FARM DESIGN AND THE ENVIRONMENT

with specific reference to cotton pesticides

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ENVIRONMENTAL OBLIGATIONS

In his now famous welcome to new growers at an industry meeting in Dalby, Harley Bligh said: "Welcome to the cotton industry and welcome to your obligations".

Cotton growers, like the rest of us, have two types of obligations: those imposed upon us by regulation and those imposed by our own social values. Happiness is when the two coincide.

Cotton growers are generally aware that some of the chemicals that they use are not without environmental risk. A number of initiatives have been taken by the industry to ensure their safe use, such as:

- the Agricultural and Veterinary Chemicals Association accreditation scheme for chemical suppliers and retailers

- Operation Spraysafe of the Aerial Agricultural Association of Australia

- establishment of the North-West Pesticides Co-ordinating Committee

- the Stay Safe program of the Moree Agricultural Health Unit

- the Cotton Consultants Association's Code of Ethics and Operational Guidelines.

In addition, the industry has had major reseach programs underway for the last 15 years, resulting in a widespread improvement in the standard of pesticide application and a significant reduction in pesticide usage (Browne, 1989). Considerable work is underway on the development of ecologically-based, non-chemical pest management programs.

Perhaps the industry's most significant indication of its awareness of its environmental obligations was in the commissioning of the Environmental Audit in 1991. Recommendations were made for changes in practices which would result in improved environmental performance. These include recommendations concerning water use and the recycling of tailwater.

MONITORING OF ENVIRONMENTAL EFFECTS

The best indication of how well the industry currently meets its environmental obligations can only be given by some measure of the health of the affected environment. Because of government's inability to properly fund a comprehensive water quality monitoring program, water users in the west and northwest of New South Wales agreed to a levy on water used, to allow a program to be implemented. The levy funds are matched on a dollar-for-dollar basis by the Department of Water Resources.

The Department has also funded the Pilot On-Farm Cotton Project, to measure pesticide runoff on farms and to determine measures which would improve or control the quality of stormwater runoff.

The results of both programs are not conclusive and are subject to ongoing analysis. Endosulfan has certainly been detected at high levels in stormwater runoff on farm (Tuite, pers. com.) and at varying levels throughout the water courses of the North-Western Region. Surveys undertaken by the then State Pollution Control Commission (now Environment Protection Agency) through the 1980's regularly detected endosulfan in waterbodies at levels ranging from a trace to over 2 ppb. The latter level would be expected to result in fish mortality. Higher levels may result from samples taken from waterbodies following storm runoff.

In Queensland, water samples taken in the St. George, Theodore and Darling Downs regions during the 1990-91 season did not contain measurable levels when tested for organophosphates, organochlorines and the herbicides, diuron and atrazine. Fortnightly monitoring of the Nogoa River at Emerald has detected endosulfan at very low concentrations on one occasion only. However, the results should be treated cautiously, as they may not necessarily reflect the true nature of pesticide contamination in Queensland (Barrett, et al, 1991).

IMPROVEMENTS TO FARM DESIGN

There are basically three ways of preventing cotton farm runoff from contaminating the riverine environment:

- prevent all runoff from reaching a waterbody
- keep the runoff pure or purify it en route to a waterbody
- a combination of both, whereby all tailwater and most surface runoff is recycled, with contaminants stripped from excessive runoff which escapes the farm.

The simplest (and simplistic) approach is to quarantine all runoff. On most farms this would (theoretically) be achieved by either installing a large storage with pumping capacity to match the anticipated maximum runoff rate, or by constructing a high levee around the farm, with all stormwater impounded. In some cases it could (and is) achieved by allowing gravity inflow to a buffer storage, for later pumping to a ring tank. Only in rare cases would a gravity buffer site be sufficiently large, however, that all runoff could be stored without overflow.

