CropLife INTERNATIONAL

Representing the Plant Science Industry

Water Matters for Sustainable Agriculture

A collection of case studies

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April 2004

"UNEP applauds all efforts from the private sector to encourage environmentally sound technologies in the field of water conservation and water use savings in agricultural practices."
Klaus Töpfer, Executive Director,
United Nations Environment Programme (UNEP).

"Freshwater is one of the world's most precious, yet most threatened natural resources. Canada is fortunate to be home to about 20% of the world's freshwater, however only 7% of that water is renewable. In this country, agriculture-based water withdrawals return less than 30% back to sources. It is simple math that if we continue to take more than we give back, even our seemingly abundant water stores will be threatened with depletion. I am pleased to see the efforts CropLife International and its partners are undertaking to address this critical issue."
The Honourable David Anderson, P.C., M.P.,
Minister of the Environment, Canada.

"The engagement of the agricultural sector in water management innovations will be essential for the protection of water sources and ecosystems."
Achim Steiner, Director General,
IUCN The World Conservation Union.

"The WBCSD recognizes the weight of agricultural water use in the balance of water management worldwide and welcomes this informative initiative to promote understanding of how the plant science industry is contributing to the protection and more efficient use of water resources."
Björn Stigson, President,
World Business Council for Sustainable Development (WBCSD).

"Water is essential for food security and essential for food production. Research must provide for innovation that makes water as food and water for food more accessible to the poor. Crop science and institutional innovations play the key roles in accomplishing this critical goal."
Joachim von Braun, Director General,
International Food Policy Research Institute (IFPRI).

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I. Introduction

Water is central and vital to life. However, over a billion people live without access to safe water supply and sanitation. Global demand for water is estimated to have risen over six times from 1900 to 1995, more than double the rate of population growth, while more water is being removed from rivers and groundwater than is being naturally replaced. As world population grows and global food production increases to meet demand, water management in agriculture, which accounts for approximately 70% of all water use, is becoming one of the key collective challenges to achieving sustainable development worldwide. Given its importance, the eleventh session of the United Nations' Commission on Sustainable Development (CSD 11), in April-May 2003, chose water, together with sanitation and human settlements, as the first post-World Summit on Sustainable Development (WSSD) area to focus actions on in the 2004-2005 period.

Land management and advanced technologies can help maximise the "crop per drop" that farmers produce worldwide. Water used in irrigation accounts for 90% of agricultural water demand. Improving irrigation systems is therefore crucial to making contributions to water savings in agriculture. As the international community noted at the Earth Summit in Rio in 1992, the agricultural sector "must not only provide food for a rising population, but also save water for other uses. The challenge is to develop and apply technology and management approaches that enhance water use efficiency and protect water quality." The plant science industry, represented through CropLife International, accepts its responsibility in stepping up to this challenge through its activities that contribute to water use efficiency and water protection in agriculture.

> Actions should be taken at all levels to "Promote programmes to enhance in a sustainable manner the productivity of land and the efficient use of water resources in agriculture... especially through indigenous and local community-based approaches"
> **WSSD Plan of Implementation, paragraph 38(d) Johannesburg 2000**

CropLife International has produced this publication of water-related case studies from around the world to increase awareness on the issue. They bring to light possible water saving approaches and good practices for water management as recommended in Agenda 21.These include strategies to conserve water resources, prevent water pollution and protect aquatic ecosystems.

CropLife International has also asked other partners in the agribusiness sector and relevant stakeholders to contribute good water management examples. We particularly welcome the case studies submitted by the International Fertilizer Industry Association (IFA) and the University of Cape Town, South Africa.

As the University of Cape Town case study and the industry case studies relating to drought and stress resistance research illustrate, plant biotechnologies offer great potential to improve plants´ water use efficiency. However these technologies are at this point in the research and development stage and their applicability in the field still needs to be demonstrated. Thorough testing before their release is an integral part of their development.

The plant science industry is committed to being 'part of the solution' to protecting the planet's water resources through activities, which contribute to water use efficiency and water protection in agriculture.

Herbicides play a major role in water conservation. They are used in crop management to control weeds, which compete with crops for water, light and nutrients, and thus contribute significantly to a more efficient use of water during crop growth. Additionally, land management approaches that improve water retention such as conservation tillage often make use of herbicides. Herbicides are also the basis of innovative rice production practices which require less water than traditional production systems. These systems are already in place in many countries and are good examples that indicate the way forward. The use of herbicides is also an important tool to efficiently control invading alien plants that threaten scarce water resources.

The plant science industry is responding to the collective challenge to achieving sustainable development worldwide by promoting awareness of management practices and approaches that protect and save water resources, through good agricultural practices.

In any agricultural production system the promotion of good agricultural practices and product stewardship[1] is fundamental for sustainable agriculture. Industry is part of various multi-stakeholder partnership initiatives that support efforts to protect water quality. These include reducing soil erosion, avoiding pesticide run-off and maintaining wildlife habitats as part of a holistic farm or land management approach.

