on farm

Improving cost-effectiveness of supplementation systems for breeder herds in northern Australia

Project number DAQ.098
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Foreword

This Final Report was written with consideration of several objectives.

- Firstly it was prepared to meet commitments to the Meat Research Corporation in relation to its partial funding of the project.
- Secondly it is a documentation and collation of the technical reviews and research which was conducted for Project DAQ.098.
- Thirdly it is intended to provide the first level of analysis and interpretation of the experimental results, and thus provide an initial report of the technical findings of the project.

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Abstract

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Summary:

Low level strategic supplements constitute one of the few options for northern beef producers to increase breeder productivity and profitability. Objectives of the project were to improve the cost-effectiveness of using such supplements and to improve supplement delivery systems. Urea-based supplements fed during the dry season can substantially reduce breeder liveweight loss and increase fertility during severe dry seasons. Also when fed during the late wet season these supplements increased breeder body liveweight and increased fertility of breeders in low body condition. Intake of dry lick supplements fed free choice is apparently determined primarily by the palatability of the supplement relative to pasture, and training of cattle appears to be of limited importance. Siting of supplementation points has some effect on supplement intake, but little effect on grazing behaviour. Economic analysis of supplementation (urea, phosphorus or molasses) and weaning strategies was based on the relative efficacy of these strategies to maintain breeder body condition late in the dry season. Adequate body condition of breeders at this time of the year is needed to avoid mortality from under-nutrition and achieve satisfactory fertility of breeders during the following wet season. Supplements were highly cost-effective when they reduced mortality, but economic returns were generally low if the only benefit was increased fertility.

Executive

Summary

1. Executive summary

1.1 Background

Undernutrition is clearly the principle cause of the generally low productivity of the breeder herd in the dry tropics of northern Australia; on average branding rate is only about 60% and breeder mortality is about 10% per annum. Where disease control is effective, usually the most important factor reducing fertility of *Bos indicus* cross herds is the interval for the breeder to become pregnant again following calving. The general relationships between liveweight (or body status) of lactating breeders and their fertility are well known, and low breeder liveweight during lactation is one obvious reason for low breeder fertility. In addition short-term changes in nutrition during late pregnancy or during lactation may also substantially modify fertility. The efficacy of supplements to alleviate under-nutrition need to be compared with alternative strategies (eg. early weaning and survival feeding) to make optimal management decisions.

Even though the importance of protein nutrition during the dry season in northern Australia has been known for decades there has been limited investigation of the responses of breeders to protein supplements. Recommendations for protein supplementation are based on a few experiments with young cattle and on general nutritional principles. Most research has concluded that urea-based supplements are useful for reducing dry season liveweight loss and hence breeder mortality, but have little effect on fertility. However some producer experience suggests substantial fertility responses (eg. increases in branding rates by 5-10%) to urea supplements, especially when low levels (eg. 50-100 g/breeder.day) of cottonseed meal are included in dry licks.

Difficulties with the delivery of low palatability urea and phosphorus supplements to cattle grazing under extensive conditions has long been recognised as a major constraint to implementing supplementation strategies. It is often difficult to achieve target intakes of supplement, particularly during the wet season. Intake of supplement may vary widely within the herd with a substantial proportions of shy-feeders which consume no supplement. Information presently available on alternative supplement delivery systems is mostly limited to producer experience.

Better understanding of the consequences of supplements on breeder fertility and effective supplement delivery systems are needed if producers are to use supplements most cost-effectively. The magnitude of breeder production (particularly fertility) responses expected for a variety of conditions (particularly pasture systems, seasonal conditions and body reserves of the breeder) for input of various amounts of supplements need to be estimated to make best-bet decisions on supplementation strategies. The importance of nutrition for breeder fertility and the relative lack of information on the optimal use and delivery of urea-based supplements for the northern cattle industry led to the project described in this report.

1.2 Objectives

The general objective of the project was to improve options for the producer to increase the profitability of the breeding herd managed under extensive grazing conditions in the intermediate and harsh zones of northern Australia, by more cost-effective and more widespread use of strategic supplements. This was to be done by improving understanding of the consequences of strategic supplementation systems on breeder herd productivity (as both fertility and other aspects of breeder performance) and by developing best-bet management packages to assist decision-making.

The specific objectives of the project were:

(a) to further develop supplementation technology to improve the cost- effectiveness of using supplements to increase the performance of the breeder herd in northern Australia,

(b) to improve supplement delivery systems to achieve target intakes of supplements and reduce variability of supplement intake amongst animals, and to identify the consequences of siting of supplement feeding sites.

1.3 Methods

The program consisted of three task areas which required experimentation, economic assessment and integration of past and present information into management packages. Experimentation focussed on better prediction of the optimal types, amounts and timing of supplements and better management procedures to deliver supplements as required. The majority of the research was conducted at Swan's Lagoon Research Station.

1.3.1 Task 1. Experimentation on the effects of urea-based supplements on breeder productivity.
Breeders were grazed in small (eg. 40-100 ha) native pasture trial paddocks allowing replication of experimental treatments. Various types of urea-based dry lick supplements were fed during the dry season and/or the late wet season. Measurements of breeder body status through the year and reproductive performance were made so as to understand animal responses in relation to pasture and supplement conditions. In addition, pen trials were conducted to improve understanding of the consequences of urea-based supplements on the protein and energy status of the cattle.

1.3.2 Task 2 and 3. Experimentation on supplement delivery systems.
A marker technique was used extensively to measure individual intakes of supplements in the field by grazing mobs of cattle. This was done for a range of supplements and classes of cattle during both the wet and dry seasons. The relationships between supplement intake and cattle behaviour were explored. These techniques were also used to investigate siting and design of supplementation points, and the consequences of siting on paddock use by cattle.

1.3.3 Tasks 4 and 5. Economic assessment and comparison of urea-based supplements with other management options to improve breeder productivity.
The consequences on breeder productivity of using strategic supplements for breeder herds ranging in historical productivity levels and in several climatic zones were assessed. This was achieved by developing a spreadsheet model (BREEDMOD) to predict fertility and mortality changes from breeder body condition status. The outputs of BREEDMOD were then used in the BREEDCOW herd model to examine the changes in gross margin of the breeder herd as strategic supplements were used to increase herd productivity.

1.3.4 Task 6. Development of management packages and technology transfer.
Early in the project a major report was prepared collating previous experimentation on the nutritional management of breeders, the results of Producer Demonstration Sites and industry experience on supplement delivery systems. A Management Package on strategies for supplementation and weaning in the dry tropics is being developed during the final stages of the project. Technology transfer was designed to depend principally on producer group interaction, development of the Management Package, publication in the Swan's Lagoon Research Reports and rural media and by established scientific publication procedures during and following the project.

1.4 Main results of the project

1.4.1 Task 1. Responses of breeders to urea-based supplements

(a) During severe dry season conditions (eg. with no rain from March until December) urea-based supplements substantially reduced loss of breeder body reserves during the dry season. For example, in one experiment, liveweight loss during the dry season (as a % of liveweight at the beginning of the dry season) was reduced from 29% to 23% in first-calf cows, and from 24% to 14% in second-calf cows. This increased pregnancy rate by 8 and 14% units respectively in first- and second-calf cows. As well as the increase in the proportion of cows becoming pregnant during the mating period, improved nutrition due to supplementation caused cows to reconceive earlier which led to a tighter and more appropriate calving interval in the subsequent year. However in years when there was sufficient storm rain to grow at least a "green pick" during the winter and spring there was no response to urea-based supplement, presumably because the breeders were able to meet their requirements for rumen degradable protein from pasture.

(b) Weaning breeders in April at the commencement of the dry season conserved breeder liveweight by 10 - 15 kg per month, about twice the benefit due to feeding urea-based supplements. The benefits of earlier weaning and urea-based supplement to conserve body condition of the breeder through the dry season were generally additive.

(c) Increases in breeder fertility due to feeding urea-based supplements during the dry season were closely related to the improved liveweight and body condition of the breeders at the time of mating. For *Bos indicus* cross cows in lower than "store" body condition, fertility was increased by about 5% units for each 10 kg increase in breeder liveweight at mating.

(d) Urea-based supplements fed during the late wet season following seeding of native grasses improved liveweight status of lactating breeders and increased fertility of breeders in "backward store" or lower body condition. It did not increase fertility of those breeders which were in at least 'store' body condition at this time and where fertility was already high.

(e) The results support the model that fertility of *Bos indicus* and *Bos indicus*-cross breeder herds in the dry tropics is limited primarily by the time required for resumption of ovarian activity by the lactating cow, and that improved breeder body condition during early lactation can markedly increase fertility. In addition fertility can be adversely affected by severe liveweight loss pre-calving during the dry season, and by sub-maintenance nutrition post-calving when the seasonal break is delayed.

(f) Urea-based supplements increased roughage intake and microbial protein synthesis, and in some circumstances also increases the efficiency of microbial protein synthesis by cattle consuming dry season senesced pasture. Intake of dry season pasture was increased even when very high levels of urea supplement were fed. Thus improvement in animal performance occurs over a very wide range of intakes of supplementary urea, and for maximal animal response the amount of urea supplement required is much greater than current recommendations.

(g) Inclusion of cottonseed meal in urea-based supplements fed during the dry season did not improve pasture intake or efficiency of microbial protein synthesis, but did increase voluntary intake of supplement. The benefits of including cottonseed meal in urea-based supplements are most likely due to achievement of high intakes of urea supplement rather than to any specific nutritional benefit of the small amount of cottonseed meal in the dry lick.

1.4.2 Task 2. Improving supplement delivery systems to achieve target intakes and reduce variability.

(a) The most important factor influencing voluntary intake of low palatability dry lick supplements fed *ad libitum* was the palatability of the supplement relative to the palatability of pasture.

(b) Classes of animals with higher requirements for nutrients usually consumed more supplement. For example lactating cows consumed more supplement than dry cows.