The cost of the first two options would be unrealistically high. Even to match the runoff rate from say a one in five year storm would require a pumping capacity more than ten times that of a normal tailwater recirculation system. To impound all stormwater inside a levee system under normal circumstances would involve excessive losses of crop yield due to waterlogging. In some circumstances this problem can be overcome, as described later. Both options involve the continual recycling of chemicals on farm, the overall effects of which need further research.

Most cotton farms now incorporate on-farm storage of water to some degree, for water harvesting from adjacent streams or for collection of tailwater and stormwater from the farm. Many farms also have some buffer storage, filled by gravity inflow. These storages go some way towards preventing contaminated runoff from reaching the riverine environment.

Even in the government schemes, such as the St. George Irrigation Area, there has been a proliferation of tailwater return systems and on-farm storage. There is now very little tailwater inflow to drains. Most stormwater runoff in the drains is also pumped to storage before finding its way to the river.

All of this storage helps, but if we cannot afford to capture every drop of water that falls on our place, how much should we store? What do we need to design for?

The regulatory agencies in the two cotton growing states have both attempted to answer this question in guidelines. Guidelines in Queensland are probably closer to implementation, and suggest that sufficient empty on-farm storage capacity be provided to retain 25 or 10 millimetres of stormwater runoff in addition to tailwater, for "high" and "medium" hazard farms (defined later) respectively. "Low" hazard farms would require no action. These guidelines are currently being rewritten, however, and will probably become less prescriptive.

The current approach of the Environment Protection Agency of New South Wales is that the "first flush" of stormwater be fully collected and retained. The design of the stormwater retention system would be based on retaining the runoff from the first hour of a 1 in 20 year storm (of unspecified duration) OR the volume generated during a period equal to the time of concentration of the irrigation catchment during such a storm, whichever is the greater. For a 1200 hectare farm, for example, this could mean storing 800 megalitres in about 9 hours.

Both agencies agree that there is need for further research to substantiate these guidelines. They support the efforts of the Cotton Research and Development Corporation and the Land and Water Resources Research and Development Corporation to ascertain research priorities and fund projects in this area.

So the answer is that we really do not know how much water to store or, indeed, whether storing any stormwater runoff is going to have a significant environmental benefit.
However, it would appear logical that some storage will be of benefit and the more the better, if feasible.

In some cases topography or space limitations will not allow the provision of buffer storage. In many instances, surplus water is disposed of over adjacent pasture. If this option is denied by neighbouring development, consideration may have to be given to holding the water on the developed fields until it can be pumped to the ring tank. This will have a serious effect on yields if the field is in cotton and may be environmentally unacceptable from a soil management perspective.

In some cases, two fields are available at the lower end of the property, with one always kept in fallow and available to accept excess stormwater runoff. The tailwater culverts need to be gated, with that into the fallow field always kept open for stormwater inflow, while the culvert on the adjacent field is only opened while tailwater is running off the field. The fallow field then accepts stormwater runoff from the entire farm, acting as a buffer storage until the water can be pumped to the ring tank. Once this water has been removed, the gate on the culvert of the adjacent cropped field can be opened, with this water then also pumped to storage. This field will suffer yield depression at its lower end, as the price to pay for stormwater retention.

Unless all water is impounded by levees or totally retained in buffer storage, some must inevitably run off. Overflow from a buffer storage can either spill through a drop pipe or through an earthen bywash. From a physical point of view, a drop pipe is preferable as erosion can be prevented. An earthen bywash may be required in addition though, for the rare events when stormflows exceed the drop pipe capacity. The further the point of overflow from the point of inflow the better, giving pesticide contaminated sediments more time to settle rather than short circuiting through the storage.

The water that passes off the farm, either directly or as overflow from a buffer system, may need decontaminating before reaching a waterbody. The longer the route, the less the hazard. The Queensland Department of Environment and Heritage classifies farms with no discharge to a susceptible waterbody as "low hazard", while those discharging via a watercourse with settling or filtering would be "medium hazard". "High hazard" farms would discharge directly to a susceptible waterbody.