CropLife International, its member associations and leading companies and its agribusiness partners are proud to be promoting good agricultural practices and product stewardship to ensure clean and safe water supplies and to contribute to water use efficiency in agriculture through the development of new technologies. The case studies in this publication demonstrate the plant science Industry's and its partners' commitment to respond to the water challenge. They are examples intended to inspire others to follow suit and build upon.

"Water resources are essential for satisfying basic human needs, health and food production, energy, and the restoration and maintenance of ecosystems, and for social and economic development in general, and sustainable agriculture and rural development."
CSD-8, 2000, Decision on Agriculture, paragraph 34.

The Millennium Declaration pledged to halve, by the year 2015, the proportion of people without sustainable access to safe drinking water. It also promised to "stop the unsustainable exploitation of water resources, by developing water management strategies... which promote both equitable access and adequate supplies", UN Millennium Development Goals

[1] Product stewardship is the responsible and ethical management of a plant protection or biotechnology product throughout its lifecycle – from research, development, manufacture, distribution and use through to the disposal of any waste.

Water and Agriculture in Context

Improvements in irrigation systems will be key to meet the water challenge in agriculture.

Water use within agricultural systems, primarily irrigation, account for almost 70% of global water withdrawals. This amounts is expected to increase in the next thirty years to support the expected 20% increase in the amount of land devoted to irrigation. Irrigation water use efficiency is currently about 38% worldwide and is expected to improve to an average of 42% by 2030, using technology and improved irrigation water management practices. Also by 2030, it is projected that 60% of all land with irrigation potential will be in use. Currently, irrigated land accounts for approximately one fifth of the total arable area in developing countries and developing countries account for approximately 75% of the world's irrigated areas[2].

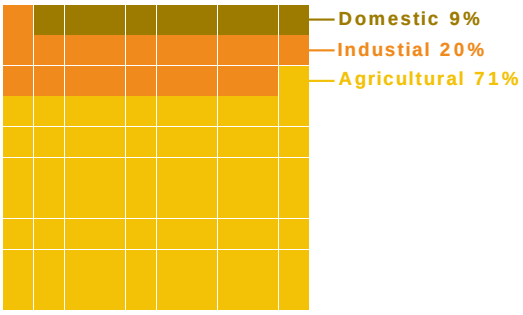
Given this situation, numerous changes in current water use trends must be undertaken to achieve a "sustainable water scenario."[3] Investments in irrigation and water management technology clearly must be undertaken to achieve this scenario. The adoption of advanced farming techniques, investment in crop research, technological change, rural infrastructure and reform of water management to boost water productivity and the growth of crop yields in rainfed farming are additional necessary components.

The case studies included in the following pages point to new directions for crop research and crop management strategies to improve the efficiency of water use in the agricultural sector. The farming techniques, research and multistakeholder approaches discussed in this collection of case studies provide examples of some of the actions that can and must be taken to achieve a sustainable water scenario.

Key Facts: The importance of water to agriculture

- ***Producing a person's daily food can take up to 5,000 litres of water.***
- ***Food and fibre crop production uses 70% of the freshwater withdrawn from natural sources for human use.***
- ***A 1% increase in water productivity in food production makes available - in theory, at least - an extra 24 litres of water a day per head of population.***
- ***While only 20% of the world's farmland is irrigated, it produces 40% of our food supply.***
- ***Over 50% of total river basin area is under agricultural cover in the major watersheds of Europe and South Asia; over 30% of total basin area is under agricultural cover in large parts of the United States, South America, North Africa, Southeast Asia, and Australia.***

Water use by sector



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[2] *The UN World Water Development Report: Water For People, Water For Life*, World Water Assessment Programme, UNESCO Publishing (2003)

[3] *Global Water Outlook to 2025: Averting an Impending Crisis* (2002), by the International Food Policy Research Institute (IFPRI) and the International Water Management Institute (IWMI), presents three alternative scenarios (business-as-usual, water crisis and sustainable water scenario) for global water supply and demand.

II. Research and Innovation

Research into new products that address farmers' needs while at the same time protect essential water is underway in the private and public sectors. This includes new crop varieties, bred traditionally or through plant biotechnology, that are stress tolerant and require less water or that use water more efficiently. With new crop protection products, the plant science industry carries out exhaustive testing before a product is placed on the market to avoid negative impacts on water quality (see case study 4). This is complemented by the development of increasingly targeted application technologies. Both address the need to reduce water consumption, minimise run off and protect ecosystem health. The following examples illustrate different research and development efforts related to water matters. It also contains a case study provided by scientists of the University of Cape Town, South Africa.

1. Stress tolerant crops economise water consumption

Throughout the growing season, crops are exposed to many different stresses, including: cold nights, hot midday sun, too little rain, too much rain, early frosts, etc. The accumulated damage caused by these stresses can reduce yields in all crops by 30-70%. Bayer CropScience developed a "stress tolerant plant trait" that functions as a 'shock absorber' and protects plants from unfavourable growth conditions, including low water levels. The technology has already helped to develop corn and oilseed rape varieties with higher vigour and tolerance to a broad range of stresses. The power of this broad stress tolerance was demonstrated in experiments in which oilseed rape, a crop that is very sensitive to drought, was exposed to acute periods of drought combined with high temperatures. Because drought and heat stress often occur together, tolerance to a combination of these stresses is of utmost importance. Since this technology is interacting with pathways that exist in all plants, it is expected that it will be applicable to the majority of, if not all, crops.

