Many developing countries lack proper regulations for the safe management of pesticides and chemical fertilisers. Farmers are often unaware of the environmental – and health – hazards that these active agents represent.

Photo: Jörg Böthling

Tackling agricultural water pollution – a 21st-century challenge

Agriculture is critical to the economies of developing countries. It is the basic source of food supply and a major contributor to economic development. But there is a cost. Today, agricultural water pollution undermines economic growth and threatens the environmental and physical health of millions of people around the world. The annual social and economic costs of agricultural water pollution could reach trillions of dollars. Yet the issue receives scant attention in global research and debate.

By Javier Mateo-Sagasta

Agriculture is the main source of food, income and employment for rural populations and plays a key role in supporting food and nutrition security, economic development and health. Unfortunately, it is also the leading cause of water pollution in many countries, outstripping city living and industry. Rapid population growth, combined with changing diets, has led to unsustainable agricultural intensification.

A multi-faceted problem

Agriculture, including livestock, uses much more land today than it did 50 years ago, often at the expense of forests or grasslands. Agricultural expansion onto marginal lands, as well as changes in land use from forestry to agriculture, have accelerated runoff and erosion, with heavier sediment loads affecting river quality, aquatic life and the operations of water storage reservoirs.

The growth in crop production over the past five decades owes much to the intensive use of pesticides and chemical fertilisers. The overuse and misuse of these inputs can poison flora and fauna, as well as threatening water resources and drinking water supplies. Many developing countries lack proper regulations for the safe management of such chemicals, and farmers are often unaware of the hazards they pose.

The area used for irrigation grew from 139 million hectares in 1961 to 320 million hectares in 2012. While it remains an essential element of any strategy for increasing food production, irrigation agriculture can cause the loss of water quality through pesticide and fertiliser runoff and leaching. Irrigation also increases the seepage of saline groundwater into water courses: every year, drainage from irrigation transports billions of tons of salts to freshwater bodies.

The growing desire for milk and meat products, stimulated by population growth, rising affluence and urbanisation, caused livestock production to surge from 7.3 billion units in 1970 to 24.2 billion units in 2011. Livestock are probably the single largest source of water pollution today. In many parts of the world, particularly in drylands, overgrazing has caused land degradation and erosion, which has in turn increased sediment loads in water. Animal manure and slurries contain pathogens, ammonia and phosphate and, increasingly, large amounts of antibiotics, vaccines and growth hormones.

For its part, aquaculture, especially inland aquaculture, has grown 20-fold since the 1980s, particularly in Asia; this has led to a

greater use of antibiotics, fungicides and anti-fouling agents. All of these contaminants can easily reach downstream water ecosystems and drinking water sources by leaching and runoff from livestock and aquaculture farms, as well as through the application of manure and slurries to agricultural land.

Today, nearly 40 per cent of the water bodies in the European Union are affected by agricultural water pollution, while in China, agriculture is the main activity responsible for groundwater pollution by nitrogen. And water pollution from agriculture poses a growing threat to human health and the environment in many developing countries.

Mitigating agricultural water pollution

The unsustainable intensification of agriculture will continue to contaminate rivers, lakes, aquifers and coastal waters until we develop interventions that increase food production and farm income with minimum or no pollutions loads. Admittedly, this is a major undertaking. Finding a solution will require policies that influence changes in farming practices, as well as significant investments in research and development.

Policies and incentives are needed to limit pollutants at their source or to prevent them from reaching vulnerable ecosystems. Regulatory instruments could include water quality standards, mandatory best environmental practices, and restrictions on agricultural practices or the location of farms. As the case of Denmark shows, taxing hazardous agrochemicals, such as pesticides, can promote a switch to safer pest control options and more efficient use.

A new approach allocates maximum tolerable pollution loads (often called caps) to landowners, based on the maximum tolerable concentration of a given pollutant in a water body. This requires farmers to focus on practices to minimise pollution outputs, rather than restricting farm inputs. Such an approach has been adopted, for example, in the Chesapeake Bay area in the United States and at Lake Taupo in New Zealand, with promising results.

Economic and other incentives can be used to encourage farmers to adopt good farming practices; these might include providing free advisory services and compensating farmers for improving the management of animal feed, additives and pharmaceuticals. Education and awareness-raising create behavioural change and help convince people to adopt more sustainable diets and farming practices. Enforcement remains a challenge, however, as does assessing the effectiveness of anti-pollution measures, particularly when they come from a variety of sources. A combination of agricultural water policy approaches tends to be most successful; these should ideally be part of comprehensive national policy frameworks and strategies around pollution.

A range of cost-effective management measures is also available to mitigate agricultural water pollution. For example, the integrated management of crops, livestock, trees and fish can optimise the use of resources by using waste from one activity as an input to another. At the same time, an effort to limit postharvest food losses and waste can reduce the loss of productive resources and associated environmental impacts. Practical measures can improve the efficiency of irrigation schemes and enhance the type, amount and timing of fertiliser applications to crops. More effectively managing animal diets, feed additives and medicines to minimise the use of drugs, nutrients and hormones can help control water pollution from livestock. Ensuring that aquaculture production does not exceed the carrying capacity of the fishpond can improve its sustainability as will standardising feed inputs to avoid excess, using fish drugs correctly and removing excessive nutrients in the water. Applying protection zones around surface watercourses and buffer strips at the margins of farms and along rivers can decrease the concentration of pollutants entering water bodies. Industrial livestock production can be decentralised, so that waste can be recycled without overloading the soils.

Addressing knowledge gaps

Although there have been considerable advances in our knowledge around agricultural water pollution, significant research gaps remain. We need to understand when and why pollutants enter farming systems, and where they end up. This requires the development of water quality models and chemical and microbial markers to identify and track pollution sources, pathways and attenuation processes. Tracking pollution sources can help optimise agricultural management strategies, while modelling can simulate cause-effect relationships and thus enable predictions under various mitigation scenarios. Comprehensive, high-quality data is needed to ensure accurate water quality models and effective water policies. The International Water Management Institute (IWMI) collaborates with different research groups to fill local data gaps and model sources as well as the transport and fate of water pollutants and contributes to global initiatives such as the World Water Quality Alliance which work to address knowledge gaps on water quality.

In addition to tracking the usual suspects, such as pesticides and agricultural wastewater, we need to refine our understanding of the source, composition and abundance of so-called 'contaminants of emerging concern' in farming systems. These include pharmaceuticals, antibiotics, hormones, personal care products, anti-microbial cleaning agents and microplastics. Although not commonly monitored or controlled, these agents can cause serious ecological and human health problems. We need to find more effective practices for reducing pollution, and determine how they can best be replicated and shared. We need to identify policies and incentives that motivate farmers to adopt these practices. We need practical studies to verify the environmental impact and costs of different interventions under different circumstances. Finally, we need to monitor the effectiveness of these interventions and determine how best to communicate their benefits to farmers.

Summing up

Tackling agricultural water pollution will require new policies and regulations, economic incentives, education and awareness initiatives, all backed by research and innovation. A clearer notion of the causes, effects, costs and impacts of pollution will be critical to increasing food production and farm income, while at the same time mitigating its negative impacts. The increasing environmental awareness and the new global sustainability agenda allow us to be optimistic. We are witnessing the emergence of effective solutions in many parts of the world with potential for replication in the Global South where water pollution from agriculture is emerging.

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