to the surface – and some money as well. And he has neither. All his adult life he has waited for the government to build another dam – and now his oldest son has left the village to work in the greenhouses built by Israeli investors. He is not sure what is better, to have access to irrigation, like in Godino, or to have a steady job for a good salary like his son. But he knows that both of these would be a great improvement over the farming he is doing – that will never produce enough to send all of his kids to school.

Photograph by Frank Rijsberman, IWMI

A Story from the Krishna Basin

Many dams have been built in the Krishna basin over the last few decades. Sardana has heard that the river barely reaches the sea anymore. Below the city of Hyderabad, the river Musi, that flows into the Krishna, is really nothing more than an open sewer. It seems there really is no more water left, but the city is taking more and more water that used to go to farmers for irrigation. For farmers such as herself and Dinesh the only option seems to be to grow crops that use less water or to move to the city too. Maybe once Shilp finishes university and finds a job there, they can move there too.

The government says they can bring water from other river basins, where there is enough water. Linking all the rivers of the country and ending drought forever. Sardana is not sure that that would work, but it certainly would be very expensive and probably not bring water to her farm in time.

Photograph by Frank Rijsberman, IWMI

Action Message

Balancing water for food and other ecosystem services

~ Giving voice to the silent actor ~

ACTIONS:

Future management of water must continue to work towards achieving a sustainable balance between water for agriculture and water for natural ecosystems. There is, therefore, a need to develop, test and apply best practice frameworks that enable explicit inclusion of the environment as a sector in basin water resources development and management to avoid the often irreversible and costly damage to the environment. The starting point for the discussion is that all water in the hydrological cycle has a value in terms of ecosystem services; none of it flows to the sea wasted. All use for human purposes is a trade-off between current and future use.

Photograph by IWMI

Securing water for the needs of the environment

Development and application of methodologies to determine the water requirements of ecosystems, or environmental flow requirements, must be followed up by actions to secure these water requirements through formal and informal mechanisms.

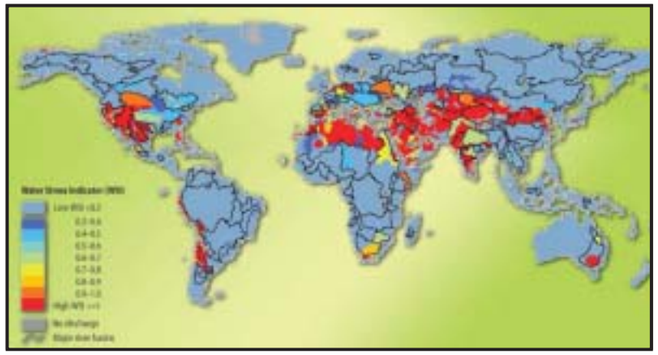
Photograph by IWMI

Sufficient water is required for wetlands to maintain themselves and provide for the flora and fauna dependant on them.

FACTS AND FIGURES

Percentage of rainfall consumed/used to support direct and indirect human uses of water

System/use	% of rainfall
Food - irrigation	2
Food - rainfed	4
Domestic & Industry	1
Instream ecology	8
Flood runoff	27
Permanent Grazing	18
Grasslands	11
Forests and woodlands	17
Arid lands	5
All others	7
Total	100



Source: IWMI

The map above shows environmental water stress using the Water Stress Indicator (WSI). The different degrees of water stress are shown within major river basins around the world.

Enhancing benefits in agriculture-wetlands interactions

Accounting for both livelihood and environmental service benefits offers the opportunity to use wetlands wisely. In Southern Africa, for example, irrigated agriculture (in Malawi, Mozambique, Tanzania, Zambia and Zimbabwe) is closely linked to the development of small wetlands or dambos. While to date agriculture has often completely replaced the wetland ecosystem (through "land reclamation"), opportunities exist to optimize two functions jointly.

Photograph by Matthew McCartney, IWMI

Manage agricultural water use sustainably: ignoring environmental impacts can lead to failed projects

While all agricultural water use has positive and negative environmental impacts, failure to understand upstream soil erosion and resulting reservoir siltation, or impacts of flow reduction on downstream recession agriculture, or impacts of environmental changes in waterborne diseases such as schistosomiasis or malaria, has led to failed projects. The good news is that well-managed agricultural water use can offer major opportunities to improve health and environmental values.

Photograph by Sanjini de Silva, IWMI

In the upper photo farming is taking place alongside a wetland in Ethiopia. In the lower photo a lady in Ghana carries firewood representing yet another use of the environment.

