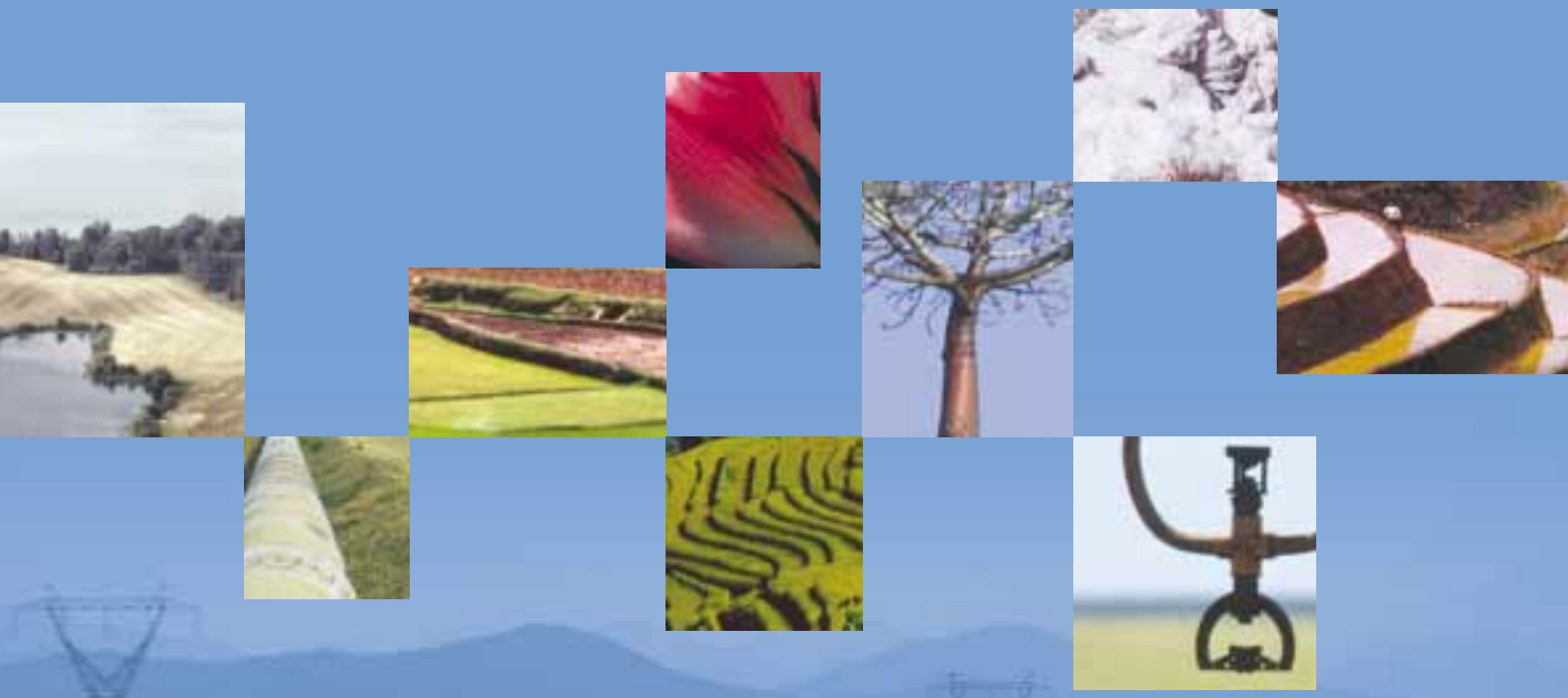
Living Waters

Conserving the source of life



Thirsty Crops

Our food and clothes: eating up nature and wearing out the environment?

Thirsty Crops

Our food and clothes:
eating up nature and
wearing out the environment?

The world is facing a water crisis. It is estimated that over 2 billion people are affected by water shortages in over 40 countries, and the extensive withdrawal of water for agriculture from river, lakes and aquifers results in limited supplies for other human needs, such as drinking, washing, cooking and sanitation. According to the *UN World Water Development Report*, the average supply of water per person will drop by a third in the next two decades.