Plant biotechnological developments leading to stress tolerance and drought resistance hold great potential for future water saving approaches.

2. Drought resistant traits in the product pipeline

The plant biotechnology product pipeline of Monsanto covers five stages and can take up to 13 years from discovery to final regulatory approval. One programme currently in the discovery phase is an effort to identify genes that might provide "drought stress tolerance." Projects within this programme that have advanced to the first phase, include testing of specific genes for drought tolerant corn and soybeans.
First results from trials in 2003 show that drought tolerance substantially increased the grain yield through improved water utilisation and thus less water consumption. The future potential of this new technology for better water use efficiency is obvious.

3. Drought resistance through plant biotechnology – a great water saving potential

Scientists at the University of Cape Town are on the cutting-edge of research in drought-resistance - using genes from *Xerophyta viscosa*, a "resurrection" plant indigenous to South Africa to confer drought tolerance to crop plants, such as maize. Resurrection plants are capable of surviving severe desiccation and have the unique ability to resurrect from their dehydrated state usually within three days after re-watering. University of Cape Town researchers have isolated some 60 genes from *X. viscosa* that could potentially be used to improve drought resistance, and have transferred some of them into model plants. The rationale is to determine which of these genes confer any significant improvement in drought resistance. To date, the scientists have observed significant improvements in drought, heat and salt tolerance from one gene and are currently in the process of testing another gene. Once these and other genes of interest are identified, scientists will test them in crops, which may eventually lead to the development of seeds that improve agricultural production in dry regions. The ultimate goal is to increase food security in poor areas while also saving scarce water resources for other uses.

4. Marathon of crop protection product testing prior to registration – water focus

Great efforts are being made to constantly improve the test methods for the protection of aquatic organisms: from smallest to largest, fish (above), phytoplankton (below).

New crop protection products require up to ten years of research and development before they are placed on the market. To reach the market, they must be exhaustively tested in the laboratory and field to ensure that they do not unacceptably impact non-targeted species, soil, water or air, while still accomplishing their intended task. In relation to water, the answers to three primary questions are sought during this testing marathon: does the compound reach water systems and how? how does the compound behave in water? and if it reaches water ecosystems, how does it affect water quality and the health of living organisms? To answer these questions, the decomposition pathways of potential crop protection products are analysed within different crops, soils and water. Once the degradation pattern has been established, analysis methods are developed for measuring residues. Other studies analyse the effects of crop protection products and their major metabolites on living organisms such as non-target insects, birds, soil and aquatic animals, and soil micro-organisms. Such trials are run not only during product development but also after their market launch. In fact products are subject to continued monitoring and re-evaluation, taking into account the latest state of the art developments. As far as aquatic organisms are concerned, compounds are tested not only on fish, but also on algae and water-fleas. Water-fleas for instance are a very sensitive organism and tests run with them are good indications for water quality changes. Overall great efforts are made to constantly improve the testing methods for the protection of even the smallest organism in natural water bodies.

Thorough testing of all crop protection products is undertaken to ensure that they accomplish their objective without unacceptable impacts on non-targeted species, soil and water.

5. New application technologies to save water

Targeted application saves water.

Research and development activities are continuously underway to minimise water volumes required to spray crop protection products, while maintaining their efficiency and efficacy. In some countries, innovative application technologies such as the use of air induction nozzles, which mix air with the spray liquid, are becoming more common in horticultural crops. They can potentially reduce water volumes used to 200-800 litres per ha in comparison to conventional sprayers, which may use 1,500-2,500 litres of water for the same area. The use of low volume water-based sprays combined with application nozzles that target each crop row uses only between 8 to 50 litres of water rather than 800 litres.

More efficient termite control applications provide another opportunity to protect water resources. To exclude soil-inhabiting termites from buildings, large volumes of liquid chemical insecticide were traditionally applied. However, creating an uninterrupted barrier of treated soil beneath an existing building is extremely difficult, and gaps in the barrier may still enable termites to access them. Dow AgroSciences therefore developed an application system that does not use water to apply the insecticide. The system begins by monitoring for termite activity. When termite activity is detected, the monitoring device is replaced by a bait, which is consumed and delivered throughout the colony by the termites themselves, leading to a very targeted control mechanism. For average buildings, liquid soil application requires the use of 760 litres of water; the new system not only fully preserves these water resources for other uses but also eliminates the possibility of contamination of ground and surface water.

New application technologies often use less water while better targeting the application of crop protection products, offering additional opportunities for saving water.

