Syngenta and Water

Protecting Water Quality

From the decision to develop a chemical molecule to the disposal of the product container, stewardship is essential to ensure the sustainability of the product, the agricultural enterprise, and the environment. Syngenta is proactive in our approach to stewardship, recognizing that agriculture can only be sustainable if agricultural chemicals are well-understood and handled appropriately.

Protection of water quality is a key component of our stewardship efforts. Our partnerships with dealers, growers, government agencies and other concerned organizations result in water quality stewardship efforts that lead the industry.

Water Quality

Pesticide movement into the water environment can occur by three physical processes. There first must be a pesticide **available** for release, whether it's in storage, on transfer equipment, on field application equipment, or on the soil or plant following an application. Once a pesticide source is available, it may become **detached**. The final physical process, **transport**, moves the pesticide to ground or surface waters. This can happen through spray or vapor drift, leaching, or run-off. Once in an aquatic environment, pesticides may be available for ingestion or absorption by aquatic life or humans, or bind (adsorb) to sediments.

Pesticides are used to destroy target weeds, control diseases, or control insects for the protection of food and feed crops, turf and ornamentals, industrial sites, and structures such as homes, schools, hospitals and businesses. Pesticides are vital to our quality of life; managing the availability, detachment, and transport of these products into the environment is also vital.

Maintaining and improving the quality of water and managing pesticides properly are both clearly important for a sustainable future for people, agriculture, and the environment. Federal and state governments in the US have established a clear regulatory mandate for water quality protection from all potential contaminants, including agricultural products like pesticides, fertilizers, and livestock by-products. The pesticide industry supports this effort with voluntary programs that focus on partnerships, stewardship, and good science.

How does water pollution occur?

Water quality is impaired when pollutants enter a water body and limit its use for drinking, fishing, swimming, or some other purpose. Pollutants enter or are delivered to a water body through a process called "loading." Nonpoint source loading begins with the **availability** of pollutants: Tilled soil is exposed, pesticides are applied, or animal waste is spread on the land, for example. These available pollutants are then **detached** (as when the impact of raindrops dislodges soil particles), adsorbed (pesticides adhere to clay particles, for example), or dissolved by rainfall or snowmelt, which then **carries** the detached, adsorbed, and dissolved pollutants to nearby surface water bodies or into ground water. The major pollutants resulting from agricultural activities are nutrients, sediment, animal manures, pesticides, and

salts, but these substances can come from other sources as well.

Management practices reduce pollution where they decrease the availability of the pollutants; prevent their detachment, adsorption, or dissolution; or interrupt the transport process. Reducing the availability of pollutants is the first step in pollution prevention – an important step in protecting the quality of both surface water and ground water."(*USDA-NRCS RCA Issue Brief #9 March, 1996.*)

Water Pollution Process Triangle

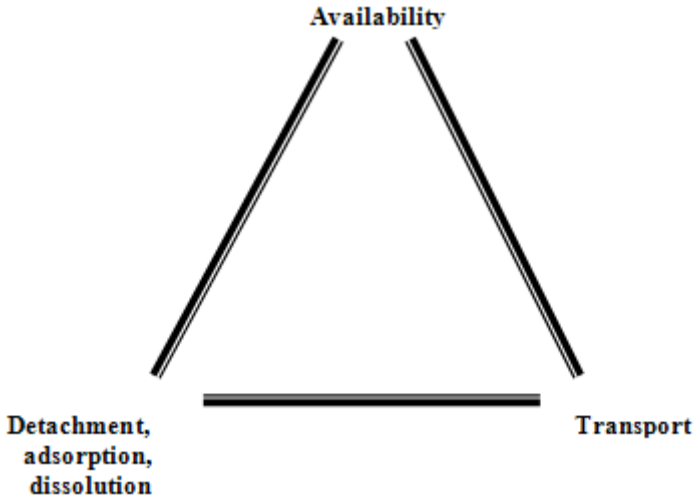

Diagram courtesy of USDA-NRCS

Protecting Water Quality – Federal Efforts

Federal and State Regulatory Programs

Federal and state government programs have been developed to protect water and to monitor or mitigate the presence of pesticides and other compounds. The US EPA leads the protection effort through federal mandates of the Clean Water Act (**CWA**); Federal Insecticide, Fungicide and Rodenticide Act (**FIFRA**); Federal Food, Drug, and Cosmetic Act (**FFDCA**); Food Quality Protection Act (**FQPA**); Safe Drinking Water Act (**SDWA**); and other laws. State governments in many instances are responsible for implementing specific aspects of each of these programs within their geographic boundaries.