Agriculture is by far the biggest user of water. Because of this, the water that a person 'eats' everyday contained in food products is much larger than the volume of water a person drinks. Of all freshwater withdrawn for human use, industrial and household uses account for 20 and 10 percent respectively, while agriculture consumes on average around 70 percent and much more in some locations. Furthermore, it is expected that by 2030 the global average agricultural water withdrawal for irrigation itself will be some 14 percent higher.

Rice terraces High Plateau, Madagascar

Food production and water

Based on a nutrition level of 2,700 (kilogram) calories per person daily and an 85 percent cereal-based diet, the UN Food and Agriculture Organisation estimated the amount of water required for food self-sufficiency. Assuming that $1m^3$ of water is required to produce 1,000 calories of plant-based food and $5m^3$ per 1,000 calories of animal-based food, the daily water requirement to provide 2,700 calories is $4.3m^3$ per person daily, or $1,570m^3$ per person annually. In dry climates this has to be provided by irrigation water, whereas in wet climates the entire volume can be supplied from rainfall and soil moisture.

Since the world's population is forecast to grow by at least 2 billion in the next 50 years, regardless of all other factors considerably more food needs to be produced world-wide by 2050. International studies have calculated that the irrigated area of cropland will need to increase by about 14 percent over the coming 25 years. Although part of the extra water needed may come from higher irrigation efficiency or recycling, these studies assume that the rest will need to be developed as new water resources which may grow by as much as 1,000 km^3, from the current level of about 3,300 km^3 worldwide.

Changes to the assumptions made in these types of calculations e.g. regarding sources of protein, or improvements in rainfed agriculture, make considerable reductions in the amount of additional water required, and hence reduce what would otherwise lead to highly significant impacts on freshwater ecosystems.

Agriculture provides many opportunities for water-savings as much of it is currently wasted in transit to the field, through inappropriate irrigation methods, and by growing crops that are not suited to the local environment. Such waste is driven by misplaced subsidies and artificially low water prices (unconnected with the amount used), low public and political awareness, and poor water management, while not being checked by incomplete environmental legislation.

As a result, unsustainable agriculture harms the environment by sucking rivers, lakes and underground water sources dry, increasing soil salinity and thereby destroying its quality, and by washing pollutants and pesticides into rivers destroying downstream ecosystems as far as corals and breeding grounds for fish in coastal areas. Disruption to marine ecosystems is at least as important as that in rivers, with both suffering from changed flood and sediment regimes and blocked migration routes created by dams. Ultimately unsustainable agriculture destroys the livelihoods of the farmers practicing it, and of fishermen and communities dependent on natural ecosystems.

Kafue Flats, Zambia.
Water supply (from the Kafue River) to sugar cane fields

Living Waters
Conserving the source of life

Cotton factory Faisalabad, Pakistan

More than nutrition

Beyond basic nutrition, using water wisely to produce food is a question of survival in many parts of the world. Improving agricultural water use is a key element for increasing food production, especially in many developing countries, where currently around 800 million people - 13 percent of the world's 6 billion people - are suffering from chronic hunger. More than half the world's population live in rural areas and depend largely on farming for a livelihood; in Africa and Asia up to 70 percent of the population depends on farming. The UN Food and Agriculture Organisation projects that world food production needs to be increased by around 60 percent to feed an additional 2 billion people by 2030. These forecasts suggest that developing countries may need to expand their irrigated area from 202 million ha to 242 million ha by 2030.

With more than 1 billion people living on less than a dollar a day, buying food is a daily challenge for too many. The poorest people on the planet spend up to 70 percent of their income on food. At the other end of the spectrum, food manufacturing is one of the largest and most successful industries. The top five food companies have a combined turnover of more than $125 billion USD, which is more than the combined GDP of 50 of the poorest countries.

Clothing is also a multi-billion dollar business that meets a basic need but also caters to luxury and fashion fads. Cotton represents nearly half the fibre used to make clothes and other textiles worldwide. Much of the rest comes from non-renewable synthetic products derived from petro-chemicals.

Our use of cotton comes at huge and unnecessary cost: growing cotton unsustainably, with massive inputs of water and pesticides, has already been responsible for the destruction of large-scale ecosystems such as the Aral Sea in central Asia and the deteriorating health and livelihoods of people living there.