6. Protecting plants from inside out

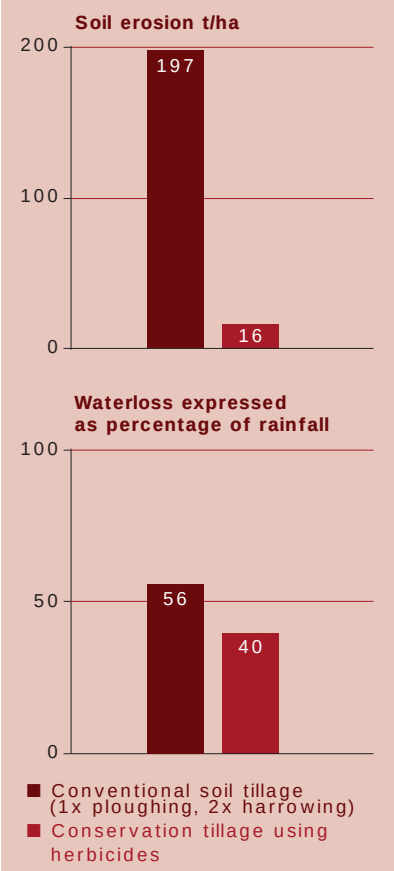
Systemic crop protection products are used for seed treatment and work "from the inside out." On germination, the treated seeds take up the active substance, which is transported to all parts of the growing plant via its sap. Through this method the most sensitive young plants are protected against sucking pest and disease pressures at the earliest stage. Depending on the crop, the seed treatment product used, and the pest to be controlled, the period of protection may last 6 to 10 weeks. This means that a number of whole area foliar sprays of about 500 litres each can be replaced, thereby saving the equivalent water volumes. Many companies represented by CropLife International develop seed treatment products. As an example, one specific seed treatment insecticide replaced between 7 to 8 foliar applications in lettuce cultivation, while in cotton, between 2 and 3 applications are spared.

"If a farmer in an arid developing country improves water efficiency on average by 1%, he or she will gain around 200 000 litres of freshwater per hectare per year. This amount of water would be sufficient to provide drinking water for more than 150 people"
Kenji Yoshinaga,
Director of the FAO Land and Water Development Division

Herbicides play a major role in water conservation. They are used in crop management to control weeds, which compete with crops for water, light and nutrients; they therefore contribute significantly to a more efficient use of water during crop growth. Additionally, land management approaches that improve water retention such as conservation tillage often make use of herbicides. Herbicides are also the basis of innovative rice production practices which require less water than traditional production systems. These systems are already in place in many countries and are good examples that indicate the way forward.

7. Conservation tillage prevents water loss world wide

Reduced or no tillage ("no-till"), as part of integrated crop and weed management are collectively described as conservation tillage or conservation agriculture. They help to increase productivity while using available water more effectively by promoting increased levels of soil organic matter and thereby increasing water retention. For crops grown without irrigation in drought-prone soils, this can translate into higher yields. No-till also prevents soil erosion, reduces the release of greenhouse gases from the soil, improves air quality and protects wildlife habitat and biodiversity. The demonstrable benefits of conservation tillage have led to widespread adoption of these practices in many countries, including Australia, Argentina, Brazil, Chile, Paraguay, Canada, and the US. In Australia, for example, over 80% of all crops sown in 2002 used conservation systems.



In the 1990s, no-till with mulch was introduced in Ghana through a joint programme between the Crops Research Institute in Kumasi, Sasakawa Global 2000, and the Monsanto Company. It is estimated that in 2000, no-till was used by 100,000 small-scale farmers on 45,000 hectares of land. As a result of no-till, more water was available in dry years due to increased soil coverage. Less crop turnaround time was needed because the land remained fertile, and pest control was facilitated due to the presence of a larger number of beneficial insects. No-till farmers in Ghana obtained maize yields that were 45% higher than farmers who did not use this technology during normal years. In a dry year such as 2000, the yield was 48% higher.

In Europe, Syngenta is collaborating with the EU LIFE programme to assess the viability and effectiveness of conservation tillage systems. The SOil and WAter Protection (SOWAP) project aims to develop sustainable arable systems for farmers, based on scientific evidence. Soil disturbance produced by tillage creates high runoff rates and silty water that drains into streams, ditches and ponds. SOWAP will study the effects of conservation tillage on water quality, biodiversity and assess other ways of reducing the impact of agricultural practices on freshwaters bodies and sources. The three-year €4 million project includes installation of innovative high-tech monitoring equipment on test sites in the UK, Belgium and Hungary, as well as being linked to a coordinated monitoring network in France, Italy and southern Europe.

Land management systems such as conservation tillage offer farmers options to save precious water resources.

8. Developing less water-intensive rice production systems

Current rice production systems are extremely water-intensive. In fact, 90% of agricultural water use in Asia is used for rice production. The International Rice Research Institute (IRRI) estimates that it currently takes 5,000 litres of water to produce one kilogram of rice. The development of rice production systems that use less water is therefore critical.

In the Philippines, direct seeding of pre-germinated rice is a growing practice that more effectively manages water in rice production. Pre-germinated rice seeds are directly broadcast onto the fields after land preparation. This avoids the need to maintain young rice plants, for at least 20 days, prior to traditional transplanting. Traditional transplanting uses about 15 to 20% more water than the direct seeding practice. However, the latter requires a different type of weed management strategy and farmers have been reluctant to change the traditional practice if an effective weed control product is not available. Two years ago a new Bayer CropScience broad spectrum herbicide was introduced mainly for the direct seeding market. This has readily gained wide acceptance by farmers. They now increasingly adopt the direct seeding practice and benefit from less water-intensive rice farming practices.

