The Use of Treated Sewage Water from Settlement Ponds in San Juan, Lima

The Treatment and Use of Sewage Water programme started at CEPIS twenty years ago in order to contribute to increasing the sewage water treatment network in the region using technologies that would allow for the removal of pathogenic organisms as well as organic materials. So far, CEPIS and the various Peruvian institutions have carried out a series of experiments on the treatment and use of sewage water at the Bio-Ecological Complex in San Juan, south of Lima.

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he Research and Development Project entitled "Aquaculture with treated sewage water in the San Juan settlement ponds" is one of the most important contributions of these institutions. Its aim is to study sewage water treatment using aquaculture. The use of bioengineering, health and socio-economic criteria to improve this type of integrated system aims to make it possible to produce high-quality products, after which this new technology can then be applied in other countries in the region.

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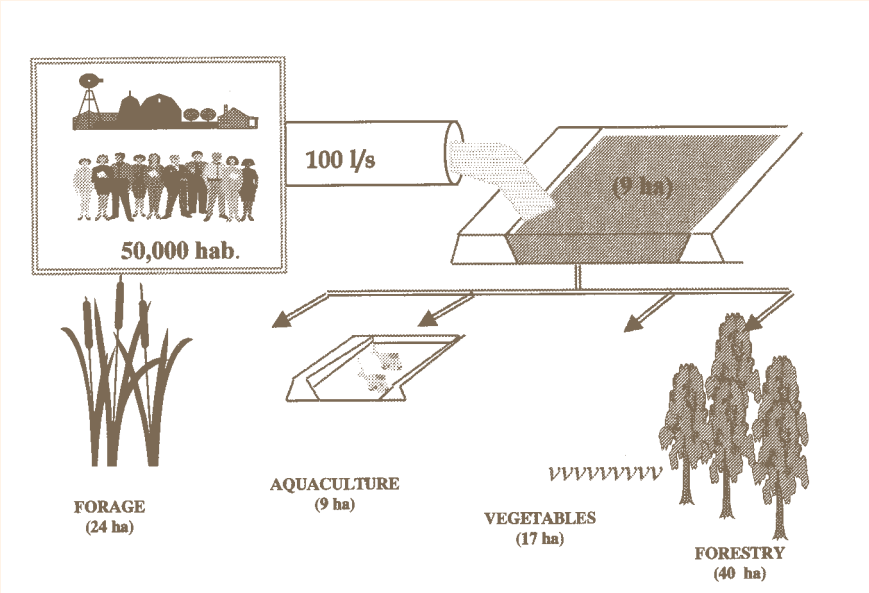
SETTLEMENT PONDS

The objective of the project was to treat sewage water in the settlement ponds to reach the appropriate quality for fish culture. The research showed the efficiency of settlement ponds in removing parasites (helminth eggs and protozoan cysts), viruses and pathogenic bacteria, including *Vibrio cholerae*. The settlement ponds in San Juan have the potential to reduce the level of faecal coliforms by 5 logarithms and attain an effluent with 10,000 MNP/100 ml levels.

Because the fish ponds were in independent systems the concentration of faecal coliforms was reduced to the level recommended by the WHO (100 MPN/100 ml)for fish culture. No other conventional system can compete with this efficiency in the removal of pathogens, unless the process of effluent disinfection is refined, which would increase costs and make the treatment process and its overall maintenance more complex.