Standards and Criteria

Human health water-quality standards have been developed for drinking water and recreational contact waters. Agricultural compounds comprise a small number of the compounds for which water-quality standards have been established.

Drinking Water. National Primary Drinking Water Regulations (NPDWR) are legally enforceable standards developed by the US EPA Office of Ground Water and Drinking Water that apply to public water systems under the Safe Drinking Water Act. Primary standards protect human health by limiting the levels of contaminants in drinking water. These standards are referred to as Maximum Contaminant Levels (MCL).

Waters of the United States. National Recommended Water Quality Criteria (NRWQC) for human health and aquatic life have been developed by the US EPA Office of Water under authority of the Clean Water

Act for the protection of ambient water quality. Approximately 150 compounds have been identified and criteria established. These criteria were published for guidance to state and tribal governments in implementing sections of the Clean Water Act.

Monitoring

The **United States Geologic Survey** (USGS) monitors the quality of surface waters across the US to observe short and long-term trends in water quality. Over 350,000 water-monitoring stations in rivers, streams, lakes, and ground water are used for evaluating water quality across the US. Nationwide water-quality-monitoring programs are also part of federal mandates through the Clean Water Act (**Ambient Water Quality Monitoring**) and the Safe Drinking Water Act (**SDWA Compliance Monitoring**) and are implemented by individual states and community water systems.

Best Management Practices for Protecting or Improving Water Quality

"Good quality water reflects what we do on the land as well as what we do in the water. Because agriculture is by far the most extensive land use in the United States, improved water quality depends in large part on the commitment of American farmers and ranchers to improving the quality of soil and other natural resources as well as water. The improvements in water quality we've already seen reflect that commitment in action." (USDA-NRCS RCA Issue Brief #9 March 1996)

Best Management Practices (BMPs) are methods used by agricultural producers to eliminate, minimize, or control the release of sediment, nutrients, and pesticides from cropland or from pesticide mixing, loading, and storage areas into surface water and ground water. BMPs are used for controlling the physical processes (availability, detachment, transport) that result in pesticides entering aquatic environments.

Surface Water Protection through Cropland Best Management Practices

The United States Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS) has assisted landowners for decades in the design and installation of BMPs for cropland and water quality protection. The USDA-NRCS has developed National Conservation Practice Standards for use in agricultural settings. These conservation/best management practice standards specify BMP applicability, design, and maintenance requirements. These are soil and water conservation practices designed for controlling and managing the movement of water from a specific slope or field. Cropland BMPs include conservation cropping, cover crops and mulching, conservation tillage, contour farming and terraces, buffers and filters, and water and sediment control basins. All of the National Conservation Practice Standards are available at https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/ncps/.

Ground Water Protection through Wellhead Best Management Practices

One of the major sources of accidental groundwater contamination with pesticides is via entry through poorly constructed wells. Wellhead protection BMPs prevent groundwater contamination by managing/eliminating potential contaminant sources in the land area that contribute surface water to the aquifer, and the location, construction, maintenance, backflow prevention and abandonment of wells. A discussion of these practices is available at https://www.epa.gov/water-research/wellhead-protection-area-whpa-model.

Pesticide Use, Handling, and Storage Best Management Practices

The improper use and handling of agricultural pesticides presents an opportunity for an unintentional release into the water environment. Purdue University Extension Service has developed a water-quality planning guide that incorporates pesticide use and handling practices (*Field Assessment for Water Resource Protection*, www.ecn.purdue.edu/SafeWater/Field/WQ_42.pdf). This guide discusses pesticide storage, labels, mixing and loading, overspray and drift, disposal, record-keeping and emergency planning for pesticide use and handling.

Surface Water Protection through Cropland Best Management Practices

For technical guides related to national conversation practices, visit https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/?cid=nrcs143_026849.