DEBATES

- **Ecosystems: are they users or providers of water?** While some view ecosystems as providers of water through wetlands and other ecosystem services, others contend that ecosystems do not provide water, they consume water, just as much as agriculture does.
- **Need to balance water for ecosystems as their services are in greater demand.** As income per capita goes up, as happened in Asia, notably in China and India at present, the demand for ecosystem services such as clean air and recreational values, goes up.
- **Ecosystems provide valuable services that are the foundation upon which human life is built.**
- **Need to consider the multifunctionality of agricultural lands and include agricultural lands in biodiversity conservation.**
- **Irrigated rice fields and irrigation channels are classified as part of the human-made wetland by the Ramsar Convention.** In this respect, the eco-friendly feature of rice paddy fields with ponded water has to be re-evaluated. In the Asia Monsoon region, Water in paddy fields is not only vital for food production, but also provides a broad range of services related to ecosystems. Thus paddy-systems can be defined as wetlands which have good potential for maintaining both human cultures and natural ecosystems in a sustainable manner.

Photograph by Matia Mariyandima, IWMI

Irrigated agriculture being undertaken through the development of dambos in Zambia.

A Story from the Awash Basin

Another duty of Nighist and her sisters is to find enough firewood for her mother's kitchen fires. They also dry cow dung and use it as fuel, but there never seems to be enough of that, and if they find some good firewood, her mother is happy and the fire stays on to warm them at night. There are few trees left within walking distance, however, except some that were planted, it is said, by Emperor Haile Selasi. And walking back up the hill with a big bundle of branches is almost as heavy as carrying the water – and much further. Her uncle says that cutting the trees is bad for the land. Too many animals and not enough trees. Without trees to hold the soil, the rain will wash it down the hill, where it fills up the reservoir. But where else can they find fire wood?

The only thing Nighist enjoys on her long walks to get firewood is to see the birds. There are so many birds everywhere. Huge clouds of birds passing through their village as they migrate North and South with the season. Nighist knows all the birds that live in their area and most of the visitors. Some days she plays a little game with her sisters on who sees the most types of birds on every trip to get firewood. Last time she won – she saw seventeen types of birds. And she is always on the look-out for a bird she has never seen before – some visitor from far away. She wishes she could fly with them and visit their summer and winter homes, far, far away from here.

Photograph by Frank Rijsberman, IWMI

A Story from the Krishna Basin

Sardana does not feel very well. She often has headaches and her bones ache. She knows that the wastewater she irrigates with cannot be very healthy. The drinking water they have comes from a deep well, that is probably safe. Although her sister thought that for many years too and now it appears there has been too much fluoride in the water of her well. Her children have discolored teeth and her sister has developed a form of arthritis it seems. Sardana worries she will get that too. But what else can they do? There does not seem to be any clean water available anywhere, even the water some people buy from water sellers can give you diarrhea.

When Sardana was a child, her parents were poor but the water was clean. There were several lakes nearby where the children played and bathed. There were more birds too. Wild animals too and wild flowers everywhere. Not so long ago there was an environmental activist in the village who gave a lecture on the risk of all the poisons farmers use – pesticides and herbicides – and how these all end up in the water too. Sardana worries how she can protect the health of her children. She has heard that in the neigbouring village the people have jointly bought their own water treatment plant – maybe they should do that too.

Photograph by Sanjini de Silva, IWMI

Action Message

Investing in water security to aid poverty alleviation

~ Targeting poor areas with pro-poor designs ~

ACTIONS:

Providing reliable access to water for productive purposes is one of the key opportunities in the water sector to alleviate poverty for a considerable share of the three quarters of the world's 'dollar-poor' that live in rural areas. What is needed is an assortment of interventions that combine technology, institutions and social marketing, implemented through decentralized organizations closely linked to or directed by the users.

Photograph by Sanjini de Silva, IWMI

Women collecting water from a reservoir in Ghana. Many people around the world don't have access to reliable sources of water for domestic and productive purposes.

FACTS AND FIGURES

- The multiplier benefits from irrigation-induced economic expansion can be large, with estimates ranging from 1.22 to 6, and an average for India estimated around 2.
- In South-Asia poverty among tail-enders in irrigation systems is 5-10 percent higher than among head-enders, but in China and Vietnam this difference is less than 2 percent, due to more equal access to land and water resources

Target geographic areas with high concentrations of poverty and focus on pro-poor project design

While specific targeting of poor groups has run into implementation difficulties, targeting areas with high incidence of poverty and design of projects that are explicitly pro-poor, have been found to be effective.

