# FINAL REPORT

# FEEDLOT WASTE MANAGEMENT PROJECT

## PROJECT NO. DAQ.064

Report prepared by Feedlot Services Group
Queensland Deparment of Primary Industries

December 1992

Department of Primary Industries

REPORT TO

MEAT RESEARCH CORPORATION

PROJECT NO. DAQ.064

# FEEDLOT WASTE MANAGEMENT

FROM

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

NOVEMBER 1992

Part 1 - Public Release Document

# ABSTRACT

A rapid expansion in the Australian lot feeding industry raised concerns about the impact of feedlots on the environment. Lot feeders feared that these concerns might lead to major restrictions on the growth of the industry so the Meat Research Corporation funded the "Feedlot Waste Management" research project. The Queensland Department of Primary Industries recently completed this project.

Current US regulations, designs and waste management practices were reviewed. The US industry is large and most states have their own feedlot regulations. A survey of Australian feedlots provided details of the size of the industry, the location of feedlots and their waste management practices. US guidelines are inappropriate for Australia due to differences in climate, soils types, rations, waste management practices, regulatory systems and community expectations.

We built a state-of-the-art dynamic olfactometer to measure odour intensity. Odour generation from feedlot pads revealed that wet pads produce odour with a higher intensity and offensiveness than dry pads. Odour intensity peaked 24-72 hours after wetting. Manure from cattle fed sorghum based rations also seemed more odorous than manure from cattle fed barley. Odour emissions were 10-100 times greater than those previously measured. By entering these odour emission rates into Gaussian Plume Models, odour nuisance at neighbour's homes could be predicted. The predicted odour impacts were also much higher than previously predicted. However, acceptable odour impact levels at receptors may also have been set at unrealistically low levels.

Hydrological monitoring was undertaken for almost the entire duration of the program but a prolonged drought limited the amount of data that could be collected. It was found that Australian feedlots are located in areas with higher rainfall intensities and average annual rainfalls, have greater pen slopes and have better manure management than US feedlots. Australian feedlots therefore have greater surface runoff rates, total volumes of runoff and sediment movement.

Ground water contamination is unlikely to occur at most Australian feedlots. The project indentified design and waste management practices associated with ground water contamination.

A wide range of technology transfer activities were conducted to best transfer research findings to all client groups. Clients included lot feeders, consultants, researchers and regulatory bodies. Activities included Farmnotes, journal articles, odour workshops, producer seminars and meetings.

The future benefits of this project to industry include improvements to the regulatory process, and to waste management and minimisation practices used by Australian lot feeders. Because of this research, industry is developing in an environmentally sustainable way and in harmony with community expectations.

# SUMMARY

The rapid expansion of the Australian lot feeding industry from 1985 to 1990 raised concerns that feedlots may pollute the environment. The development of guidelines and local government by-laws was an attempt to limit this. However a lack of base data meant that these were often poorly formulated. The continuing expansion of the industry has increased the need for appropriate regulations and waste management and waste minimisation strategies.

The Meat Research Corporation (MRC) commissioned the Queensland Department of Primary Industries (QDPI) to complete a "Feedlot Waste Management" research program (DAQ.064). The program commenced in January 1990 and continued until June 1992. The research team, based in Toowoomba, consisted of an Executive Engineer, two Agricultural Engineers, a Beef Cattle Husbandry Officer and an Electronics Technician.

The original objectives of the project were to:

1. Establish base data and management practices on existing feedlots in relation to water quality, odour production and waste management;

2. Test the validity of data used in formulation of "Guidelines for the Establishment and Operation of Cattle Feedlots";

3. Establish standardised methodologies of measurement and sampling odours; and

4. Identify, prioritise and address areas requiring additional research and development during the life of the project.

These objectives were revised to better address specific environmental impact issues and to better address the issues industry regarded as important. The revised objectives of the project were to:

1. Document the current state of waste management in the United States of America and Australian lot feeding industries;

2. Provide means to eliminate odour nuisance from feedlots;

3. Understand the hydrological performance of Australian feedlots and develop models to improve this aspect of the feedlot guidelines as well as to be able to model odour generation frequency;

4. Determine where ground water contamination by feedlots might occur and determine whether this has happened in Australia; and

5. Disseminate appropriate waste management technology to lot feeders, consultants and regulators and promote discussion on topics requiring consensus acceptance.

A major literature search was undertaken to establish the current status of the US and Australian lot feeding industries. All references were stored on a bibliographic database and hard copies on file at Toowoomba DPI. The database of references was available to interested regulators and researchers. The US feedlot guidelines currently in use were reviewed. This revealed that the US has a large lot feeding industry and that the major lot feeding states have their own guidelines and by-laws for the establishment and operation of

feedlots. A survey of the Australian lot feeding industry was also undertaken. This survey provided details of the size of the industry, its location and waste management practices. On completion of this review, we concluded that the US guidelines were inappropriate for Australia since it has a different climate, soil type, rations, waste management techniques, regulatory system and community expectations. Clearly Australian solutions must be found for the Australian lot feeding industry's problems.

Odour nuisance is difficult to measure. It must be quantified by frequency, intensity, duration and offensiveness of the odour received by a receptor.

Using the latest technology, an olfactometer to measure odour intensity was constructed. The olfactometer was tested in the Australian inter-laboratory olfactometer testing program. Also, standard odorants were regularly tested so that the data could be compared with other olfactometers and so that feedlot odours measured could be standardised to the equivalent of a standard odorant concentration.

It is necessary to understand the factors that affect odour generation from the feedlot pad before odour nuisance can be reduced or eliminated. Two experiments were undertaken to test this, one using simulated feedlot pads and the other at a commercial feedlot. The data showed that odour generation from the feedlot pad is related to both moisture content of the pad and time since wetting. Odour generation peaked 24-72 hours after wetting due to a peak in anaerobic digestion around this time. It also appears that barley based rations are less odorous than sorghum based rations.

An understanding of odour emission and dispersion is needed to predict odour nuisance at neighbouring residences. Emissions were measured using wind tunnels and back-calculated using the Gaussian Plume Models. The surface emission rate data was 10 - 100 times higher than previously measured. Using this data in dispersion models will result in odour impacts predicted at neighbours being much higher than previously predicted. The reasons for this are unclear.

Hydrological monitoring was undertaken over most of the project. Unfortunately, a prolonged drought prevented much runoff data from being collected. However, most Australian feedlots are located in areas with higher average annual rainfall and rainfall intensities than US feedlots. Also, Australian feedlots often have greater pen slopes and better manure management than their US counterparts. This means that Australian feedlots tend to have greater surface runoff rates, total volumes of runoff and sediment movement.

The project identified some design and waste management issues associated with potential ground water contamination at feedlots. Observation bores were installed at two commercial feedlots. However data from these bores was unavailable at the end of the program. It appears that ground water contamination is unlikely to occur at most Australian feedlots.

Technology transfer activities were tailored to suit the various clients of the research program. The research findings were transferred to lot feeders using a series of Farmnotes, articles in industry journals, workshops, producer seminars and meetings with industry representatives. Odour workshops, producer seminars and research reports transferred technology to consultants, regulatory officers and other researchers. The odour workshops provided a forum to address odour research and measurement issues and provided a forum for consensus agreement. Also, participation in the National Feedlot Guidelines Workshops promoted extension of research findings to regulatory authorities in other states. The general public became aware of the group's activities via two displays at Farmfest Field Days.

# RECOMMENDATIONS

## GENERAL

1. Research into feedlot waste management should continue so that industry expands in harmony with public expectations and so that guidelines and by-laws for the establishment and operation of feedlots can be better formulated resulting in a smoother licensing process.

2. There should be continued community input into feedlot waste management research so that a standard of operation acceptable to the community can be met.

3. QDPI should continue to consult with Shire Councils, industry and regulatory bodies so all parties can agree on the revised feedlot guidelines.

4. A report should be prepared collating all available information on nutrient analyses of feedlot manure (fresh, in pens and in stockpiles) and effluent (fresh and stored) in Australia. This document would provide valuable information on the pollution potential and the fertiliser value of feedlot wastes.

5. The concept of waste minimisation in feedlots should be explored. This might include ration modification eg. through a reduction in surplus mineral content or by commercial odour suppressants.

6. That standard plans and management procedures be developed for effluent disposal irrigation systems that are appropriate to the feedlot context.

7. The relationship between annual rainfall and rainfall intensity and stocking density should be investigated for Australian conditions and the stocking density of new feedlot designs should take account of local rainfall.

8. Research should be undertaken into the functional design and layout of feedlots aiming to minimise operating costs and maximise work efficiency.

9. A workshop on feedlot design should be held to inform feedlot managers of the latest ideas on pen slopes, stocking density, feed and water trough design and design for ease of pen cleaning.

10. Research should be undertaken into the relationship between pen slope, manure depth, rainfall intensity and manure movement. This could be undertaken using rainfall simulators as used in soil erosion studies.

## ODOURS

11. The Australian inter-laboratory olfactometer testing program should continue so that the performance of all Australian olfactometers can be assessed and compared.

12. The Australian standard for odour sampling and measurement techniques needs to be finalised. This should include the regular testing of standard odorants so that all odour measurements can be standardised.

13. Further research to quantify odour emission rates from feedlot surfaces needs to be undertaken to help explain the rates recorded in this project that were greater than those previously measured. Also, odour dispersion rates predicted at various distances away from the feedlot need to be quantified since the predicted values were also higher than previously reported.

14. Feedlot designs and waste management must promote rapid drying of the feedlot pad following rain so that odour generation from the pad can be minimised.

15. Regulators should link odour intensity limits with a frequency of occurrence standard and also with community expectations.

HYDROLOGY

16. Further runoff data from Australian feedlots needs to be collected and analysed so it can be incorporated in design plans.

17. The research into the effect of feedlots on ground water quality using the observation bores installed in this project should continue.

18. Australian design plans for sedimentation basins and retention ponds need to be drawn up for use in Australian feedlots. US design plans are unsuitable for use here due to differences in climate, soil type, ration, waste management programs, regulatory processes and community expectations.

19. A widely applicable hydrological simulation (water balance) model should be developed so that the performance of different designs and management options for ponds and irrigation systems can be assessed in different climatic zones. This program could be the basis for a manure balance model and nutrient balance model to be developed in the future. The model also can be used to predict odour generation.

20. Data on water usage and management in Australian feedlots should be collected so that a complete hydrological simulation (water balance) model can be prepared and so that all aspects of the design of water systems can be improved.

21. Research should be undertaken into the appropriate design and management of effluent irrigation systems to maximise nutrient usage and minimise deep percolation and surface runoff.

22. New feedlot designs should include drain slopes in the order of 0.5% to 0.8%. This is steeper than generally used in the past.

23. Research should be undertaken into the design of different types of sedimentation basins so that workable solutions for high intensity rainfall zones can be formulated.

24. The environmental performance of direct dispersal systems for feedlot runoff should be researched. These systems do not require ponds and are most useful for small feedlots.

25. Research into the design and management of anaerobic ponds for feedlots located in high rainfall areas and winter dominant rainfall areas should be undertaken.

REPORT TO

MEAT RESEARCH CORPORATION

PROJECT NO. DAQ.064

# FEEDLOT WASTE MANAGEMENT

FROM

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

NOVEMBER 1992

TABLE OF CONTENTS

# 1 INTRODUCTION

The Feedlot Waste Management Project (DAQ.064) resulted from an application made to the Australian Meat and Livestock Research and Development Corporation (AMLRDC) (now the Meat Research Corporation - MRC) in November 1988 by the Queensland Department of Primary Industries (QDPI). Following lengthy discussions between MRC, QDPI and industry, the project eventually commenced in January 1990. MRC-funded staff were engaged in February 1990. The contract covering the project was signed in July 1990. The project ended in June 1992 and a follow-on project (Feedlot Waste Management, DAQ.079) commenced in July 1992.

# 2 BACKGROUND AND INDUSTRY CONTEXT

From 1985 to 1990, the Australian lot feeding sector expanded rapidly. Concerns by regulatory authorities and the public about the effect of cattle feedlots on the environment accompanied this expansion. During this period, State and local government regulators from the major lot feeding areas developed feedlot guidelines and by-laws. These guidelines were often contradictory and there was a strong feeling within the feedlot sector that the environmental regulations were too onerous. To exacerbate the problem, the regulatory process for approving new feedlots became slow, confused and expensive. The industry felt that the new regulations and guidelines were inhibiting their expansion and as a result they felt threatened. However industry was aware of the environmental problems feedlots can cause if they are poorly designed or managed and wanted these issues addressed.

There are expectations that the feedlot sector will continue to expand to supply a greater share of domestic market requirements and to take advantage of market opportunities in Japan, Korea and other Asian markets. If this expansion is to occur according to community expectations, it is imperative that environmental contamination is minimised through appropriate waste management and waste minimisation strategies.

# 3 OBJECTIVES

## 3.1 Original Contract Objectives

The objectives of the project as stated in the contract were:

(i) To establish base data and management practices on existing feedlots in relation to water quality, odour production and waste (solid and liquid) management.

(ii) To test the validity of data used in formulation of "Guidelines for Establishment and Operation of Cattle Feedlots".

(iii) To establish -

. Standardised methodologies of measurement
. Standardised methodology and frequency of sampling

which have the agreement and adoption of the relevant government authorities, (the State Pollution Control Commission (SPCC) in New South Wales and the Environment Protection Agency (EPA) in Victoria).

(iv) To identify, prioritise and address areas requiring additional research and development during the life of the project.

This was the first MRC project directly related to the environmental impact of cattle feedlots. Therefore, many specific issues were not clearly defined at the start of the project. (In fact, part of the project was to define the significant environmental issues and to propose research strategies.) Also, consultation with industry was inadequate in the early stages. Not surprisingly, there were differences of opinion between QDPI, MRC, regulators and industry as to the major thrust of the project. It took 6-12 months before consensus was reached on the objectives and methodology. Even then, certain aspects changed throughout the life of the project. In particular, several milestones were either deferred or abandoned and there was a shift of emphasis from hydrology to odour when it became clear that odour nuisance was regarded as an immediate problem.

## 3.2 Revised Objectives

Although they were not explicitly stated, the revised objectives of the project are listed below, and address:

- Position Statement;
- Odour;
- Feedlot Hydrology;
- Groundwater; and
- Technology Transfer.

### 3.2.1 Position Statement

The objective of this component was to document the present position of the US and Australian feedlot industries with regard to the following issues:

- environmental research;
- environmental regulations;
- regulatory procedures;
- waste management techniques; and
- industry size, geographic and climatic location.

### 3.2.2 Odour

The objective of the odour research was to provide means to eliminate odour nuisance from feedlots by:

- developing standard and acceptable methods of odour measurement;
- developing strategies for the reduction of odour generation at feedlots;
- developing methods to estimate acceptable separation distances between feedlots and neighbours (receptors); and
- clarifying the definition of odour nuisance in both a regulatory and technical sense.

### 3.2.3 Feedlot Hydrology

The objectives of the hydrological component of the project were to:

- obtain an understanding of the hydrological performance of cattle feedlots in sub-tropical environments; and
- develop hydrological models so that this component of feedlot guidelines could be improved and so that odour generation frequency could be modelled.

### 3.2.4 Groundwater

The objectives of the groundwater research area were to:

- determine the circumstances, if any, under which groundwater contamination problems might develop at a feedlot site and recommend design and management procedures to prevent this from occurring; and
- determine if groundwater contamination by a feedlot has occurred in Australia.

### 3.2.5 Technology Transfer

The objectives of this component of the project were to:

- disseminate appropriate waste management techniques to lot feeders, consultants and regulators;
- disseminate research findings to lot feeders, consultants and regulatory authorities; and
- promote discussion on topics that require consensus acceptance, particularly issues related to odour.

# 4 METHODOLOGY

## 4.1 Original Contract Methodology

The methodology of the project as taken directly from the MRC contract was:

(i) Collect and collate published and experimental information on feedlot development and management.

(ii) Prepare additions to the Research Organisation's Feedlotter's Manual on feedlot and waste management design and management and feedlot economics. Supplement this with other publications such as "Farmnotes" or industry press articles. The information will be aimed at new and existing facilities and practices for improved environmental performance.

(iii) Prepare and conduct a series of consultative workshops and field days on feedlot design and management for existing and prospective feedlotters, local government officers, construction contractors and other interested parties.

(iv) Instrument and monitor a number of representative feedlots to measure performance. Variables measured will include run-off, pond volumes, pump rates and usage, smell, groundwater (with Darling Downs Institute of Advanced Education (DDIAE))[1], dust and fly numbers.

(v) Undertake concurrent research and development activities to determine:-

  (a) the effects of feed additives on odour.

  (b) cost effective means of manure materials handling.

  (c) modified design procedures for run-off control applicable in sub-tropical and tropical environments.

  (d) the effect of feedlot operations on ground water quality.

(vi) Identify opportunities or problems requiring further research.

Standardised methodologies of measurement and sampling to be agreed by the relevant authorities in New South Wales and Victoria.

## 4.2 Amended Methodology

As mentioned above, the original proposal was changed during the project. Following consultation with regulators, industry, MRC and Dr. John Sweeten (a consultant engaged by MRC from Texas A & M University), it was agreed that there would be no work on dust and fly numbers; cost effective means of manure materials handling; pond volumes and pump rates and usage and several other areas suggested by QDPI. The major emphasis of the project was to be feedlot odour followed by hydrology.

---

[1] DDIAE is now the University of Southern Queensland (USQ).

The specific activities undertaken within the project are outlined in Section 8.

## 5 STAFF

In the original contract, Mr. John Round was the nominated person. However, as the project proceeded and the roles of various staff with the Feedlot Services Group of QDPI were defined, Dr. Peter Watts took over the role of principal investigator. The following staff were employed using MRC funding:

QDPI Staff

Mr. Simon Lott, Agricultural Engineer
Miss Robyn Tucker, Beef Cattle Husbandry Officer
Mr. Steve Fennell, Electronics Technician

University of Southern Queensland Staff

Mr. Michael Jones, Agricultural Engineer and Industrial Chemist.

## 6 LOCATION

The project team was based at the QDPI centre in Toowoomba. However, commercial feedlots in southern Queensland were used for much of the research. These feedlots are noted and thanked in the Acknowledgments (see Section 15).

## 7 ACHIEVEMENT OF OBJECTIVES

In general, objectives (i), (iii) and (iv) of the original contract (see Section 3.1) were achieved. Section 8 gives a brief outline of the activities undertaken in the project. The achievement of the revised objectives will be noted in this section.