'Persuading governments and business to change the context within which farmers live and work to one that is sustainable, environmentally, socially and economically, is one of the biggest challenges we face in the 21st Century.'

Dr. Claude Martin, Director-General of WWF-International

The white substance in photo is the salt caused by poorly managed irrigation in Delicias, Chihuahua Desert, Mexico

Market failure, government failure

Daily, farmers make rational decisions about what to farm and how to do it. The problem is that, often, through no fault of their own, farmers make decisions that are unsustainable economically, environmentally and socially.

In rich countries, subsidies and market barriers virtually force farmers to produce more food and fibre than are needed and to use excessive amounts of farm chemicals. These subsidies make no sense when they lead to severe ecological impacts and higher prices for everyone in the shops, while securing fewer and fewer jobs on farms. In poor countries farmers often lack rights to the land they farm, reliable water supplies and other inputs, and access to knowledge about better farming technologies and practices. Under such circumstances only short-term survival counts. Additionally, cash subsidies in rich countries cause environmental degradation in poor countries as farmers strive to compete against unfair competition. In all these cases it is the environment that pays the difference.

Cotton facts

Just 2.4 percent of the world's arable land is planted with cotton yet cotton accounts for 24 percent of the world's insecticide market and 11 percent of the sale of global pesticides.

73 percent of global cotton harvest comes from irrigated land.

'It is clear that we need to reduce farming's wasteful use of water, its overuse of chemicals hazardous to people and wildlife, its soil erosion and pollution, and its slash and burn appetite for natural habitats. Only then can we feed and clothe ourselves without worrying about tomorrow's harvest.'

Jamie Pittock,
Director of WWF's
Living Waters Programme

Living Waters
Conserving the source of life

No water, no crops

Without water, there is no life. Agriculture withdraws the vast majority of water taken from rivers, lakes and underground sources. Water is delivered through irrigation systems using methods that range from the simple to the elaborate: a farmer drawing water from a well, to the Indus Basin Irrigation system which distributes water over more than 14 million hectares, an area about the size of England. Making the required amount of water available is only possible in many cases through the damming and diversion of rivers and extensive pumping of underground aquifers, often destroying the very ecosystems that make agriculture possible.

Intensive agriculture around the Parchim Lake Nature Reserve Northern Germany

Agriculture and water availability

The integrity of ecosystems, and various geological and climatic factors, largely determine the total amount of water available in a river basin. Agriculture affects the quantity of water available for human uses in two main ways.

Firstly there are direct withdrawals of water for farming which account for about 70 percent of all human uses. Not all of this water is actually used on farms, however, since a significant portion is lost in transit, or returns to the environment as runoff from fields, or by trickling down through the soil to replenish underground water sources. If the returned water is polluted by pesticides, fertilizers, or sediments, then it is unfit for other uses and, thus, reduces the available water supplies in a river basin.

Secondly, agriculture is responsible for changes in land-use that affect the way that water is collected, stored and released into the environment. Changing natural grasslands or forests into farmland, or plantations, affect the overall availability and cycle of water in a river basin.

The urban population has grown from 43 percent to around 60 percent in the last 10-15 years and global food consumption patterns are changing. City dwellers with higher incomes tend to eat more meat and, with it, increase the need for more water for livestock, for feed crops and in some cases, pasture. In China for example it is estimated that in 2025 annual grain production will need to be about 170 million tonnes higher than today's figure of 380 million tonnes, to be achieved by irrigating an extra 25-30 million hectares of land.

Rice, a way of life

About half the world's population depends on rice as a basic food. More than 90 percent of the world's rice harvest of about 450 million tonnes is grown and consumed in Asia.

A person living in the Mekong Basin in south-east Asia eats 160 kg of rice annually on average; a typical American eats 9 kg and a European 4 kg.

It takes 3,000 – 5,000 litres of water to produce 1 kg of rice. Asian rice growers use 13 percent of global pesticides.