Photograph by Sanjini de Silva, IWMI

Gender-equitable development boosts productivity

Women form the majority of the agricultural labor force. In addition, in significant parts of Africa where men migrate to find work elsewhere, female headed households can imply that the majority of farmer decision-makers are women as well. Gender-equitable water development projects have a higher productivity and gender-equity is therefore not only a welfare issue. Where acceptance of women's roles remains problematic, affirmative gender-action can increase the success of water development projects.

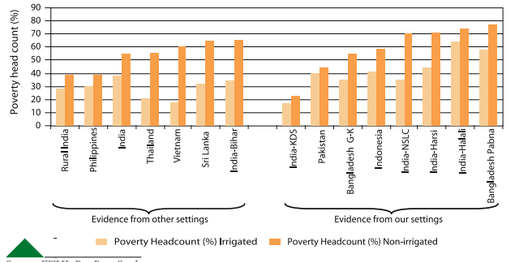
Photograph by Frank Rijsberman, IWMI

Require ex-ante poverty impact assessments for water resources investments.

Assessments ought to be conducted for proposed investments that determine: (a) whether they are strongly pro-poor, pro-poor, neutral or anti-poor; (b) the direct and indirect benefits and dis-benefits, particularly impacts on wage labor; (c) the beneficiaries/affectees; and (d) constraints and opportunities for enhancing poverty alleviation at micro, meso and macro level.

Photograph by Sanjini de Silva, IWMI

Small scale technologies have proven successful for helping poor farmers- but these must be carefully evaluated in the context of conditions and contraints of those areas where technologies are introduced.

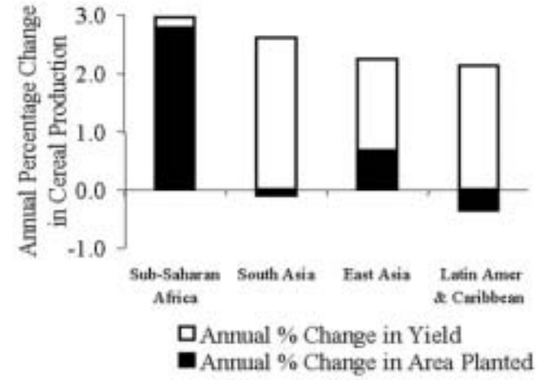


Source: IWMI, Pro Poor Study

Graph showing the poverty headcount (%) in irrigated and non-irrigated settings shows greater poverty in non-irrigated settings, highlighting poverty alleviation role of irrigation.

DEBATES

- **Irrigation reduces poverty;** while poverty is still high in irrigated areas, it is much higher outside irrigation systems in non-irrigated areas.
- **Poverty alleviation can occur through irrigation- but how?** Poverty alleviation of irrigation for the poorest of the poor is more likely to be through wage labor than through increased crop productivity, as the truly poor are often landless.



Source: World Bank

These women in Ethiopia are winnowing tef but as the graph above shows- while land area for cultivation has inceased in sub-Saharan Africa, the yield has not increased greatly. Improving yield without major expansion is one goal of water resources developments towards alleviating poverty.

Photograph by Frank Rijsberman, IWMI

A Story from the Awash Basin

That evening as her family shares the food that is remaining from lunch, Nighist asks her uncle to tell them more about his visit to the village on the other side of the hill. What can they do here to harvest rainwater? Do the girls go to school there? Is her uncle going to try as well? Her uncle tells her to shush, this is serious business and not for girls. But her mother disagrees. She thinks that if she can grow enough onions she could sell them in the market. They could certainly use some extra money. She is willing to try.

She asks her brother to take both herself and Nighist on a visit to the other village, next time. She and her daughters are strong; they can prepare the land, they can make bunds. Maybe she can ask Regassa to bring her one of those "drip kits" instead of clothes on his next visit. In her heart she has decided that her baby daughter will go to school. Whether it is on this land, or down below on Regassa's farm, she is determined to see that her daughters will lead a better life.

Photograph by Frank Rijsberman, IWMI

A Story from the Krishna Basin

Sardana and Dinesh have a long discussion that evening. Can they have a future here on this land? Can they use the water they have access to for a higher family income? For now it seems to them that the best thing is to get more income through Sardana's vegetable farming and then use the money to convert some of the rice and bananas to fruit trees. Mango trees perhaps. With drip irrigation. Maybe Shilp can advise them what to do. If it does not work they may have to move to the city, but they do not want to do that – they are farmers after all, and their families have lived here for generations.

