

EXECUTIVE SUMMARY

Abattoirs generate large amounts of solid waste and effluents such as rumen contents, blood and wash water. From data prepared for the Water Research Commission (Water Research Commission, 1990), a typical D-Grade abattoir (that slaughters up to 15 head of cattle per day) generates up to 1 ton of wet rumen contents and blood and up to 34.7 kl total wastewater per day.

Abattoir wastewater has high pollutant loads of organic and suspended solids. Abattoirs often have difficulties in disposing of the solid wastes and wastewater in an environmentally acceptable fashion and in many instances untreated rumen contents, blood and/or other abattoir effluents and wastewater are released into the environment. The resulting pollution not only causes problems related to odour, flies and hygiene, but surface and ground water can be polluted with pathogens and undesirable chemical compounds.

Earthworms are often used in large-scale intensive systems to reduce the obnoxious attributes of a variety of organic wastes including elimination of bad odours and rotting material. A considerable amount of information is available from the literature on vermicomposting and the use of *Eisenia fetida* for the breakdown and composting of solid wastes such as sewage sludge, municipal and industrial wastes. An important benefit of vermicomposting is that processing can take place *in situ* and that worthless or decomposing wastes need not be transported over long distances. The end products have value as fertilizer, compost, potting soil and as a protein source.

The objective of the project was:

The development of a robust system to treat effluent from abattoirs by the utilisation of earthworms and associated systems, which will be economically and practically feasible to apply to small and medium size rural and urban installations.

Previous South African studies were directed at the decomposition of solid abattoir wastes alone. With an extensive literature survey as basis, the purpose of the current project was to "clean up" wastewater in addition to solid wastes. It differs from the standard vermicomposting process in that large volumes of wastewater pass through the system. The main problem that had to be solved was to ensure that the earthworms remained sufficiently active to convert the solid effluent to vermicompost under conditions where large volumes of liquid effluent passed through the system.

The contract was awarded to ABAKOR (Multilog) and the ARC-ANPI was subcontracted to do the laboratory-scale studies using solid wastes and wastewater from the experimental D-Grade abattoir on the premises at Irene. Multilog as main contractor in the project was to have evaluated the results and build a pilot-scale plant. A Technical Sub-Committee met regularly to guide the project. This Sub-Committee was of great assistance and made valuable recommendations as to the design and operation of the system. Between February 1996 and July 1997, 5 detailed reports on the project were submitted to the Technical Sub-Committee and 2 annual reports were prepared for the Steering Committee of the Water Research Commission.

The original brief to the Technical Sub-Committee with regard to the project was that the laboratory-scale system consist of a cascade system of 3 containers with a high density of earthworms. However, problems with the concept of the 3-container system highlighted in the

laboratory-scale studies, led to the redesign of the system. A single container, adapted to ensure better filtration and harvesting of the vermicompost was designed and a laboratory-scale prototype built and evaluated.

Results

- ◆ Typically from a feed with a COD of 1325 mg/l an 80 % (± 10 %) reduction was achieved.
- ◆ Both the solids collecting on the surface of the container and the effluent were efficiently deodorised.
- ◆ The earthworm systems effectively removed the suspended solids. On standing hardly any solids settled out from the effluent. The low level of suspended solids is advantageous for subsequent treatment of the effluent.
- ◆ The original concept of using 3 stacked containers did not prove have any advantage for the removal of solid effluents and deodorisation of the effluent. After passing through the top container, no further improvement in the COD values or removal of suspended solids were observed when the effluent percolated through the middle or bottom container of a stack. This trend was observed for small and medium containers and also for large trays.
- ◆ A laboratory-scale prototype apparatus was designed in which solutions to previously experienced problems were incorporated. This apparatus was able to deal with about a fifth of the rumen solids from a cattle unit per day ($0,25 \text{ m}^2$ surface area). Previous problems with sufficiently rapid drainage of the liquid, crust and slurry formation, harvesting of the vermicompost and distribution of the liquid effluent were successfully addressed. Solid wastes were manually placed into the apparatus.
- ◆ The earthworm ecosystem could be adapted to tolerate addition of blood provided it was not too concentrated (blood 0,7 % of the feed liquid). COD values of the effluent with blood were higher than without blood (COD values up to 900 mg/l and 450 mg/l respectively). The reduction of COD with added blood was on average 73 ± 10 %.
- ◆ Provided the water could drain away within hours (about 3 hours in the present series of experiments), the earthworms were able to maintain a good speed of composting (10-15 cm per week) even when large volumes of water (similar to the amount of effluent from an abattoir) passed through the system.

General conclusions and recommendations

- ◆ In general it can be stated that the use of earthworms for cleaning up abattoir wastes is technically feasible. It is an attractive system, especially for odour removal and prevention of putrefaction at small (D-Grade and smaller) abattoirs.
- ◆ The system works well provided the layer of added solids does not exceed 2-3 cm per day; the liquid drains away fairly fast and aerobic conditions are maintained. The system is simple but adequate supervision to ensure a well maintained system is required.
- ◆ The present process opens up the possibility to rid abattoir effluent of solids and to make the resultant liquid effluent more amenable to further treatment with existing systems. The effluent from the earthworm plant is not yet sufficiently clean to be released into the environment without further cleaning and polishing.
- ◆ Successful application in abattoirs will only become a sustainable proposition once it also becomes financially rewarding for the abattoirs to sell the vermicompost and/or to avoid financial penalization for pollution of the environment.

- It can be concluded from the study that the following aspects still need attention:
 - Testing of the system on a larger (pilot-plant) scale.
 - Determination of sustainable conversion rates by the earthworms, including effect of population density (harvesting).
 - Determining the chemical composition of the effluent from the prototype apparatus. The effluent is brown (even without blood in the feed).
 - Factors that play a role regarding utilisation of blood by the earthworm ecosystem. These could include the maximal amount of blood the system can tolerate and the influence of congealed blood on the system.
 - The chemical composition of the vermicompost. It is foreseen that the large volumes of water passing through the system may leach components out of the vermicompost and that the composition may differ from typical vermicompost from solid abattoir wastes.
 - Biological quality of the vermicompost. The vermicompost may occasionally contain plant/animal/human pathogens or viable plant seeds.
 - Cost-effective ways of pasteurizing (partially sterilising) the vermicompost need to be explored.