While more land area is needed, millions of hectares of farmland are lost each year due to inadequate water management, such as poor application and drainage leading to high salt levels that destroy soil fertility. Additionally agriculture is the largest source of pollution, including water pollution, in most countries. Cotton alone is responsible for a quarter of all insecticides and herbicides used in farming with severe health impacts on workers in the field and on ecosystems that receive excess doses that run-off with rains.

In parts of some countries such as Pakistan, China, India, USA, Australia, Uzbekistan, Spain and Morocco, physical limits to renewable water resources have already been reached, or are close, causing concern among politicians, farmers and water experts alike. Already, water tables are dropping fast, by as much as 10 metres annually in the worst cases, leading to a less reliable supply of safe water. This is made worse in cases where deeper underground waters are of poor quality, such as in central India, where polluted water pumped-up from deep aquifers, trickles through the root zones of irrigated crops into the now dry upper aquifers, thereby rendering them unsuitable for replenishment.

Opposite:
Center pivot irrigation of wheat crop, Zambia

Although irrigated farming is the biggest water user in the world, this is only part of the food production picture. Farming that relies solely on rainfall, or annual floods, is also vitally important in many countries. Rainfed farming still produces the majority of food supplies, notably in many wet, northern rich countries and in many dry southern poor ones. Rainfed farming still has major impacts on biodiversity through land clearing for crops and runoff of pollution and soil.

The Rio Conchos is the main source of irrigation water for crops grown in the Chihuahua Desert, Mexico

Developing water resources for irrigation, and other uses, can also threaten the sustainability of other food sources. For example, the construction of large dams alters the natural hydrology of river systems, disrupts the breeding cycles of fish and blocks migration routes resulting in decimated fish stocks in rivers and the sea. Freshwater fish stocks have declined by up to 90 per cent in many of the world's largest rivers such as the Yangtse River in China, the Volga River in Russia, the Niger River in West Africa, the Plata River in South America, and the Murray & Darling Rivers in Australia. Tens of millions of the world's poor in places like the Mekong River basin rely on freshwater fish for protein and calcium.

‘Thirsty’ crops in river basins

It takes a lot of water to grow crops and raise livestock. See table A.

A recent study completed for WWF sought to determine the threat posed by irrigated farming to the environment in selected river basins of high importance for biodiversity. The study identified a range of well-known agricultural products as the ‘thirstiest’ water users in these basins as in Table B.

Overall four of these commodities stand out as being the ‘thirstiest’ i.e. the largest total water users in these river basins: rice, sugar, cotton and wheat, with vegetables being locally important in many cases. In the Indus Basin, rice is the thirstiest crop using about 70 million cubic metres of water annually, with cotton, wheat and sugar all using about 50 million each. This is despite the fact that there are more hectares of wheat grown than the other three crops put together.

Table A. Water-intensive crops.

Crop	Typical water requirement (in litres) per kilogram of crop
Cotton	7,000 - 29,000
Rice	3,000 - 5,000
Sugar Cane	1,500 - 3,000
Soya	2,000
Wheat	900
Potatoes	500

Pasture for livestock probably represents a special case in that not only are pastures and hay irrigated in some cases, but the feedstuff for cattle are often in themselves irrigated crops e.g. maize, wheat, alfalfa (lucerne) and soy. Adding this up, raising livestock for dairy or beef is almost certainly the biggest water user in parts of USA and Australia.

Children washing in sugar cane drainage channel, Zambia

Table B. ‘Thirstiest’ crops in major world rivers

Region	River Basin	Thirstiest crops
Africa	Niger River & Lake Chad	rice, vegetables, sugar, wheat
	Zambezi River	sugar, wheat, rice, vegetables
Asia	Indus River	rice, cotton, wheat, sugar
	Yangtze River	rice, wheat, maize, soy
	Mekong River	rice, sugar, vegetables
Europe and Middle East	Konya Closed Basin (Turkey)	wheat, sugar, grapes, alfalfa
Australia	Murray-Darling River	pasture, cotton, rice, cereals
North America	Rio Grande River	alfalfa, maize, cotton, wheat

Living Waters
Conserving the source of life

Sugar cane plantation, Sao Paulo State, Brazil

Sugar, water and ecosystems

Sugar cane is a deep-rooted crop grown in warm countries which, unlike most seasonal crops, remains in the soil all year round and as a result uses a lot of water. Even in areas where sugar cane is not irrigated, the crop can have a great impact on river flow as it reduces run-off from the catchment into rivers and draws heavily on ground water resources. Sugar is also produced from sugar beet, especially in Europe, and alternative sweeteners are also made from other crops such as maize.