One of the most difficult weeds to manage in rice production is a weed that is botanically the same species as cultivated white rice. It is called red rice. The lack of chemical control measures for red rice has forced growers to adopt costly and wasteful crop practices to manage this weed, such as the "flood and plant" system used in parts of the United States. Flood irrigation prior to planting suppresses red rice growth by creating anaerobic conditions, but is not very effective and causes water quality degradation and also the washing away of sediments. A new herbicide, developed by BASF has allowed farmers to control the weed without flooding and therefore conserving water.

BASF also developed a rice seed that allows farmers to grow more rice by reducing the planting intervals between crops. Used by farmers in Colombia, the seeds eliminate the need to leave a rice field bare for 4-6 weeks, a traditional practice that allows the red rice to emerge so it can be controlled before replanting the field. The field moisture used by the growing red rice weed during this unproductive period is instead conserved and utilised to cultivate the white rice.

Pre-germinated seed uses less water than traditional transplanting of rice.

New less water-intensive rice production systems call for new weed management strategies, which the plant science industry is working to supply.

IV. Water Body Protection, including Management of Alien Species

Water body protection is part of a broader integrated management of farms or landscapes. This not only protects against the degradation of water catchment areas but also contributes to the promotion of coherent biodiversity networks and thus their conservation. Many invading alien plants are threatening scarce water resources and can be managed efficiently through the use of herbicides.

9. Water bodies are important preservation areas on the farms

Growing native seedlings for planting around water bodies.

A "water" pilot project was launched in 2001 in Brazil by Bayer CropScience, the Department of Biological Sciences of the University of Sao Paulo and a large citrus farmer. It seeks to raise awareness among farmers about water body protection and biodiversity conservation and thus the importance of maintaining or reestablishing permanent wildlife preservation areas on the farm. By the end of 2002, about 4000 native plant seedlings had been planted around the water body on the citrus farm to regenerate an area of natural vegetation. A number of tools have been developed to help disseminate information from this pilot project to other farmers in the area. They include a joint report by all project partners, a manual explaining how the farmer can produce native seedlings and a video that documents all phases of the project. These tools aim to not only increase awareness of the issue but also to help other farmers improve their knowledge and adoption of appropriate techniques for water body and biodiversity protection.

10. Partnership promotes streamside buffers

The Illinois Buffer Partnership in the United States is a collaboration of private and public agricultural and conservation organisations to promote and showcase the voluntary efforts of farmers and landowners in the planting, maintenance and enhancement of streamside buffer zones. The effort was initiated by the Illinois Council on Best Management Practices and Trees Forever. Its sponsoring partners include Syngenta, Illinois' Department of Agriculture and Environmental Protection Agency and the US Department of Agriculture's Natural Resources Conservation Service. One hundred demonstration sites are planned by 2005, primarily on farms. Farmers and landowners will learn how buffer plantings of trees, shrubs, and grasses improve water quality, reduce soil erosion, and increase wildlife habitat.

Trees, shrubs and grasses along water ways protect catchment areas, enhance water quality, reduce soil erosion, and increase wildlife habitat.

11. Two hundred watershed projects underway to evaluate land management techniques

The French Plant Protection Industry is working with agricultural organisations and government officials in France to launch several small watershed projects that take into account cropping systems and landscape.

This cooperative effort evaluated the beneficial effects of buffer strips and restoration of hedges and embankments, particularly in sensitive areas such as Brittany. Based on this experience, about 200 watershed projects have been established by 2004 that will evaluate adapted agricultural practices and land management techniques for water body protection, covering a large diversity of soil and climatic conditions, and farming systems.

12. Removing alien plants saves water and protects ecosystem health

Water hyacinth clogs natural water and irrigation systems in many tropical and sub-tropical countries.

Plants that are not indigenous to an area often require more water than native plants. In South Africa, a multi-stakeholder programme under the Department of Water Affairs and Forestry (Working for Water, WfW) was set up in 1995 to tackle the problem of invading alien plants. Over 150 species of invading alien plants exist in South Africa, depleting up to 10% of the scarce annual water supply. These plants can also pose a threat to the environment by crowding out indigenous plants, fueling fires and endangering wildlife. The WfW programme has approximately 300 projects throughout South Africa and clears alien plants from 200,000 hectares per annum. To date, the bulk of efforts to manage these alien plants have used very labour intensive clearing methods and has been an important source of local employment. Additionally, some biological control programmes are in place. However, these methods, are insufficient to deal with the issue exhaustively. The programme is now also using herbicides, which have proved to be very useful in dealing with some of these invasive species. One important example is the control of water hyacinth, a plant that clogs natural water and irrigation systems in Southern Africa, as well as many other countries in the tropics and sub-tropics.

Plants that are not native to a region may demand more water than the region can support. In these cases, crop protection products from the plant science industry can assist in efforts to manage alien plant species.

13. The mighty thirst of the invading salt cedar tree

Aerial view of the Pecos River, Texas, U.S. Green strip of the invasive saltceder along the river before diversion dam; brown strip after the dam has been treated.

