

## Aquaculture

### Interaction between aquaculture and water quality in farm dams

## A completed WRC-funded study investigated sustainable practices for fish farming in irrigation dams.

### Background

Practising intensive fish farming operations in existing open water bodies can increase the nutrient levels of the water via the addition of organic material as byproducts from fish feed and metabolic waste. Under such conditions the primary usage (irrigation, drinking water and recreation) of these water resources can be compromised.

This study served as a second phase of investigations into the impact of fish farming on the water ecology of small farm dams. Among others, the project aimed to draw up a monitoring and evaluation water sampling protocol to quantify environmental impact; develop guidelines to improve management procedures and practices for pollution prevention and minimisation; evaluate environmentally-friendly aquafeeds; and to implement mitigating measures by which farmers can minimise aquaculture waste.

### Methodology

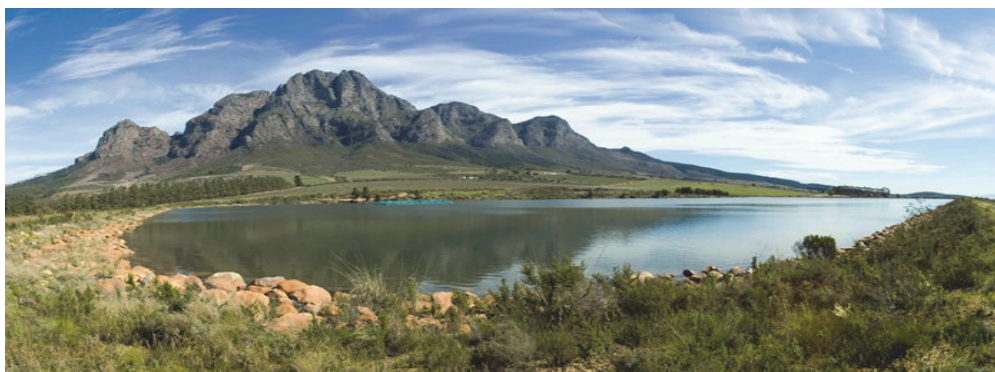
A total of 29 irrigation dams were commissioned for research

in three distinct geographical areas, including Grabouw/Caledon, Stellenbosch/Franschhoek, and Ceres/Worcester. All the dams were smaller than 20 ha and had a history of fish farming at some stage during the period under investigation.

Production cycles varied from one to four. The dams were all seasonal producer of high-value rainbow trout (*Oncorhynchus mykiss*) destined for the retail market. Water samples were collected once during each of the seasons (winter, spring, autumn and summer) over a period of 40 months (starting in June 2008 and ending in August 2011).

The water samples were analysed for a range of physico-chemical parameters as well as for biological parameters (phytoplankton).

Feed management issues were addressed through participatory appraisals via questionnaires and workshops to ascertain the level of awareness of the feed suppliers and trout producers (large scale and small-scale commercial farms) to weigh the level of concern; and to determine the ability of the industry's role-players in the supply chain to address these concerns.



*Mountain vineyards experimental site.*

To manufacture more environment-friendly aqua feeds, faecal stability is important to reduce dissolving. Furthermore, the longer the faeces remain intact, the more waste can be removed from suspension with mechanical systems and the less feed will dissolve in the water column.

The research investigated the effect of increasing levels of a guar gum pellet binder on the feed and faecal stability of Mozambique tilapia (*Oreochromis mossambicus*).

Two mitigation measures were evaluated. These included one mechanical measure (demand feeder) and one biological measure (floating gardens). Both trials were conducted at farm dams with a history of fish farming.

## Results

### Monitoring and evaluation water sampling protocol

Any form of intensive agriculture will have an impact on the ecology of the natural environment. Therefore, intensive aquaculture is assumed to be no different. Animals are farmed in high stocking densities and fed high volumes of artificial diets, with resultant organic waste.

In the process farming is driven to maximise profits and optimise feasibility in a sustainable manner. However, the very operation is threatened if farmers cannot foresee long-term environmental sustainability.

In general, results indicated that the classical physico-chemical parameters, such as dissolved oxygen, nitrogen and phosphorous concentrations, have been impacted. However, the commercial farms that accommodate these fish farming projects have a history of applying fertilizers and pesticides to the crops and soils.