Ecosystems impacted by reduced water flow caused by sugarcane include the St Lucia World Heritage Site in South Africa, the Indus Delta in Pakistan, and the Godavari River Basin in India. The impacts of water quantity on ecosystems are generally coupled with water quality and effluent run-off problems. These issues are particularly prominent in the Everglades in the USA and the Great Barrier Reef in Australia.

Water withdrawal by these crops is only one of their impacts on nature and people. Several of these crops, notably rice and cotton, are associated with the use of large amounts of hazardous chemicals (pesticides and herbicides), and almost all use synthetic fertilizers of some kind. The incessant expansion of farming onto natural areas, especially forests, may be the biggest impact for other major crops such as palm oil or soy bean.

Cotton flower (Gossypium sp.) on a plantation Faisalabad, Pakistan

Solutions to quench agriculture's 'thirst'

To start improving the way farming uses water, action is required at several levels. Overall only some 20-50 percent of water withdrawn actually reaches the crop, and losses occur before it gets to farms and in the farm application itself. This means there are many opportunities for improved water management at various levels. Taking these opportunities is a shared responsibility.

Water-savings on farms

On a farm, there are both general and crop-specific practices that can increase water use efficiency in irrigated and rainfed farming. These involve reducing losses in storage and conveyance, evaporation from the soil or water surface, and from runoff and drainage. Measures can also be taken to improve the farm's 'micro-climate', for example, by planting trees for shade or windbreaks, or adding plant wastes to increase the organic content of soil, to increase water retention and reduce overall use. Such measures have wider farm productivity and biodiversity benefits.

It is also important to grow the crops suited to the location and season to get maximum benefit of available water. In the Niger River basin for example, rice is grown in the dry season and is vulnerable given its high water demand. Switching to growing wheat would enable 20-40 percent less water to be used, while still producing a crop of commercial and food value. Farmers, in rich or poor countries, may not have easy access to information needed to make such choices about water-saving practices, shown in table C.

Table C. Water-saving practices

Crop	Selected water saving practices
Rice	Shorter land preparation period
	Direct or dry seeding
	Laser levelling
	Switch to aerobic rice varieties
Sugar	Drip, sprinkler and alternate furrow irrigation
	Water deficit during crop elongation
	Replanting crop die-off each year
Cotton	Knowledge about cotton growth models
	Water deficit during early crop development and before harvest
	Shallow soil cultivation
	Drip, sprinkler and alternate furrow irrigation
Wheat	Broad bed cultivation
	Drip, sprinkler and alternate furrow methods
	Zero tillage and laser levelling
	Water deficit in non-critical growth periods
	Crop varieties that grow under sub-optimal water availability

Living Waters
Conserving the source of life

©WWF-Canon/Mauri RAUKARI

©WWF-Canon/Michel GUNTHER

Irrigation Systems and river basins

To avert wider water shortages, and to conserve nature, there is more required than simply producing more crops with less water on each farm. In many countries individual farmers are dependent for their water supply on whoever controls large-scale irrigation systems. Much can be done to improve efficiency through better system design, regular maintenance and effective drainage, and equitable procedures for allocating water among farmers when there are shortages.

There is also a need to consider the whole river within which the cumulative impacts of water use, chemicals and land use are felt by people and nature. Without basin agreements on returning water saved to nature to maintain 'ecological' flows, the result will be more intensive farming, a downward cycle of land and water degradation, ecosystem decline and the need to expand into new areas. Ignoring the river basin perspective jeopardises the long-term goal of sustainability for farming.

Breaking this cycle will not be easy, and requires new forms of engagement among farmers, governments, environmental organizations, and the food companies who transform the raw materials into products we recognize on our supermarket shelves. There are encouraging approaches emerging in Australia's Murray-Darling River Basin, for example, where WWF has played a role in recent years.