(c) Exposure of weaners to high palatability supplements was investigated as a means to subsequently increase intake of low palatability supplements and reduce the proportion of shy-feeders in later life. Exposure of calves or weaners to palatable (eg. cottonseed meal based) supplements improved acceptance and intake of low palatability supplements for several weeks when they were first provided, but had no long-term effects on intake of such supplements. In some experiments feeding dry lick supplement to weaners did change, while in other experiments it did not change, their subsequent intake of supplements. These differences between experiments were not resolved. However, in summary, exposure to and familiarisation with specific tastes does appear to have a role, but only a secondary role, to modify supplement intake.

(d) The proportion of shy-feeders within a mob and the individual variation in intake of supplement fed *ad libitum* depended primarily on the voluntary intake of supplement and the amount of feeder space available. When palatable supplements, based on molasses or cottonseed meal, were fed with adequate trough access the proportion of shy-feeders was negligible and the variation in supplement intake was always low (coefficient of variation (CoV) 20-40%). When intake of supplements was in the range 50-200 g/head.day there were often up to 20% shy-feeders and variation was intermediate (CoV 50-90%). When supplement intake was less than 50 g/day the proportion of shy-feeders was high and was inversely related to intake. Reducing access to a supplement, by for example providing one small feeder for a mob of 100 head, increased the proportion of shy-feeders to more than 40% of the mob, even when supplement intake was in the range 50-200 g/head.day.

(d) No consistent relationships were observed between intake of supplement and behaviour such as social rank (dominant-subordinate) characteristics.

(e) Siting of supplements distant (eg. 2 km) from water reduced intake of block or molasses supplements by 20-30%, but did not change variability in supplement intake or the proportion of shy-feeders.

(f) Design of supplement shelter sheds had little influence on voluntary intake or variability in intake of supplement. Cattle consumed supplement as readily when it was fed in sheds enclosed on 3 sides as from sheds without sides. This indicates that supplements can be fed during the wet season in enclosed sheds for good weather protection without adverse effects on variability of supplement intake.

1.4.3 Task 3. Consequences of siting of supplementation points on grazing behaviour.

In cattle grazing small paddocks (eg. 2 km long x 0.3 km wide) siting block supplements at water or 2 km from water had no discernible effect on paddock utilization. In addition in a large paddock (200 cows and calves grazing in an 700 ha paddock) changing siting of low palatability dry lick supplements had no discernible effect on grazing behaviour; the preferred grazing areas were apparently determined principally by soil type and vegetation. Although the cattle consumed the supplement when it was provided in the established grazing areas, they would not walk to another part of the paddock to consume this supplement or change their grazing area. Presumably cattle will walk to a supplement point if the supplement is sufficiently attractive (eg. salt for salt-hungry cattle, molasses.

1.4.4 Task 4. Comparison of urea-based supplements with other management options to improve breeder productivity

For managers to make best-bet decisions and choose the most appropriate management options for a specific situation it is clearly necessary to compare the efficacy and the cost-effectiveness of alternative strategies (eg. phosphorus supplements, earlier weaning, survival supplements). Since the most important factor influencing breeder fertility and mortality is breeder body condition status in the late dry and early wet seasons, management options were compared by their cost-effectiveness to achieve acceptable breeder liveweight at this time of the year (Figure 1). Breeder body condition late in the dry season can be improved by:

(i) increased body condition at the end of the wet season (depending primarily on time of calving, pasture quality, seasonal conditions, phosphorus supplements), and

(ii) reduced rate of loss of body condition through the dry season (depending primarily on pasture quality, seasonal conditions, lactation status, urea supplements).

The option of using survival supplements (eg. M8U) to avert mortalities in years when there is a delayed seasonal break allows deferment of decisions until seasonal conditions are known. Thus there is expenditure on supplements only in those years when it is essential.

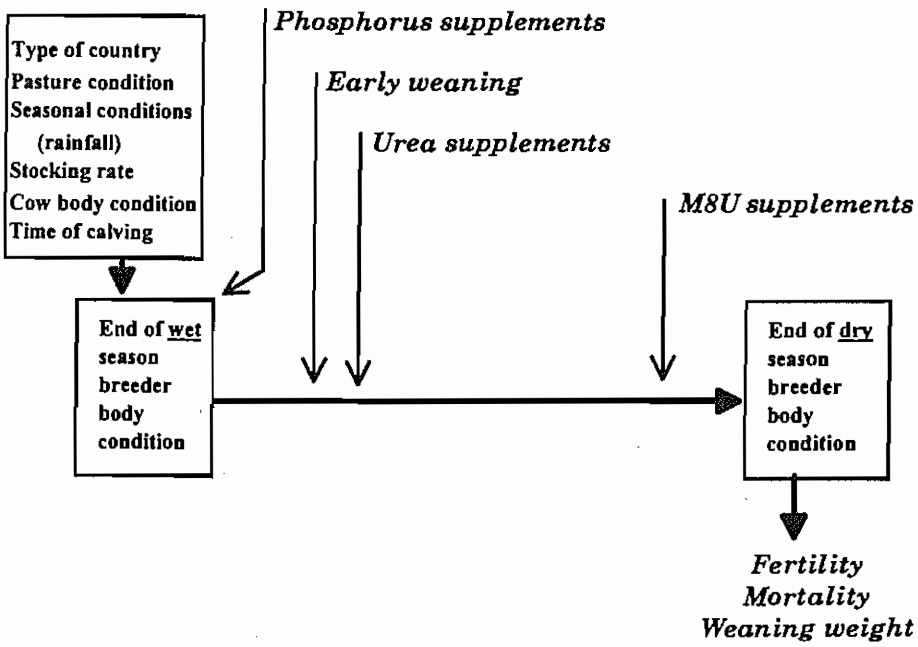


Figure 1.1 A schematic representation of the factors influencing breeder productivity in a semi-arid environment. It is assumed that fertility and mortality are determined primarily by breeder body condition at the end of the dry season and by the timing of the seasonal break. Breeder body condition at the end of the wet season may be increased by pasture management and phosphorus supplements in phosphorus deficient areas. Rate of loss of breeder body condition during the dry season may be reduced by weaning or by urea-based supplements. Alternatively survival supplements (eg. M8U) can be fed late in the dry season to avert mortality.

1.4.5 Task 5. Economic assessment

Changes in gross margin of the breeder herd due to strategic supplementation were highly dependent on supplementation costs to achieve an increase in the breeder body condition at the end of the dry season. The cost of urea-based supplements to increase breeder body condition at this time was estimated from experiments conducted during the project, past experiments and industry information. The estimated cost to increase breeder body condition by one unit (eg. from "backward store" to "store" condition) ranged from about $7 (for efficient water medication) to $15 (for dry licks where it is difficult to achieve target intakes) to $30 (for some lick blocks). When urea-based supplements reduced breeder mortality they were highly cost-effective with, for example, increases in gross margin of up to $11 per animal equivalent. Where the only benefit valued in the assessment of the urea-based supplements was increased number of calves weaned, and supplementation was assumed to cost $15 per breeder per annum, the increases in gross margin were generally small (eg. $-5 to $+2 per animal equivalent). However when supplementation costs could be reduced (eg. to $7 per breeder by water medication) the gross margins due to supplementation were improved (eg. $1 to $16 per animal equivalent).

Benefits to improved management which were not valued in this economic assessment included:

(a) a tighter calving pattern earlier in the wet season leading to lines of weaners at first-round muster which are heavier and more similar in age and liveweight (this would increase the value of the weaner crop),

(b) fewer breeders lactating after first-round muster and during the dry season in continuously mated herds (leading to simpler and lower cost management of the breeder herd),

(c) much greater management flexibility in the event of a light or failed wet season and higher cull cow values because breeders are in better body condition year-round (thus reducing risk associated with variability between seasons).

The economic analysis also indicated that increases in gross margin were fairly similar for the three principal management options which can be applied within the annual seasonal cycle in the northern industry (ie. for urea-based supplements during the dry season, phosphorus supplements during the wet season and early weaning).

1.4.6 Task 6. Development of Management Packages and Technology transfer.

A comprehensive management package discussing the nutritional management of the breeder herd has been developed. This was based on present and past experimentation and trials, and experience in the industry. This document is written at a level suitable for extension officers and other technical staff servicing the cattle industry, and for leading-edge producers. An advanced draft version is currently being circulated among QBII staff and industry representatives for comment and discussion.

Many opportunities have been taken to present information developed during the project to groups of producers at field days, to NQBRC and Swan's Lagoon Committee of Management producer committees and at the Emerald Meat Profit Day. Material has been extensively made available in publications for industry (eg. Swan's Lagoon Research Report, Northern Muster newsletter, NAP3 News), incorporated into presentation material for QBII/MLA Nutrition Workshops and published in proceedings of scientific conferences.

1.5. Recommendations to industry:

1.5.1 Breeder herd nutrition

(a) The flow diagram presented in this report provides a basis to compare strategies. Urea-based supplements should be considered as only one possible strategy to improve breeder body condition. The best combination of management strategies will by highly dependent on individual circumstances.

(b) Where strategic urea-based dry season supplements reduce breeder mortality due to under-nutrition they are highly profitable. Where increased weaning rates are the only benefit from urea supplementation which is valued the returns are marginal. However there are other benefits (eg. as reduced risk and greater management flexibility) from improving the nutrition of the breeder herd which would often justify increased inputs.

(c) Economic returns from urea-based supplements were highly sensitive to supplement input costs. With efficient water medication systems the supplement costs may be less than half the cost of dry lick systems, and one-fourth the cost of lick block systems. Even when the increased economic return depends entirely on increased weaning rate, urea supplementation using water medication could be highly profitable.

(d) Urea-based supplements are likely to be most appropriate in regions where:

   (i) long-term rainfall records indicate that there is a low likelihood of storm rains during the dry season and a low variation between years in the date of the seasonal break ending the dry season,

   (ii) in circumstances where breeder mortality from under-nutrition is expected to be high in the absence of intervention,

   (iii) where there is a substantial amount of dry standing feed available, and

   (iv) where survival supplementation systems are not appropriate or are very high in cost.

