Fish food from wastewater

Waste from livestock has been used to fertilise aquaculture systems in Indochina and Asia for over a century. Now Australia's Environmental Biotechnology Cooperative Research Centre (EBCRC) is using the principles of this production system to turn the nutrient-rich wastewater from our intensive agricultural industries into useful products, including fish, biogas and recyclable water. A demonstration of the concept and related technology shows promise that agricultural industries such as feedlots, dairies and meat processors can dramatically reduce the environmental impacts of their wastewater, improve farm incomes and generate regional employment.

Dr Martin Kumar of the South Australian Research and Development Institute (SARDI) says the Asian concept essentially involves recycling the valuable nutrients in livestock manure, through aquaculture ponds, to produce fish for human consumption.

'In Asia, farmers fertilise their ponds with manure to produce phytoplankton (algae) and zooplankton (animal plankton), which provides food for fish,' he says.

'With the appropriate fertilisation strategy they can increase fish production five-fold and farm income by 10-fold.'

Through the EBCRC, Dr Kumar is adapting this concept to recycle nutrients from agricultural wastewater to produce fish for pet food, fish meal, or aquariums (ornamental fish), and to use the resulting clean, pathogen-free water for other farming needs. This 'integrated biosystem' will provide a more economical and environmentally sustainable way of dealing with wastewater and enable farmers or farming networks to build diversified enterprises.

'Many Australian agricultural industries have limited water resources and problems with wastewater disposal,' Dr Kumar says. 'This technology provides a way to profit from wastewater, through aquaculture, and to use the cleaner water that results, for other ventures such as horticulture, cropping or viticulture.'

Feeding time at a Queensland prawn farm. Australia's aquaculture industry is expanding at a rate of about 20% per year. As the industry expands, so does the demand for high-quality feeds. CSIRO Marine Research

According to Dr David Garman, Executive Director of the EBCRC, farmers usually deal with liquid and solid wastes by storing it in anaerobic (oxygen-free) and aerobic (using oxygen) ponds until the water evaporates or the organic matter degrades to a point where it can be discharged to rivers or used for irrigation. Unless there is specific reuse, greenhouse gases are released, nutrients can enter surface or groundwater, and water is lost through evaporation.

'Problems really arise if there are high concentrations of pollutants such nitrogen, phosphorous or carbon in the wastewater,' Dr Garman says. 'At times, the concentrations of these limit the amounts of water that can be applied by traditional disposal and re-use methods such as irrigation. Farmers could treat the waste by conventional means (municipal sewerage systems) at a cost of around 20c a kilolitre, but this cost may double for high levels of nutrient removal. For big water users this is a significant cost.'

'An integrated biosystem on such a farm would not only save this amount but also generate income by creating valuable new products, such as fishmeal needed for our rapidly expanding aquaculture industries.'

A key component of the integrated biosystem is a series of bacterial processes that release the nutrients in wastewater into biologically usable forms of nitrogen and phosphorus, which can be processed by algae in aquaculture ponds. This requires that the wastewater pass through an anaerobic microbial 'digester', which generates biogas (methane and carbon dioxide) and volatile fatty acids (a food source for certain useful bacteria), and ultimately inactivates pathogens. However, there are a range of questions and issues that need to be investigated.

'In order to optimise the system for different environmental conditions and different sources of wastewater, we need to develop a better understanding of the sorts of organisms that are in wastewater; how microbial populations change through the different stages of digestion and within the aquaculture ponds; how we can manipulate these populations to optimise results; and how we can remove or manage pathogens,' Dr Kumar says.

A $4.5 million demonstration of the technology, launched in April at Adelaide University's Roseworthy Campus by the EBCRC and South Australian government, aims to answer these questions and develop the technology on a commercial scale, using piggery wastewater as a model. The EBCRC will trial effluent from meat processing waste.

Dr Kumar says the technology could be used in a range of ways by farmers or farming networks to diversify income. A cattle farmer, for example, could treat wastewater on the farm using the aquaculture system and then reuse the water for other activities. The farmer could also lease the aquaculture ponds to an independent operator.

'Or wastewater could be collected in regional centres and these centres could operate as an integrated farming operation, with profits shared among the farmers,' Dr Kumar says. 'This would create employment in the rural area.'

As a part of major research strategy, SARDI and its research partners would also like to bring diverse industries together, including viticulture, brewing, horticulture, abattoirs, cropping and sewage treatment, to discuss ways of integrating their wastewater resources. A workshop in June, 'Turning waste into valuable resources', has kicked off this process.

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