Objective (ii) related to the validation of the formulae used in the Queensland feedlot guidelines. Of particular interest were the formulae relating to separation distances between feedlots and sensitive receptors so that odour nuisance would not develop. The project did not validate these formulae. There are several reasons for this:

1. The extent of the work involved in odour measurement and modelling was far greater than originally envisaged. It was necessary to develop most of the equipment from scratch including the odour measuring equipment (the mobile dynamic olfactometer) and the odour emission rate sampling equipment (the portable wind tunnel). As no standards exist, acceptance of the new equipment by relevant regulatory authorities was an issue. Acceptance could be achieved only through the consultative process that was on-going throughout the project.

2. Even if enough information had been obtained to predict the impact of odours on receptors, the guidelines could not be validated because there is no accepted regulatory standard for the allowable odour impact on receptors. The group has tried to initiate informed discussion on this point. However, ultimately, this is a community acceptance issue that cannot be resolved without community input. (Such community input is planned in the next project.)

3. Validation of the guidelines requires technical, sociological and political inputs. The acceptance of revised guidelines by Shire councils and industry is a major issue and a consultative process needs to be initiated to achieve this acceptance. The data necessary for effective consultation to occur became available only towards the end of the project. Time did not permit the necessary dialogue and acceptance of the guidelines.

# 8 SUMMARY OF ACTIVITIES

The following sections cover the activities undertaken during the project. Appendices 1 and 2 are annual reports and these cover the activities in greater detail. All publications prepared as part of the project are listed in Section 13.

## 8.1 Position Statement

The objectives with regard to the position statement were met by the following activities:

(i) A major literature review was undertaken and more than three thousand references were entered on to a bibliographic database (see Appendix 1). This is available to regulators and other researchers interested in cattle feedlots.

(ii) A review of the guidelines currently used in the United States was undertaken (Lott *et al.* 1990). Copies of the review were distributed to various regulatory authorities.

(iii) A survey of the Australian lot feeding industry was undertaken (Tucker *et al.* 1991). This report provided statistics on the size geographical and climatic distribution of feedlots in Australia. It also included a summary of some aspects of feedlot design and management, particularly waste management techniques. Fifty copies of the report were made available to regulatory authorities and other interested parties. Copies of the report can be purchased from the Queensland Department of Primary Industries. To date, over 200 copies have been sold.

## 8.2 Odour

### 8.2.1 Odour Measurement

A major difficulty with odour measurement is its subjective and qualitative nature. To address the issue scientifically, it is first necessary to be able to quantify odour intensity (strength) and, to a lesser degree, odour offensiveness (character or quality). In the original contract, odour measurement was to be undertaken on a contract basis by the Queensland Department of Environment and Heritage (DEH) who had an olfactometer based in Brisbane. After a review of the situation, we concluded that this was not a viable option. The reasons were:

(i) The cost per test was high and insufficient tests could have been undertaken with the existing budget;

(ii) The design of the DEH olfactometer was some years old. The use of this device may have lead to criticism of the data;

(iii) It was logistically difficult to collect 100 L odour samples at a remote feedlot and transport them to Brisbane for testing; and

(iv) The quality of samples arriving in Brisbane after a trip of two hours or longer would probably have deteriorated significantly.

We decided to construct a new olfactometer that could be dedicated to the project. The design criteria were that it should use the latest odour measurement technology ( i.e. it would be a forced-choice, dilution-to-threshold, dynamic olfactometer); that odour intensity be measured in terms of odour units (the current international *de facto* standard); that it be capable of undertaking many measurements in a short period; and that it be mobile. Consequently, an olfactometer was designed that fitted inside a caravan. As there was no budget allocation for this, the olfactometer was constructed from equipment available at QDPI. Owing to the time taken to finalise the project objectives; the time taken to review the literature (see Jones and Watts 1990, Jones 1991, Jones 1992, Jones *et al.* 1992b) and to design and construct the olfactometer, the device was not available for use until June 1991.

Standardisation of odour measurement techniques is a major problem. Most of the previous research from the USA cannot be used because the odour measurement techniques are out-dated and the methods used not standardised. Even between and within dynamic olfactometers, large differences in sensitivity, reproducibility and repeatability can occur. While some improvement can be obtained by standardising designs and operating procedures, the variability of panellists remains. Therefore, we started a program of regularly testing standard odorants such as butanol and ammonia so that data from our olfactometer could be compared with others.

Because odour measurement is a developing science, the olfactometer is under constant development. Odour researchers and regulators from throughout Australia have inspected the device at the Odour Workshops and the approach taken by QDPI has gained general acceptance. The existing olfactometer is described in Jones *et al.* (1992a, 1993). The group has participated in an Australian inter-laboratory olfactometer testing program (Williams and Verrall 1992).

Dynamic olfactometers are usually used only to measure odour intensity. QDPI has developed a method by which odour offensiveness can also be measured (Watts *et al.* 1992b, Lott 1992).

During the project, we leased a 1-butanol olfactometer from Texas A & M University and this was evaluated at various feedlots. The unit did not suit the objectives of this project because it did not measure odour intensity in terms of odour units and because it could be used only to measure ambient odours. It could not be used to measure odours from point sources or extensive surfaces. Some of the experiments with the 1-butanol olfactometer are described in Watts (1992a).

### 8.2.2 Factors Affecting Odour Generation at Feedlots

Before strategies for the reduction of odour at feedlots can be proposed, it is necessary to obtain an understanding of the factors that affect the generation of odour. The aim is to understand the process and develop predictive odour generation models. Unfortunately, previous US feedlot odour research provided little quantitative data in this area. Two experiments were undertaken .

(i) The Wellcamp Experiment

In this experiment, we measured odour emissions from simulated feedlot pads. This approach was taken because it was suspected that many parameters affect the odour generation process. It would be difficult to control these factors in a commercial feedlot. However, in a controlled simulated feedlot pad, variables such as climate, manure deposition rate and age of pad could be partially controlled. The first part of the experiment involved a cattle feeding trial. We fed cattle six different rations and measured cattle performance and faeces characteristics. About 1.5 tonnes of faeces was frozen for later use in the simulated feedlot pads. A description of the feeding trial is found in Tucker (1992a) and Tucker and Watts (1993). The faeces were then progressively placed in 1.0 m x 0.25 m trays to simulate a feedlot pen stocked at 12 $m^2$ per head. The trays were in the open air but could be protected from rainfall by a rainout shelter. After about three months of preparation, odours from the trays were measured under both wet and dry pad conditions. We sampled the odours using an open-bottomed wind tunnel that was placed over each tray. The intensity and offensiveness of odour emitted was then measured using the dynamic olfactometer. This experiment is described in Tucker (1992a).

(ii) The Kerwee Experiment

Having developed and tested the olfactometer and having established some understanding of the odour generation process from the Wellcamp experiment, the group undertook a trial at a commercial feedlot. Over a fortnight and under wet and dry conditions, the researchers sampled odours using the wind tunnel and tested them to determine the intensity and offensiveness of the odours. The 1-butanol olfactometer was used also. This experiment is described in Watts (1992a).

### 8.2.3 Dispersion of Odours from Feedlots

Before it will be possible to predict odour impact on feedlot neighbours and the validity of the Queensland guidelines, it is necessary to understand the manner in which odours are emitted from feedlot surfaces and then dispersed in the atmosphere. This proved to be one of the more difficult components of the whole project. (Dr. Rod Smith of the University of Southern Queensland undertook much of this work.)

Initially, theoretical reviews and analyses of the dispersion of odours from extensive surfaces were undertaken (Smith 1992a, 1992c). The determination of odour emission rates from extensive surfaces was reviewed (Smith 1992b, Watts *et al.* 1993). These reviews suggested that odour emissions should be measured using wind tunnels and by back calculation of Gaussian plume dispersion models. These techniques were used at the Kerwee experiment. The odour emissions measured in this experiment were 10-100 times greater than those previously reported (Watts 1992a). At this stage, we do not know why the differences between the Kerwee data and other existing Australian data occurred. However, recent Australian data (Freeman 1992) tends to confirm the QDPI data. More work needs to be done in this area.

### 8.2.4 Understanding Odour Nuisance

No progress can be made on the elimination of odour nuisance from feedlots until researchers, regulators, industry and consultants understand the concept of nuisance. At present, nuisances are handled by common law. There are no legislative standards of odour nuisance. Hence, the group has tried to promote discussion in this area via the Odour Workshops (Watts 1991b, Watts 1992c, Dean 1991) and through the National Feedlot Guidelines development process (Watts 1991a). Recently, a review of odour nuisance has been undertaken and a new regulatory definition of odour nuisance has been proposed (Watts and Sweeten 1993).

## 8.3 Feedlot Hydrology

After reviewing the climatic zones in which feedlots are located and the different drainage configurations of feedlots, we chose three feedlots for the hydrological studies (see Appendix 1). Automatic weather stations and runoff-recording flumes were purchased and installed by July 1990.

Unfortunately, for 18 months after their installation, there was a severe drought in S.E. Queensland (see Appendix 2). The drought broke in early 1992 and runoff data were collected. As this occurred near the end of the project, these data were not analysed and interpreted within this project. This analysis will occur in the early stages of DAQ.079.

The on-going hydrological monitoring was complemented by some rainfall simulation studies and by analyses of feedlot manure settling characteristics (Lott *et al.* 1993).

## 8.4 Groundwater

The activities undertaken in this area are reported in Appendices 1 and 2. Mazzone *et al.* (1992) prepared a position paper outlining the issues associated with potential groundwater contamination at feedlots. Several observation bores were installed at two feedlots. Due to various delays, data from these bores were not available before the end of this project. A seminar was held with representatives of New South Wales and Queensland Water Resources Commissions (Kelly 1991).

## 8.5 Technology Transfer

The specific technology transfer activities undertaken depended on the types of clients who included:

- lot feeders;
- industry organisations;
- the public (neighbours of feedlots);
- consultants;
- regulators (local and state governments); and
- researchers.

Technology transfer to lot feeders has taken the form of a series of Farmnotes on feedlot waste management (see Section 13), publications in industry magazines and a series of one-day seminars (see Appendix 2) and presentations at numerous meetings.

Technology transfer to consultants, regulatory officers and Shire councillors has occurred mainly via the two Odour Workshops. These workshops were forums for discussion of odour measurement techniques, odour generation at feedlots and the general issue of regulation of odour problems. They enabled all parties to obtain a clearer idea of the manner in which odour issues can be addressed. In particular, the workshops offered a forum for the frank discussion of problems and the development of solutions to obtain consensus acceptance. The proceedings of these workshops have been distributed widely in Australia, in New Zealand, and the USA.

A major technology transfer effort to regulators occurred during the development of the National Feedlot Guidelines where a member of the group presented a keynote address (Watts 1991a). Dr Watts was also a member of the coordinating committee and participated in the two Guidelines workshops. The regulatory and technical ideas generated by this research project were included in the National Guidelines.

The public has become aware of the activities of this project via various outlets including two major displays at FARMFEST (a major 3-day agricultural exhibition near Toowoomba). At FARMFEST 1990, we conducted an odour identification test to attract public interest. This test is reported in Watts *et al.* (1992).

The activities of the group were widely covered in the media (see Appendices 1 and 2).

# 9 FINDINGS AND CONCLUSIONS

The findings of this research project are only very briefly described here. More details can be found in the numerous publications prepared during the project (see Section 13).

## 9.1 Position Statement

The United States has a very large lot feeding industry, and considerable research into the environmental impact of feedlots was conducted in the 1970's and early 1980's. The results were then incorporated in various guidelines. However, this information is of limited use in Australia due to differences in climate, soil types, ration types, manure management, regulatory systems and community expectations. Clearly, community expectations and the subsequent responses of regulators are higher in Australia than in the US. For example, approval for a large feedlot in Australia requires preparation of an environmental impact assessment or similar document. The regulators are aware of the differences between the two countries and are requiring site-specific solutions to Australian feedlot problems. The conclusion of this review is that Australian solutions must be found to Australian problems.

## 9.2 Odour

### 9.2.1 Odour Measurement

Odour measurement remains a developing science. There are few odour measurement laboratories in Australia and, as yet, no Australian standard for odour measurement. Throughout the project, we observed differences in the sensitivity of the QDPI olfactometer between odour measurement periods. These are mainly attributed to panellist changes. To overcome this, we recommend that standard odorants be regularly tested and the data presented whenever other olfactometer data are discussed. It is further advocated that all olfactometer data should be standardised to the equivalent of a standard odorant concentration, e.g. 100 ppb butanol.

### 9.2.2 Factors Affecting Odour Generation at Feedlots

It was shown that odour generation from feedlot pads is related to both the moisture content of the pad and also the time since wetting occurred. Odour generation reaches a peak about 24-72 hours after wetting depending on conditions such as pad temperature. This finding is in accordance with anaerobic metabolism theory that suggests that the micro-organisms take some days to reach peak activity. As the feedlot pad dried out, odour generation reduced rapidly. Odour emitted from wet pads had an intensity 50-100 times greater than that from dry pads. This very strongly reinforces the efforts of regulators to have feedlots designed and managed such that they dry rapidly after rainfall, with few potholes available for sustained odour production. While it was not possible to show statistically that odour generation varied between rations, preliminary trends suggest that barley-based rations produced less odour than sorghum-based rations. Pad temperature, time of day, surface windspeed, pad age and condition, and surface disturbance are all likely to affect odour generation.

### 9.2.3 Dispersion of Odours from Feedlots

The surface emission rates measured in this project were significantly higher than previously measured. It is unclear yet whether the old data was erroneous due to poor surface sampling techniques and poor olfactometry or whether the new wind tunnel approach has some problems. If the new odour emission rate data is used in standard odour dispersion models, odour impacts predicted at neighbours homes are much higher than previously accepted. This may be because the dispersion models are not correctly calibrated for odour. Alternatively, the previous standards for acceptable impact on neighbours may be too low. This area of research has raised more questions than answers. It highlights the poor understanding of this process (both in Australia and overseas) and the need for further research. At present, all odour emission rate data and the results of odour dispersion modelling activities should be treated with caution.

### 9.2.4 Understanding Odour Nuisance

The current regulatory response to odour nuisance seems out of step with centuries of common law precedence. There is a need for regulators to link their limits of odour intensity with both a frequency of occurrence standard and with community expectations. Standards should not be set without gauging community response. Further discussion of this topic is warranted.

## 9.3 Feedlot Hydrology

While little data were analysed during this project, the following observations can be made regarding feedlot hydrology in S.E. Queensland. These observations are drawn from the hydrological monitoring, the data collected in the feedlot survey and other sources, and discussions with Dr. John Sweeten.

(i) Feedlots in Australia are located in different climatic zones from those in the USA. In particular, annual rainfall and rainfall intensities are higher;

(ii) Due to the apparently better level of manure management and greater pen slopes in modern Australian feedlots compared to US equivalents, runoff rates and total volumes of runoff are greater than reported in US literature even under similar rainfall conditions. Hence, US design methods are generally inappropriate, particularly for the very well managed feedlots in Australia; and

(iii) Due to the increased volume and rate of runoff, sediment movement from Australian feedlots seems to be greater than that reported in US literature. Hence, US designed sediment basins are inappropriate. The frequent poor performance of older sediment basins in Queensland shows this. Many clog and become odorous or allow too much manure to enter the retention pond.

### 9.4 Groundwater

It was concluded that, for the vast majority of feedlots in Australia, groundwater contamination is unlikely to occur. However, there are certain sites and management techniques that should be avoided. No data have yet been found that conclusively link a feedlot to groundwater pollution.

### 9.5 Technology Transfer

We employed a range of communication methods to make the wide range of client groups aware of the results of the project. In particular, the workshops have been particularly useful in providing a forum at which consensus can be obtained from all parties on various issues.

## 10 COMMERCIALISATION

There was no aspect of the project that was suitable for commercialisation in the sense of development of a product for sale by a commercial company. However, many findings have been adopted by different clients. Consultants are now able to prepare better environmental impact assessments than previously possible and the regulatory authorities are better informed about environmental issues associated with feedlots. This should ensure that the assessment process is thorough, reasonable and timely.

## 11 FUNDING

The funding for the project is given in Table 1.

Table 1 - Budgeted and Actual Expenditure - Project No. DAQ.064

| | Operating | Capital | TOTAL |
|---|---|---|---|
| 1989/90 (2 quarters) | | | |
| Allocated Budget | $ 68,000 | $ 32,000 | $ 100,000 |
| Actual Expenditure | $ 72,900 | $ 22,200 | $ 95,100 |
| 1990/91 (4 quarters) | | | |
| Allocated Budget | $ 185,704 | $ 54,000 | $ 239,704 |
| Actual Expenditure | $ 171,020 | $ 41,690 | $ 212,710 |
| 1991/92 (4 quarters) | | | |
| Allocated Budget | $ 203,162 | | $ 203,162 |
| Increase for Inflation | $ 13,127 | | $ 13,127 |
| Actual Expenditure | $ 241,418 | | $ 241,418 |
| TOTAL PROJECT COSTS | 1992/93 | | |
| Allocated Budget plus Inflation | $ 470,993 | $ 86,000 | $ 556,993 |
| Actual Expenditure | $ 485,338 | $ 63,890 | $ 549,248 |

In addition to funds provided by MRC, there was considerable input from other sources including:

- QDPI provided staff and facilities;
- USQ provided staff and facilities; and
- The Water Resources Commission of Queensland which provided approximately $ 60,000 for the drilling, installation and monitoring of the groundwater observation bores.

## 12 IMPACT ON MEAT AND LIVESTOCK INDUSTRY

It is not possible to quantify the impact of this research on the meat and livestock industry in clear dollar terms. The benefits are intangible, not related to production or marketing and may take several years to be fully accepted.

However, since the project started, the regulatory process has been significantly improved. Initially most people would consider that this was a response by government to the complaints of industry. However, the relaxation of regulatory vigour that has occurred is partly due to the availability of better technical information on the environmental impact of feedlots that has been generated by the project. Regulators now have more confidence in making decisions on the substantive issues and are relaxed about the side issues. Similarly, lot feeders are better informed about the significant environmental issues and are more receptive to the incorporation of a waste management plan as part of an overall feedlot management plan. There is no doubt that the environmental management of feedlots is improving and will continue to improve as more information comes to hand. The environmental performance of feedlots has improved and at the same time industry confidence has improved with industry feeling less threatened by the regulations and guidelines.