(e) Current general recommendations for amounts of supplementary urea should be retained (eg. 45-60 g urea per breeder per day during the late dry season; half these amounts during the late wet/early dry season). However, cattle will respond to a wide range in amounts of supplementary urea, and lower or higher amounts of urea supplement may often be appropriate to achieve a target animal response.

1.5.2 *Supplement delivery systems*

(a) It is clearly important to minimise supplement costs per unit of protein or phosphorus and the lowest cost system appropriate to the specific circumstances used. Generally water medication systems can be the lowest in cost, followed by dry lick and then lick block systems.

(b) Intake of dry lick supplements fed *ad libitum* is determined primarily by the palatability of the supplement compared to the palatability of pasture. Thus, supplement intake should be monitored and can be manipulated by adjusting the palatability of the dry lick supplement. Supplement intake can be reduced by up to about one-third by siting supplementation points distant from water.

(c) Exposure and familiarisation of cattle to supplements and to some specific flavours has some role in increasing acceptance. For example, where problems of acceptance of supplements by adult cattle occur, weaners should be exposed to the range of supplements expected to be used subsequently.

(d) To avoid a high proportion of shy-feeders and high variation in supplement intake, average supplement intake by the mob should be at least 50 g/head.day. Supplements can be fed in 3-sided sheds or similar structures that provide good weather protection without introducing a shy-feeder problem.

(e) Changing siting of low palatability dry lick supplements does not appear to change paddock utilisation by cattle.

1.6 Recommendations for further R, D & E.

1.6.1 Publication of Management Package

The comprehensive Management Package which is being developed should be published as a professionally-prepared high quality publication comparable with the Phosphorus Manual.

1.6.2 Breeder herd nutrition

(a) There should be further development of the proposed framework for comparing management options to increase breeder productivity and the spreadsheet model (BREEDMOD) for predicting quantitatively consequences of increased breeder body condition on productivity.

(b) Improved prediction of breeder productivity from body status is needed. This requires an improved quantitative understanding of the consequences of both pre-partum and post-partum nutrition on breeder fertility for the genotypes and range of nutritional conditions commonly encountered in northern Australia. For example, in the pre-partum cow, although it is clear that severe liveweight loss during the dry season reduces subsequent fertility, we need to know the importance of individual factors (eg. minimum breeder body condition, rate of loss of body condition). Similarly, improved understanding of nutrition on fertility is needed for the post-partum *Bos indicus* breeder (eg. in the late wet /early dry seasons when pasture quality is declining). The equations used to predict breeder fertility from body status in the BREEDMOD model need to be improved for satisfactory use of this model.

(c) An improved understanding is needed of the amounts of supplementary urea required as pasture quality changes through the seasonal cycle. Faecal nitrogen concentration alone is not a satisfactory general predictor. Even if NIR analysis of faeces can be developed to be an acceptable predictor of ingested dietary protein, other factors such as endogenous urea recycling and the degree of selection of pasture leaf need consideration. Dose-response curves of breeders to supplementary urea are needed.

1.6.3. Supplement delivery systems

(a) An improved understanding of the factors which determine palatability of a supplement under specific conditions is needed to achieve target intakes of dry lick and block supplements and design optimal supplement mixtures. In addition we need to be able to predict salt appetite and the role of known and novel ingredients to change palatability and modify intake of dry licks.

(b) Wet licks based on molasses (eg. containing 30-50% urea) where voluntary intake is controlled by acidity of the mixture would have many advantages (eg. flexibility, labour, infrastructure) for the northern industry and should be developed. It has been shown in principle that this is possible.

(c) More information is needed of the factors controlling the proportion of shy-feeders in mobs, particularly for larger mobs of cattle and in relation to supplement intake, feeder access and habituation to flavours in supplements.

(d) Improved understanding of the magnitude of the inefficiencies when supplements are fed infrequently (eg. once a week) or at different times of the year (eg. feeding phosphorus supplements during the dry season) are needed.

1.6.4. Consequences of supplementation strategies for sustainable rangeland management

In view of the importance of rangeland management and the perception (albeit often ill-informed) that supplements are a primary cause rangeland degradation, more information is clearly needed and the conflicting evidence resolved.

1.7 Conclusions

Project DAQ.098 has substantially advanced the understanding of the role of management options, and in particular urea-based supplements and supplement delivery systems, to increase breeder herd productivity in the dry tropics of northern Australia.

- The project has collated and extensively reviewed available information on supplementation and weaning management of the breeder herd in this environment. This material is being prepared for publication as a comprehensive Management Package suitable for technical personnel servicing the northern cattle industry and for "leading-edge" producers.

- A conceptual framework, based on the fundamental relationships between breeder body status with fertility and mortality, was developed to compare the efficacy of dissimilar management strategies (eg. urea-based supplements during the dry season, phosphorus supplements during the wet season, early weaning, M8U survival supplements) and to link breeder herd and pasture productivity. Although this framework is at present principally qualitative, it provides a basis to build quantitative predictions of breeder performance, and to utilise historical information and best-available pasture and weather forecasting Decision Support Systems. The most important phase of this conceptual model (ie. breeder body condition during the late dry season) was developed into a spreadsheet model (BREEDMOD) to estimate quantitatively, for a range of circumstances, the consequences on breeder fertility and mortality of using management options to increase breeder body status. However, there are serious inadequacies in our ability to predict fertility from breeder liveweight and liveweight pathways. Changes in herd gross margin were used to evaluate the economic consequences of using management strategies such as urea supplements.

- The project has greatly improved understanding of the circumstances in the northern cattle industry where it is most appropriate to use urea-based supplements, and the likely increases in breeder productivity. Urea-based supplements are likely to be most appropriate where breeder mortality from under-nutrition is high, where there is a low likelihood of winter rain and where early weaning and survival supplementation strategies are not appropriate.

- Systems to deliver strategic supplements to cattle grazing under extensive conditions were investigated with scientific rigour. Considerable progress was made to understand how target intakes of supplements can be achieved in the paddock.

Main

Research

Report

Introduction

2. Introduction

2.1 General introduction and background

Productivity of the breeder herd in the marginal and harsh areas of northern Australia is much lower than in the more favourable environments of southern Australia. On average across north Australia branding rate is only about 60%, while breeder mortality is about 10% per annum. Undernutrition is clearly a principle cause of this low productivity, and phosphorus and protein are often the limiting nutrients.

There are many possible reasons for low breeder fertility. However in the dry tropics of north Australia, providing that disease control is effective, generally the most important factor reducing fertility of Bos indicus cross herds is the interval for the breeder to resume ovarian activity following calving. The general relationships between liveweight (or body status) of breeders and their fertility are well known, and low breeder liveweight at mating is one obvious reason for low breeder fertility. However it is clear that short-term changes in nutrition during late pregnancy or during lactation may also substantially increase fertility. The interactions between breeder liveweight, large changes in short-term nutrition (as 'spike-feeding') and small changes in long-term nutrition (such as that achieved by dry season urea supplements or wet season phosphorus supplements) need to be understood to manage the breeder herd most cost-effectively. Furthermore means need to be developed to compare the efficacy of low-level supplements such as urea or phosphorus fed during the dry season and growing season respectively with other management alternatives such as early weaning and crisis feeding with molasses-based supplements.

Even though the importance of protein nutrition during the dry season is well recognised there has been limited investigation of the responses of breeders to nitrogen supplements in the northern environment. Recommendations for nitrogen supplementation of breeders are based primarily on work done with young cattle in north Australia and on general nutritional principles developed in temperate environments. Most research (eg. Holroyd *et al.* 1983, 1988) has concluded that urea-based supplements are useful for reducing liveweight loss of breeders during the dry season and hence reducing breeder mortality, but have little effect on the conception rates of the surviving breeders. However producer experience suggests substantial fertility responses (eg. increases in branding rates by 5-10%) to urea-based dry lick supplements. This appears to occur especially when low levels (eg. 50-100 g/breeder.day) of cottonseed meal are included in dry lick supplements, even though this amount of cottonseed meal would not be expected to have any appreciable effect on the protein supply to the breeder. Also in one experiment (Siebert *et al.* 1976) a very large increase in pregnancy rate was observed due to feeding a low level of cottonseed meal through the dry season.

Better understanding of the consequences of nutrition on breeder fertility, and the efficacy with which supplements improve nutrition, is needed if producers are to use supplements most cost-effectively. The magnitude of breeder production (particularly fertility) responses expected for a variety of pasture systems, seasonal conditions and body reserves of the breeder for input of various amounts of supplements have to be estimated by managers to make best-bet decisions on supplementation strategies.

The delivery of low palatability urea and phosphorus supplements to cattle grazing under extensive conditions has long been recognised as a major constraint to implementing supplementation strategies. Firstly it is often difficult to achieve target intakes of supplement. Commonly intakes are too low during the wet season and too high during the dry season. Secondly intake of supplement may vary widely among individual animals in the mob, and substantial proportions of a mob may be shy-feeders which consume little or no supplement. Thirdly the cost of supplements must be minimised. The advantages and disadvantages of alternative supplement delivery systems need to be understood to make the best-bet decisions for specific situations, but the information presently available is mostly limited to anecdotes and producer experience. Also consequences of supplement delivery systems on grazing behaviour and land use need to be understood to maintain and improve sustainability of grazing systems. Some anecdotal evidence suggests that cattle fed strategic supplements will walk further from water, utilise available pasture in larger paddocks more evenly and thus reduce local "hot-spots" of overgrazed pasture. However other anecdotes and observations suggest that local over-grazing may increase in frequency as cattle congregate around supplementation sites.

The importance of nutrition for breeder fertility and the relative lack of information on use of urea-based supplements for breeders and on supplement delivery systems appropriate for the northern cattle industry led to the development of the project described in this report.