This practice could lead to eutrophication if not well-managed. The impact of fish farming on the water quality of farm dams was evaluated within this context of multi-purpose storage.

The analysis for the minimum and maximum concentrations of the physico-chemical parameters indicated that the water quality is conducive to trout farming. The fact that these trout operations were conducted during the colder, winter months when the water temperatures were low and the dam levels were high, supported the notion that the impact is minimal.

Dissolved oxygen levels differed significantly between surface and bottom samples. Furthermore, there were no statistically significant differences found in oxygen concentration in dams with and without fish farmed. However, phosphorous concentrations differed significantly between surface and bottom samples and between fish farmed and non-fish farmed sites.

The occurrence and phytoplankton biomass distribution fluctuated with dam water levels and nutrient concentrations. The prevailing phytoplankton communities are important to fish farmers for two reasons: 1) influence on dissolved oxygen concentrations through users and producers and 2) algal taint of trout flesh due to geosmin producing species.

The anticipation of the impact of existing phytoplankton on the quality of trout production requires reinforcement. It was evident that phytoplankton biomass and diversity can be controlled by ensuring sub-optimal conditions through reducing nutrient input.

There was no direct link between physico-chemical parameters for water quality and production yield of harvested fish at the different sites. The yields of farms were directly linked to the quality of juveniles as supplied by different hatcheries and the feed conversion ratio achieved by the respective fish farming projects. In this study, the importance of good management for optimal yields and the maintenance of good water quality is discussed. Compliance with such management guidelines and strategies will ensure sustainability.

### Guidelines to improve feed management procedures

To achieve better feeding management procedures requires not only good on-farm management, but also consideration of what happens off the farm and in feed manufacturing. It is important that farmers start looking at how the aquafeed is made and where the ingredients come from in order to address end consumer concerns.

In addition, on-farm management of the aquafeed is essential not only to optimise the use of the aquafeed but also to maintain an optimal aquatic environment for the farmed species. Mismanagement of aquafeed can have a damaging effect on the water quality of the farming system.

To ensure that the aquafeed is used correctly, procedures have been written that can be used by farmers to ensure that aquafeeds are correctly handled. At the conclusion of this project, 60 procedures were written for aquafeed manufacturing as well as for feeding fish.

## Mitigating measures to reduce aquaculture waste

**Floating gardens:** Due to the nature of the project it was impossible to collect sufficient data on the growth of the plants. The growth of the lettuce was very slow due to the harsh production conditions. It was suggested that other, more hardy crops, such as basil or parsley would grow better under these conditions.

**Pendulum demand feeders:** A possible feeding technique to reduce the impact of wasted uneaten feed is to use a demand feeder, where the fish control their feed supply according to their appetite. Widely-used sensor-operated demand feeders function well on cage system for they are robust and insensitive to adverse weather conditions. However, they are expensive, and thus inaccessible to most smaller-scale farmers.

## Conclusion

It was found that irrigation dams in the Western Cape have a history of enrichment through external factors, such as agriculture (fertilisers and pesticides), runoff and stormwater

from the surrounding areas and effluent from infrastructure extension (housing and informal settlements). The incorporation of aquaculture into such dams adds additional nutrients to the water column and sediments although the nutrients are not very concentrated.

Irrigation dams can play a role in providing water bodies of floating net cage farming systems. However, the research found that water-quality analyses over the research period indicated that farm dams in the Western Cape overall had good water quality, indicating that commercial crop farmers are exercising better management practices.

**The introduction of aquaculture under the prevailing farm dam water quality guidelines generally did not pollute the water to such an extent that crop farming was compromised. Thus, there is a case to be made for promoting integrated aquaculture-agriculture farming.**

### Further reading:

To order the report, *Interaction between aquaculture and water quality in on-farm irrigation dams* (**Report No. 1802/1/13**) contact Publications at Tel: (012) 330-0340, Email: [orders@wrc.org.za](mailto:orders@wrc.org.za) or Visit: [www.wrc.org.za](http://www.wrc.org.za) to download a free copy.