## 13 PUBLICATIONS

The following is a list of publications produced during the project. It includes those prepared by Feedlot Services Group, as well as some produced by other authors for presentation at workshops and seminars run by the Group as part of the project.

### REPORTS

Cleary, C. D. (1991) "An Investigation of the Physical Characteristics of a Feedlot Pad", University College of Southern Queensland, Student Report, Nov 1991, 53 pp.

Jones, M. and Watts, P. J. (1990) "The Measurement of Odour - A Discussion Paper for Australia", AMLRDC Report No. DAQ64/5, Internal Report, Qld Dept. of Primary Industries, Brisbane, Qld, 40 pp.

Kelly, I.D. (ed.) (1991) "Working Papers of a Cattle Feedlot Workshop held at Toowoomba", June 1990, New South Wales Department of Water Resources, Sydney.

Lott, S. C., Watts, P. J., Tucker, R. W., Jones, M. and Round, P. J. (1990) "Procedural Arrangements and Design Requirements for Feedlot Licensing", AMLRDC Report No. DAQ64/4, Internal Report, Qld Dept. of Primary Industries, Brisbane, Qld, Aug 1990, 131 pp.

Mazzone, J., Dillon, P. J. and Pavelic, P. (1992) "A Review of the Impact of Feedlots on Groundwater Quality", Center for Groundwater Studies, Report No. 43, Aug 1992, CSIRO Div. of Water Resources, Glen Osmond, SA.

Pavelic, P., Dillon, P. J. and Evans, P. A. (1992) "Evaluation of the Potential for Groundwater Contamination at a Cattle Feedlot in Southeast Queensland", Centre for Groundwater Studies, Report No. 38, Jan 1992, CSIRO Div. of Water Resources, Glen Osmond, SA.

Steiner, J. W. (1992) "An Interim Report on Establishing a Link Between Metals in Feedlot Manure, Feed Rations, Odour Intensities and Odour Offensiveness", Qld Dept. of Primary Industries, Internal report, MRC Report No. DAQ64/22, Brisbane, Qld.

Tucker, R. W., Lott, S. C., Watts, P. J. and Jukes, P. D. (1991) "Lot Feeding in Australia - A Survey of the Australian Lot Feeding Industry", Qld Dept. of Primary Industries, Information Series QI91019, Brisbane.

Watts, P. J. (1991a) "Environmental Impact of Cattle Feedlots - Discussion Paper", (presented at the National Feedlot Guidelines Workshop), AMLRDC Report No. DAQ64/8.

Watts, P. J., Jones, M., Tucker, R. W., Lott, S. C. and Fennell, S. J. (1992a) "The FARMFEST Experiment - An Evaluation of the Ability of the Population to Identify Agricultural Odours", MRC Report No. DAQ64/10, Internal Report, Qld Dept. of Primary Industries, Brisbane, Qld, Feb 1992, 27 pp.

Watts, P. J., Smith, J. N. , Smith, R. J., Jones, M., Lott, S. C. and Tucker, R. W. (1992b) "The Offensiveness of Odours from Cattle Feedlots", MRC Report No. DAQ64/20, Internal Report, Qld Dept. of Primary Industries, Brisbane, Qld, May 1992, 36 pp.

## JOURNAL PAPERS

Smith, R. J. (1992a) "Dispersion of Odours from Ground Level Agricultural Sources", *Journal of Agricultural Engineering Research* (accepted)

Jones, M., Watts P.J. and Smith. R.J. (1993) "A Mobile Olfactometer for Feedlot Odor Studies", *Transactions of the ASAE* (submitted)

Lott, S.C., Loch R. and Watts P.J. (1993) "Settling Characteristics of Feedlot Feces and Manure" *Water Resources Research* (in preparation)

Tucker, R.W. and Watts P.J. (1993) "Waste Minimisation at Feedlots by Ration Modification", *Transactions of the ASAE* (submitted)

Watts, P.J., Smith R.J. and Lott S.C. (1993) "Determination of Odour Emissions from Extensive Surfaces: A review", *Journal of Agricultural Engineering Research* (in preparation)

Watts, P.J. and Sweeten J.M. (1993) "Towards a Regulatory Definition of Odor Nuisance" *Journal of Air and Waste Management Association* (in preparation)

## CONFERENCE AND WORKSHOP PAPERS

Blackall, L. (1992) "Anaerobic Metabolism of Feedlot Wastes", in 'Odour Update 92', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, MRC Report No.DAQ64/24, Toowoomba, Aust. 31 Mar - 2 Apr. 1992, pp 63-70.

Dean, M. (1991) "Odour Nuisance as a Regulatory Problem", in 'Agricultural Odours', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, AMLRDC Report No. DAQ64/7, Toowoomba, Aust. 19-20 Feb. 1991, pp 9-15.

Dillon, P. J. (1991) "Feedlots and Nitrate Contamination of Groundwater", in 'Working Papers of a Cattle Feedlot Workshop Held at Toowoomba', New South Wales Department of Water Resources, I.D. Kelly (Ed.), June 1990, 8 pp.

Freeman, K. (1992) "Odour Measurements at New South Wales Feedlots", in 'Odour Update 92', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, MRC Report No.DAQ64/24, Toowoomba, Aust. 31 Mar - 2 Apr. 1992, pp 93-102.

Gates, G., Jiwan, J. and Mount, T. (1991) "Site Selection for Cattle Feedlots - a Groundwater Perspective", in 'Working Papers of a Cattle Feedlot Workshop Held at Toowoomba', New South Wales Department of Water Resources, I.D. Kelly (Ed.), June 1990, 6 pp.

Jones, M. (1991) "Design Considerations for Dynamic Olfactometers", in 'Agricultural Odours', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, AMLRDC Report No. DAQ64/7, Toowoomba, Aust. 19-20 Feb. 1991, pp 49-69.

Jones, M. (1992) "Odour Measurement Using Dynamic Olfactometry", in 'Odour Update 92', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, MRC Report No.DAQ64/24, Toowoomba, Aust. 31 Mar - 2 Apr. 1992, pp 17-32.

Jones, M., Watts, P. J., Lott, S. C., Tucker, R. W. and Smith, R. J. (1992a) "A Mobile Dynamic Olfactometer for Feedlot Odor Studies", presented at ASAE Winter Meeting, Dec 15-18, 1992, Nashville, Tennessee.

Jones, M., Watts, P. J. and Smith, R. J. (1992b) "Quantification of Odours from Agricultural Waste", in *Conference on Engineering in Agriculture 1992*, Albury NSW, 4-7 Oct 1992, The Institution of Engineers, Australia Preprints of Papers pp 159-164 (National Conference Publication No. 92/11).

Kaye, R. B. (1991) "The Development of Olfactometry Techniques and Standards in the Netherlands", in 'Agricultural Odours', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, AMLRDC Report No. DAQ64/7, Toowoomba, Aust. 19-20 Feb. 1991, pp 29-35.

Laut, P. (1991) "Assessment of Land Capability for Safe Land Disposal of Intensive Rural Industry Wastes", in 'Working Papers of a Cattle Feedlot Workshop Held at Toowoomba', New South Wales Department of Water Resources, I.D. Kelly (Ed.), June 1990, 5 pp.

Lott, S. C. (1992) "Odour Offensiveness", in 'Odour Update 92', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, MRC Report No.DAQ64/24, Toowoomba, Aust. 31 Mar - 2 Apr. 1992, 137-156.

Mackay-Sim, A. (1992) "Electronic Odour Detection - Problems and Possibilities", in 'Odour Update 92', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, MRC Report No.DAQ64/24, Toowoomba, Aust. 31 Mar - 2 Apr. 1992, pp 57-62.

McPhail, S. M. (1991) "Modelling the Dispersion of Agricultural Odours", in 'Agricultural Odours', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, AMLRDC Report No. DAQ64/7, Toowoomba, Aust. 19-20 Feb. 1991, pp 85-88.

Ormerod, R. J. (1991) "Modelling Emissions and Dispersion of Feedlot Odour: A Case Study", in 'Agricultural Odours', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, AMLRDC Report No. DAQ64/7, Toowoomba, Aust. 19-20 Feb. 1991, pp 89-108.

Smith, R. J. (1992b) "Measurement, or Calculation of Odour Emission Rates?", in 'Odour Update 92', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, MRC Report No.DAQ64/24, Toowoomba, Aust. 31 Mar - 2 Apr. 1992, 123-136.

Smith, R. J. (1992c) "The Prediction of Feedlot Odour Emissions from Downwind Measurements of Odour Concentrations", in 'AG ENG 92', Proc. of 5th AG ENG Conf., Upsalla, Sweden, June 1992.

Sweeten, J. M. (1992) "Case Study of a Private Nuisance Action Against a Cattle Feedlot in Western Oklahoma", in 'Odour Update 92', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, MRC Report No.DAQ64/24, Toowoomba, Aust. 31 Mar - 2 Apr. 1992, pp 157-180.

Torre, P. (1991) "Odour Flux Determinations using the Odour Flux Hood", in 'Agricultural Odours', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, AMLRDC Report No. DAQ64/7, Toowoomba, Aust. 19-20 Feb. 1991, pp 73-84.

Tucker, R. W. (1992a) "Odour Measurements From Simulated Feedlot Pads", in 'Odour Update 92', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, MRC Report No.DAQ64/24, Toowoomba, Aust. 31 Mar - 2 Apr. 1992, pp 103-122.

Verrall, K. A. and Williams, R. L. (1991) "Queensland Regulatory Experience in the Sensory Measurement of Odours Using Dynamic Olfactometry", in 'Agricultural Odours', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, AMLRDC Report No. DAQ64/7, Toowoomba, Aust. 19-20 Feb. 1991, pp 37-47.

Watts, P. J. (1991b) "Characteristics of Agricultural Odours", in 'Agricultural Odours', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld. Dept. of Primary Industries, AMLRDC Report No. DAQ64/7, Toowoomba, Aust. 19-20 Feb. 1991, pp 17-28.

Watts, P. J. (1991c) "The Environmental Impact of Cattle Feedlots", in 'Working Papers of a Cattle Feedlot Workshop Held at Toowoomba', New South Wales Department of Water Resources, I.D. Kelly (Ed.), June 1990, 25 pp.

Watts, P. J. (1992a) "Odour Measurements at a Queensland Feedlot", in 'Odour Update 92', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, MRC Report No.DAQ64/24, Toowoomba, Aust. 31 Mar - 2 Apr. 1992, pp 71-92.

Watts, P. J. (1992b) "What is an Odour Unit?", in 'Odour Update 92', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, MRC Report No.DAQ64/24, Toowoomba, Aust. 31 Mar - 2 Apr. 1992, pp 5-16.

Watts, P. J., Gardner, E. A., Tucker, R. W., Moody, P. W. and Gilbert, M. (1992) "Phosphorus Balance for Cattle Feedlots", in *Conference on Engineering in Agriculture 1992*, Albury NSW, 4-7 Oct 1992, The Institution of Engineers, Australia Preprints of Papers pp 153-158 (National Conference Publication No. 92/11).

Watts, P. J., Jones, M., Lott, S. C., Tucker, R. W. and Smith, R. J. (1992) "Odor Measurements at a Queensland Feedlot", presented at ASAE Winter Meeting, Dec 15-18, 1992, Nashville, Tennessee.

Williams, R. L. and Verrall, K. A. (1992) "Quality Assurance and Inter-laboratory Testing in the Determination of Odour Detection Thresholds using Dynamic Olfactometry", in 'Odour Update 92', Proc. of a Workshop on Agricultural Odours, Watts, P.J. (Ed.), Qld Dept. of Primary Industries, MRC Report No.DAQ64/24, Toowoomba, Aust. 31 Mar - 2 Apr. 1992, pp 33-56.

**EXTENSION MATERIAL**

Watts, P. J. (1992d) "Feedlot Waste Management Series - No. 1 - Manure Production Data", in 'Feedlotting Notes' - a collection of farmnotes notes, Qld. Dept. of Primary Industries, Information Series QI91032, pp 32-35.

Watts, P. J. (1992e) "Feedlot Waste Management Series - No. 2 - The Feedlot Pad", in 'Feedlotting Notes' - a collection of farmnotes notes, Qld. Dept. of Primary Industries, Information Series QI91032, pp 36-38.

Watts, P. J., Tucker, R. W. (1992) "Feedlot Waste Management Series - No. 3 - Pen Cleaning (Manure Harvesting)", in 'Feedlotting Notes' - a collection of farmnotes notes, Qld. Dept. of Primary Industries, Information Series QI91032, pp 39-42.

Tucker, R. W., Watts, P. J. (1992) "Feedlot Waste Management Series - No. 4 - Design Concepts to Aid Cleaning", in 'Feedlotting Notes' - a collection of farmnotes notes, Qld. Dept. of Primary Industries, Information Series QI91032, pp 43-46.

Tucker, R. W., Watts, P. J. (1992) "Feedlot Waste Management Series - No. 5 - Mounding in Yards", in 'Feedlotting Notes' - a collection of farmnotes notes, Qld. Dept. of Primary Industries, Information Series QI91032, pp 47-48.

Tucker, R. W., Watts, P. J. (1992) "Feedlot Waste Management Series - No. 6 - Attention to Detail", in 'Feedlotting Notes' - a collection of farmnotes notes, Qld. Dept. of Primary Industries, Information Series QI91032, pp 49-52.

Tucker, R. W., Watts, P. J. (1992) "Feedlot Waste Management Series - No. 7 - Manure Removal and Stockpiling", in 'Feedlotting Notes' - a collection of farmnotes notes, Qld. Dept. of Primary Industries, Information Series QI91032, pp 53-54.

Watts, P. J. (1992f) "Feedlot Waste Management Series - No. 8 - Dust Control", in 'Feedlotting Notes' - a collection of farmnotes notes, Qld. Dept. of Primary Industries, Information Series QI91032, pp 55-58.

Tucker, R. W. (1992b) "Feedlot Waste Management Series - No. 9 - Fly Control", in 'Feedlotting Notes' - a collection of farmnotes notes, Qld. Dept. of Primary Industries, Information Series QI91032, pp 59-62.

Watts, P. J. (1992g) "Feedlot Waste Management Series - No. 10 - Using Weather Conditions", in 'Feedlotting Notes' - a collection of farmnotes notes, Qld. Dept. of Primary Industries, Information Series QI91032, pp 63-66.

Tucker, R. W. (1992c) "Feedlot Waste Management Series - No. 11 - Disposal of Carcasses", in 'Feedlotting Notes' - a collection of farmnotes notes, Qld. Dept. of Primary Industries, Information Series QI91032, pp 67-69.

Tucker, R. W. (1992d) "Beef Cattle Feedlot - Animal Welfare", in 'Feedlotting Notes' - a collection of farmnotes notes, Qld. Dept. of Primary Industries, Information Series QI91032, pp 30-31.

## 14 MEDIA COVERAGE

The issues addressed in this project were closely related to the community's often poor perception of the lot feeding industry. In order to reassure the public that feedlot environmental issues were being addressed, we sought media coverage of the project even before any experimental results were at hand. The project was covered on television (local networks and ABC's Landline), ABC and local rural radio and the written press. Examples of the coverage in the written press are given in the Annual Reports (see Appendix 1 and 2).

## 15 ACKNOWLEDGMENTS

This project would not have been successful without the cooperation of the Australian Lot Feeders Association and the individual feedlots who cooperated with the experimental work. Special thanks are extended to Rod Hadwen and Richard Sturgess (Beef City), Des Rinehart (Lillyvale Feedlot), Trevor Lee (Brisbane Valley Feedlot), Robin Hart and Rod McLean (Kerwee Feedlot) and Brian McLean (Alpair Feedlot).

**APPENDIX 1 - Annual Report 1990**

## FEEDLOT WASTE MANAGEMENT

## AMLRDC PROJECT NO. DAQ.064

## SUMMARY OF ACTIVITIES - 1990

The Queensland Department of Primary Industries is undertaking this project. The project commenced in January, 1990. The following is a summary of the research and extension activities undertaken by the Feedlot Services Group during 1990. Staff for the project commenced work in January and February 1990.

### 1 LITERATURE SEARCH

A comprehensive literature search has been undertaken covering all aspects of feedlot waste management and environmental aspects of feedlot development. We have loaded these references into a bibliographic database (Procite). This system allows rapid searching and retrieval of references. As of December, 1990, there were about 1280 references on the database. The references have been collated into a report - Feedlot Waste Management Bibliography (Report No. DAQ.64/2).

### 2 REVIEW OF AMERICAN FEEDLOT REGULATIONS

A review was undertaken of procedural arrangements and design requirements for feedlot licensing in the United States and Canada. Requests were made for government officials and university staff in the US to supply details of feedlot regulations in their state. These data were then collated into a report in which we reviewed each state using a standard format (Feedlots in North America - Report No. DAQ.64/4). The report summarised the various regulations and design guidelines that apply in the US and correlated these guidelines with local climate.

This report has been distributed to all Australian regulatory authorities that have a role in feedlot licensing. Contents of the report have since been discussed with various government authorities.

### 3 AUSTRALIAN FEEDLOT SURVEY

A survey is being undertaken of the Australian feedlot industry. The aims of the survey are to:

(i) obtain statistics on industry size and growth;
(ii) locate feedlots within geographic regions, climatic zones, river catchments, etc.
(iii) obtain data on feedlot design and construction methods;
(iv) obtain data on feedlot management;
(v) obtain data on current feedlot waste management techniques;
(vi) locate and collate novel solutions to various design and management problems associated with feedlot waste management;

(vii) obtain samples of manure and effluent for testing to establish a database on feedlot waste quality and quantity;

(viii) obtain a sound understanding of the industry so that solutions proposed as part of the research program are both practical and economically viable.

To date, there are over 600 hundred feedlots on the database. These include existing and proposed feedlots across Australia. A member of the research group has visited most large feedlots (over 1000 head) in Queensland and New South Wales. Smaller feedlots and feedlots in Victoria, South Australia and Western Australia have been surveyed by telephone. A report is being prepared. The report will include various graphs, maps and tables compiled from the survey database as well as written information which describes the design and management options collated during the survey.