2.2 Objectives

The general objective of the project was to improve options for the producer to increase the profitability of the breeding herd run under extensive grazing conditions in the intermediate and harsh zones of northern Australia by more cost-effective and more widespread use of strategic supplements. This was to be done by improving understanding of the consequences of strategic supplementation systems on breeder herd productivity, and by developing best-bet management packages to assist decision-making. The specific objectives of the project were:

(a) to further develop supplementation technology to improve the cost- effectiveness of using supplements to increase the performance of the breeder herd in northern Australia,

(b) to improve supplement delivery systems to achieve target intakes of supplements and reduce variability of supplement intake per animal and to identify the benefits on the environment of improved siting of supplement feeding sites.

The improvements in the supplementation system will occur by better prediction of the optimal types, amounts and timing of supplements and by better management procedures to deliver supplements as required. Specific target increases in breeder herd productivity are indicated in Table 2.1 for herds presently at Low, Medium or High levels of productivity.

2.3 General methods

The improvements in supplementation systems focussed on better prediction of the optimal types, amounts and timing of supplements and better management procedures to deliver supplements as required. The program consisted of three task areas requiring experimentation, while additional task areas involved integration of past and present information into management packages and economic assessment. The majority of the research program was done at Swan's Lagoon Research Station utilising the extensive cattle resources, trial paddock facilities and the supporting infrastructure.

2.3.1 Task 1. Experimentation on the effects of urea-based supplements on breeder productivity. Breeders were grazed in small (eg. 40-100 ha) native pasture trial paddocks allowing replication of experimental treatments. Various types of urea-based dry lick supplements were fed during the dry season and/or the late wet season, and sufficient measurements made of breeder body status through the year and of reproductive performance to understand animal responses in relation to pasture and supplement conditions. In addition intensive pen trials were conducted to improve understanding of nutritional responses to urea-based supplements.

Table 2.1. Specific target increases in breeder herd productivity

	Parameter		Present level of productivity		
			Low	Medium	High
1	Breeder mortality %	Present Target	14 6	8 4	4 3
2	Pregnancy rate of lactating first-calf cows at 6 months post partum (%)	Present Target	15 40	30 50	60 75
3	Weaning rate from second and later parity cows (%)	Present Target	55 65	65 72	75 80
4	Median anoestrus period of first-calf cows (months)	Present Target	- -	8 6	5 4
5	Mean body condition of lactating cows at end of wet	Present Target	4.0 4.5	4.5 5.0	5.0 5.5
6	Mean body condition of pregnant dry cows in late dry season	Present Target	3.5 4.0	4.0 4.5	4.5 5.0
7	Proportion of pregnant breeders CS <4 (backward store) in the late dry season	Present Target	40 20	25 13	10 5
8	Calf liveweight from first-calf cows at end of wet season (kg)	Present Target	140 150	150 160	160 170

Body condition expressed as condition score on scale 1-9.

2.3.2 Task 2 and 3. Experimentation on supplement delivery systems. The lithium marker technique was used extensively to measure individual intakes of supplements in the field by animals grazing in mobs. This was done for a range of supplements and types of cattle during both the wet and dry seasons. Supplement intake was related to animal behaviour. These techniques were also used to investigate siting and design of supplementation points, and the consequences of siting on grazing behaviour.

2.3.3 Economic assessment. The consequences of using strategic supplements to increase productivity benefits for breeder herds ranging in historical productivity levels and in several climatic zones was assessed by developing a spreadsheet model (BREEDMOD) to predict such changes from breeder body status. The outputs of BREEDMOD were then used in the BREEDCOW herd model to examine the changes in Gross Margin of the breeder herd as strategic supplements were used to increase herd productivity.

2.3.4 Development of management packages and technology transfer. Early in the project a major report collated previous experimentation on the nutritional management of breeders, the results of relevant Producer Demonstration Sites and industry experience on supplement delivery systems. A Management Package on strategies for supplementation and weaning in the dry tropics is being developed during the final stages of the project. Technology transfer was designed to depend principally on producer group interaction, publication in the rural media and standard scientific publication procedures during and following the project.

Main

Research

Report

Task 1

Experimentation on the effects of urea-based supplements on breeder herd productivity

3. Task 1. Experimentation on the effects of urea-based supplements on breeder herd productivity.

The objective of Task 1 was to further develop technology on the use of strategic urea-based supplements to increase breeder herd productivity.

3.1 The importance of the problem

Undernutrition is clearly the principle cause of the generally low productivity of the breeder herd in the dry tropics of northern Australia. On average branding rate is only about 60% and breeder mortality is about 10% per annum in this environment. Supplementation with urea-based or phosphorus supplements, manipulation of weaning and survival feeding are important strategies which can be used by producers to improve nutrition of the breeder herd and improve herd productivity.

When disease control is effective, usually the most important factor reducing fertility of *Bos indicus* cross herds is the interval for the breeder to become pregnant again following calving. The general relationships between liveweight (or body status) of lactating breeders and their fertility are well known, and low breeder liveweight during lactation is one obvious reason for low breeder fertility. In addition short-term changes in nutrition during late pregnancy or during lactation may also substantially modify fertility. The interactions of breeder liveweight with large short-term changes in nutrition (eg. 'spike-feeding') and small changes in long-term nutrition (eg. dry season urea supplements or wet season phosphorus supplements) need to be understood to manage the breeder herd most cost-effectively. Furthermore the efficacy of urea or phosphorus supplements need to be compared with other management alternatives such as early weaning and survival feeding.

Even though the importance of protein nutrition during the dry season in northern Australia is known there is limited information on the responses of breeders to nitrogen supplements. Recommendations for nitrogen supplementation are based on a few experiments with young cattle in the northern environment and on general understanding of nutritional principles. Most research has concluded that urea-based supplements are useful for reducing dry season liveweight loss and hence breeder mortality, but have little effect on fertility. However some producer experience suggests substantial fertility responses (eg. increases in branding rates by 5-10%) to urea supplements, especially when low levels (eg. 50-100 g/breeder.day) of cottonseed meal are included in dry licks. These observations are difficult to explain since this amount of cottonseed meal would not be expected to have any appreciable effect on the protein supply to the breeder.

Better understanding of the consequences of supplements on breeder fertility is needed if producers are to use supplements most cost-effectively. The magnitude of breeder production (particularly fertility) responses expected for a variety of conditions (particularly pasture systems, seasonal conditions and body reserves of the breeder) for input of various amounts of supplements need to be estimated by managers to make best-bet decisions on supplementation strategies. The importance of nutrition for breeder fertility and the paucity of information on the optimal amounts, timing and mixtures of urea-based supplements for the northern cattle industry led to the development of this Task Area of the project.

3.2 Experimental approach

A series of experiments were conducted to examine the effects of urea-based supplements fed during various intervals of the dry season or late wet season, and on breeders weaned early or late in the dry season, on breeder herd productivity. These experiments were conducted in trial areas with small paddocks to allow replication of experimental treatment. We considered that the advantages for scientific rigour associated with replicated experimental treatments, a high degree of cattle control and an ability to make measure and sample cattle frequently were more important than the advantages of working on commercial cattle properties.

Experiments were conducted using cows drawn from the Swan's Lagoon Research Station breeder herd and generally managed following the practices for weaning, growth pathways of heifers and first mating age established for this herd. Cattle were run in small (up to 100 ha) native pasture experimental paddocks and changes in plane and timing of nutrition were imposed by providing strategic supplements, in most experiments in the form of dry licks. Measurements typically included liveweight and body condition score changes, calving dates, detection of ovarian activity from plasma progesterone concentrations and pregnancy diagnosis by rectal palpation. In some experiments behavioural oestrous was also monitored using Heatmount detectors, and intake of supplement by individual animals was measured using the lithium marker technique. Measurements of pasture availability and quality, animal metabolic indicators and rumen microbial protein synthesis were made to improve the generic understanding of the animal responses, and to broaden and increase confidence in prediction of responses in alternative situations. In addition pen trials were conducted to improve understanding of the consequences of urea-based supplements on the protein and energy status of the breeder.

The responses of breeders to phosphorus supplements was not investigated since this has been thoroughly reviewed in the book "Phosphorus Nutrition of Beef Cattle in Northern Australia" by McCosker & Winks and is also currently being addressed project DAQ.093.

3.3 Description of experiments

Relevant experiments and brief description of each experiment

(i) E811 (p. 25). Effect of dry lick supplements fed during the dry season and/or the wet season on productivity of Bos indicus x Shorthorn cross breeder cows in a tropical semiarid environment (1994/95 draft of cattle).

(ii) E821 (p. 37). Effect of dry lick supplements fed during the dry season and/or the wet season on productivity of Bos indicus x Shorthorn cross breeder cows in a tropical semiarid environment (1995/96 draft of cattle).

(iii) E823. (p. 44). Effect of dry season dry licks containing dried molasses or cottonseed meal for first-calf heifers (1995/96 draft of cattle).

(iv) E833. (p.48). Effect of dry season dry licks containing dried molasses or cottonseed meal for first-calf heifers (1996/97 draft of cattle).

(v) E841. (p. 52). Effect of dry lick supplements fed during the early and/or late dry season on productivity of Bos indicus x Shorthorn cross breeder cows.

(vi) E843. (p. 57). Effect of time of weaning and urea-based dry lick supplements fed during the dry season on productivity of second-calf cows.

(vii) E836. (p. 61). Effects of urea-based dry lick supplements fed to breeders during pregnancy on cow and calf performance.

(viii) E828. (p. 65). Rumen microbial protein production in heifers fed speargrass hay and urea or M8U supplements.

(ix) E840. (p. 68). Rumen microbial protein production in heifers fed speargrass hay and supplements of urea.

3.4 Main conclusions from the research

3.4.1 Responses of breeders to urea-based supplements fed during the dry season

The response of breeders in terms of both body weight status and fertility was highly dependent on seasonal conditions.

During severe dry season conditions such as occurred during experiment E811 (eg. with no rain from March until December) urea-based supplements substantially reduced loss of breeder body reserves during the dry season. In this experiment liveweight loss during the dry season as a percentage of liveweight at the beginning of the dry season was reduced from 29% to 23% in first-calf cows, and from 24% to 14% in second-calf cows; this increased pregnancy rate by 8 and 14% units respectively. Similarly in experiment E843 LW loss from April to October was 9% of the liveweight at the beginning of the dry season in unsupplemented cows and 3% in urea-supplemented cows. This increased pregnancy rate of cows calving in November and December from 25% to 39%.