In the United States the Salt Cedar tree, which was originally introduced from Eurasia to prevent soil erosion near rivers and lakes, now threatens native plant species through its ability to absorb great quantities of water. One mature Salt Cedar plant may absorb up to 750 litres of water per day. Where these have spread, rivers and lakes have shrunk. The problem is exacerbated by the fact that the plant's leaf glands excrete a saline solution that increases soil and water salinity. US Government agencies started a three-year experimental project along the Pecos River, which runs south through New Mexico and Texas. A BASF herbicide together with a state-of-the-art application technology has cleared some 2570 hectares and over 200 kilometres of Salt Cedar. This has resulted in an estimated increase of over 60 billion litres of water flow in the river during the 2002-2003 season. The improvement in water quantity and quality has also protected the Pecos River pupfish from becoming endangered, and the cleared areas have seen a marked increase in wild biodiversity.

V. Promoting Good Agricultural Practices to Protect Water Quality

In any agricultural production system the promotion of good agricultural practices and product stewardship is fundamental for sustainable agriculture. Industry is part of various multi-stakeholder partnership initiatives that support efforts to protect water quality. These include reducing soil erosion, avoiding pesticide run-off and increasing wildlife habitat as part of a holistic farm or land management approach. This chapter contains case studies also provided by the International Fertilizer Industry Association (IFA).

14. Demonstration farm identifies lessons

A watershed-focused project at DuPont's Chesapeake Farms in the United States has compared four local farming systems typical to the region. This project has involved collaborators from environmental and agricultural non-profit organisations, government agencies, academia, DuPont Crop Protection and farmers. The purpose was to evaluate and characterise the farming systems with regard to economic and environmental impacts, including water quality. The four farming systems, for instance, make optimal use of fertilizers and crop protection products, and employ good management practices to keep sediments, nutrients and crop protection products on the field and out of the water. The project helped farmers appreciate the various aspects of management that influence water quality. For instance the subsurface pathway of nitrate flow to the Chesapeake Bay was successfully reduced by winter rye cover cropping. Also, the benefits of increased water retention through conservation tillage were highlighted, especially in soybean production, and farmers are increasingly taking up the practice.

Demonstration projects lead the way to highlighting good agriculture practices as well as providing farmers with first-hand evidence of the benefits derived.

15. Reusable packaging system reduces need for water to clean empty containers

The large farms in eastern Germany need bigger packages of crop protection products than small farms in other areas of the country. Therefore BASF, together with farmers and other partners, developed the "Ecomatic-System." Distributors oversee the distribution of these containers and logistic specialists coordinate the recollection and cleaning of empty containers, which can be refilled with crop protection products and repeatedly re-used. A similar closed system concept was also developed for a BASF product used in South America and Central America - Multitrip containers are refilled in the production plant and transported to the location of use. There the product is mixed with water to prepare the spray solution and the sprayer is loaded in a closed system, so neither the operator nor the environment is exposed to the product. The empty containers are collected and returned to the production plant to be cleaned, checked for damage and refilled. Through these recycling activities less packaging material is wasted, the need for water to clean empty containers is minimised and the safe disposal of rinse water can be assured.

16. Reducing crop protection product residues from rinse water

In France, Dow AgroSciences, some other crop protection product companies, the Ministries of Agriculture and Environment, the Chambers of Agriculture, university and research institutes and agricultural technical institutes are participating in the development of a photocatalytic treatment process that will decrease the concentration of crop protection products in the post-application rinse water from spray tanks and sprayers. The objective of this new tool is to significantly reduce the concentration of active substances in the rinse water, enabling farmers to more safely and conveniently dispose of the rinse water on their farm.

17. European multi-stakeholder capacity building efforts to protect water

Numerous European farms are on or near water catchment areas, requiring special attention from farmers. In many European countries, studies have been carried out to identify how improved farm management practices would minimise run-off of crop protection products, and cooperative ventures between various partners have been created to ensure that farmers follow these good practices. Progress since the 1990's has seen the many efforts pay off and the issue is no longer viewed as the problem it once was.

In Germany, farmers, the crop protection industry and water utility companies teamed up in 1990. In the Stever catchment area, for example, good practices identified included optimised application timing and amount, as well as choice of products used. In recognition of this collaborative effort´s successful work, the cooperation contract with Gelsenwasser, the water utility company, has been extended until 2006. A similar approach is used in the United Kingdom in the River Cherwell area. Here, the UK Crop Protection Association, farmers and the Thames Water utility company teamed up to identify good practices for the area. Participants in this effort found that, for instance, improved handling and pouring of crop protection product containers minimised glugging and splashing and led to reduced spillages. In Sweden, DuPont, several Swedish governmental bodies, a county government board, an environmental foundation, a farmers' federation, the Association of Swedish Plant and Wood Protection Industries, and the European Union funded a project in 1990 to investigate pesticide sources, pathways and occurrence in stream water within the Vemmenhög catchment, and to educate farmers regarding good management practices. In France, the crop protection association (Union des Industries de la Protection des Plantes – UIIP) and Arvalis – Institut du Végétal (Technical Institute) collaborated with scientists, farmers and local and regional advisors to maintain water quality in the Fontaine du Theil watershed. Here too, improved practices resulted in considerable water protection achievements.