## 4 HYDROLOGICAL INVESTIGATIONS

The project has instrumented four feedlot catchments so that hydrological data can be collected. The sites have been chosen because they reflect differences in climate, cattle type and feeding period, feedlot topography and design and feedlot waste management. An automatic weather station has been installed at each site. The station records rainfall, rainfall intensity, wind speed and direction, air temperature, humidity and pad moisture content. Evaporation can be calculated from these data. These data are collected on a two weekly basis using a laptop computer. Stainless steel flumes have been installed at three sites to gauge the runoff coming from the feedlot. These data are automatically logged into the weather station. In addition, a chart recorder is used to make a graphic record. Two sediment samplers have been purchased. These devices are actuated automatically during a runoff event. The sediment samplers pump samples of runoff water into 50 bottles for later analysis. These devices will be shifted to different catchments when sufficient data are collected at the current sites.

The data collected with this equipment will be used to calibrate computer simulation models of feedlot hydrology. The model will be developed from existing models written by Dr. Watts and Mr. Lott. The model will be used to propose and test design guidelines for different climatic regions (e.g. summer or winter dominant rainfall, high or low rainfall) and management systems. A component of the model will be the prediction of pad moisture content. These data are essential in any odour generation model.

The group is also investigating the design of various components in the drainage system of a feedlot. One area of concern is the design of sedimentation basins and semi-permeable weirs. The group has re-designed a semi-permeable weir for a feedlot that had a weir that clogged continuously. The new design has been installed and, based on one runoff event, it is apparently working better than the previous design. The new design is both cheap and functional.

## 5 GROUNDWATER POLLUTION

In the original AMLRDC Feedlot Waste Project, a small component was the investigation of groundwater pollution. However, it has become evident that potential groundwater pollution caused by feedlots is of major concern, particularly in NSW. Hence, the project is attempting to expand the effort in this area. Meetings were held between the QDPI, the Water Resources Commission, the University of Southern Queensland (formerly DDIAE) and the CSIRO Centre for Groundwater Studies. The outcome was a submission to the

Australian Water Research Advisory Committee (AWRAC) for funds for a large project. Whilst this project received good reviews, AWRAC declined to fund the work. However, when the Murray Darling Commission became aware that the AWRAC submission was unsuccessful, they agreed to provide funds to CSIRO to undertake some work. Hence, groundwater pollution research will now be jointly funded by AMLRDC Feedlot Waste Management, Qld Water Resources Commission and the Murray Darling Commission.

A number of meetings have been held to discuss the areas to be investigated. In particular, discussions have been held with NSW Water Resources Commission to ensure that priority areas are targeted. Sites have been selected and we hope that field work will commence early in the new year.

## 6 EFFECT OF RATION ON FEEDLOT ODOUR

Many lot feeders claim that grain type and processing method have a significant effect on odour generation. Furthermore, a number of firms are marketing feed additives that they claim reduce odour. This issue is being addressed with a trial at the QDPI research farm at Rocklea.

Groups of cattle are being fed 6 different rations. The rations are steam-flaked barley, dry-rolled barley, steam-flaked sorghum, dry-rolled sorghum, dry-rolled sorghum with Actigest and dry-rolled sorghum with a Hoechst additive. Feed conversion efficiency and weight gains are being measured. The cattle have been trained to wear a faecal collection pouch. For intensive 7 day periods, all the faeces produced by the cattle are collected. This is weighed and the majority of the faeces is frozen for later use. Some of the faeces is being analysed to determine if there are any significant chemical differences between the faeces that might indicate different odour generation potentials. The feeding and faeces collection trial will end at the end of December.

The second phase of the trial will be the creation of small scale feedlot pads using the frozen faeces. The faeces will be allowed to decompose in a similar manner to an actual feedlot pad. The addition of urine and rainfall will be controlled by the use of a "rain-out" shelter. Odour samples will be collected from above the pad and measured to determine if there are significant differences between the different manures.

## 7 ODOUR COLLECTION AND MEASUREMENT

A critical component of the research program is the ability to collect and measure odour samples.

In the original research proposal, the odour measurements were to be undertaken on a sub-contract basis by the Queensland Department of Environment and Heritage (DEH). However, after the literature search had been completed, we discovered that this was not a viable option. This is because:

(i) Odour samples from feedlots must be analysed within about 4 hours of collection or the sample will deteriorate significantly. It is logistically difficult to take samples at feedlots to the west of Toowoomba and have them tested in Brisbane within four hours.

(ii) Although we did not obtain a firm quotation, it appears that each sample would cost several hundred dollars to test. (The DEH test requires an operator plus 9 panellists). As it is anticipated that several hundred samples will eventually be tested, the cost would have been prohibitive.

(iii) Odour measurement is a rapidly changing field of research. The literature review indicated that the method currently used by DEH might be considered to be a little out-dated. The existing equipment apparently has some shortcomings that, in all probability, would underestimate odour intensity.

For the reasons listed above, we decided to construct a new olfactometer based on the latest literature.

Initially, a draft design proposal was developed. This was circulated to all the agencies in Australia who might be interested in odour measurement. We requested that these agencies provide details of their current methods for measuring odours and to comment on the QDPI proposal. When these responses were received, a review paper was written. This is "The Measurement of Odour" - Report No. DAQ.64/5. This report has been circulated to the same agencies. The report outlines the design criteria for the dynamic olfactometer currently being constructed and tested by the QDPI. The report also outlines the sampling techniques proposed for point source and ambient odours as well as odour flux rates from extensive surfaces.

In order to obtain further acceptance of other agencies of the QDPI olfactometer and to compare the QDPI equipment with other machines, an odour workshop is being planned for February. At present, Dr. John Sweeten will be the key note speaker. Representatives of the relevant agencies from Queensland, New South Wales, Victoria, South Australia and Western Australia have indicated that they wish to attend the workshop.

## 8 SEMINARS, CONFERENCES AND EXTENSION ACTIVITIES

The group sees extension of existing information and information collected during the study as an important activity. There are three groups to whom information should be extended. They are:

(i) industry (lot feeders and their industry bodies)
(ii) community groups (neighbours of feedlots)
(iii) regulatory authorities (State departments, shire councils)

These groups require information of different types and at different technical levels.

Throughout the year, members of the Feedlot Services Group have attended numerous seminars and conferences, addressed various workshops and conducted various tours of feedlots. The specific activities have been as follows.

17-18 Apr Feedlot Managers Short Course conducted by industry and AMLC - Main speaker - Dr. John Matsushima

10 May Beef '90 Field Day - UGA - held at Lillyvale Feedlot

29-31 May Review of Research Program and Field Trip - Dr. John Sweeten

| | |
|---|---|
| 1 June | Open Meeting and Review of AMLRDC Feedlot Research, Brisbane - Dr. John Sweeten |
| 4-6 June | Interstate Liaison Meeting with NSW Ag. and Fisheries, SPCC, NSW Water Resources, DARA, Vic, SA Dept of Ag. - Seminar in Brisbane and field trip to Downs feedlots |
| 25-29 June | Lotfeeding and Beef Production - Refresher Course - University of Sydney |
| 5 July | Queensland Feedlot Liaison Committee - presentation of outline of research program to committee meeting |
| 5 July | Agricultural Engineering Society of Australia - presentation of outline of research program to monthly meeting |
| 18 July | Feedlot Seminar in Dubbo - ALFA AGM and Launch of NSW Feedlot Manual |
| 8 August | Queensland Feedlot Advisory Committee (FLAC) - presentation of outline of research program and presentation of summary of review of US guidelines - inspection of research equipment. |
| 4-6 Sept | FARMFEST - Interactive display outlining odour and associated research - 1230 participants in odour identification test |
| 12 Sept | Agricultural Odour Seminar - SPCC, Sydney - presentation of paper on feedlot odours |
| 25-26 Oct | Hydrology Symposium - presentation of paper and field trip to Beef City research site |
| 11-14 Nov. | National Conference on Agricultural Engineering - presentation of papers on feedlot hydrology - co-ordination of workshop on feedlots - field trip to feedlots |
| 19-21 Nov. | Field trip and meetings with SA Dept of Ag. officers regarding feedlot design, management and licensing |
| 27 Nov | Filming of feedlot TV program for TSN 11 - arranged by Bunny Powne, Chairman of FLAC - filming at research sites and interviews regarding research program. |
| 4-7 Dec | Workshop and field trip for NSW Water Resources officers regarding groundwater pollution from feedlots. |

Activities planned for 1991

| | |
|---|---|
| Feb | Odour Workshop in Toowoomba with Dr. John Sweeten and Australian regulatory authorities. |
| Apr-May | Manure Handling Field Days - to be arranged jointly with industry, Wylie and Assoc. and QDPI - Day 1 for Feedlot Managers - Day 2 for Shire Council representatives |

Other activities:

Members of the group are participants in the Feedlot Liaison Committee and in the Queensland Feedlot Improvement Project. This project is an initiative of the Beef Cattle Husbandry Branch of QDPI.

## 9 PUBLICITY AND EXTENSION ARTICLES

The group has actively sought publicity for the project so that the general public is aware that the issue of feedlot waste management is being addressed. Although little research information has been obtained to date, the group has published some extension articles. Publicity and extension articles are attached.

# Feedlot waste, smells subject of DPI study

A three-year project to investigate feedlot waste management which will cost more than $800,000 was launched in Toowoomba yesterday.

The project was launched at the offices of Department of Primary Industries which will be doing most of the work on the project in conjunction with the University College of Southern Queensland.

Funding for the project will come from the Australian Meat and Livestock Research and Development Corporation whose consultant Dr John Sweeten, from Texas A and M University, will also be involved.

A team of five DPI researchers will work on the project full-time and Dr Peter Watts, executive engineer with the department's feedlot services group, said particular attention would be paid to problems of water pollution and odours from feedlots.

Dr Watts said: "We will be looking at the designs of feedlots to ensure that waters are not polluted.

"There has been a lot in the press about rivers being polluted. In principle it can occur but it is possible to design feedlots properly so that this doesn't happen."

Dr Watts said odour research would be carried out the most natural way, with a panel of "odour sniffers" setting up camp in a DPI caravan to monitor smells.

He said: "Odour is obviously a key issue but it is something that is very difficult to measure. The bottom line is that the only thing that knows is the nose."

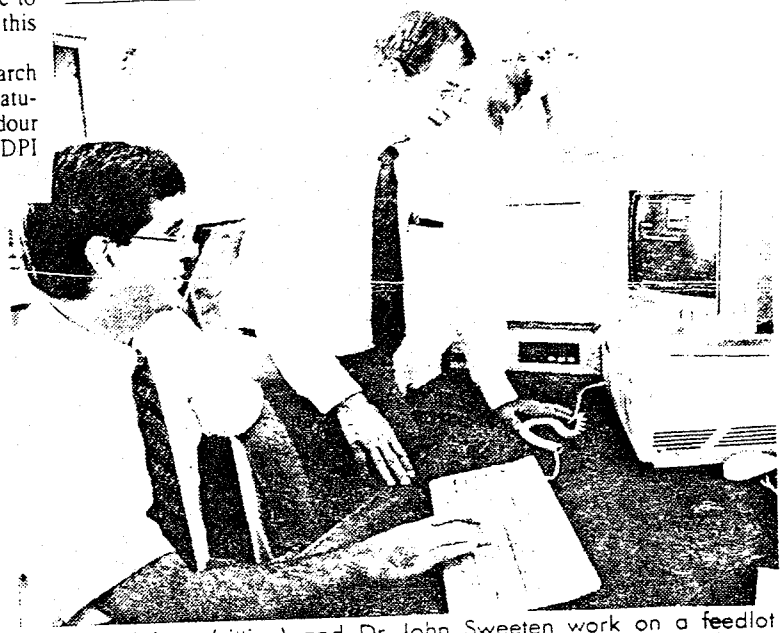
Dr Watts said the project did not result from the recent Government registering of feedlots and had been in the planning stage for the past two years.

"The project has taken a long time to come to fruition because it is a sensitive area," he said.

The project will be based in Toowoomba and research will be carried out within a radius of a two-and-a-half hour drive of the city, an area which covers 60% of the country's feedlots.

Dr Sweeten said he was looking forward to the project.

He said: "It is an interesting experience for me to come and see this research team and see their energy. They have done their homework pretty well."



Dr Peter Watts (sitting) and Dr John Sweeten work on a feedlot waste management project at the DPI offices in Toowoomba yesterday.

Toowoomba Chronicle

1990

AUSTRALIAN RURAL TIMES
The Business of the Nation

enough issue. The letter forwarding the decision from the show's producers was passed on to the minister last week with a hastily scribbled notation by a staffer: "Don't give up the day job".

### On the nose

QUEENSLAND Department of Primary Industries scientist Dr Peter Watts has been given the task of determining whether or not feedlots pong.

Given charge of the feedlot waste management research program, he is trying to decide whether feedlot odours are pollutants and nuisances.

There being no instruments to measure this, he has gathered together a team of people "sniffers" who, in a specially fitted caravan, use their olfactory senses to judge how offensive feedlot waste is, or isn't.


In common with the skills of master perfumers, Redback understands the waste sniffers are also required to have keen noses. But he wonders if any on this panel will be tempted to bottle the aromas.

### Pigging out

IT HAS been a grim week for the Australian pork industry.

Not only did it lose its seven-year battle to stop Canadian pigmeat imports into Australia, but a Wollongong abattoir worker who had a 350 kilogram pig carcase fall on his head was last week awarded $158,418 compensation in the Supreme Court.

Such are the hazards when pigs do fly.

### Latin emus

VENUZUELAN farmers are already looking into the prospects of farming one half of the Australian coat of arms — the emu.

One CSIRO researcher says he has had one inquiry into the requirements for emu farming sitting on his


Aust. Rural Times, Aug 2-7, 1990

# FEEDLOT RESEARCH

By John Round, Manager
(Special Projects) QDPI

Lotfeeding of cattle is now firmly established and an expanding segment of the cattle industry in Queensland. It is likely most of the new market opportunities for beef which are now emerging will be supplied with lotfed products.

So far the industry has been operating using technology, mainly from the United States. While much of this is valuable to the Australian industry, there is a shortage of information relating to the higher rainfall, subtropical conditions experienced in Queensland.

There is the need to conduct research which will add local knowledge to the available data with regard to environmental issues. Accordingly, following discussions with the lot feeding industry, the Queensland Department of Primary Industries applied to the Australian Meat and Livestock Research and Development Corporation for funding during the next three years to carry out a research programme aimed at making the feedlot industry more efficient and environmentally acceptable.

This funding has been approved, and the research programme is now underway. To carry out the work the Department is establishing a small research group in Toowoomba. It is intended that the members of this unit will consult and work closely with members of the feedlot industry to ensure that the studies carried out are relevant and of importance to that industry.

Important factors which have already been identified include: Design and construction, siting, management of waste products and their removal and ultimate usage, pen cleaning systems, effect of manure and liquid wastes on crop lands, influence of different rations on odour generation, use of odour suppressants, and the effect of stocking densities.

In the initial stages it is intended to thoroughly summarise information already available from Australia and overseas, and then obtain as much information as possible on practices currently being used in Queensland. A large degree of industry participation is being sought.

As the feedlot industry is increasing throughout Australia, plans are already in hand to have a high level of consultation with involved organisations in other states.

# Staff to 'sniff out' feedlot problems

TOOWOOMBA staff of the Queensland Department of Primary Industries don't know it yet but their noses are going to be called to the service of the feedlot industry.

They're going to be asked to become "sniffers" in a two and a half year feedlot waste management project by the research section of QDPI's Feedlot Services Group.

The six member section is carrying out the project with some $540,000 from the Australian Meat and Livestock Research and Development Corporation.

Headed by John Round, QDPI's manager of special projects for QDPI's beef cattle husbandry branch, and agricultural engineer Peter Watts, the section includes two other agricultural engineers, one of them with expertise in applied chemistry, a rural technologist and an electronics technician.

According to Dr Watts, the section's research accepts the basic premise tht feedlots have the potential to cause environmental problems.

"These problems — real or perceived — complaints by neighbours and the tendency for governmental authorities to over-regulate have hindered the growth of the feedlot industry" he said.

Country Life, 22 Nov 1990

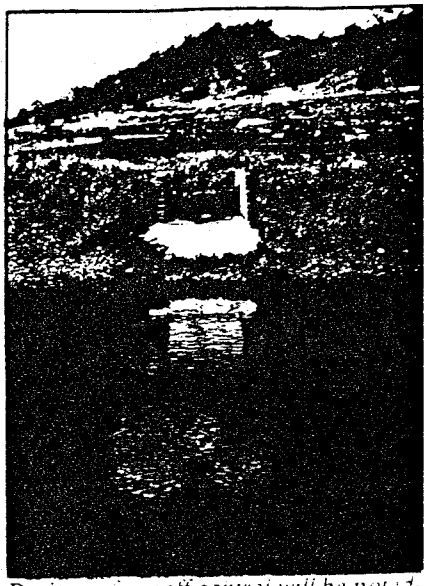
# FEEDLOT WASTE MANAGEMENT SURVEY

**A national feedlot survey is currently being conducted by the research section of the Queensland Department of Primary Industries Feedlot Services Group. Most of the surveying will be conducted during feedlot inspections although some feedlotters will be contacted by phone.**

The survey's main objective is to establish a profile of the Australian feedlotting industry, know exactly how feedlots in Australia are being operated and managed so that relevant extension material can be prepared. Considerable emphasis will be placed on the types of waste management practices currently being used by each class of feedlot, know the stocking densities used and the frequency and method of pen cleaning, drainage systems, waste disposal, water pollution, odour creation and feedlot design. Any innovative ideas relating to waste management control will be appreciated.

Feedlotters will also be asked to supply details of feedlot design and layout, general nutrition, husbandry and management practices, know what facilities are commonly used (eg. scales, vet crushes, self-feeders or troughs), types of ingredients frequently used in rations as well as any animal health programs used.

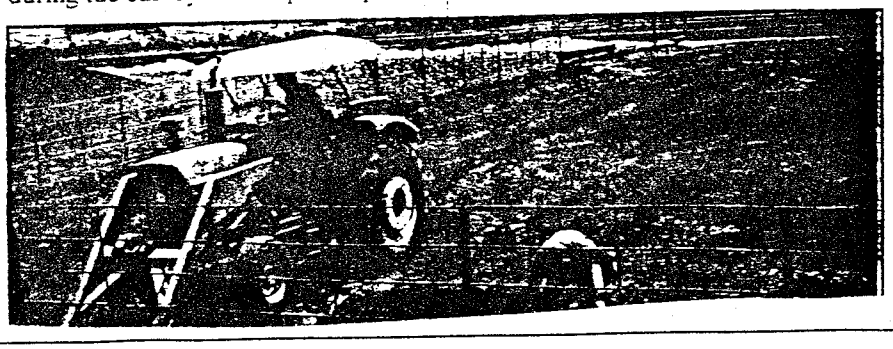
Each person surveyed will be asked to provide details of the number of cattle they have fattened in the past. Estimates of cattle numbers in the future will help to establish a trend of the growth of the industry. The percentage of cattle being fattened for each market will also be of interest. It is hoped that the information received during the survey will help to explain the expected trends in feedlot cattle numbers.