In contrast to the above results, in the 1995 and 1996 dry seasons (experiments E821, E823, E833, E841) when there was sufficient storm rain to grow at least a "green pick" during the winter and spring, there was no response to urea-based supplement. This was presumably because the breeders were able to meet their requirements for soluble protein (ie. rumen degradable protein) by selection of sufficient "green pick" from the pasture.

These contrasting results between years demonstrate that whether the strategy of urea-supplementation during the dry season is appropriate for a specific region will be highly dependent on the probability of sufficient storm rain during the winter and spring to increase pasture quality during the dry season. The probabilities of such rain can be estimated from rainfall records and other indices of climate forecasting such as the Southern Oscillation Index.

3.4.2 Responses of breeders to urea-based supplements fed during the late wet season

Urea-based supplements fed during the late wet season from early March and following seeding of native grasses until weaning in May improved liveweight status of lactating breeders and increased fertility of breeders in "backward store" or lower body condition (E811 and E821). It did not increase fertility of those breeders which were in at least 'store' body condition at this time and where fertility was already high.

3.4.3 Interactions between urea supplementation and time of weaning.

In experiment E843 weaning breeders in April at the commencement of the dry season conserved breeder liveweight by 10-15 kg per month during the dry season, but due to compensatory growth effects by about only 6 kg per month from April until the following January. The importance of the compensatory liveweight gain effects would vary widely depending on the timing of the seasonal break and the subsequent plane of nutrition. The large effect of time of weaning on breeder liveweight in the late dry season demonstrates why earlier weaning can have such a large effect on breeder mortality when the seasonal break is delayed. The benefits of earlier weaning on breeder liveweight were about twice the benefit due to feeding urea-based supplements. In addition the benefits of earlier weaning and urea-based supplement to conserve body condition of the breeder through the dry season were generally additive.

3.4.4 *Timing of conceptions*

Improved nutrition of the breeder due to feeding urea supplements during the dry season led to cows becoming pregnant earlier in the mating season. This was observed regardless of whether the pregnancy rate at the end of the wet season was increased. Earlier pregnancies would lead to cows calving earlier and at a more appropriate time in the subsequent year, and hence heavier and more homogenous lines of weaners at first-round muster early in the dry season. For example in experiment E811 feeding dry season supplements resulted in 21% instead of 3% of cows pregnant by late January, and 73% instead of 52% of cows pregnant by mid-March. In experiment E841 the proportion of cows pregnant in the early wet season (late January) or the late wet season (mid-March) was correlated with the liveweight and body condition score of the cows in December, and the liveweight loss during the previous dry season. However the proportion of breeders pregnant by May was poorly correlated with the liveweight or condition score measurements in the late dry season because cows in lower body condition became pregnant later in the wet season after recovering from the consequences of the liveweight losses.

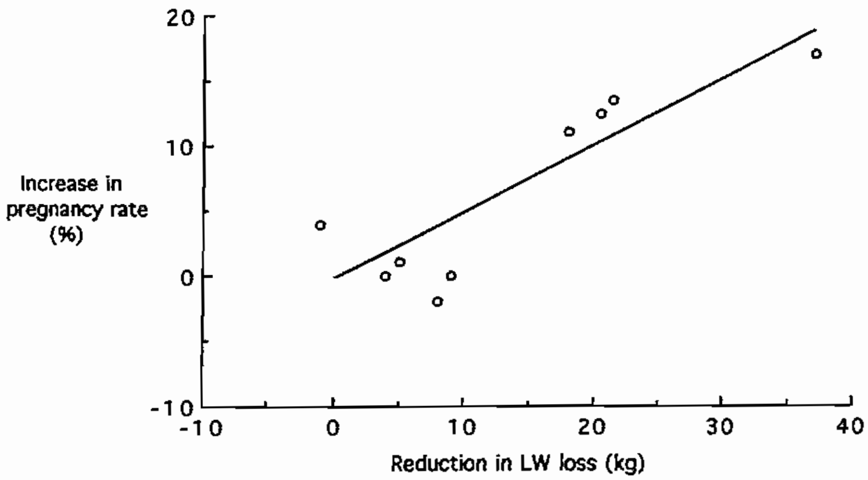


Figure 3.1 The relationship between the reduction in liveweight loss of non-lactating pregnant breeders during the dry season due to feeding urea-based supplements and the increase in pregnancy rate during the following wet season. Data are from experiments at Swan's Lagoon in the northern speargrass zone and are from experiments of Holroyd *et al.* (1983; 1988) and R. M. Dixon (Experiment 811, this report).

3.4.5 *Relationships between breeder body status and fertility.*

Increases in breeder fertility due to feeding urea-based supplements during the dry season were closely related to the improved liveweight and body condition of the breeders at the time of mating. For *Bos indicus* cross cows in lower than "store" body condition, fertility is increased by about 5% units for each 10 kg increase in breeder liveweight at mating due to supplementation. This is shown in Figure 3.1 which collates results from the present and previous experiments. The magnitude of this increase in fertility is similar to the increase observed due to changes in 'start-of-mating' liveweight in herds where supplements have not been fed and the variation in 'start-of-mating' liveweight has been due primarily to seasonal effects (See Appendix 3, present report).

The above results support the model that fertility of *Bos indicus* and *Bos indicus* cross breeder herds in the dry tropics is limited primarily by the time required for resumption of ovarian activity by the lactating cow, and that improved breeder body condition during early lactation can markedly increase fertility. In addition fertility can be adversely affected by severe liveweight loss pre-calving during the dry season, and by sub-maintenance nutrition post-calving when the seasonal break is delayed.

3.4.6 Amounts of urea required and microbial protein synthesis

In pen studies with yearling heifers (experiments E828 and E840) and mature cows (experiment E836) urea-based supplements increased intake of low quality native pasture hay by 20-30%, an increase comparable with that observed in previous experiments. In experiment E840 the increase in roughage intake was linear over a wide range of supplementary urea intakes, and continued to increase when supplementary urea was twice the recommended level. Thus we conclude that for maximum animal response much larger amounts of supplementary urea are needed then current recommendations.

In pen studies where low quality pasture hay was fed and heifers were losing liveweight only slowly (experiment E828), urea supplements increased both the amount of microbial protein synthesised per day and amount synthesised per kg of hay intake. This increase in efficiency of microbial synthesis was likely to be due to very low availability of rumen degradable protein in the unsupplemented heifers. In the same experiment feeding an M8U supplement instead of a urea-based dry lick resulted in a further large increase in microbial protein synthesis; this was associated with the large increase in metabolizable energy supply from the molasses in combination with the urea. In the situation where urea supplements were fed to heifers consuming low intakes of poor quality hay and where the heifers were therefore losing liveweight rapidly (E840), the urea supplements increased microbial protein synthesis per day but did not change the amount of microbial protein synthesised per kg of hay intake. The absence of any change in amount of microbial protein per kg hay intake was probably because some rumen degradable protein was supplied by recycling of blood urea to the rumen.

In cows grazing dry season pasture the synthesis of microbial protein was increased by urea supplements by about 20% in one experiment (E811), but was not changed in a second experiment (E843). In both experiments there were large differences in microbial protein synthesis at different times of the year which were in agreement with expected differences in metabolizable intake from pasture; for example microbial protein synthesis in May was about twice that in October. In experiment E843 microbial protein synthesis in lactating cows was 10-23% higher than in non-lactating cows at various times during the dry season, due presumably to the higher intake by the lactating cows.

3.4.7 Importance of including cottonseed meal in urea-based dry licks

In a pen study (experiment E828) inclusion of cottonseed meal in urea-based supplements for low-quality hay did not improve roughage intake or efficiency of microbial protein synthesis. In the two field experiments (experiment E823 and E833) intended to assess the value of including cottonseed meal in urea supplements there was no response to the supplements, but this was associated with the unseasonal rain during winter and spring. However in several other field studies (eg. experiments 822A and 829) inclusion of cottonseed meal in dry lick supplement did increase voluntary intake of supplement. The benefits of including cottonseed meal in urea-based supplements are most likely due to achievement of high intakes of urea supplement rather than to any specific nutritional benefit of the small amount of cottonseed meal in the dry lick.

3.5 Reports of individual experiments

The reports of the individual experiments conducted in this Task Area 1 follow.

Responses to urea-based supplements - Experiment 1

Effect of dry lick supplements fed during the dry season and/or the wet season on productivity of Bos indicus x Shorthorn cross breeder cows (1994/95 draft of cattle) - SWN-E811

Rob Dixon, Ian Porch, Bev Gelling, Geoff Fordyce and Michael D'Occhio

Summary

1. First-calf (152) and second-calf (48) Bos indicus x Shorthorn cows grazing speargrass dominant native pasture were used to examine the effect of dry lick supplements on breeder liveweight (LW) and body condition score (BCS) changes, on calf growth to weaning, and on conception of the cows while lactating. Cows calved between November 1994 and early January 1995, and were mated from mid-December to late April 1994. Calves were weaned in early May 1995.

2. Dry lick supplements were offered *ad libitum* during the dry season (DS) (July-November 1994), or during the later part of the following wet season (WS) (March-May 1995), or at both of these intervals. Control cows were not fed any supplement. Intake of DS supplements averaged 175 g per head per day, and intake of WS supplements 116 g per head per day. In addition M8U supplement was fed *ad libitum* to all animals from late November 1994 until early January 1995 as a survival supplement to avoid excessive mortality.

3. During the dry season unsupplemented first-calf cows lost 86 kg LW and decreased from BCS 7.2 to BCS 4.3. Second-calf cows lost 61 kg LW and decreased from BCS 5.1 to 3.3. DS supplements reduced LW and BCS loss of first-calf cows by 20 kg and 0.6 BCS units, and of second-calf cows by 39 kg and 1.0 BCS units.