Conservation Cropping, Cover Crops, and Mulching. The objective of **conservation cropping** is to keep the land covered for as long as possible. A good conservation cropping sequence contains crops that are low growing in habit with a heavy canopy, producing large amounts of after-harvest residue. Crops producing low residue should not be planted in the same field in two consecutive years.

If the soil is to be left fallow (unplanted) over a season where erosion is likely, a fast-growing **cover crop**, such as small grains, can be planted to provide soil protection. Cover crops can be harvested and the land tilled after the likely erosion season has passed.

An alternative to using crops or crop residues to protect the soil surface is to add **mulch** made of organic matter. Increasing the organic matter near the soil surface improves water uptake and soil structure, though the release of nitrate can be hard to control. Straw mulching is widely accepted as a BMP to decrease irrigation-induced erosion in furrow-irrigated fields.

Photograph courtesy of USDA-NRCS

Conservation Tillage. This is any tillage type that leaves about 1,500 pounds of straw per acre (30% of the previous year's crop residue) on the soil surface. This should result in at least 60% of the soil surface being covered, which protects it from the impact of rainfall until the crop canopy covers the ground. This can be achieved with ***no-till*** (minimal disturbance of the soil) or ***mulch-till*** (disturbance of the surface but limited residue burial). In addition to the benefits for run-off and erosion control, conservation

tillage helps to retain soil moisture, provides cover for wildlife and beneficial species, and decreases fuel consumption through fewer passes of tillage equipment through the field.

Photograph courtesy of USDA-NRCS

Contours, Terraces, and Strip-Cropping. As much as possible, tillage operations should follow the **contours** across a slope rather than up and down. The ridges that are left will trap precipitation and promote infiltration of water rather than run-off. **A terrace** is an earthen embankment that also follows a contour, slowing and re-directing water running downhill.

Photograph courtesy of USDA-NRCS

Strip-cropping is an extension of contour farming and terracing where the field is divided into strips that run with the contours and are planted alternately with high-erosion crops (e.g., corn or soybeans) and low-erosion crops (e.g., alfalfa or small grains). Strip-cropping can also decrease wind erosion where this is a problem, such as in flat areas with light soils.

Photograph courtesy of USDA-NRCS

Buffers and Filters. Where water runs straight from a field into a stream, dissolved and suspended chemicals and sediment can affect water quality in the watershed. Land management practices that take cropped fields right up to the edge of the water body provide no protection and contribute to poor water quality. An important way to minimize movement of chemicals and sediment in water to streams and other surface water bodies is a buffer or filter strip. **Buffers and filters** retain precipitation in agricultural fields by disrupting surface run-off patterns and promoting water infiltration of the soil, thereby preventing run-off and erosion.

Photograph courtesy of USDA-NRCS

Riparian Buffer Strips. Riparian buffer strips are wooded or grassed strips, typically between 50 and 100 feet wide, between streams and agricultural fields. The resistance of grass and other plant stems in these strips decreases the velocity of water approaching the stream and allows sediments to come out of suspension, often taking pesticide and fertilizer residues with them. Trees and shrubs that are deep-rooted allow for greater infiltration of water into the soil, and plant growth in the strip promotes the uptake of nutrients from run-off water, both of which add to the filtering effect. Trees not only add to the stability of the buffer zone and the resistance to wind erosion and spray drift but also provide an increased number of niches for insects, mammals, and especially birds. The buffer strip is also good habitat for microorganisms that can degrade chemicals. Finally, temporary or permanent wetland commonly develops adjacent to riparian buffer strips, contributing to a more even flow of water in the stream that is beneficial to the establishment of a diverse aquatic community that further improves water quality.

Photograph courtesy of USDA-NRCS

Water Control Basins. Water control basins are earthen embankments or concrete flumes set across smaller watercourses that decrease peak flow rates to prevent gully erosion and encourage the fall-out of sediment from the water run-off.