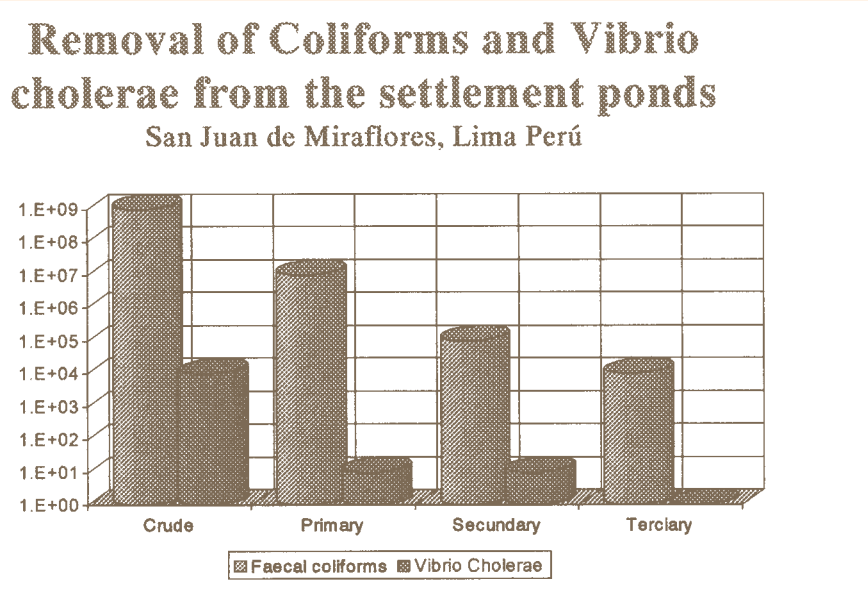
AQUACULTURE TRIALS

Some of the preliminary experimental trials in the quaternary settlement ponds were quite satisfactory for the culture of Nile tilapia 'Oreochromis niloticus' and common carp 'Cyprinus carpio', but not



for the giant freshwater prawn 'Macrobrachium rosembergii'. The Tilapia was the most resilient and best accepted by the local population. Therefore this was the species selected for our research.

These preliminary trials further showed the impracticality of using settlement ponds for fish culture because such ponds need to be totally drained for the fish harvest, thus temporarily stopping the treatment system. Also, the high levels of mud and sedimentation normally produced in the settlement ponds made it difficult to collect the fish at harvest time. Finally it was observed that the frequent fluctuations in water flow were affecting the environmental quality, which directly affected the fish growth even causing some mortalies. It was therefore recommended that in the construction and thus design of ponds, especially for tilapia culture the ponds should be supplied by tertiary effluents from the settlement ponds.



TILAPIA CULTURE IN FISH PONDS

After constructing an experimental aquaculture unit, the second stage of the project was carried out, which was based on the settlement pond's sewage water treatment, in order to guarantee the health and welfare of the cultured fish in the fish ponds. This effluent, which is rich in nutrients, made the algae blooms (phytoplankton) that were the primary natural food source for the fish.

The fish from three out of four experimental cultures were qualified as "very good". In only one experiment, 6% of the fish were rejected due to an increase in faecal coliforms (which went over the 100,000 MPN[1]/100 ml level) in the effluent that fed the fish ponds . This allowed us to propose 100,000 MPN/100 ml as the health quality standard limit for the effluent used for tilapia culture. It was also observed that tilapia in their system has a great capacity for maintaining acceptable water quality as long as the level of faecal coliforms is reduced for a minimum period of 30 days.

In subtropical climates like Lima, the growth of Nile tilapia during the warmer months is encouraging and similar to that obtained in tropical climates. Sex-reversed tilapias with an initial weight of 60 g can be cultured during the four months of warm weather at densities of 2 fish/m?, to reach a commercially acceptable size of 250 g and above. The fish ponds' maximum productivity during the summer season is higher than 30 kg/ha/day, obtained from the initial biomass of 960 kg/ha. The maximum stocking density has been set to 4,400 kg/ha, obtained exclusively with the natural feed produced by the fish ponds and with the water supplied from the settlement ponds. The high production of algae, between 700 to 1600 mg of chlorophyla per litre, demonstrated that the addition of artificial feed complements would not increase the fish biomass. Elimination of this step can reduce production costs by up to 70% and allowed us to produce the product for US $0.48/kg. In tropical areas it has been estimated that similar systems could be carried out continuously and produce three crops of tilapia a year, tripling the annual productivity per hectare and lowering the production costs even more.

AN INTEGRATED MODEL

The aquaculture project's initial results were used to elaborate a virtual model to expand commercial farms to sub-tropical and tropical regions. This model also enables economic evaluation and a sensibility analysis to study the profitability variation at different land prices, water treatments and product prices. A new version of the model incorporates the use of sewage water in other farming and forestry activities (see figure). These products allow CEPIS to promote the use of appropriate technologies in the treatment and use of domestic sewage water throughout the Latin American region, using a training programme that includes workshop courses and technical cooperation with different Latin American and Caribbean countries. All these materials are available at the Sewage Water web-page, which is part of the Virtual Library in Environmental Health web site (www.cepis.ops-oms.org).

For more than 15 years the San Juan Aquaculture Unit has been maintaining a pilot project for commercial production in order to meet the local market's demand. The project sells live tilapia weighing between 250 and 600 g for human consumption and sex-reversed juveniles to supply other commercial farms in Peru. This continuous operation proves the sustainability of these integrated systems.

The integrated system of treatment and use of sewage water is a sustainable and viable way to improve living standards in cities. It enables the adequate the lack of which is management of domestic sewage water, the main cause of aquatic environmental contamination and the spread and proliferation of intestinal and parasitic illnesses in developing countries.

NOTE

1) MPN = Maximum permissible number