4. During the late wet season (from 9 March to 8 May 1995) lactating unsupplemented first-calf cows gained 19 kg LW and increased from BCS 5.2 to 5.4. Lactating unsupplemented second-calf cows also gained 19 kg LW, and increased from BCS 4.8 to 5.2. WS supplements resulted in both age groups of cows gaining an additional 10 kg LW and 0.4 BCS units.

5. Effects of DS and WS supplements on cow LW and BCS were generally additive. Provision of both DS and WS supplements resulted in first-calf cows at the end of the annual cycle in May which were 40 kg LW and 1.0 BCS units heavier, and second-calf cows which were 52 kg and 1.0 BCS units heavier. Calves were 11 kg heavier at weaning.

6. DS supplements resulted in a greater proportion of both age groups of cows reproductively active throughout the growing season. Pregnancy rate at weaning was increased from 69% to 82% in first-calf cows, and from 52% to 79% in second-calf cows. DS supplements also reduced median post-partum anoestrous interval (PPAI) from 120 days to 95 days.

7. WS supplements increased pregnancy rate in first-calf cows, but had no effect in second-calf cows. This different responses were related to the body condition of the cows. Pregnancy rate at weaning of cows which were in "poor" body condition (BCS $\leq$3.5) or at least "store" body condition (BCS $\geq$5.0)in February 1995 were not affected by WS supplements, but conception rate of cows in "backward store" body condition (BCS 4.0 - 4.5) was increased from 61% to 81%.

8. Concentrations of urea and inorganic phosphate in plasma, and of total N and total P in faeces, suggested that the cows were deficient in rumen degradable N during the dry season, and may also have been deficient in rumen degradable N during the later part (April/May) of the growing season. P was not likely to be limiting at any time, and the effects of supplements.

Experimental

1. Cattle, management and treatments

First-calf and second-calf Bos indicus x Shorthorn cross breeder cows from the Swan's Lagoon Station herd were grazed in eight 100 ha paddocks during the experiment. The first-calf cows had been joined at approximately two years of age in January 1994, and 152 predicted to calve between late October 1994 and early January 1995 were selected for the experiment. Second-calf cows (48) had a similar history of management, but were one year older. All had raised a calf to weaning in May 1994, and were selected to calve during the same interval as the first-calf cows. In addition 40 weaner steers (6-9 month old) of similar genotype, were introduced on the 18 July 1994, and were removed on the 25 October 1994. Two reproductively-sound bulls were introduced to each paddock on 12 December 1994, and were removed on the 27 April 1995. Cows were vaccinated for botulinium and leptospirosis.

The cattle were allocated by stratified randomization based on stage of pregnancy and age group to eight paddock groups. Each paddock group consisted of 19 first-calf cows and 6 second-calf cows. The eight paddocks, were considered on the basis of position and soil types as two blocks each of four paddocks. One paddock group within each block was allocated at random to each of four treatments.

Table 1. Composition of supplements (g/kg, air dry)

Component	Dry season lick	Wet season lick
Ingredients (as fed)		
Cottonseed meal	318	330
Urea	273	150
Salt	182	300
Kynophos	136	210
Ammonium sulphate	91	-
Elemental sulphur	-	10

The four treatments consisted of dry lick supplements fed during the dry season (DS) and hence also during pregnancy, and/or dry lick supplement fed during the later part of the wet season (SW) and when the cows were lactating. DS were fed for 20 weeks from the 12 July 1994 until the 26 December 1994 when the seasonal break occurred. WS supplements were fed for 10 weeks from the 24 February 1995 when most grass species were in flower until the 8 May 1995. The supplements were introduced gradually over 3-4 weeks. A mixture of CSM and salt was fed initially, then the kynophos, low concentrations of urea and ammonium sulphate were introduced, and then the final mixture was fed (Table 1). Restricted amounts of supplement were fed during the introductory phase, and then supplements were fed *ad libitum*. Supplements were fed twice weekly in open-ended troughs near the water point.

M8U supplement was fed *ad libitum* to all paddock groups of cattle from 24 November 1994 until 9 January 1995. The cattle were inspected 2-3 times each week during November, December and January to record calving dates of individual cows, and to mother-up cows and calves.

Table 2. Mean composition of pasture samples (g/kg DM)

Sample date	OM	N	P	Ca	IVDMD	IVOMD
13-16 Sept 94	932	3.54	0.50	1.63	397	391
8-9 Nov 94	932	3.41	0.48	1.48	420	415
7-8 Mar 95	909	14.86	1.56	2.83	583	575
12-13 Apr 95	914	8.30	0.98	2.60	464	448
11-12 May 95	921	5.73	0.66	2.73	419	412

The cattle were mustered to yards nine times during the experiment (23 August, 25 October, 13 December 1994, 23 January, 2 February, 9 March, 27 April and 8 may 1995, or one day later at each muster). At each muster all cattle were weighed and body condition score (BCS) estimated. In addition the BCS was estimated in the paddock on the 11 November 1994. Samples of blood, faeces and urine were obtained from subgroups of animals at each muster. Calves were weaned on the 8 May 1995.

2. Pastures samples

Pastures samples were taken twice during the dry season (13 September 1994 and 8 November 1994) and three times during the wet season (7 March, 12 April, 11 May). Only areas of the paddocks and grass species observed to be utilised were sampled.

3. Liveweight, body condition score and supplement intake

Cattle were weighed following an early morning muster, and when possible before access to water. BCS of cows were estimated on a 9 point scale where score 4 was "backward store", score 5 'store' and score 6 "forward store" body condition.

Intake of supplement by each paddock group was measured twice weekly from the amounts of supplement offered and refused.

Intake of supplement by individual animals was estimated four times (22 August and 24 October 1994, 19 March and 26 April 1995) using lithium marker mixed with the supplement, although analysis of lithium is presently available for only the first of these measurements. all animals (including bulls and calves) in paddocks fed supplement were blood sampled on the day on which the cattle were musted.

4. Reproductive activity

Plasma progesterone concentrations were measured twice at 10 or 11 day intervals to determine reproductive activity at three time windows. For Window A cows were blood sampled on the 23 January and the 2 February 1995, for Window B cows on 9 and 20 March 1995, and for Window C on the 27 April 1995 and 8 May 1995.

Behavioural oestrous activity was measured during Window A and B using Kamar Heatmount detectors. These detectors were attached to each cow on the 23 January 1995 for Window A, and on the 9 March 1995 for Window B. Detectors lost during the following 10 days were replaced at the second muster for each Window. Cows were inspected in the paddock twice weekly for 3 weeks, and colour change of detectors indicating mounting behaviour and behavioural oestrous was recorded. The Heatmount detector observations would have measured oestrous activity about three weeks later than the plasma progesterone concentrations, and the two measurements are not directly comparable.

Pregnancy diagnosis of all cows was carried out on the 27 April 1995, and again 8 weeks later.

5. Metabolic parameters

Samples of jugular blood were obtained from 6 first-calf cows, and all second-calf cows on the musters of 23 August 1994, 25 October 1994, 9 and 20 March 1995, 27 April 1995 and 8 may 1995. In addition first-calf cows from paddocks allocated not to receive supplements were sampled on the 2 February 1995. Steers were sampled on the 23 August and 25 October 1994. These samples, were subsequently analysed for urea nitrogen (PUN) and inorganic phosphorus (PIP).

Faecal grab samples were obtained when possible from the subset of first-calf cows used for blood sampling on the 23 August 1994, 25 October 1994, 20 March 1995 and 27 April 1995. Contents of total N and total P were subsequently determined.

Urine samples were obtained from some of the first-calf cows in each paddock group on the 23 August 1994, 25 October 1994, 20 March and 8 May 1995. In addition, urine samples were obtained on the 2 February 1995 from some first-calf cows from paddocks allocated not to receive supplements. Urine was subsequently analysed for purine derivatives, creatinine and urea.

Results

1. Seasonal conditions and pasture quality

The rainfall during the 1993/94 wet season preceding the commencement of the experiment was similar to the long-term mean, but there was negligible rain from 1 April 1994 until 26 December 1994. Thus there was a large amount of senesced pasture on offer in June 1994 at the commencement of the experiment, and negligible green pasture was available during the dry season and until the break of the season on the 26 December 1994. Wet season pasture growth from January 1995 was typical of the Swan's Lagoon environment, although since the last effective rain was on the 13 March 1995, the wet season tended to be shorter than the long-term average for the area.

The pasture samples (Table 2) consisted largely of Indian couch (*Bothriochloa pertusa*), Golden beard grass (*Chrysopogon fallax*) and black speargrass (*Heteropogen contortus*). N content was less than 0.4% and digestibility less than 42% IVOMD during the late dry season. In the mid-wet season in March 1995, N content, P content, P content and IVOMD were 1.5%, 0.16% and 58% respectively. Contents of N, P and IVOMD then declined rapidly such that by mid-May these were almost as low as in the previous late dry season (0.6%, 0.07% and 41% respectively).

2. Intakes of supplement

Mean intake of the DS supplement was 175 g per animal, and was little affected by the stage of the dry season (Table 3). The lower intakes during the first four weeks were because only small amounts of supplement were provided at this time.

Table 3. Intakes (g as fed per head per day) of supplements

Supplement	No DS supps		Plus DS supps	
	No WS	Plus WS	No WS	Plus WS
Dry season				
Weeks 1-4	-	-	126	132
5-8	-	-	135	198
9-12	-	-	169	190
13-16	-	-	196	205
17-20	-	-	198	202
Mean	-	-	165	185
M8U (wet)				
Weeks 1-5	1020	953	1155	2084
6-8	608	360	735	368
Mean	866	731	998	1418
Wet season				
Weeks 1-2	-	47	-	41
3-6	-	168	-	60
7-10	-	155	-	151
Mean	-	139	-	92

Table 4. Variation in intake of dry lick supplement, and number of non-consumers of supplement, measured using lithium-labelled supplements in four approximately equal paddock groups on the 23 August 1994

Class of cattle	Number	Intake (g/d)		Intake ($g/W^{0.75}$)		Number of non consumers
		Mean	CoV	Mean	CoV	
First calf cows	90	180	63	2.0	64	3
Second calf cows	32	196	46	2.3	46	1
Steers	20	95	40	1.8	39	0

The variation in intake of DL supplement among individual animals measured using lithium marker in 22 August 1994 differed ($P<0.05$) among age groups of animals when expressed on a g per head basis, with the weaner steers consuming only 51% of the amount consumed by the cows (Table 4). However, there was no difference between steers and cows in supplement intake when the intake was expressed relative to the liveweight. The coefficient of variation of supplement intake was 39-40% for steers and 46% for second-calf cows, and tended to be greater (63-64%) for first-calf cows. Few (4/132 or 3%) animals did not consume any supplement.