18. Raising awareness for water protection: H2ok

Industrieverband Agrar (IVA) represents the crop protection industry in Germany. It developed the "H2ok" campaign to address water protection aspects of farmyard practices. The campaign encourages farmers to implement good crop protection practices such as filling tanks, rinsing containers and cleaning sprayers in the field instead of in the farmyard, resulting in less run-off. The campaign uses a variety of avenues to ensure the message reaches farmers: provision of various information materials to experts, interactive tools and the development of teaching materials for vocational schools. The German farmers organisation (Deutscher Bauernverband) and governmental crop protection extension services support the campaign. It has made considerable strides already, improving understanding of the importance of water protection and encouraging responsible handling of crop protection products on the farm.

Industry recognises that multi-stakeholder approaches are critical to identify good agriculture practices and inform farmers about these strategies.

19. Joining forces to identify and implement good practices

Agriculture is a major component of land use in Prince Edward Island (PEI) in Canada. Farmers here face the multiple challenges of growing potato crops on sloped land running to water ways in a maritime province that is subject to periods of intense rainfall. As a result, a committee was formed in 2002 to improve land stewardship measures. Members include representatives from Environment Canada, Agriculture and Agri-Food Canada, PEI Department of Agriculture & Forestry, PEI Department of the Environment, Syngenta Crop Protection Canada, PEI Potato Board and the Bedeque Bay Environmental Management Association, as well as a potato grower representation. The team looked into improving land management practices to reduce pesticide run-off, prevent soil erosion and effective means to increase the adoption of soil conservation. On-farm demonstrations and grower driven communications highlighted good management practices and proved to be very efficient as most farmers watch and learn from other farmers.

20. Preventing nitrogen from reaching water supplies

To help farmers use nitrogen fertilizers more efficiently, Dow AgroSciences developed a product to inhibit the process of nitrification. Nitrification is a first step in the conversion of ammonium into forms that can be leached into the environment. It has therefore been associated with concerns over water quality. The product, applied with nitrogen fertilizer (either commercial nitrogen or livestock manure), reduces both the loss of nitrogen into water supplies and nitrous oxide released to the atmosphere. In the past five years, adoption of Dow's product has substantially increased because nitrification inhibition is recognised as a good agricultural practice that increases fertilizer use efficiency while avoiding nitrogen leaching into the environment. Currently, it is used on over 2 million hectares yearly, resulting in the potential conservation of over 56 million kilograms of nitrogen annually.

21. Controlled-release fertilizers match crop needs

Controlled-release fertilizers, which become available to plants gradually, improve the efficiency of nutrient uptake by ensuring that nutrients are in the soil in plant-available forms when the crops need them most. Because plants receive the right nutrients at critical stages of development, controlled-release fertilizers can improve root growth, drought tolerance, shoot quality and flowering while reducing leaching significantly. At this time, controlled-release fertilizers remain a niche market. Nonetheless, their long-term potential to reduce unwanted impacts on waterways and to improve water use efficiency is strong, especially where farmers lack access to high-tech equipment for precision fertilization.

22. Fertigation: fertilization and irrigation working together

A major breakthrough in targeting the application of crop nutrients came with the development of "fertigation", or feeding crops water-soluble minerals through the irrigation water. In a series of field trials carried out in India and Thailand, crops receiving fertigation produced yields that were between 120 and 200% of those receiving conventional fertilization and irrigation. The technique is used in a limited way, so its potential positive impact is still largely unrealised. Well-nourished plants are better able to absorb the water they need to grow, so fertigation can also improve the efficiency of irrigation, thus reducing water consumption.

"Fertigation" - application of water-soluble minerals through irrigation water.

Fertilizers raise water use efficiency by increasing rooting depth and density, as well as the crop's ability to withstand drought stress.

VI. Community Programmes Relating to Water and Sanitation

Industry´s activities extend beyond bottom line business imperatives. The needs of the communities in which it operates are often addressed as well as those of other communities.

23. Drip irrigation project increases household food security while saving water

A multi-stakeholder project in Eritrea, involving the Eritrean College of Agriculture at the University of Asmara and the University of Bern's Center for Development and Environment among others has undertaken a drip irrigation demonstration project for small-scale farmers with funding from Syngenta's Foundation for Sustainable Agriculture. Small-scale farmers cultivate less than one hectare of land, and drip irrigation systems appropriate for this scale were introduced. The project demonstrated that household food security increases with drip-irrigation, which also offers significant water conservation benefits. The cost of the recommended drip-irrigation systems can be recovered in two or three cultivations due to increased profitability.

24. Ensuring drinking water for communities

Access to drinking water was a daily constraint prior to 1999 for the community of Lote in India. To address Lote's water needs, DE-NOCIL Crop Protection Ltd. (a joint venture between Dow AgroSciences and the Indian company NOCIL) installed three water tanks, each with a 5000 litre capacity. The water tanks benefit between 1500 - 2000 people in the area by providing drinking water that is available 24 hours a day, 365 days a year. Dow AgroSciences and its partner took on a similar project in the Belwadi village of India. The water source for residents of Belwadi village was seasonal streams for which they had to walk 3-4 kilometres per day. DE-NOCIL built a water storage tank in the village and installed water taps at various hamlets, making a 24-hour potable water supply available at the villagers' doorsteps.