Dinesh will talk to the village elders to see how they can have their own water treatment plant in the village. There is probably some organization that can help with that; they must ask how they have done that in the neighboring village. Today was a good day; the water came and Dinesh could irrigate his fields. They will have to take it day-by-day.

Photograph by Sanjini de Silva, IWMI

Cross-cutting actions

In the previous pages recommendations for action are given in 8 key areas. In order to achieve these, several issues cut right across all these:

- The need for Integrated Water Resources Management to be implemented.
- The importance of basic hydrologic data collection (rainfall, river discharge, groundwater levels, water quality) through long-term monitoring networks.
- Capacity building, both in human resources at all levels from extension workers, technicians, engineers, scientists and water resources management; as well as institutionally to build water research organizations and implementing agencies that are well-structured and sustainably financed, and empowered water users associations.

Water action cannot be successful on its own, rather, it needs to be incorporated into an overall approach to sustainable development that aims to achieve all Millennium Development Goals – not only the water and sanitation target. Vice versa, few Millennium Development Goals (MDGs) can be achieved without progress in the water sector. Poverty Reduction Strategies (PRSPs) form a useful framework to demonstrate how water can contribute to overall development.

Photograph by Sanjini de Silva, IWMI

Acknowledgements

This document is based on the collective wisdom and experience of the International Water Management Institute (IWMI) and a number of partners, and based on projects carried out around the world, particularly in Asia and Africa. Partners involved in the source of information for and development of the document include:

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Special mentions

- Many of the recommendations for action in this document are influenced by the emerging results from the Comprehensive Assessment of Water in Agriculture (CA). The CA is a major program of research and assessment, sponsored by the CGIAR, FAO, Ramsar Convention and Convention on Biological Diversity that involved some 500 of the world's key scientists as either authors or reviewers to answer the question "how much water will we really need for food and rural livelihoods by 2025?". The results of the Comprehensive Assessment of Water Management in Agriculture are due to be released in August 2006.

  More results can be found on www.iwmi.org/assessment

- The CA recommendations are priorities for the CGIAR Challenge Program on Water and Food (CPWF). The CPWF is a program of research and capacity building that aims to demonstrate how water productivity can be increased at the basin level so that the needs for food and livelihoods can be fulfilled without increasing the diversion of blue water to agriculture. It focuses on 9 benchmark basins in Asia, Africa and Latin-America.

  For more information see www.waterforfood.org.

- An important source for this document are the emerging conclusions from the "Investment in Agricultural Water for Poverty Reduction and Economic Growth in Sub-Saharan Africa" collaborative program of ADB, FAO, IFAD, IWMI and World Bank.

- This work is supported through important collaborations between partners. Of special mention is the support and collaboration of GEF:

  "IWMI and partners are all actively moving forward on this agenda. The GEF Secretariat is collaborating with the partners to provide finance for country-driven projects that address these needs as part of its strategic priorities in support of WSSD targets in the GEF International Waters Focal Area" (Al Duda, GEF).

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ACTIONABLE MESSAGES- THINGS WE CAN DO.

1. Increasing Blue Water Productivity: getting the most out of renewable water resources.

- Improving irrigation management
- Adapting farming practices to increased water scarcity
- Enhancing the safe and productive use of wastewater in irrigated agriculture
- Multiple use systems: single systems for domestic use, agriculture, aquaculture, agroforestry and livestock.

2. Increasing Green Water Productivity: making the most of soil moisture.

- Rainwater harvesting
- Supplemental and micro irrigation
- Increased infiltration and reduced runoff through land and water conservation

3. Increasing Access to Water Resources: investing in water resources developments that are crucial to achieving MDGs in Africa.

- Coping with climate variability requires investment in water storage, through large and small dams
- Farmers are the private sector and will invest in water and land development, management and conservation wherever this is a viable business proposition
- Returns to agricultural water investment increase with access to markets and when combined with hydropower, livestock, aquaculture or drinking water
- Making an asset out of wastewater holds the promise to make sanitation affordable for poor people

4. Balancing Water for Food and Other Ecosystem Services: giving voice to the silent actor.

- Securing water for the needs of the environment
- Enhancing benefits in agriculture-wetlands interactions
- Manage agricultural water use sustainably: ignoring environmental impacts can lead to failed projects

5. Investing in Water Security for Poverty Alleviation: targeting poor areas with pro-poor designs.

- Target geographic areas with high concentrations of poverty and focus on pro-poor project design
- Gender-equitable development boosts productivity
- Require ex-ante poverty impact assessments for water resources investments

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