Intake of M8U was higher from 24 November to 21 December 1994 (1.3 kg/d) than from 21 December 1994 to the 9 January 1995 (0.5 kg/d). There was a tendency ($P = 0.06$) for M8U intakes during the interval 24 November - 21 December 1994 to be higher for groups of animals which had been fed dry lick supplements during the previous dry season (1.6 and 1.3 kg/d respectively), but there was no difference during the interval 21 December 1994 - 9 January 1995 (0.7 and 0.6 kg/d respectively.

Intakes of WS supplement (116 g as fed per head per day) were lower then during the previous dry season, and were not affected by whether groups of animals had been fed DS supplements (Table 4).

The low intakes during the first two weeks (47 and 41 g/d respectively) were due to provision of only restricted amounts of the supplements.

Table 5. LW of various classes of cows and steers (not corrected for conceptus)

Class of animal and date of measurement	No dry season supp		Plus dry season supp	
	No WS	Plus WS	No. WS	Plus WS
First-calf cows				
23 Jun 94	407	411	412	403
25 Oct 94	390	391	403	407
13 Dec 94	325	320	339	347
late Jan 95	298	304	312	332
mid Mar 95	344	347	357	373
early May 95	362	376	375	399
Second-calf cows				
23 Jun 94	356	341	345	356
25 Oct 94	346	332	368	379
13 Dec 94	294	282	317	337
late Jan 95	270	280	284	324
mid Mar 95	328	328	333	373
early May 95	342	356	356	395
Steers				
18 Jul 94	188	-	189	-
25 Oct 94	185	-	193	-

Table 6. CS various classes of cows and steers

Class of animal and date	No dry season supp		Plus dry season supp	
	No WS	Plus WS	No. WS	Plus WS
First-calf cows				
23 Jun 94	7.2	7.3	7.2	7.2
25 Oct 94	5.2	5.1	5.4	5.5
13 Dec 94	4.3	4.1	4.6	4.9
late Jan 95	4.2	4.3	4.6	4.9
mid Mar 95	5.0	5.0	5.5	5.7
early May 95	5.3	5.6	5.8	6.1
Second-calf cows				
23 Jun 94	5.1	5.1	5.2	5.4
25 Oct 94	4.0	4.2	4.6	4.7
13 Dec 94	3.3	3.2	4.1	4.4
late Jan 95	3.4	3.6	4.1	4.5
mid Mar 95	4.5	4.8	5.4	5.4
early May 95	4.9	5.5	5.7	5.8

3. Changes in liveweight and body condition score

First-calf cows were on average 408 kg LW and BCS 7.2 on 23 June 1994 (Tables 5 and 6). Unsupplemented first-calf cows decreased to 325 kg LW and BCS 4.3 by the 13 December 1994, and hence had lost 78 kg uncorrected LW. LW and BCS did not change during the early wet season up until 2 February 1995 (311 kg LW and 4.4 BCS), but had increased to 363 kg LW and 5.1 BCS by the

8 May 1995. Hence between 2 February 1995 and 8 May 1995 these unsupplemented first-calf cows gained 52 kg LW or 0.6 kg LW/day. Second-calf cows were lower in LW (mean 350 kg) and BCS (mean 5.2) than first-calf cows on the 23 June 1994 (Tables 5 and 6). Unsupplemented second-calf cows decreased to 294 kg and BCS to 3.3 at the 13 December 1994, and hence lost 62 uncorrected kg LW during the dry season. There was little change in either LW or BCS during the early wet season up until 2 February 1995. These second-calf cows then increased to 340 kg LW and 4.7 BCS by the 8 May 1995, and hence gained 56 kg or 0.6 kg LW/d during this period.

DS supplements reduced loss of LW and BCS to December 1994 by 20 kg LW and 0.6 BCS units in first-calf cows, and by 39 kg LW and 1.0 BCS units in second-calf cows.

Much of the difference in LW and BCS due to DS supplements was retained through the wet season. At weaning on the 8 May first-calf cows were 14 kg and second-calf cows 22 kg heavier than their counterparts which had not been supplemented during the dry season. Unsupplemented steers lost 3 kg LW to 25 October 1994, while DS supplements resulted in LW gain of 4.2 kg LW (Table 5).

The M8U prevented mortality until wet season pasture was available. However, all paddock groups lost LW during the period 13 December 1994 - 23 January 1995; even those cows with the highest intakes of molasses-urea (T4, 1.4 kg M8U/d), lost 20-22 kg LW.

The supplements fed during the later WS increased LW gain and BCS gain from 2 February 1995 to the 8 May 1995, by 10 kg in first-calf cows and by 12 kg in second-calf cows. These estimates are after allowing for differences, apparently due to chance, at the beginning of this period of measurement. First-calf cows which were supplemented gained 61 kg LW (0.64 kg/d) and second-calf cows which were supplemented gained 65 kg LW (0.68 kg/d).

Calf growth rate was high (0.8 - 0.9 kg/d) for all treatments. Calf weaning weight was increased from 167 to 171 kg by DS supplements, and from 166 kg to 172 kg by WS supplements.

The effects of DS and WS supplements on cow LW and BCS, or on calf weaning LW, were independent. There was no evidence of any interaction between the provision of supplements and the season during which they were fed on these measurements.

4. Reproductive activity

The proportion of cows which were pregnant, which were reproductively active (ie demonstrating ovarian cycles) but were non-pregnant, or were reproductively inactive (neither cycling or pregnant) at Windows A, B or C are shown in Table 7.

At Window A there were large effects of the previous DS supplementation on reproductive activity of first-calf cows, but not of second-calf cows. Among first-calf cows, the proportion reproductively active was increased from 9% to 37%, and within this group the proportion pregnant increased from 3% to 20%. In addition the proportion of animals showing behavioural ovarian was increased from 25% to 44%. Among second-calf cows, DS supplements tended to increase the proportion reproductively active from 4% to 10%. The proportion of animals showing behavioural oestrous tended to increase from 21% and 35%.

At Window B, there was a substantial effect of the previous DS supplementation on the proportion of first-calf reproductively active (75% and 86%), or pregnant (52% and 72%). Similarly DS supplements increased the proportions of second-calf cows reproductively active (54% and 78%) and the proportion pregnant (46% and 70%).

Table 7. Proportions of first-calf or of second-calf cows in various reproductive activity at three measurement windows during lactation

Measurement	No dry season supp		Plus dry season supp	
	No WS	Plus WS	No. WS	Plus WS
First-calf cows				
Window A				
Not cyc, not preg	94	87	68	50
Cycling, not preg	6	7	19	15
Pregnant	0	7	14	27
Behavioural oestrous	17	35	35	54
Window B				
Not cyc, not preg	30	19	24	3
Cycling, not preg	18	29	14	14
Pregnant	52	52	62	83
Behavioural oestrus	58	50	52	40
Window C				
Pregnant	68	74	76	86
Second-calf cows				
Window A				
Not cyc, not preg	100	92	82	100
Cycling, not preg	0	8	9	0
Pregnant	0	0	9	0
Behavioural oestrous	33	10	18	50
Window B				
Not cyc, not preg	40	50	36	8
Cycling, not preg	20	0	9	8
Pregnant	40	50	55	83
Behavioural oestrous	25	50	67	22
Window C				
Pregnant	50	50	64	92

At Window C, previous DS supplements increased pregnancy rate of first-calf cows from 72% to 81%, and of second-calf cows from 50% to 78%.

The effects of WS supplementation on reproductive activity were generally much less than the effects of the previous DS supplements. At Window B, which coincided with the first three weeks of the wet season supplementation, the proportions of cows pregnant or reproductively active tended to be greater for groups of animals fed wet season supplements (Table 7). For first-calf cows the proportions reproductively active were 73% and 89%, and pregnant 57% and 67%. For second-calf cows the proportions reproductively active were 58% and 71%, and pregnant 47% and 67%. At Window C WS supplements increased the proportion of first-calf cows pregnant from 72% to 80%. Pregnancy rate of second-calf cows was increased from 57% to 71%, and all of this increase occurred in the groups of cows which had previously been DS supplements.

The accumulative proportion of cows pregnant with time (Figure 1) shows the large differences due to treatment. Previous DS supplementation increased the proportion of cows pregnant at the commencement of wet season supplementation on Day 420 (24 February 1995) from 10% to 36%. Among cows not fed DS supplement, WS supplements had little effect on conception rate; pregnancy rates were 68% and 74% for first-calf cows and 50% for both treatments of second-calf cows (Table 7). In contrast the effects of WS supplements were quite large in cows which had previously received

FIGURE 1. The accumulative percentage of cows pregnant at various times through the mating season. Cows were not fed (-DS) or fed (+DS) dry lick supplements through the preceding dry season, and not fed (-WS) or fed (+WS) dry lick supplements during the later part of the wet season. The wet season supplements were commenced on Day 420 and as indicated by ↓.