Sediment Basin photograph courtesy of USDA-NRCS

Protecting Water Quality - Syngenta Efforts Including Cooperative Demonstration Research Project Approach

Sustainable agriculture requires the continued use of pesticides and their stewardship. Syngenta has been involved in numerous water quality stewardship initiatives across the US to minimize or eliminate the occurrence of pesticides in water, working with growers and grower organizations, government agencies such as EPA and the USDA Cooperative Extension Service, universities, and non-governmental organizations (NGOs). These initiatives include research, monitoring, education, and field-level cooperative demonstration projects to better evaluate the effectiveness of different BMPs in reducing pesticide surface run-off subsequent to row crop applications. The demonstration projects have provided proven methods that growers can adopt to preserve water quality.

Solutions for Minimizing or Eliminating Pesticide Release into Ground and Surface Waters

Iowa Buffer Initiative

The Iowa Buffer Initiative, initiated in 1997 with Trees Forever (www.treesforever.org), is an outgrowth of Iowa State University's "Bear Creek Project." This project demonstrates different ways to establish

and maintain buffers. It also demonstrates to landowners the effectiveness of buffers in improving water quality and reducing soil erosion in different soil types and terrain. The Iowa Buffer Initiative, which now contains close to 100 demonstration and project sites, has created a network of buffer specialists, and recognized farmers who include buffers in their management plans. Syngenta has been a sustaining sponsor of Trees Forever since 1997.

Picture caption: In only four years, vegetative buffering has transformed this stretch of Bear Creek in Central Iowa into a thriving ecosystem. Bear Creek has evolved into a national model demonstrating how buffers protect water quality, curb sedimentation and provide habitat for wildlife.

Illinois Buffer Partnership

The Illinois Buffer Partnership (http://www.treesforever.org/Illinois_Buffer_Partnership), initiated in 2001, is a collaboration of private and public agricultural and conservation organizations to promote and showcase the voluntary efforts of farmers and landowners. The program is a collaborative partnership of Trees Forever, the Illinois Council on Best Management Practices, and key sponsoring partners (Syngenta Crop Protection, GROWMARK, IL Dept. of Agriculture, IL EPA, and USDA Natural Resources Conservation Service), as well as other research and technical partners. Its primary goals are:

- To reduce soil erosion, improve water and soil quality, as well as provide wildlife and pollinator habitat.
- To highlight the ongoing efforts to restore Illinois' flood plains.
- To increase the awareness of buffers and other conservation practices.

Illinois Council on Best Management Practices (CBMP)

The Illinois Council on Best Management Practices (http://illinoiscbmp.org/) is a coalition of agricultural organizations and agribusinesses including Illinois Farm Bureau, Illinois Corn Growers Association, Illinois Soybean Association Checkoff Program, Illinois Pork Producers Association, Illinois Fertilizer and Chemical Association, Syngenta, GROWMARK, and Monsanto. CBMP was founded in 1999. Its mission is working to assist and encourage adoption of best management practices (BMPs) to protect and enhance natural resources and the sustainability of agriculture in Illinois. The program focus is on reducing nutrient losses and enhancing nutrient efficiency. Significant resources are dedicated to education and outreach on best management practices to the agricultural community in eight priority watersheds, including Lake Springfield, Lake Decatur, Evergreen Lake, Lake Bloomington, Vermilion River (Illinois Basin), Salt Fork Vermilion River (Wabash Basin), Lake Vermilion, and Lake Mauvaise Terre.

The goals of the CBMP are to:

- Identify effective, environmentally sound and economically sustainable BMPs for production agriculture

- Increase farmers' voluntary adoption of BMPs through promotion, education, information transfer, demonstration, evaluation, incentives and recognition programs
- Communicate with stakeholders the progress made toward BMP adoption

Missouri Watershed Research, Assessment, & Stewardship Project (WRASP)
The Missouri Corn Growers Association, Missouri Department of Natural Resources, USDA-Agricultural Research Service and Syngenta Crop Protection formed a partnership known as WRASP to address water quality problems in the Lake Smithville and Mark Twain reservoir watersheds. The purpose of the project was to evaluate cost-effective, water-friendly farming practices. The five-year study included watershed and reservoir water quality monitoring, watershed modeling and small field plots. Pesticide and nutrient rates and timing, and buffer strip type and width were varied and resulting soil loss was measured. Experts from the Missouri Corn Growers Association continue to hold grower educational classes at the site to teach the best use of crop chemicals.