*Designs of runoff control will be noted-excellent example*

The survey should help to keep the Department informed of the current state of the feedlot industry. It should also indicate the direction in which it is heading. Once the information received has been collated, any specific problem areas can be identified. Research and extension efforts can then be targeted in an appropriate manner.

● By Robyn Tucker, Beef Cattle Husbandry Officer, Feedlot Services Group, QDPI (076) 31 4379



Today's FEED LOTTING, July 1990

Today's FEED LOTTING, July 1990

## "Only The Noses Knows!!"

# THE MOST SENSITIVE ODOUR DETECTOR

**Complaints about offensive odours have been an ongoing problem for a number of feedlots. This has resulted in a less-than- favourable public image for the industry and strict controls on the siting of new feedlots. In order to resolve some of these problems, the AMLRDC has funded a major research project into Feedlot Waste Management. A significant part of this project will study odours - their generation, dispersion and control. The basis of this project will be the ability to objectively measure odour intensities so that the subjective and emotive component of the problem can be eliminated.**

Odours are caused by the presence of chemicals in the air. Some of these are simple chemicals such as hydrogen sulfide (rotten egg gas), but the majority of agricultural odours are caused by complex volatile organic chemicals. With the right equipment, measuring the concentrations of these chemicals is relatively straightforward. Many researches have attempted to measure odour levels by determining the chemical composition of air samples using sophisticated scientific equipment. However, at this time, no one has been able to relate the concentration of particular chemicals in the air to the odour strength, quality experienced by people and most importantly, the offensiveness of the odour.

### SENSITIVE AND ACCURATE

It has been discovered that the most sensitive and accurate piece of equipment for measuring odours is the human nose. The only reliable method of measuring an agricultural odour is to use a panel of human "sniffers". The human nose is very sensitive to odours but this sensitivity varies greatly between individuals (100 times is not uncommon).

This means that one individual could find an odour offensive while another individual could not even detect it. [Understanding this variation is important in odour nuisance resolution.] The panel of sniffers must be selected so that it is representative of the general population. Within the panel there will be a range of sensitivities varying fr[illegible]gh to low. Some of the panel there will be a able to detect odours at much lower concentrations than others. People with a very poor sense of smell (e.g. smokers) should be excluded from the panel.

### MEASURING ODOURS

The process of measuring odours with the human nose is called olfactometry and the instrument used is an olfactometer. The most common method of measuring the intensity of an odour is to dilute the odour sample with clean, odour free air until one half of the sniffer panel can just detect the odour. The odour intensity can then be stated in Odour Units (ODU's). An odour measured to be 100 ODU's means that the odorous air had a measure of intensity only. They indicate nothing about the offensiveness of the odour. For example, a feedlot odour could have a similar intensity to a perfume odour but a vastly different level of offensiveness.

Measuring odour quality is more difficult than measuring odour intensity. Perceived odour quality is very subjective. What is an irritating odour to one individual may be pleasant to another. Personal background will influence an individual's attitude to an odour. A person from an urban background may find agricultural odours more offensive than a person of rural background.

### INTENSITY

The offensiveness of an odour is also dependent on its intensity. An odour which is pleasant at low concentrations may become unpleasant at higher concentrations.

In order to assess odour offensiveness the sniffer panel must be asked to rank an odour according to a scale. Such a scale may consist of the following levels: Not Offensive / Possibly Offensive / Offensive / Definitely Offensive / Very Offensive. It is much more difficult for a panel member to rate the offensiveness of an odour than to simply state whether or not the odour is detectable.

● By Michael Jones, QDPI.

# Researchers sniff at better beef

Researchers Mr Simon Lott (foreground left) and Dr Peter Watts — Picture: PAUL AGER

BEEF eaters will soon thank the efforts of a band of agricultural engineers who are putting their noses on the line for the sake of higher quality meat.

The best beef comes from cattle fed in controlled conditions on a specifically alloted diet of grains and natural growth stimulants.

There are now about 500,000 cattle around Australia housed in feedlot conditions on about 1000 properties.

But poor early research based on American standards has brought many Australian feedlots into disrepute. While most cattle in the United States are managed in feedlot conditions, similarly constructed enterprises in Australia have created environmental problems because of different climatic conditions.

Australian feedlots have been established in areas that experience up to 40C heat and are close to waterways. American feedlots are established in moderate climates and away from water courses.

Companies and farmers hoping to establish new feedlots now have to meet strict environmental standards with a high degree of social acceptability. If the actual smell of the cattle manure travels to a neighbouring property, then the feedlot is generally not allowed.

Because feedlots provide cattle with grain in troughs, reducing the need for cattle to graze, thousands of cattle can be contained in a small area. The manure run-off from the cattle is immense apart from the smell.

The Queensland Department of Primary Industries and the Australian Meat and Livestock Research and Development Corporation are conducting research to provide environmental controls for feedlots in different climatic areas.

## Social acceptability

By measuring rainfall, humidity, solar radiation, wind speed, wind direction and manure temperature, the QDPI feedlot services group hopes to review the present design standards for feedlots.

But the biggest stumbling block is that there are no scientific measures for smell.

To provide some objectivity to the degree of stench emanating from a number of cattle confined in a specified area in a certain climate, the feedlot group has built a dynamic olfactometer — otherwise known as using the human nose to assess the level of manure stench.

According to the research supervisor, Dr Peter Watts, and research engineer, Mr Simon Lott, the work will help judge the degree of stench from any feedlot.

The olfactometer, which will be placed in a caravan, allows a sample of manure to be diluted and then sniffed by a panel of eight people.

If more than four people can smell the odour after it has been diluted up to 10 times, then the odour can be judged in degrees of severity.

The executive director of the Australian Lot Feeders Association, Mr Bob Coombs, believes the better controls will help launch a new range.

The new beef, exclusive to association members, identifiable by its own brand and available early next year, will allow consumers to buy beef accredited as always tender.

— PAUL DOWNIE

The Australian, 19 Nov 1990

# Sniffing caravan to study feedlots

An odour-sniffing caravan is being built at Toowoomba DPI as part of a project to investigate feedlot waste management.

Dr Peter Watts, who is supervising the waste management project, said the mobile sniffing device would be the only one of its kind in Australia.

The caravan, equipped with eight sniffers, would be taken to feedlots to measure odour concentrations at various points.

"We will also look at things like the effect of ration on odours. There's all sorts of scuttlebutt about sorghum producing worse smells than barley, but there's no factual evidence one way or the other.

"Another factor is the depth of manure and moisture content and how they affect odour.

"There has been comment that wet, deep manure causes worse odour, and if that's the case we will have a good argument about why feedlotters should clean their pens more frequently to reduce hassles with neighbours."

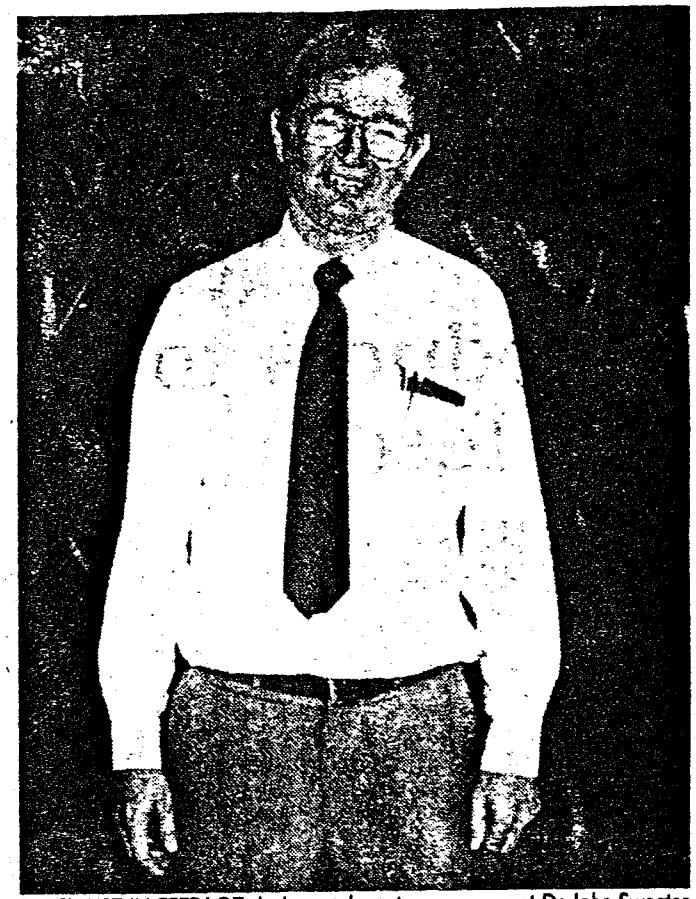
Dr Watts said other odour measuring devices in Australia were fixed facilities in laboratories in capital cities.

The waste management project also would look at run-off from feedlots and trying to prevent it getting into creeks.

"We're going to collect rainfall and run-off data from a number of representative feedlots and use that information to improve guidelines and design procedures for feedlots."

The project started in January. Dr Watts said it was the outcome of an approach by the department to the Australian Meat and Livestock Research and Development Corporation about two years ago, because of environmental concerns about feedlots in some shires.

"Originally there was a fair bit of emphasis on chemical control of odours and things like this, but such work hasn't been successful in America and it was decided to move out of that."



SPECIALIST IN FEEDLOT design and waste management Dr John Sweeten from the Texas A & M University, pictured at the Toowoomba QDPI recently. Dr Sweeten is one of a number of consultants engaged by the AMLRDC.

## AIMS OF PROJECT

The aims of the feedlot waste management project are:

- To improve the economic and operational viability of feedlots by reducing the real and perceived environmental impact.
- To identify good site selection, design and management practices for feedlot waste management systems from current practice and overseas experience.
- To transfer appropriate technology to advisory officers, feedlotters, and other State and local government agencies.
- To undertake complementary research and development activities into odour and solid and liquid waste control measures.

Qld. Farmer & Grazier, July 1990

# Sniff test scheme for feedlot research

FARMFEST visitors have been invited to have their noses "measured" and at the same time assist feedlot research.

The DPI's feedlot services group is seeking 1000 volunteers from visitors to the DPI-National Parks and Wildlife Services site to sniff 10 different jars, each containing an odour.

These may include agricultural smells like silage, cow manure and piggeries, food smells like bananas, mangoes, coffee and cloves, industrial odours such as ammonia, chlorine and acetone and others such as roses or nail polish remover.

Volunteers will be ranked on their ability to identify odours by having their responses to 30 possible answers immediately entered into a computer. Results will be compared to the average and participants ranked on their ability to identify odours.

The group hopes to obtain more than 1000 sniff tests to help their understanding of the public's ability to identify odours.

A large part of the feedlot service group's program is associated with feedlot odours and their nuisance impact on neighbours. It has the responsibility of feedlot licensing, extension and research.

Other aspects of the group's display will be feedlot site selection, design and management. A series of posters will emphasise various aspects of feedlot site selection, design and management.

**Farmfest Report**


Bill Mahon, Carpendale, receives his 'super sniffer nose' sticker from Simon Lott, an engineer with the Department of Primary Industries feedlot services division in Toowoomba. The DPI conducted an odour identification survey at Farmfest, asking patrons to try to identify eight different smells of either cosmetic, industrial or agricultrual origins.

Country Life, Aug 1990

# The man who sniffs cow dung for a living

By WILL HENWOOD

SNIFFING cattle manure as a job may not be everybody's idea of an upwardly mobile career path, but it is proving a vital method to ease the conflict between feedlot development and regulatory authorities.

But the feedlot waste management project headed Dr Peter Watts should help bring some rational debate to the intense environmental group pressure on the booming cattle feedlot industry.

His team of eight sniffers in their laboratory, a converted caravan, use their "factory senses to rate offence level of odour from solid and liquid wastes and to define the best control measures.

While the method may seem primitive, it is the best available and regarded as pioneering research.

The cattle feedlot industry believes many of the concerns expressed by government authorities are unjustified and that over-regulation is hampering the growth of the industry.

"The 64 million dollar question is how far is minimal separation to stop feedlot pollution and conflict with neighbours," Dr Watts said.

The aim of the feedlot waste management program is to improve the economic and operational viability of feedlots by reducing the real and perceived environmental impact.

The research will have a big bearing on such developments as the Itoham feedlot project at Leeton. The NSW State Pollution Control Commission draft approval conditions for Itoham include a $1m bond for odour control in neighbouring towns and curfews on transport movements from 7pm to 7am.

An angry NSW Farmers Association has threated legal action unless the performance bonds are dropped. The applicant would lose the $1m if air pollution guidelines were breached after a "subjective smell test", NSWFA cattle industry chairman Mr Ian Steele-Park said.

State Pollution Control north west regional manager, Dr Richard Whyte, stressed intelligent site selection was the key to reducing odour, noise and water pollution problems.

The guidelines, which other state environmental agencies may follow if passed, proposed buffer zones of 8km to a town and 5km to a rural residence.

Other guidelines include feedlots sited in less than 700mm of rainfall, greater than 2km from a water course, gentle slopes between 2pc and 5pc, and low permeability soils.

Dr Watts and his team of engineers and a cattle husbandry officer want to develop guidelines to identify good site selection, design and management practices for feedlot waste management from current Australian feed lots and overseas experience.

Peter Watts: on the nose

He said the United States had been using feedlots for 30 years longer and was still experiencing similar problems to the Australian industry.

The project is targeting water-borne pollutants of both ground and surface water and land degradation. It also investigates air-borne nuisances including odour, dust, flies and noise.

The NSW feedlot advisory unit has just released an advisory manual explaining the planning process, site selection, layout and construction, management, cattle nutrition, health and marketing of feedlot cattle.

Aust. Rural Times, 16 Aug 1990

# MANURE MANAGEMENT INTEGRAL PART OF EVERY FEEDLOT OPERATION

*By Dr. Peter Watts*

**In recent years, lot feeders have found that manure management is a key feature of successful lot feeding. With the increasing environmental awareness of the public and with tighter economic margins, manure management can no longer be seen as a chore but as an integral component of the overall feedlot operation.**

The costs and returns of manure management need to be optimised. The first step in improving manure management is understanding manure - the quantities produced and its characteristics.

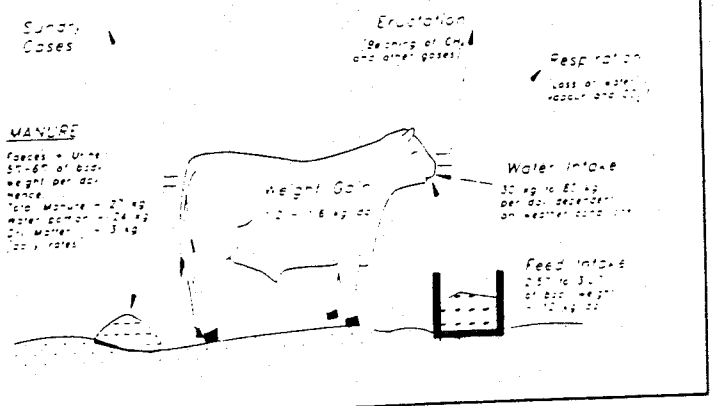
Figure One shows the daily intake and output of a typical 450kg feedlot beast. Feed consumption is typically 2.5% to 3% of body weight. For a 450kg beast, this represents about 13kg of feed intake per day. As weight gain is only 1.2 to 1.6 kg per day, the remainder must appear as manure. [Manure is the combination of faeces and urine.] In addition to feed intake, cattle drink considerable quantities of water. The daily volume depends on body weight and climatic conditions. Some of this water is lost to the atmosphere as respiration. However, a considerable proportion of the water is voided as part of the manure. Typically, the manure is 85% to 90% water. Hence, the daily manure production of a 450kg beast is about 27kg per day. This represents about 5-6% of the beast's body weight. Of the 27kg, about 24kg is water and 3kg is solid material.

The daily manure production and its characteristics for a range of animal sizes is shown in Table One. The actual amount excreted can vary by about 25% either side of these averages due to changes in ration, animal health, availability of water and climate.

## MANURE REMOVAL RATES

The total amount of manure that needs to be removed from the feedlot pens is quite variable. It depends on moisture content, digestibility of the ration, pen cleaning frequency and techniques, climatic conditions and stocking density. Manure removal rates ranging from 1 tonne to 2 tonne per head per year are cited.

FIGURE 1 - MANURE PRODUCTION FOR A 450KG BEAST




For the 450kg beast example in this article, the daily application of 3kg of dry matter becomes 1.1 tonne of dry matter per year. If the manure is at 30% moisture content when removed and if the manure is removed frequently so that little decomposition has occurred and little manure has been removed in runoff, than 1.1 tonnes of dry matter becomes 1.4 tonnes of manure to be removed. Obviously if moisture content is different or if a significant amount of decomposition and or runoff removal occurs, this figure will change.

TABLE 2 - ANIMAL MANURE PRODUCTION

(Scrapped manure assumes 30% decomposition and 30% moisture content)

| ANIMAL WEIGHT (KG) | FRESH MANURE (T/YR) | DRY MATTER (T/YR) | SCRAPPED MANURE (T/YR) |
|---|---|---|---|
| 300 | 6.6 | 0.79 | 0.72 |
| 450 | 9.9 | 1.21 | 1.10 |
| 600 | 13.1 | 1.58 | 1.44 |

## STOCKING DENSITY EFFECT

Stocking density has a significant effect on the manure accumulation rate and moisture content of the pad.

TABLE 3 - EFFECT OF STOCKING DENSITY ON MOISTURE ADDED TO A FEEDLOT PAD

(Moisture expressed as equivalent mm of rainfall)

| ANIMAL SIZE | STOCKING DENSITY SQ M/BEAST | | | | |
|---|---|---|---|---|---|
| (KG) | 10 | 15 | 20 | 25 | 30 |
| 150 | 280 | 190 | 140 | 110 | 90 |
| 250 | 480 | 320 | 240 | 190 | 160 |
| 350 | 670 | 440 | 330 | 260 | 220 |
| 450 | 860 | 570 | 430 | 340 | 280 |
| 550 | 1050 | 700 | 520 | 420 | 350 |
| 650 | 1250 | 830 | 620 | 500 | 410 |

Table Three shows the amount of water placed on the pad by cattle of different weights at different stocking densities.

