Managing and Using Feedlot Environmental Monitoring Data to Understand and Simulate the Utilisation of Manure and Effluent

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A thesis submitted for the degree of Doctor of Philosophy of the University of New England
April, 1999

CERTIFICATE

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

[redacted]

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Signature

Acknowledgments

This PhD journey has probably been like most others: spending the first month wondering where to hell to start, and muddling along during the first year, not knowing where I was heading. By the end of the second year, I was starting to get a clear idea of what was going on, and now at the end of the third year I know exactly what I should have done – and of course haven't! But I have been assured that this is research, which now I can look back with hindsight has proved to be a particularly enriching experience, despite the occasional frustration (OK, more than occasional!). There are many people who have made this experience enriching and it is appropriate that these people should be acknowledged at the beginning.

The first vote of thanks goes to the CRC for the Beef and Cattle Industry for their scholarship and the opportunity to undertake this research. I hope this project contributes to an enhanced understanding of the environmental aspects of the important lotfeeding industry. Many thanks also for the support received from CRC staff, in particular, Faye Hughes. A special thanks to the guys at "Tullimba", Reid Geddes, Stuart Murphy, Chris Smith, Chris Weber and Colin. Your help when I ran into frequent(!) difficulties was very much appreciated. Dave Sauer, Trevor Stace, Bruce Whan and Priscilla Piper, the technical and administrative staff at Environmental Engineering, were also supportive throughout the duration of the project. Special thanks to Bruce for printing the graphs for the PhD. There were many people involved in data collection and analyses, including the technical staff, undergraduate and postgraduate students. To these people, thank you for providing these data.

To Simon Murray, my principal supervisor, thank you for the freedom to make the research project mine, without constraints. Simon, I have also appreciated your encouragement to challenge my thinking patterns. Without Simon Lott, this particular project would not have been possible, so thank you Simon for your drive and commitment to get it off the ground and support and feedback throughout the project. I also appreciate the friendship extended to me by both Simons. To John Duggin, thank you also for your feedback and assistance.

Particular thanks to Paul Southcott and Richard Faulkner for their advice when I was building the model. Your patience with my endless questions, when my supervisors were unavailable is very much appreciated. Thanks also to Ian Johnson for his modelling advice and explanations about the WaterMod model, parts of which are included in the model developed in this PhD.

The bulk of chapter 4 is taken from an internal CRC report "Environmental Monitoring for Feedlots. Report to June 30 1998" (Fairweather & Lott 1998). I was responsible for the database section and had approximately 15% input into the sample collection section, which appears as Appendix A.

Austin College has been my home for the past 3 years and the students and staff, especially the wonderful people in the kitchen, have made it a very happy home. A special thanks to Alan McKenzie for his support and advice and the opportunities to learn many people skills. To all the Tutors and Seniors that I have worked with, also a big thanks for your support and I hope you all stay in touch.

I have especially enjoyed sharing my home and role at Austin College with Jason Ford these past 5 months, and I will miss you a lot, Jason. Thank you also to the support from my family, especially my parents. To Christine and Paul, thank you for your support, the proof reading and traipsing around UQ in the rain chasing journal articles for me! Best of luck to you Kaara for your PhD and thanks for your friendship over these past 2 years. I look forward to you all visiting me in Canada!

Abstract

Data from long-term monitoring of a feedlot and its environment is used in this study to investigate the sustainable utilisation of feedlot manure and effluent in a crop production system. The sustainable utilisation of the nutrients in manure and effluent and the partitioning of these nutrients into output pathways, as opposed to the disposal of the waste by-products from a beef cattle feedlot, is an important focus of the study.

As a means of achieving the objectives of this study, the relevant literature was investigated to develop a broad understanding of the issues associated with the utilisation of manure and effluent from a feedlot. Development of an Environmental Monitoring Database (EMD) is the first objective of the study. This database stores data that has been collected from the University of New England's feedlot research facility, "Tullimba" and data from other feedlots. The primary aim of the EMD is to provide safe, efficient storage of data. Another important aim of the EMD is to have the ability to manipulate the datasets to investigate the relationships in monitoring data.

The final objective of the overall study is to develop a stochastic Effluent and Manure Utilisation (EMU) model to investigate the output pathways of N, P, Na, K, Ca and Mg, within and from the utilisation area. Two important aims of the EMU model are the use of data from the EMD as input, and the use of the model to run 'virtual experiments'. The final stage of the modelling phase of this study is the evaluation of the results of the simulation and a demonstration of the usefulness of the model output in defining sustainability and adjusting management practices to optimise the likelihood of system sustainability.

The EMU model is management-oriented and developed to observe the response of the system to different application rates and times of application of manure and effluent. It is a simple conceptual model, which includes the stochastic characteristics of the system through the use of Monte Carlo techniques to sample input variables randomly. The model has potential as a tool for formulating and evaluating guidelines for best management practices.

Nutrient and water movement through the soil profile in the manure and effluent utilisation area is modelled by the use of a simple daily mass balance of water and nutrients. Cation exchange is modelled by using the Gapon exchange equations and a daily nitrogen mineralisation function is also included in the model.

Microsoft Access was used to construct the database and the EMU model, using the visual basic programming language. This application was used to allow seamless integration of the input data from the EMD to the EMU. The use of the Access environment for model output allows data manipulation to be built into the modelling package.

Using data from the Tullimba feedlot, the EMU model predicts that losses of nitrogen and phosphorus in leachate and runoff increase with increasing manure application rates, which creates a detrimental effect on the environment. However, because the cation exchange capacity in the soil increases with manure additions, the EMU model predicts that losses of cations in runoff decrease with increasing application rates, which has important ramifications for the availability of these nutrients, especially potassium.

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