Lake Springfield Watershed BMP Effectiveness Evaluation, Illinois
The Lake Springfield Watershed Resource Planning Committee (LSWRPC) and the City of Springfield conducted an intensive five-year study assessing BMP effectiveness, and from that study provided incentive payments for landowners to install filter strips through the CRP program. The Lake Springfield watershed encompasses 265 square miles or 170,000 acres in primarily Sangamon County, but also in Macoupin County. 86% of the watershed area is row crop agriculture, primarily corn and soybeans. There are rapidly developing urban areas to the south and west of Springfield, IL, along with other urban communities in the watershed including Chatham, Loami, Auburn, Thayer, and Virden. Lake Springfield covers 4,200 acres and contains 57 miles of shoreline. It serves as the drinking water supply for 165,000 customers from the City of Springfield and several surrounding communities.

Upper Big and Little Blue River Basins Monitoring and Assessment of BMPs, Kansas and Nebraska
The Upper Big and Little Blue River basins were monitored and agricultural BMPs for reducing crop chemicals in run-off were evaluated in a cooperative watershed assessment project with the University of Nebraska, Kansas State University and the Agriculture Departments of Nebraska and Kansas, and Syngenta Crop Protection.

Effectiveness of Multi-Species Buffers in Improving Surface Water Quality
The purpose of this study was to supplement the information being collected by researchers at Iowa State University and Trees Forever on the effectiveness of multi-species buffer strips (a combination of grasses, bushes, and trees between agricultural fields and streams) at improving surface water quality and wildlife associated with riparian buffers. This study was conducted in cooperation with the Institute of Environmental and Human Health at Texas Tech University, Iowa Trees Forever and Syngenta Crop Protection.

The movement of fertilizers and atrazine used in conventional farming was monitored in surface and sub-surface waters to understand effectiveness of different vegetative buffers in reducing run-off of fertilizers and crop chemicals. Water quality was monitored through aquatic biological indicator species along with the populations of birds and mammals associated with the buffer strips. The study compared conventional farming practices and stream segments having buffers of different size and composition.

Beaver Creek Watershed Impacts of Agricultural Practices on Water Quality, Tennessee
The Beaver Creek project was started in 1989 by the USGS and the Tennessee Department of Agriculture

to evaluate the effect of agricultural activities on water quality. This project developed into one of the largest voluntary, multi-agency BMP research projects in the state. The project was partially funded by Syngenta and the final results have been reported in a video, DVD, and brochure as well as on the web at https://pubs.usgs.gov/wri/1996/4186/report.pdf.

The project focused on a 95,000-acre watershed. Growers within the watershed voluntarily adopted several BMPs to reduce soil and pesticide loss from row crop fields. Results indicated that the voluntary BMPs already in place had been successfully keeping the loess soils in place in the watershed. A combination of BMPs reduced soil loss from 22 tons/A to 2 tons/A. By the end of the study, the watershed contained 480,000 ft. of terraces; 40,000 ft. of diversions; and 280 sediment basins, with 75% of the growers using no-till.

Pesticide and Surface Water Monitoring, Water Quality Laboratory, Heidelberg College, Tiffin, OH
Since 1995, Syngenta has provided funding to help support the Heidelberg College Water Quality Laboratory's pesticide and surface water monitoring program in Northwestern Ohio. This initiative has provided real-world insights into the development of drinking water and aquatic life risk assessments for selected pesticides. The monitoring program helps advance the state of the art in monitoring and understanding pesticide seasonal and annual patterns in flowing surface water.

Learn More about Water Quality Research, Monitoring, Education, and Stewardship Activities

If you would like to learn more about water quality research and stewardship activities, here are five useful websites:

- US Geologic Survey at http://water.usgs.gov/
- National Association of Conservation Districts at http://www.nacdnet.org/
- US Environmental Protection Agency Office of Water at https://www.epa.gov/aboutepa/about-office-water
- Conservation Tillage Information Center at http://www.ctic.purdue.edu/CTIC%20HOME/
- USDA Natural Resources Conservation Service's Water Quality at http://www.wsi.nrcs.usda.gov/products/W2Q/water_qual/WQ_home.html
- USDA Water and Agriculture Information Center at http://www.nal.usda.gov/waic/