The moisture is expressed as equivalent millimeter of rainfall. It can be seen from this data that the moisture contribution for large cattle at 10 sq.m per beast exceeds the contribution from rainfall in most areas of Australia.

NOTE: Manure is faeces plus urine. (Manure is approx. 33% water. Density is approx. 960 kg/m3).

• Dr. Peter Watts is Executive Engineer with the Feedlot Services Group of the QDPI, Toowoomba.

TABLE 1 - DAILY MANURE PRODUCTION FOR FEEDLOT CATTLE

| ANIMAL SIZE (KG) | MANURE PRODUCTION (KG/DAY) | TOTAL SOLIDS (KG/DAY) | VOLATILE SOLIDS (KG/DAY) | BOD (KG/DAY) | NUTRIENT CONTENT (KG/DAY) N | P | K |
|---|---|---|---|---|---|---|---|
| 225 | 13.2 | 1.54 | 1.32 | 0.35 | 0.075 | 0.024 | 0.052 |
| 300 | 18.0 | 2.08 | 1.86 | 0.48 | 0.104 | 0.034 | 0.075 |
| 450 | 27.0 | 3.13 | 2.72 | 0.72 | 0.153 | 0.050 | 0.108 |
| 600 | 36.0 | 4.18 | 3.56 | 0.96 | 0.206 | 0.068 | 0.149 |



Today's FEED LOTTING, Oct 1990

# DPI to investigate Downs feedlots' waste disposal

A newly formed group within the Department of Primary Industries (DPI) will investigate feedlot waste management on the Darling Downs.

Dr Peter Watts, executive engineer with the DPI's Toowoomba feedlot service group, said it was planned to look into the many problems surrounding feedlot management.

He said one concern was groundwater pollution.

Effluent seeping into the water table could result in high nitrate levels, a problem which, after salinity, represented the biggest contamination threat to Australia's drinking w supplies.

Dr Watts said he pl ed to drill test bores around feedlots to sample water to see if effluent contributed to pollution of groundwater.

It was also planned to sample seepage directly under feedlots.

Dr Watts said American literature suggested that problems should not exist, unless feedlots were built with pens directly near a bore.

High nitrate levels have been a problem in the Cambooya Shire where the council was forced to take action about 18 months ago when unacceptably high levels were recorded.

Cambooya Shire Council's environmental health officer, Mr Brian Harris said the problem had resulted because the town was unsewered.

Septic trenches polluted the underground streams which fed the private bores supplying the town's water.

Mr Harris said it was necessary to establish a council water supply by drilling a deep bore, 150 metres in depth, and sealing it with concrete lining.

The shallow streams polluted by septic were also capped off.

Mr Harris said council was in the process of providing a water supply for Wyreema where residents now used private bores.

"There is no nitrate problem in Wyreema, but the supply is going through as part of a land project of 40 sites being developed by the council," Mr Harris said.

Kingaroy Shire Council assistant engineer Mr Neil Kurtz said that, though nitrate levels in the shire had always been at an acceptable level, the district had experienced problems with iron manganese which produced discoloured water.

• **DPI 'has final say on feedlot applications', Page 13.**

**Toowoomba Chronicle**

**APPENDIX 2 - Annual Report 1991**

## FEEDLOT WASTE MANAGEMENT

## MRC PROJECT No. DAQ.064

## SUMMARY OF ACTIVITIES - 1991

The Queensland Department of Primary Industries is undertaking this project. The project commenced in January 1990. A summary of activities was prepared for the calendar year 1990. The following is a summary of the research activities undertaken by the Feedlot Services Group during 1991.

### 1 SURVEY OF AUSTRALIAN FEEDLOTS

In the last half of 1990, a survey was undertaken of the lot feeding industry in Australia. In total, we recorded 630 feedlots on a database and about 150 feedlots were surveyed. This represented about 50% of the pen capacity of the industry.

In 1991, a report was prepared outlining the findings of the survey (Report No. DAQ64/6 - Lot Feeding In Australia). The report included statistics on the size, history and growth of the industry; the geographical distribution of lot feeding; the climatic distribution and design and management data. The report also included a number of recommendations for further research that were identified during the survey.

About 80 copies of the report were prepared. The group distributed these to industry, MRC, industry groups, state departments of agriculture, state departments of environment and other interested parties. Following this distribution, there remained a strong demand for copies of the publication. Due to the number of colour photographs, it was not within the budget of the project to produce an unlimited number of copies. Hence, the report was reproduced as a saleable item by QDPI. Over 190 copies of the publication have been sold (Dec. 1991).

### 2 RESEARCH PRIORITIES

Following completion of the survey report, the findings were presented to FLAC (Feedlot Advisory Committee). The committee reviewed the report and the recommendations for further study. These recommendations were ranked in order of priority and forwarded to MRC.

### 3 ODOUR WORKSHOP

One of the aims of the project is to have research results obtained in odour studies incorporated into feedlot guidelines. Whilst this is a desirable outcome, it is quite difficult to achieve. This is due to the subjective and emotive nature of the issue of odour nuisance and the fact that odour measurement is a developing technology.

Before the odour data collected in the study will be accepted by consultants and regulatory authorities, there must be acceptance of the odour measurement and sampling procedures. In 1990, a discussion paper was prepared (Report No. DAQ64/5). We circulated this report to various authorities requesting comment. Little comment was received. Hence,

it was decided that it would be necessary to run a "hands-on" workshop at which the various parties involved in odour research and regulation could come together and discuss the issue of odour nuisance and odour technologies.

The workshop was conducted in February 1991. Representatives of all relevant regulatory authorities as well as consultants and researchers attended. There was one day of selected papers followed by two days of practical odour sampling and measurement experiments. This approach proved very successful with considerable frank and open discussion. Dr. John Sweeten also attended the workshop. He demonstrated the use of the 1-butanol olfactometer from Texas A & M University.

The proceedings of the workshop were prepared (Report No. DAQ 64/7) and forwarded to all participants and other interested parties. This is a very useful resource document outlining odour measurement. During the workshop, there were a number of television and radio interviews promoting the work being undertaken by the group.

A second workshop is planned for 31 Mar - 2 Apr 1992. This workshop will discuss odour measurement and odour emissions made at feedlots. The workshop will be open to lot feeders and local government officers as well as consultants, researchers and regulators.

## 4 ODOUR SAMPLING AND MEASUREMENT (DYNAMIC OLFACTOMETER)

In 1990, the project reviewed odour measurement technology. After consultation with various regulatory authorities, we decided to construct a mobile dynamic olfactometer using 8 panellists and a 3 port / forced choice odour detection system. This was constructed during late 1990 so that it was virtually complete by the Odour Workshop. During the Odour Workshop, various consultants and regulatory officers inspected the device. Following their comments, the device was modified.

One of the design criteria of the device was to be able to undertake the maximum number of tests per day. Hence, it was decided to have all 8 ports operating simultaneously rather than sequentially. This maximises the efficiency of the 8 panellists. Even so, only about 20 tests can be done in a day.

Selection of panellists is an issue with olfactometry. Using the Dutch standard as a basis, panellists should be between 18 and 40; should have an adequate sense of smell and should be trained. It was decided to develop a pool of "sniffers" amongst the students at the University of Southern Queensland. This system has worked well but intensive sniffing programs must coincide with university holidays. Hence, the group conduted sniffing trials in 1991 during the June, September and Christmas holidays.

The performance of any olfactometer relative to others is always a concern. At present, there is no Australian standard. There is a standard in Holland but even this does not ensure that all olfactometers produce the same odour intensity measurement for the same sample. To start to solve this problem, a committee has been established to conduct a series of laboratory tests amongst olfactometers in Australia. The Department of Environment and Heritage in Queensland is co-ordinating this committee. There are about a dozen devices in Australia of significantly varying age, cost and design sophistication. The aim of the test program is to produce sample bags of ammonia of known concentration and determine the odour intensity of these samples. This tests both the sensitivity and reproducibility of the

device. QDPI has participated in this test program. The results have shown that the QDPI olfactometer was quite sensitive but improvements could be made to reproducibility. Using this information, the olfactometer has been modified. The ammonia tests were repeated during the odour sniffing trial prior to Christmas 1991 as well as a number of butanol tests.

In addition to the olfactometer, an odour sampling system for emissions from extensive surfaces has been developed. Essentially, this is a portable wind tunnel which can be placed over the surface from which odours are to be sampled. Wind speed in the tunnel can be varied but for most cases to date, a standard speed of 1 m/s has been used. The wind tunnel is instrumented so that tunnel air temperature, tunnel humidity, surface temperature and tunnel wind speed can be logged into an automatic weather station. Odours can be sampled from the downwind end of the wind tunnel. Inlet air to the wind tunnel passes through a charcoal filter to remove background odours.

## 5 DOWNWIND DISPERSION OF ODOURS FROM FEEDLOTS

Much discussion at the Odour Workshop concentrated on the need to measure downwind dispersion of odours from a feedlot. The discussion also reinforced the difficulty in undertaking this work. It was agreed that this work should be attempted but that the results would have little meaning if the site was poorly chosen.

We developed a set of selection criteria in order to choose a feedlot at which downwind dispersion of odours could be undertaken. The criteria include:

(i) uniform topography surrounding the feedlot (no large hills, significant valleys, etc).

(ii) easy accessibility to receptor locations in all downwind directions.

(iii) regular pen layout (preferably a uniform square area of pens of identical design and use).

(iv) no complicating odour sources (e.g. nearby abattoir or piggery, no treatment ponds, no manure stockpile).

(v) established feedlot with well developed pen surface and constant usage.

(vi) close proximity to Toowoomba.

(vii) (preferably) cooperative neighbours who would assist in monitoring of odour frequency and intensity.

After some searching, a 500 head feedlot was located near Warwick which satisfies most of these criteria. We obtained permission from the owner to undertake sniffing at and around his feedlot. The site was then surveyed to obtain accurate pen dimensions and downwind distances. An automatic weather station was installed. By April, the site was ready for monitoring. However, by then the drought was established. Some odour measurements were undertaken at the feedlot but downwind odours could not be detected within even 100 m of the pens.

Should wet weather occur and if the olfactometer is concurrently available, downwind dispersion of odours will be measured with concurrent measurements of surface emission rates.

## 6 THE WELLCAMP TRIAL

Whilst it is obvious that odour measurements should be undertaken at and around commercial feedlots, we felt that an understanding of odour emission processes could be achieved only by designing an experiment in which as many variables as possible could be controlled. It was felt that the variables that would influence odour emission from a feedlot surface would include:

(i) pad moisture content
(ii) ration type
(iii) stocking density
(iv) climatic conditions.

It was felt that an experiment could be designed in which each of these variables could be controlled or, at least, kept constant during the experiment. It was decided to create a number of mini- feedlot pads (trays). They would all be created at the same site so that climatic influences on the pad would be identical. The trays were sited underneath a "rain-out" shelter. This is a large moveable cover which can be drawn across the trays to exclude rain. The feedlot pads in each tray were developed using faeces from cattle fed on 6 different rations collected in a previous animal feeding trial. These faeces had been extensively analysed (Report No. DAQ64/9) so that differences in odour emission between rations could be explained in terms of faeces characteristics. It is usually assumed that differences in odour emissions between different rations are mainly due to differences in the percentage of grain which the animal digests (more undigested grain results in more odour). However, there may be other explanations. Differences in the concentrations of metals and some other elements may affect the rate of anaerobic digestion of the manure (inhibitory effect) or may affect the chemical composition of the gases emitted (character effect). Extensive analyses of the faeces were undertaken to determine if there were any significant elemental differences in the faeces samples which may explain some odour differences (Report No. DAQ64/22).

We added faeces and urine to the trays at a constant rate (equivalent to 10 sq.m/beast stocking rate) and compacted the trays to represent, as much as possible, a commercial feedlot. An automatic weather station was installed to record the climatic conditions during pad development. After about two months of pad development, the 18 trays were ready for sniffing.

During a two week period in June, the trays were repeatedly sniffed. Initially, the trays were dry and odour emissions were low. Faeces was then added and the equivalent of 25 mm of artificial rain was applied. Odour emission increased substantially reaching a peak two days after application of the rain. In some cases, the wet pad emission was 50-100 times larger than the dry pad emission. There also appear to be differences between the odour emitted from faeces resulting from different rations. Unfortunately, it is difficult to completely interpret the data since there are additional influences on odour emission. These appear to include:

(i) degree of pad disturbance
(ii) time of day
(iii) pad temperature

(iv) pad BOD status
(v) pad Ph
(vi) tunnel wind speed.

We repeated the experiment in September but poor weather conditions and a problem with the odour sampling equipment meant that the results obtained were of limited value. A report is being prepared on this experiment (Report No. DAQ64/11). Importantly, it highlights the implications for testing odours in a commercial feedlot due to this wide range of odour generation variables.

## 7 ODOUR MEASUREMENT AT A COMMERCIAL FEEDLOT

The research at Wellcamp has provided experience with the operation of the olfactometer and the wind tunnel and valuable information about the factors which influence odour generation. This experience and information was necessary before attempting to measure odour emissions at commercial feedlots. Any field measurements made prematurely would have been costly and may have yielded useless data as well as inducing a lack of confidence in the work from industry.

During November-December 1991, a series of odour measurements were made at a commercial feedlot. The objectives were to collect data on emission rates from wet and dry pens; measure the diurnal variation in odour emission and measure some ambient concentrations at the feedlot and down wind. It was also proposed to evaluate other odour measurement techniques (1-butanol olfactometer, COSMOS olfactometer) concurrently with the dynamic olfactometer.

Considerable data were collected during this trial. These are currently being analysed and evaluated. A report will be prepared (Report No. DAQ64/21). These data will be presented at the proposed odour workshop (April 1992).

## 8 ODOUR IMPACT SURVEY

Apart from the use of the dynamic olfactometer, other ideas were pursued to try to confirm and/or develop feedlot odour guidelines. One idea was to conduct a survey of the impact of feedlot odours on neighbours. The survey would be conducted around selected feedlots. All neighbours would be interviewed and their responses would be collected on a survey form. The objectives were to:

(i) determine the odour impact of the feedlot on the person by developing a rating which included the frequency of occurrence, the duration of persistence, the intensity of the odour and the offensiveness. Clearly, such an assessment would be a subjective assessment by the neighbour and may reflect issues other than odour. Nevertheless, we felt that with careful selection of questions and surveying of ALL neighbours, individual bias could be contained.

(ii) determine the location of the neighbour with respect to the feedlot and the acceptability of that location in terms of existing guidelines.

(iii) correlate odour impact and location and determine whether current guidelines provide adequate or excessive protection from odour nuisance.

Whilst accepting that there would be deficiencies with this approach, it was seen as providing useful and rapid support to the other long term odour measurement work. The group developed a detailed survey form and circulated this to some regulatory authorities and to industry.

The concept was generally accepted by the regulatory authorities but received poor support from industry. Hence, it was decided not to proceed with this work. No surveys have been undertaken.

## 9 NATIONAL FEEDLOT GUIDELINES

For some time, industry has wanted to develop a set of feedlot guidelines that had national acceptance. Hence, we conducted a workshop to start the process of development of these guidelines.

Members of the Feedlot Services Group have had a significant input to this process. Members were on the organising committee; participated at the workshop including the presentation of the position paper on the environmental impact of cattle feedlots (Report No. DAQ64/8) and have participated in the preparation of various sections of the guidelines (data requirements for feedlot applications, environmental objectives and guidelines and monitoring requirements).

All parties agreed that the incorporation in the guidelines of certain formulae or methods (with particular reference to odour and separation distances) could only occur if there was a solid scientific basis to that aspect. There is a willingness to adopt new guidelines but a significant lack of suitable data. This attitude is reflected in the latest draft of the guidelines which notes that:

> "Unfortunately, minimum odour separation distances cannot be predicted accurately for new feedlots yet. Experience with existing feedlots though would indicate that large feedlots may need to be separated from sensitive receptors by distances of up to 10 km or more depending on feedlot size, management practices, topography and climate."

The Queensland Department of Primary Industries is developing a predictive formula for calculating minimum odour separation distances. When its quantitative parameters have been further refined, it may form a suitable basis for a national formula."

## 10 HYDROLOGICAL INVESTIGATIONS

In 1990, four feedlot catchments were instrumented with weather stations and flumes were installed at three of these feedlots. The weather station at the feedlot without a flume was subsequently removed in 1991. The group now uses this station in conjunction with the odour studies to concurrently log climate and odour sampling data.

The period following the installation of the hydrological equipment has coincided with a very severe drought caused by the "El Nino" effect. Figs 1 and 2 show the rainfall recorded in Toowoomba and Dalby respectively during this period. (Toowoomba is centrally located amongst the three feedlots.) In January/February 1991, there were a few storms and at two of the three feedlots there was some runoff. Since then, there has been below average rainfall. Hence, no runoff has occurred. Predictions by meteorologists are that below average rainfall will persist until at least March 1992 and may even continue through 1992 until March-May 1993.

The runoff has resulted from several isolated intense storm events. The feedlot pen area was dry at the time of the rain. No runoff has occurred from the feedlots over a wet summer where a series of storms would be normal and the pad would often be wet. Similarly, runoff has not occurred due to persistent rainfall events. Such "general" rains usually fall in the autumn and winter periods. It is important to obtain data from as a wide a range of hydrological circumstances as possible.

This drought highlights the problem of running a hydrological investigation over a short time period (2 years). This period is too short to obtain representative data.

The data from the runoff studies will be used to calibrate the Simulation model (see Section 12). In particular it is required to determine the parameters of the wetting and drying cycle for the pad, and thus moisture content of the pad. This relationship is directly related to the prediction of odour generation events. It is also required to determine the amount of runoff that the feedlot yields under different conditions. Such information is needed to allow the appropriate sizing of retention ponds or indeed, the possible use of other drainage systems.

Over the past 12 months, the group has regularly serviced and maintained the research sites. This has required considerable effort for which little data was collected. Software for the analysis of the data has been developed during the year.

## 11 RAINFALL SIMULATOR TRIALS

In order to overcome some of the limitations of the drought, the group decided to conduct some rainfall simulator trials. In these trials, rainfall was artificially applied to feedlot pads of different slope and surface condition. We recorded runoff volumes and timing from a 1 m x 2 m plot using several different rainfall intensities.