Field projects carried out in the Maikaal project area in India indicate that cotton can be produced with significantly less water. Compared to conventional flood irrigation systems, low-cost drip irrigation systems can save up to 80 percent of water. Field studies in Pakistan revealed water savings of close to 50 percent by various furrow irrigation methods compared to flood irrigation.

Additionally, there is considerable scope to improve drainage of excess irrigation water from fields. A lack of attention to drainage puts large areas out of production each year as salt levels rise in soils.

Top right:
Women planting rice on the outskirts of Royal Chitwan National Park, Nepal

Above:
Picking strawberries near Coto Doñana National Park, Spain

A Basin approach for the Murray-Darling River

The Murray-Darling river basin which covers more than 1 million square kilometres – double the size of France – contains the majority of irrigated agriculture in Australia. It suffers from drought and increasing levels of salt in soils and water. To address the challenges faced, the Murray-Darling Basin Commission has implemented a comprehensive planning framework for the river basin and its natural resources. As part of its approach, the Commission placed a cap on total water withdrawals at the river basin level and set-up a process to negotiate environmental flows for each tributary and the main river.

In many parts of the Basin, water-trading systems are in place enabling farmers to buy and sell their water allocations, enabling producers of low value crops or on 'leaky land' to sell their water to producers of higher value crops or who are located on better soil types. Further, government charges for water are being increased towards the real cost of supply, removing a perverse subsidy and providing an incentive for more efficient use. While there is significant room for improving the emerging systems, the net result is that water is increasingly used for high-value purposes, and minimum water levels are guaranteed in the river to support other functions, including nature that supports agriculture in the first place

Left:
Rice terraces viewed from above Eastern Sikkim, India

Opposite:
Terraced rice fields on the way from Ambalavao Andringitra Nature Reserve, Madagascar

The role of trade, markets and consumers

Crops harvested in one place often reach a destination halfway around the globe. From grower to consumer, there are opportunities to contribute to more sustainable agricultural production. There are examples emerging of multinational food companies that are progressively raising the standards by which farm produce that they buy has to be grown. To date these initiatives have not yet addressed water issues fully, nor the wider river basin perspective, but a model of more sustainable operation seems to be developing that is starting to reflect the real price of food. The organic food industry is also starting to engage in standards development for water sustainability.

There are also opportunities through international trade to encourage better farming practices, for example by importing countries giving improved market access and subsidies for commodities produced in more nature-friendly ways. At the very least, governments and trading blocks need to remove constraints to adopting more sustainable production methods from global, regional or bilateral trade agreements.

Within the European Union (EU), reform of the Common Agriculture Policy (CAP) is needed so that it no longer promotes short-term production gains over long-term sustainability. In the Mediterranean region the CAP, and other EU funding programmes, is promoting agricultural practices especially for water use that are unsuitable under prevailing natural conditions. A substantial proportion of the irrigation infrastructure is badly maintained, coupled with inefficient irrigation methods, resulting in high losses of water.

Living Waters
Conserving the source of life

Cotton market Rawalpindi, Pakistan

Reforming the EU's Common Agriculture Policy

WWF is calling for a substantial reform of the European Union's Common Agriculture Policy (CAP) in order to reduce its impact on land, water and coastal resources and to provide incentives for sustainable rural development.

This can be achieved by redirecting the CAP budget away from production-related subsidies towards a policy that promotes sustainable rural development and which encourages sound management of the countryside, nature conservation and the generation of new economic opportunities.

WWF in Action

Sustainable agriculture is a challenging part of WWF's mission to conserve nature. WWF is taking action on thirsty crops through a combination of approaches:

- **Farm level:** Working with farmers to demonstrate that improved farm water management can deliver benefits for productivity and reduce stress locally on water resources.
- **Integrated River Basin Management:** Considering the impact of thirsty crops at the river basin level and developing methodologies to improve planning decisions, and devise mitigation measures, to maintain or improve water availability.
- **Industry engagement:** Developing and testing Better Management Practices (BMPs) for water and other environmental issues in collaboration with the food and fibre industries.
- **Advocating change:** Lobbying for reform of policies and subsidy regimes that encourage unsustainable crop production, and communicating to key audiences the real cost of thirsty crops, as well as examples of crops produced by more sustainable methods.