Access to clean drinking water and adequate sanitation are important components of sustainable communities, without which industry will not be sustainable in the long run.

25. Educational outreach to protect a river basin

In 2000, the Laguna Lake Development Authority (LLDA) in the Philippines called upon industries, communities and other stakeholders to form a river council for the San Cristobal River. Bayer CropScience was asked to lead the multi-stakeholder project, which was later called the San Cristobal River Enhancement Defenders (SaCRED). This successful partnership aims at improving the water quality and rehabilitating the San Cristobal River watershed. Since its creation, other stakeholders, such as local government units including Barangays, the Department of Science & Technology, schools including the Department of Environment Management at the University of the Philippines Los Banos, industrial parks, a squadron of the coast guard, Rotary Clubs and NGOs, have become involved as well.

In 2002, this project developed the Young Environmental Stewards (YES) programme as a vital component in educating the primary stakeholders within the river basin. The YES programme trains high school leaders in environmental awareness and natural resource protection of rivers and lakes. YES uses an "Adopt Your Watershed" module, which encourages schools to take care of portions of the river, cleaning litter, planting trees, and conducting educational campaigns.

Action should be taken at all levels to "transfer and disseminate, on mutually agreed terms, including through public-private multi-sector partnerships, technologies for safe water, sanitation and waste management for rural and urban areas in developing countries and countries with economies in transition..." WSSD Plan of Implementation, paragraph 47(l) Johannesburg 2002

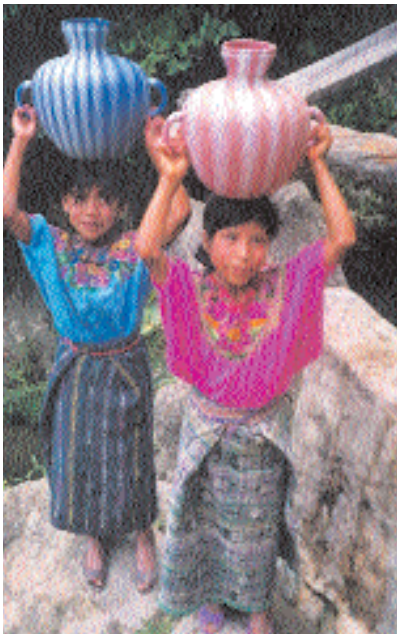
26. Eradicating the guinea worm larva from drinking water

In 1990, at the request of former U.S. President Jimmy Carter, DuPont developed a special nylon mono-filament that could be used in a fine mesh filter cloth to remove guinea worm larva from drinking water and donated millions of square feet to the Carter Center for distribution in Asia and Africa. BASF has likewise provided a larvicide to treat stagnant ponds that host microscopic fleas carrying guinea warm larvae. As a result of this and other efforts, the number of people affected by this debilitating and sometimes deadly water-borne disease has been reduced from over 1.3 million in 1986 to less than 70 thousand in 2000 and guinea worm disease is poised to join smallpox as one of only two diseases that have been eradicated worldwide.

Educational efforts about local water quality issues also affect the sustainability of communities. Industry is proud to have helped nearly eradicate the guinea worm, a water-borne disease.

27. Sanitation project improves water quality for 90 families

To mark both the EU-sponsored Green Week and the World Environment Day that took place during the first week of June 2003, the European Crop Protection Association (ECPA) sponsored an initiative to improve water quality in developing countries. ECPA joined with other industry organisations to support a water and sanitation project for the Guatemalan village of Buena Vista. The project provided a sustainable water infrastructure for 550 people in 90 families. This project was undertaken as part of the Water Relief Network, which was originally set up in 1996 to help communities hit by natural disasters. It is a partnership between global chemical industry producers and the Red Cross. Since its foundation, the network has evolved into a programme providing sustainable sanitation and drinking water supplies to communities in developing countries.



The Millennium Declaration pledged to halve, by the year 2015, the proportion of people without sustainable access to safe drinking water. It also promised to "stop the unsustainable exploitation of water resources, by developing water management strategies... which promote both equitable access and adequate supplies", UN Millennium Development Goals

CropLlife International is the global federation representing the plant science industry. It represents a network of regional and national associations in 87 countries. It is led by companies such as BASF, Bayer CropScience, Dow AgrowSciences, DuPont, FMC, Monsanto, Sumitomo and Syngenta.

The plant science industry develops crop protection products as well as plant biotechnology products that help make crop production sustainable. Through collaboration with a range of stakeholders, CropLife International initiates stewardship programmes that work hand in hand to foster a start to finish approach to the sustainable use of agriculture products that are environmentally sound, economically viable and socially acceptable.

This publication and further information on some of the case studies can be found on CropLife International website: www.croplife.org
CropLife International is a participant in the International Agri-Food Network (IAFN): www.agrifood.net

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