The data collected in these trials will complement the data collected in the long term hydrological monitoring program and will be used to refine the simulation model.

## 12 FEEDLOT SIMULATION PROGRAM

The group has started developing a feedlot runoff simulation model. This is essentially a water balance model which uses historical rainfall data and predicts runoff events and subsequently, the frequency of pond overflows. It contains a simple irrigation model used to dispose of the effluent from the retention pond.

In its present form, the model can examine hydrological balances only. As such, it routinely predicts the moisture content of the feedlot pad. However, when the relationships between pad moisture content and odour emission rate can be defined, the model can be used to predict frequency and intensity of odour emissions. Similarly, when data become available on the quality of feedlot runoff (nutrient levels, salt levels), it can be used to evaluate nutrient cycles in the land disposal areas. This will require the inclusion of a crop growth model such as PERFECT.

The uses of the model are wide and varied. At present, it can be used to evaluate the hydrological performance of feedlot designs. For example, a feedlot could be designed according to an existing guideline. The model can then be run and the actual performance of the design can be evaluated. This exercise has clearly shown that many existing guidelines are inadequate and will result in pond overflow frequencies greater than may be expected (Report No. DAQ64/13). The model can also evaluate the change in performance resulting in changes to stocking density, pen cleaning frequency and other management factors.

When the odour generation relationships are established, the model can be used to evaluate the change in odour generation associated with changes in management practices. Ultimately, such a model could be used to modify feedlot guidelines.

## 13 GROUNDWATER INVESTIGATIONS

Following the inability to obtain further funding for groundwater research from AWRAC, a reduced groundwater research program was initiated. The essential elements of this program were:

(i) prepare a thoroughly researched literature review and present a position paper on the issue.

(ii) undertake limited monitoring of groundwater quality in the vicinity of two commercial feedlots.

It was agreed that the CSIRO Centre for Groundwater Studies would undertake the literature review and prepare the position paper. This paper would:

(i) review the areas of concern for groundwater contamination.

(ii) review mechanisms and sites at a feedlot where groundwater pollution could be initiated.

(iii) review US, European and Australian experience with intensive livestock industries.

(iv) provide recommendations for regulatory authorities on siting of feedlots and reasonable methods for site assessment.

(v) provide recommendations for lot feeders on design and management options to reduce the likelihood of pollution occurring.

(vi) review future research needs.

This report will be available early in 1992.

After discussions with CSIRO and Qld Water Resources Commission, two feedlots were chosen for groundwater monitoring. The sites were chosen because they were permanent commercial feedlots located over two different geological strata. One is located over a sedimentary area with much of the land disposal areas quite sandy. The other site is located over a fractured basalt which has a shallow soil cover. These sites were chosen because they represent the major areas of concern for the Qld. Water Resources Commission.

A detailed hydrogeological assessment was undertaken of each site.In one case, it took until June 1991 to obtain permission to install a series of observation bores. These are now in place and soil and water analyses have been undertaken. Details can be found in Pavelic et al. (1991). At this site, the shallow aquifers are dry (due to the severe drought) and this will curtail continued monitoring until significant rainfall occurs. When sufficient rainfall occurs to cause the shallow aquifers to run again, water quality sampling will be undertaken. At the second site, permission was only obtained to install observation bores in November 1991. One issue at this site is that the hydrogeological assessment revealed nitrate levels in some bores in the vicinity of the feedlot which were in excess of WHO limits for drinking water. There are various sources of contamination in the area such as old dairies, septic systems and/or excessive use of inorganic fertilisers in broadacre agriculture. However, there is insufficient information currently available to determine whether or not the feedlot has contributed to the nitrate levels.

## 14 MANURE ACCUMULATION INVESTIGATION

Manure accumulation studies are currently being conducted on a Darling Downs feedlot. We selected four empty adjacent pens. The pens were cleaned and fifteen metal plates (30 cm x 30 cm) per pen were buried such that they were just below the interface layer. The depth of manure which has accumulated above each plate is measured fortnightly (if high priority work commitments permit). At the time of measurement the moisture content of the manure is also measured. Some bulk density determinations have also been carried out. These studies will provide data on the actual rate of manure accumulation on a pad allowing for normal decomposition processes. Details of the bulk density of each layer of feedlot pad will also be available. The data will also provide an indication of how much manure swells as a result of increased moisture content. This will be useful when explaining to producers the importance of regular pen cleaning and understanding the dynamics of the pad for odour studies.

## 15 EXTENSION MATERIAL

During the year, the group has produced extension material on feedlot waste management and related topics. In particular, the group has produced a series of 11 farmnotes on feedlot waste management. The farmnotes were developed using a combination of information from the USA collected during the literature review and the best ideas collected from Australian feedlots during the feedlot survey. The farmnote titles are:

| | |
|---|---|
| No. 1 | Manure Production Data |
| No. 2 | The Feedlot Pad |
| No. 3 | Pen Cleaning (Manure Harvesting) |
| No. 4 | Design Concepts to Aid Cleaning |
| No. 5 | Mounding in Yards |
| No. 6 | Attention to Detail |
| No. 7 | Temporary Storage of Manure |
| No. 8 | Dust Control |
| No. 9 | Fly Control |
| No. 10 | Using Weather Conditions |
| No. 11 | Disposal of Carcasses |

Articles based on these farmnotes have been reproduced in industry magazines. Additional extension articles are attached.

A start has been made on a set of standard plans for cattle feedlots. These plans will be issued both as hardcopy (Farmnotes or a booklet) and as AutoCad files for consultants who may wish to use some of the ideas. The plans will cover many aspects from overall feedlot layouts to pond and drain designs to fencing details.

## 16 QUEENSLAND FEEDLOT MANAGEMENT PROJECT

The Queensland Feedlot Management Project is an initiative of the QDPI. It aims to improve the profitability and sustainability of lot feeding in Queensland. It has five main components, viz, animal performance, animal health, marketing and economics, waste management and licensing.

The Feedlot Services Group has had a major input to this project. This project represents the major extension vehicle to lot feeders for the group's research output.

Apart from the preparation and distribution of a series of Feedlot Waste Management Farmnotes, the group gave presentations on waste management at 9 field days organised as part of the Feedlot Management Project. The agenda for these field days is attached.

These field days were particularly successful. Over 600 farmers and other interested parties attended. The waste management presentations were well received as they emphasised the relevant environment issues and presented cost effective and practical means for minimising environmental impact.

Reports from the feedlot licensing group within QDPI would indicate that acceptance of many of the waste management techniques following their presentation at the workshops has been high.

## 17 PUBLICITY

The group has actively sought publicity for the project so that the general public is aware that the issue of feedlot waste management is being addressed. Some of the written publicity about the group is attached. In addition, a number of television interviews have been conducted.

## 18 SEMINARS, CONFERENCES AND EXTENSION ACTIVITIES

Throughout the year, members of the Feedlot Services Group have attended numerous seminars and conferences, addressed various workshops and conducted various tours to feedlots. The specific activities have been as follows.

| | |
|---|---|
| February 18-22 | Visit by Dr. John Sweeten - review of work to date. |
| February 19-21 | Workshop on Agricultural Odours |
| April 17 | Meeting and tour with SCA - APA committee |
| May 5 | Address to ALFA Council meeting on progress to date |
| | Presentation of feedlot waste management techniques to Key Local Authorities in S.E. Queensland. |
| June | National Feedlot Guidelines Workshop |
| July 24 | Address to joint meeting of Australian Institute of Agricultural Science and the Society for Engineering in Agriculture |
| September 2-4 | FARMFEST display including inspection of olfactometer by the Minister for Primary Industries |

## 19 REPORTS AND OTHER PUBLICATIONS

The following is a list of reports and other publications arising from this project that the group has published during the year and reports that are still in progress but are expected to be finished early in 1992.

Cleary, C.D. (1991) "An Investigation of the Physical Characteristics of a Feedlot Pad", Univ. College of Southern Qld, Student Report, Nov 1991, 53 pp.

Dean, M. (1991) "Odour Nuisance as a Regulatory Problem" in Proc. of a Workshop on Agric. Odours, Toowoomba, Feb. 1991, AMLRDC Report No. DAQ64/7, pp 9-15.

Dillon, P.J. (1991) "Feedlots and Nitrate Contamination of Groundwater" in Proc. of Groundwater Workshop, Toowoomba, June, 1990, (Ian Kelly, Ed.)

Jones, M. (1991) "Design Considerations for Dynamic Olfactometers" in Proc. of a Workshop on Agric. Odours, Toowoomba, Feb. 1991, AMLRDC Report No. DAQ64/7, pp 49-69.

Jones, M. and Watts, P.J. (1992) "The Design and Operation of a Dynamic Olfactometer" MRC Report No. DAQ64/17 (in progress)

Kaye, R.B. (1991) "The Development of Olfactometry Techniques and Standards in the Netherlands" in Proc. of a Workshop on Agric. Odours, Toowoomba, Feb. 1991, AMLRDC Report No. DAQ64/7, pp 29-35.

Lott, S.C. (1992) "Hydrological Investigations of Three Cattle Feedlots in S.E. Queensland" MRC Report No. DAQ64/14 (in progress)

Lott, S.C. (1992) "Feedlot Runoff Parameters Determined using Rainfall Simulators" MRC Report No. DAQ64/15 (in progress)

Mazzone, J., Dillon, P.J. and Pavelic, P. (1991) "Impact of Feedlots on Groundwater Quality: Case Studies and Control Methods", Centre for Groundwater Studies Report No. ??, ?? p.

McPhail, S.M. (1991) "Modelling the Dispersion of Agricultural Odours" in Proc. of a Workshop on Agric. Odours, Toowoomba, Feb. 1991, AMLRDC Report No. DAQ64/7, pp 85-88.

Ormerod, R.J. (1991) "Modelling Emissions and Dispersion of Feedlot Odour: A Case Study" in Proc. of a Workshop on Agric. Odours, Toowoomba, Feb. 1991, AMLRDC Report No. DAQ64/7, pp 89-108.

Pavelic, P., Dillon, P.J. and Evans, P.A. (1991) "Evaluation of the Potential for Groundwater Contamination at a Cattle Feedlot in the Moreton Region", Centre for Groundwater Studies Report No. 38.

Smith, R.J. (1992) "Dispersion of Odours from Ground Level Agricultural Sources" submitted to J. Agric. Engng Res.

Smith, R.J. (1992) "The Prediction of Feedlot Odour Emissions from Downwind Measurements of Odour Concentration", submitted to the 5th AG ENG Conf., Upsalla, Sweden.

Steiner, J.W. (1992) "An Interim Report on Establishing a Link Between Metals in Feedlot Manure, Feed Rations, Odour Intensities and Odour Offensiveness" MRC Report No. DAQ64/22 (in progress)

Torre, P. (1991) "Odour Flux Determinations using the Odour Flux Hood" in Proc. of a Workshop on Agric. Odours, Toowoomba, Feb. 1991, AMLRDC Report No. DAQ64/7, pp 73-84.

Tucker, R.W., Watts, P.J., Lott, S.C. and Jukes, P. (1991) "Lot Feeding in Australia - A Survey of the Australian Lot Feeding Industry", AMLRDC Report No. DAQ64/6

Tucker, R.W., Watts, P.J., Lott, S.C. and Jukes, P. (1991) "Lot Feeding in Australia - A Survey of the Australian Lot Feeding Industry", Qld. Dept. Prim. Indus., Information Series QI91019, Brisbane.

Tucker, R.W., Lott, S.C. and Watts, P.J. (1992) "The Effect of Ration Type on the Performance and Faecal Characteristics of Feedlot Cattle", MRC Report No. DAQ64/9 (in progress)

Tucker, R.W. (1992) "Characteristics and Accumulation Rates of Manure in a Cattle Feedlot" MRC Report No. DAQ64/16 (in progress)

Verrall, K.A. and Williams, R.L. (1991) "Queensland Regulatory Experience in the Sensory Measurement of Odours Using Dynamic Olfactometry" in Proc. of a Workshop on Agric. Odours, Toowoomba, Feb. 1991, AMLRDC Report No. DAQ64/7, pp 37-47.

Watts, P.J. (Ed.) (1991) "Agricultural Odours" - Proceedings of a Workshop on Agricultural Odours" AMLRDC Report No. DAQ64/7

Watts, P.J. (1991) "Characteristics of Agricultural Odours" in Proc. of a Workshop on Agric. Odours, Toowoomba, Feb. 1991, AMLRDC Report No. DAQ64/7, pp 17-28.

Watts, P.J. (1991) "Environmental Impact of Cattle Feedlots - Discussion Paper", (presented at the National Feedlot Guidelines Workshop), AMLRDC Report No. DAQ64/8

Watts, P.J., Jones, M., Tucker, R.W., Lott, S.C. and Fennell, S.J. (1991) "The FARMFEST Experiment - An Evaluation of the Ability of the Population to Identify Agricultural Odours" MRC Report No. DAQ64/10

Watts, P.J., Jones, M.J., Tucker, R.W. and Lott, S.C. (1992) "Factors Influencing the Generation of Odour from Cattle Feedlots" MRC Report No. DAQ64/11

Watts, P.J., Jones, M., Smith, R.J. and Fennell, S.J. (1992) "Evaluation of the 1-Butanol Olfactometer as a Research and Regulatory Device for Feedlots in Australia" MRC Report No. DAQ64/19 (in progress)

Watts, P.J., Jones, M., Smith, R.J. and Fennell, S.J. (1992) "Evaluation of the Cosmos Odour Concentration Meter as a Research and Regulatory Device for Feedlots in Australia" MRC Report No. DAQ64/18 (in progress)

Watts, P.J., Jones, M., Smith, R.J. and Smith, J. (1992) "Objectionability of Feedlot Odours" MRC Report NO. DAQ64/21 (in progress).

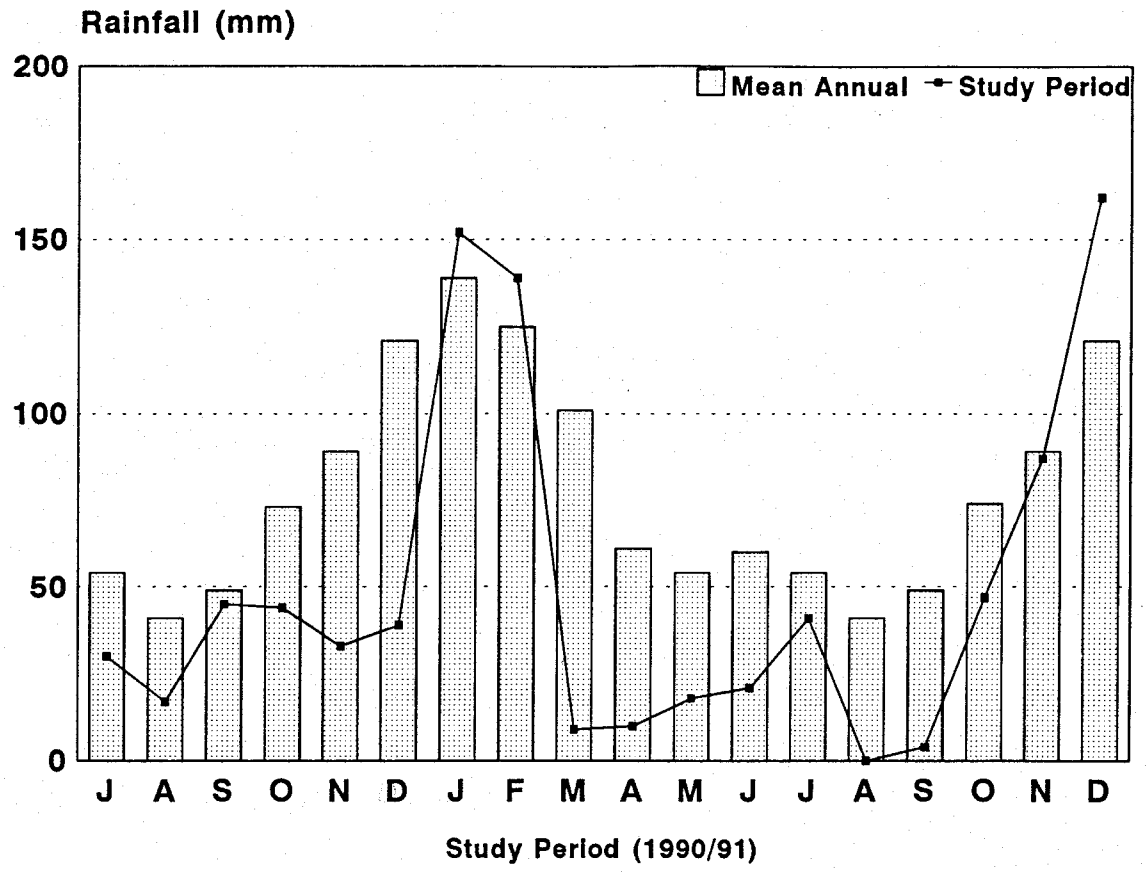



**Fig 1 - Rainfall during Study Period (Toowoomba)**

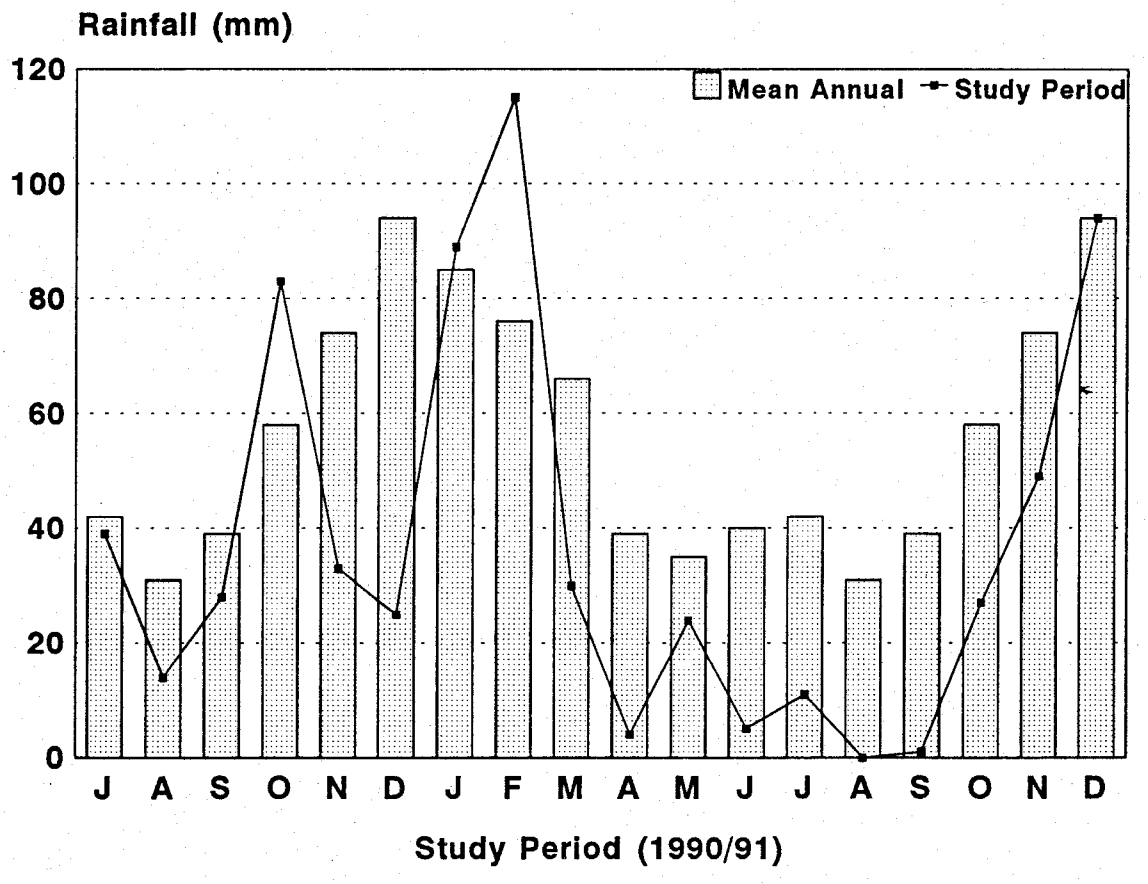



**Fig 2 - Rainfall during Study Period (Dalby)**

# Uni students put their sniffing talents to use

Australia's first sniffer van, a specially equipped caravan that will help make feedlots less smelly for neighbours, has passed its field test with flying colours.