Living Waters
Conserving the source of life

Growing better cotton in Pakistan

In Pakistan, WWF is working on small-scale field projects to conserve irrigation water in cotton by promoting the 'bed and furrow' irrigation method. This is being done in a holistic manner in combination with Integrated Pest Management (IPM) to reduce the use of toxic pesticides. In the first phase, four Farmer Field Schools have been established in South Punjab to undertake these activities in collaboration with the Punjab Agriculture Department and international partners such as CABI Bioscience.

WWF recognizes the need to join forces with partners with whom we can work together to encourage sustainable agriculture.

In its international Cotton Initiative, WWF is working with farmers, governments and investors at various stages of the market chain in a joint endeavour to promote cotton that uses less water and hazardous chemicals.

WWF's Cotton Initiative:

Three-quarters of the cotton we use everyday is grown under irrigation in dry, warm (semi-arid) countries. Cotton growing is directly implicated in the degradation of large-scale ecosystems including the Indus River Delta in Pakistan, the Yangtze and Yellow Rivers in China, the Aral Sea in central Asia and the Murray-Darling Basin in Australia.

WWF's Cotton initiative aims to reduce the amount of water used to irrigate cotton so that ecosystem health is sustained by ecological flows, as an important step towards sustainable cotton production.

In the Kafue flats in Zambia, WWF is starting to work with sugar plantation owners to reduce runoff and pollution that causes the river to become choked with hyacinths and reduces the river's capacity to perform other services. This is linked to a wider programme of work that WWF is establishing to promote sustainable sugar production especially in water scarce regions.

WWF is working with multinational food companies and with the organic food sector regarding criteria for sustainable water use that can be incorporated successfully in their respective production standards and purchasing decisions.

Broken pumping station for irrigation. Danube River Basin, Ukraine

Our work in the Global Dialogue on Water, Food and Environment, addressing how to meet current and future food needs without further environmental destruction, is another example of parties traditionally at odds with each other who are now working together.

The Dialogue on Water, Food and Environment

Ten of the primary international actors in the fields of water resources management, research, environmental conservation and health have established the Dialogue to address the balance between future water needs for nature and food production. It aims to produce tangible solutions for the seemingly conflicting interests of water for food and environment, primarily at the national and local levels by 2006.

The organisations involved are the: UN Food and Agriculture Organisation, the Global Water Partnership, the International Commission on Irrigation and Drainage, the International Federation of Agricultural Producers, the International Water Management Institute, the World Conservation Union, the UN Environment Programme, the World Health Organisation, the World Water Council and WWF.

WWF is setting up river basin dialogues to consider the future options for food and water in India, Zambia, Kenya, Far East Russia and the Mekong Basin.

Opposite:
Rice paddy fields with baobab trees
Morondava, Madagascar

By valuing the ecosystems and water on which we all depend, a new balance can be found to allocate water equitably to meet the needs of people, agriculture and the environment.

'For agriculture to become truly sustainable and able to feed fast growing populations, matters such as soil fertility, biodiversity, water resources and the quality of rural life must be addressed. Unilever is developing together with many different stakeholders agricultural best practice guidelines for its key crops addressing these issues.'
Jeroen Bordewijk, Senior Vice President Supply Chain Excellence Programme, Unilever, one of the world's largest food manufacturers

Living Waters
Conserving the source of life

WWF

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:
– conserving the world's biological diversity
– ensuring that the use of renewable natural resources is sustainable
– promoting the reduction of pollution and wasteful consumption.

Conserving the source of life

Living Waters
Conserving the source of life

Contacts:
c/o P.O. Box 7
3700AA Zeist
Netherlands
Tel: +31 30 693 7803
Fax: +31 30 691 2064
livingwaters@wwf.nl
www.panda.org/livingwaters

Avenue du Mont Blanc 27
1196 Gland
Switzerland
Tel: +41 22 364 9027
Fax: +41 22 364 0526
livingwaters@wwf.nl
www.panda.org/livingwaters