Many of the commonly used pesticides bind to soil, sediment and dissolved organic matter, where they may degrade at various rates, while others degrade in the water column. Hence the value of "holding up" the overflow, allowing the silt to settle and the degradation process to proceed.

Where space permits, the overflow can be directed through a waterway deliberately maintained in a well grassed condition. Alternatively, artificial wetlands can be created. Caution is needed here though, as the wetland will become colonised with native flora and fauna, which may restrict its use for further irrigation. Research is also needed into the effects of the contaminated water on fauna, as genetic effects have become apparent in waterfowl overseas. In some areas the wetlands may contribute to rising watertables.

Where space is limited, consideration may have to be given to more immediate methods of decontamination, such as silt traps and filters. A silt trap is in effect a buffer storage, but may be built into the tailwater system rather than being external to it. Tailwater could possibly be run through charcoal filters, but stormwater runoff would generally be expected to exceed the filter flow capacity. Laying a wide expanse of coal dust downstream of the system overflow point may warrant investigation, as coal dust has an enormous number of potential adsorption sites. It may also be possible to utilise floodway systems as biologically active chemical degradation zones, where excess farm water is carried and directed away from rivers.

Apart from minimising water runoff from the farm, the best way to reduce pesticide runoff is to minimise sediment movement. Sediment movement is an inevitable consequence of surface irrigation, where the soil is used as the transport medium for water application. The amount of sediment transported can be minimised by careful attention to design and water application.

Erosion is proportional to field slope and the velocity of flow down the furrows. Pushing high furrow flows through rapidly may be advantageous in terms of minimising the time of field saturation, but furrow streams should be as non-erosive as possible.

A major source of field erosion can be at drops into tailwater culverts. The pipes are inevitably of greater diameter than the depth of the taildrain, requiring a headwall and a drop at the inlet. Without a controlled drop, the result is an ever deepening taildrain and ever increasing furrow erosion back up the field.

Some growers have opted for sprinkler or drip irrigation which do not generate tailwater. Stormwater runoff is generally more diffuse than for surface irrigation. Where this diffuse runoff is remote from water bodies, the potential for contamination may be low. Others may be encouraged to explore this option for this reason.

In summary, therefore, in the design and operation of an irrigation system, the objectives should be to:

- reduce and control sediment runoff
- prevent any tailwater from leaving the farm and to store as much stormwater runoff as possible, and to
- detain overflow for as long as possible and/or filter it en route to a waterbody.

In addition, it may be possible to utilise floodway systems in irrigation areas to take excess flows from irrigation farms onto grasslands where chemical degradation can take place.

ENVIRONMENTAL HARMONY

Can cotton farms and the environment work in an acceptable harmony? Before answering this question we need to step back and look at the bigger picture. Is irrigation itself environmentally sustainable? Can any industry work in acceptable harmony with the environment? Can mankind? How many people are we to cram onto this planet? Pollution is a people problem and the more of us there are in this country, the more stressed will become the environment in which we live.

If we are still optimistic about the future of our planet and our country, we have even more cause for optimism regarding cotton farming and the environment:

- After almost 30 years of cotton farming, our rivers still maintain a diverse community of organisms

- The potential for a problem has been recognised and largely been accepted by the cotton growing community

- A considerable amount is known about the processes which can cause a problem and the industry is taking steps to find out more

- The development of ecologically-based, non-chemical pest management programs should result in a significant reduction in pesticide usage

- Chemical pesticides developed in the future are likely to be more environmentally benign

- Farmers are taking steps to keep their pesticides on farm and out of our waterways.

Much remains to be done, but at least it appears that we are taking large steps in the right direction.

References

Barrett, JWH, Peterson, SM and Batley, GE (1991) The Impact of Pesticides on the Riverine Environment with specific reference to cotton growing, a report for the Cotton Research and Development Corporation and the Land and Water Resources Research and Development Corporation.

Browne, RLH (1989) Cotton Irrigation and environmental issues in the Gwydir Valley, NSW Agriculture and Fisheries, November.