The van's designer, agricultural engineer Mr Mike Jones, developed it as part of a research project to reduce offensive agricultural odours, particularly feedlot smells.

The van was needed because agricultural odours are so complex that they cannot be measured by chemical analysis. This means human noses, not machines, are used.

Mr Jones, employed by the University College of Southern Queensland (UCSQ), works with the Department of Primary Industries (DPI) Feedlot Services Group. Part of the group's role is to tackle agricultural smells.

In its first field outing at Wellcamp, the van, its complex equipment and the noses of eight USCQ students were used to find the effects different feeds and moisture levels on smells.

The results pointed to moisture rather than the type of feed used in a feedlot as the culprit in creating an offensive odour.

In the trial, eight panellists were asked to sniff samples about 2000 times during the two weeks. The students needed no particular qualifications other than a sense of smell.

The material to be tested was collected in a plastic bag. Each smell was diluted a number of times with different amounts of air and distributed to the panel members through a web of pipes and hoses. The panellists indicated their selection by pushing one of three buttons that fed results directly into a computer for analysis.

An objective measure of the odour strength was obtained when half the panellists could not accurately identify from which of three outlets the smell was coming.

There are a number of checks to ensure the accuracy of the measurements. For each test, each panellist sniffs three ports, two of which have no smell. The panellists must choose one of the ports as being the source of a smell. The ports with the smell are randomly switched according to a computer program.

In other tests, the panellists were asked to indicate the offensiveness of various smells.

Mr Jones says the van is the only smell test system in Australia that can process the results from eight panellists simultaneously.

He sees research, not dispute settlement, as the major use for the van. By identifying problem spots and practices in feedlots, the smell nuisance for neighbours can be reduced.

The research is being funded until next year by the Australian Meat Livestock Research and Development Corporation.

Mike Jones in the "sniffer van" for detecting and measuring feedlot odours.

# Seminar on feedlots

Co-ordinator of the Queensland Feedlot Management Project and Department of Primary Industries regional manager Jim Cavaye with "Wainui" feedlot manager Phil Myers (right) during a visit by participants in the Toowoomba feedlot seminar.

The seminar was one of a series organised in southern and central Queensland to provide information on feedlot management and design.

The Toowoomba seminar attracted a capacity audience to hear specialist speakers cover all aspects of lot feeding including nutrition, animal health and welfare, waste management, licensing and regulations, economics and marketing.

Seminars still to be held are at Emerald today, Warwick (June 18), Wondai (June 19) and Biloela (June 20).

# Workshops on feedlots

A series of feedlot workshops will be launched in Toowoomba tomorrow by Department of Primary Industries (DPI) Director-general Mr Jim Miller.

The workshops, starting on Wednesday, will cover aspects of lot feeding such as animal health and welfare, waste management, licensing, regulations, nutrition, economics and management.

Lot feeding is a growing but sometimes controversial industry now worth $520 million a year in domestic and export sales.

Queensland has 600 feedlots — 75% of the national total — with a total of 220,000 head, and most of them are on the Darling Downs or in surrounding areas.

The nine workshops over the next fortnight are expected to be attended by representatives of the grazing industry, lot feeding, DPI, business and politics.

The launch is at the Burke and Wills Hotel tomorrow at 9.45 a.m. After the Toowoomba workshop there will be others at Dalby (June 7), Goondiwindi (June 11), Condamine (June 12), Roma (June 13), Emerald (June 14), Warwick (June 18), Wondai (June 19) and Biloela (June 20).

More information is available from the DPI Beef Cattle Husbandry Branch on 31 4200.

# Survey finds feedlots improving their image

A department of Primary Industries survey has found a "clear trend" towards better design and management of feedlots.

"This should lead to a reduction in the impact of feedlots on their neighbours and the environment," the survey found.

DPI director-general Mr Jim Miller this week launched *Lot Feeding in Australia, a survey of the Australian lot feeding industry*, compiled by four members of the department's Feedlot Services Group.

It is one of the resource materials for a series of workshops being conducted under the Queensland Feedlot Management Project.

The first was in Toowoomba yesterday with one at Dalby today, Goondiwindi (June 11), Condamine (June 12), Roma (June 13), Emerald (June 14), Warwick (June 18), Wondai (June 19) and Biloela (June 20).

The survey says the Australian feedlot industry began on the Darling Downs in the early 1960s, and, except for 1975-76, has expanded since.

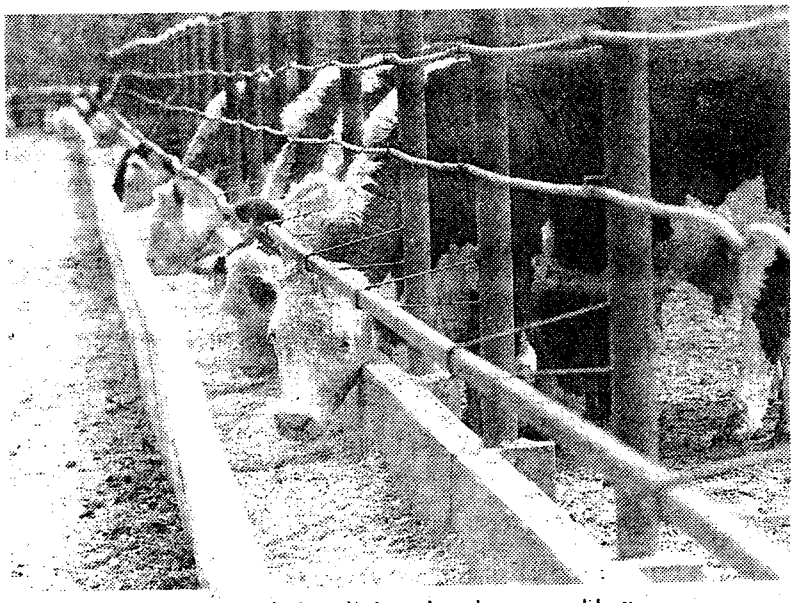
Queensland has about 75% of 630 feedlots in Australia but only just over half of the 485,000 head, which could more than double under current expansion plans.

Beef City, near Toowoomba, is listed as the nation's largest with 25,000 head as at December last year, followed by Whyalla, Texas, with 20,000 and Charlton, Victoria, 18,000.

Other major feedlots listed on the Downs and nearby areas are: Aronui, Dalby, 10,000 head; Lilyvale, Condamine, 5300; Sandalwood, Dalby, 5000; Wide Bay, Kilkivan, 5000; Kurrawong, Quinalow, 4000.

The survey also has 20 recommendations covering industry issues such as design and layout, relationship between stocking and annual rainfall, odour control, effluent disposal by irrigation and climate.

The book is available from QDPI Publications, GPO Box 46, Brisbane 4001 (phone 07 239 3100; fax 07 239 3760) for $50 plus $7.50 handling costs.



Feedlots are being designed and managed better.

# FEEDLOT WASTE MANAGEMENT PROGRAM

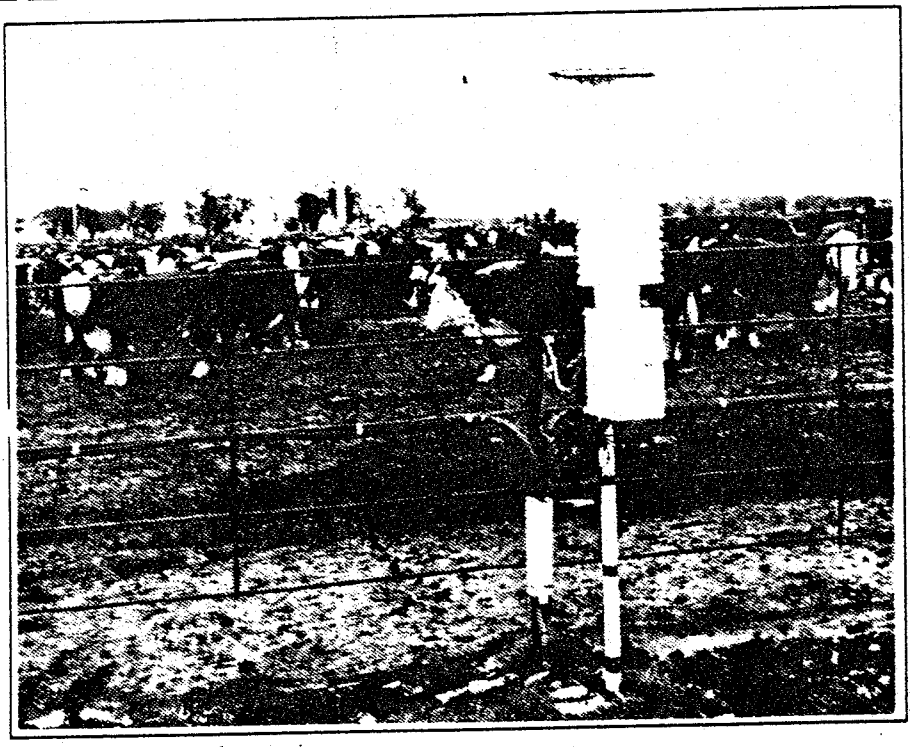
*By Peter Watts, QDPI, Toowoomba*

**LOT feeding continues to be an expanding industry.**

With depressed grain prices and the liberalisation of the Japanese market, the outlook for the industry remains sound. Regulatory authorities in Queensland and New South Wales are faced with a number of applications for large feedlots [20,000 to 30,000 head]. The main impediment to the rapid development of these proposals is concerns about environmental issues, the main issues being odour and water pollution.

With funds provided by the Australian Meat and Livestock Research and Development Corporation, the Queensland Department of Primary Industries has instigated a major research program on feedlot waste management. There are five staff based in Toowoomba working on a wide range of projects.

Hydrology is the study of the relationship between rainfall and runoff. In order to understand feedlot hydrology in Australia, a number of feedlot catchments have been instrumented. Automatic weather stations have been installed to measure rainfall, rainfall intensity, evaporation, pen moisture content and other meteorological data. Stainless steel flumes have been installed to measure the quantity and flowrate of runoff coming from the catchments.



*An automatic weather station*

The feedlots chosen are in different rainfall zones, have different designs and layouts and styles of management. Data collected in these studies will be used to improve design methods and regulatory guidelines.

Odour research is very difficult. The problem is that the only sensor available to measure odours is the human nose. However, this sensor is quite variable in its response to different odours. In order to obtain valid results, a panel of eight "sniffers" is required. The QDPI has built a device - an olfactometer - to supply odours at different concentrations to eight panellists so that feedlot odours can be evaluated.

The first odour trial is the effect of feedlot ration and preparation methods on odour generation. Many lot feeders claim sorghum causes worse odours than barley and steam flaking reduces odour generation.

Furthermore, a number of companies are marketing feed additives that are claimed to control odours. To date, no scientific evaluation of these claims has been made.

Trials are currently under way in which cattle are being fed six different rations. The manure collected from cattle on different rations will initially be analysed to determine if they are significantly different. The second phase of the experiment will be to use collected manure to create small feedlot pads and to collect and measure the odour.

The work being undertaken by the research section of the Feedlot Services Group will be of use to feedlot managers, regulatory authorities and, ultimately, neighbours of feedlots. With this information, the orderly development of the industry will be ensured.

# Seminar sniffs out ways of gauging smells

**By Rural Editor KERRY WHITE**

It was noses to the grindstone at a Toowoomba conference this week.

An agricultural odours workshop organised by the Feedlot Services Group of the Department of Primary Industries (DPI) attracted researchers, representatives of regulatory authorities and industry and private consultants.

They included Dr John Sweeten, an agricultural engineer from Texas A & M University in the United States, a world authority on feedlot odour management and a consultant to the Australian Meat and Livestock Corporation.

Feedlot Services Group head Dr Peter Watts said the aim of the workshop was to exchange information on ways of collecting and measuring agricultural odours, a growing community problem.

The program included a visit yesterday to a Darling Downs cattle feedlot to try out olfactometers (devices for measuring odours), including a 1-Butanol Olfactometer developed by Dr Sweeten and another developed by the DPI.

While guidelines for the growing feedlot industry in Australia have only been developed recently, Dr Sweeten said regulations had been in force in the US since the mid-1970s.

New feedlots had to use the best — "rolling state-of-the-art" — technology available at the time of development.

More than nine million cattle were in feedlots of more than 100,000-head capacity in the US, compared with a total of around 500,000 in Australia, the biggest less than half the size of US ones.

More odour complaints in the past two years had been from dairy farms than from feedlots and the "swine industry has more cases go to litigation".

Mr Michael Dean from the New South Wales Pollution Control Commission told the conference comprehensive new measures covering odour and including feedlots would be introduced in a legislation to establish an Environmental Protection Authority in that State.

"Assessing and abating odours is the most difficult challenge facing us," he said.

"We are being pressed by complainants to do something about odours that have been around for years but have intensified. Buffer zones are the only real solution."

Dr Watts said the DPI believed it would be able to significantly reduce the frequency of odours affecting neighbours of feedlots.

"We believe we can make a major impact by reducing what may be (a nuisance) for, say, 200 days a year to 10 days caused by rain, etc.

"If that level is acceptable we may have achieved something."

The conference, which began on Monday afternoon, ends today.

Dr John Sweeten, world authority on feedlot odour management.

Measuring odour levels at a Darling Downs feedlot yesterday are Department of Primary Industry officers Stephen Fennell (left) and Michael Jones, an engineer on secondment from the University College of Southern Queensland using an olfactometer from Texas in the United States.

Farm Forum Kerry W

# Expert noses on the scent

While an odour workshop may not have mass appeal, the ideas has proved a drawcard to a national audience of professionals interested in collecting, measuring and controlling agricultural smells.

The Odour Workshop, organised by the head of the DPI's Feedlot Services Group, Dr Peter Watts, has attracted 30 invited professionals from throughout the country.

It starts in Toowoomba on Monday and finishes on Thursday.

Dr Watts said an aim of the workshop was to exchange the latest information on ways of collecting and measuring agricultural odours, which were a growing community problem.

The invited delegates include researchers, regulatory officers, relevant Government officers and a few private consultants.

Keynote speaker is Dr John Sweeten, an agricultural engineer at the Texas A & M University, who is also a consultant to the Australian Meat and Livestock Research and Development Corporation and a recognised world authority on feedlot odour management.

The workshop will include presentations on the characteristics of odours, how to sample and measure them and how to predict where they spread.

On Wednesday, the group will visit some Downs feedlots to sample and measure odours.

There will be opportunities for interested delegates to try out an olfactometer, an instrument used to measure smells.

The Feedlot Services Group was established partly to research feedlot odours and their nuisance impact on neighbours.

# Queensland feedlot industry now set for huge expansion

**By Rural Editor KERRY WHITE**

Feedlot cattle numbers in Queensland could more than double, if applications for new operations are successful.

According to a Department of Primary Industries survey, the State now has 471 feedlots with a capacity of 262,200 head and applications for new ones or for expansion could boost this to 484 with 657,240 head.

But the survey says many of these will not come to fruition, explaining that the Australian Lot Feeders' Association (ALFA) uses a yardstick of 50% for the proportion expected to eventuate.


Department of Primary Industries Director-general Mr Jim Miller (right) and Australian Lot Feeders' Association vice-president Mr Kev Roberts at the launch of the Queensland Feedlot Management Project.

The survey shows Queensland has 75% of feedlots in Australia but only 54% of capacity while New South Wales has 14% of feedlots and 25% of capacity.

The book detailing results of the survey was launched in Toowoomba yesterday by DPI Director-general Mr Jim Miller as part of the Queensland Feedlot Management Project.

As part of the project a series of seminars starting in Toowoomba tomorrow will be conducted in Central and Southern Queensland.

Mr Miller said to gauge the implications of the industry, the multiplier effects on sectors such as graingrowing, transport and store cattle production needed to be looked at.

The Queensland industry was using 350,000 tonnes of grain a year, 40% of barley and 20% of sorghum, and spent $225 million on grain and other feed requirements.

It was important as a value-added industry and earnt $420 million a year in exports and $100 million domestically.

It demonstrated the "essence of value-adding", turning grain worth 50¢ into a product worth $2.50.

ALFA vice-president Mr Kev Roberts said the industry had a "history of volatility" and was one of "high input and high risk".

Many people had pinned their hopes on feedlotting to save the ailing grain industry.

With the assistance of the DPI the industry's image had improved but "there is still a way to go".