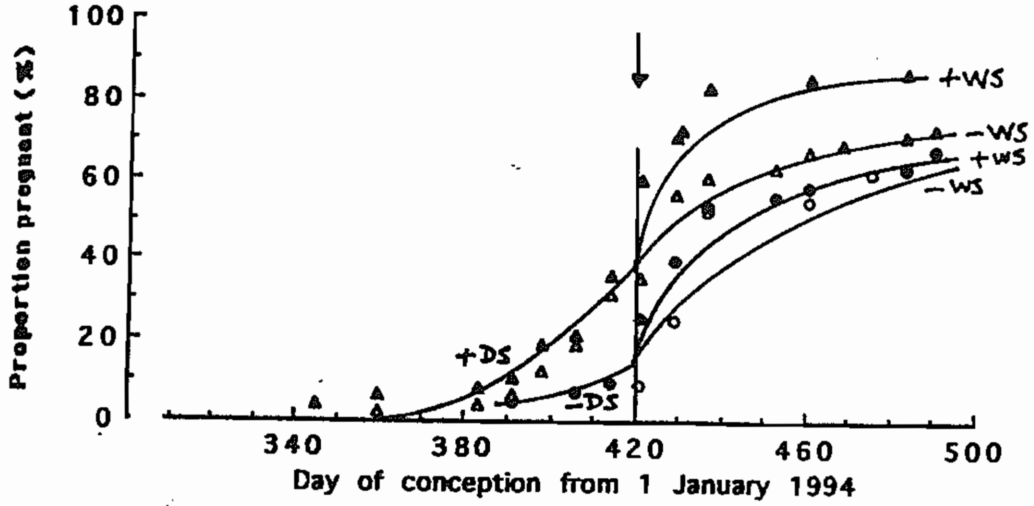


FIGURE 2. Effect of WS supplements on reconception up to weaning of cows in a range of body condition scores in the mid-wet season. Results from first-calf and second calf cows have been combined. The number of observations in each group is shown.

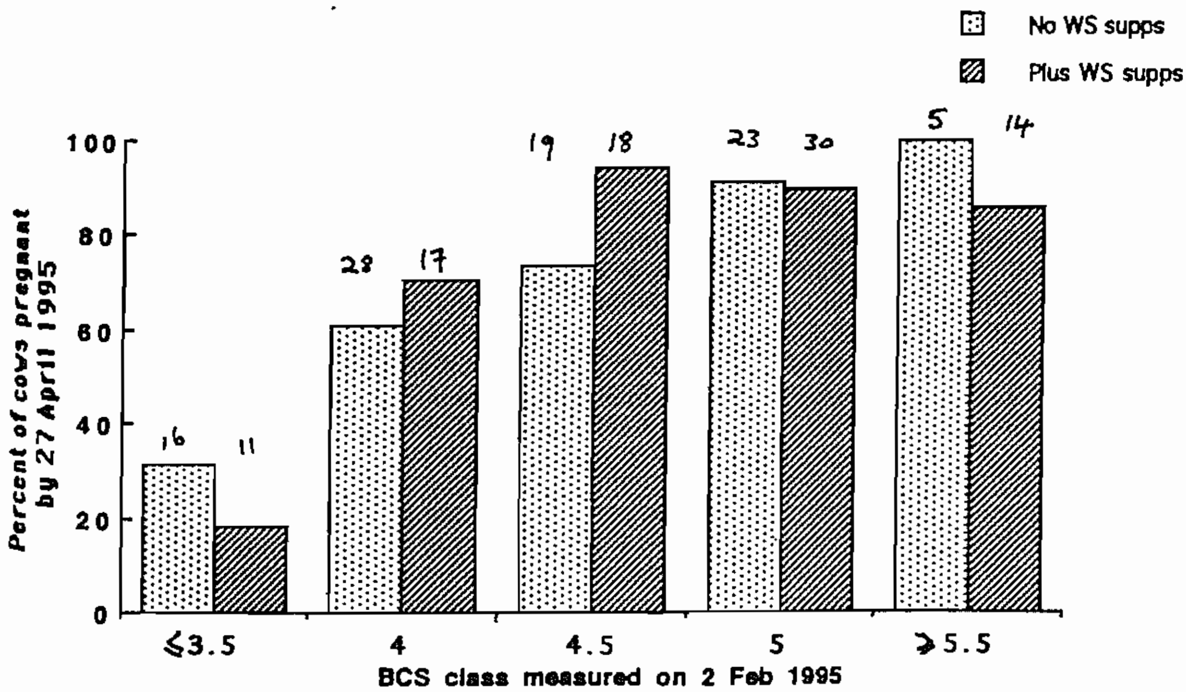


Table 8 Measures of rumen microbial protein synthesis calculated from excretion of purine derivatives, plasma urea nitrogen (PUN), plasma inorganic phosphorus (PIP) and concentrations of total and total P in faeces of first-calf cows.

Measurement and date	No dry season supp		Plus dry season supp		Significance		
	No WS	Plus WS	No. WS	Plus WS	DS	WS	DSxWS
Microbial N synthesis (gN/d)							
Aug 94	42		47		*		
Oct 94	36		41		*		
early Feb 95	103						
late Mar 95	92	99	90	92			
early May 95	60	64	61	70			
PUN (mMol/L)							
Aug 94	1.48		1.84		(-)		
Oct 94	1.06		1.82		***		
early Feb 95	7.80		6.62		**		
early Mar 95	5.68	5.62	5.07	4.36	**	ns	ns
late Mar 95	4.31	4.92	3.58	3.32	***	ns	ns
late Apr 95	3.55	2.54	2.07	1.86	***	*	(-)
early May 95	3.00	2.25	1.85	1.37	***	**	ns
Faecal N (% N)							
Aug 94	1.14						
Oct 94	1.18						
late Mar 95	1.74		1.52				
late Apr 95	1.29		1.10				
PIP (mMol/L)							
Aug 94	1.39		2.09		***		
Oct 94	1.42		2.16		***		
early Feb 95	1.12		1.31		*		
early Mar 95	1.62	1.04	1.64	1.75	*	ns	*
late Mar 95	1.36	1.37	1.44	1.56	ns	ns	ns
late Apr 95	1.38	1.72	1.15	2.10	ns	***	ns
early May 95	1.15	2.06	1.03	2.02	ns	***	ns
Faecal P (% P)							
Aug 94	0.147						
Oct 94	0.138						
late Mar 95	0.283		0.286				
late Apr 95	0.187		0.181				

DS supplements; WS supplements increased pregnancy rates from 76% to 86% in first-calf cows, and from 64% to 92% in second-calf cows.

There were differences between treatments in the proportion of cows pregnant at various post-partum anoestrous intervals (PPAI) which were similar to the differences observed for the day of conception. Median PPAI was 130 days for cows which did not receive any supplements. Median PPAI was reduced to 110 days by wet season supplements alone, to 100 days by dry season supplements in the absence of wet season supplements, and 90 days by the combination of both dry season and wet season supplements.

BCS of cows affected both the pregnancy rate and the pregnancy rate response to WS supplements (Figure 2). Cows which were in "poor" body condition at the commencement of WS supplementation (BCS $\leq$ 3.5) had a low conception rate (26%) up to the end of mating on 26 April 1995, and conception rate was not affected by WS supplementation. Presumably few of these cows achieved the threshold level of body reserves necessary for ovarian activity and conception. Cows which were in at least "store" body condition at the commencement of WS supplementation (BCS 5 or BCS $\geq$ 5.5) achieved a high conception rate (92%) up to the end of mating, and also conception rate of these classes of cows was not affected by WS supplementation. Presumably this was because most of these cows were heavier that the threshold level of body reserves necessary for oestrus activity and conception; although WS supplements increased liveweight gain this could not increase conception rates.

The conception rate of cows in BCS 4.0 and 4.5 at 2 February 1995 was intermediate between those in lighter or heavier body condition (mean pregnancy rate 73%). Among those cows non-pregnant at the commencement of WS supplementation, and therefore able to respond in conception rate, WS supplementation increased conception rate from 61% to 81%. It appears that it was this group of cows in which the increase in LW gain due to WS supplements was important to increase ovarian activity and conception rate.

5. Rumen microbial protein synthesis and concentrations of N and P components in plasma and faeces

In unsupplemented cattle rumen microbial protein synthesis was increased from 36-42 gN/day in the dry season to 103 gN/day in the early wet season, and then declined to 92 and 60 gN/day in late March and early may respectively (table 8). Rumen microbial protein synthesis was increased by 12-14% by urea-based supplements during the late dry season.

Plasma urea concentrations in unsupplemented first-calf cows tended to be lower 25 October 1994 (1.06 mMol/L) than on the 23 August 1994 (1.48 mMol/L), and were increased to 1.82 - 1.84 mMol/L by supplements.

Plasma urea concentrations in the same treatment group of animals were high (7.80 mMol/L in the early wet season on 2 February 1995, and declined progressively to 3.00 mMol/L by the 8 May 1995. Cows fed DS supplements had lower ($P<0.01$ or $P<0.001$) plasma urea concentrations at each of the five sampling times during the following wet season than the cows not fed DS supplements. Decreases ranged from 11% (5.68 to 5.07 mMol/L) on the 9 March 1995, to 42% (33.55 to 2.07 mMol/L) on the 27 April 1995. WS supplements had no effect on the 9 or 20 March 1995, but reduced ($P<0.05$ or $P<0.01$) plasma urea concentration by 22% and 25% on the 27 April 1995 and the 8 May 1995 respectively. Faecal N concentrations in unsupplemented first-calf cows were 1.14% N on the 23 August 1994, and 1.18% N on the 25 October 1994 (Table 11). In the mid-wet season on 20 March 1995, faecal N concentration in first-calf cows which had not been fed DS supplements was 1.74% N and this decreased to 1.29% N by the 27 April 1994. DS supplementation reduced faecal N concentration, from 1.74% N to 1.52% N on 20 March 1995, and from 1.29% N to 1.10% N on the 27 April 1995.

Faecal P concentrations in unsupplemented first-calf cows were 0.147% P and 0.138% P on the 23 August 1994 and 25 October 1994 respectively. Plasma inorganic phosphate concentrations at these sampling times were 1.39 - 1.42 mMol/L, and were increased by supplementation to 2.09 - 2.16 mMol/L.

Faecal P concentration during the wet season were not affected by previous DS supplementation, and averaged 0.285% P on the 20 March 1995 and 0.184% P on the 27 April 1995. Plasma inorganic phosphorus concentrations were increased by previous DS supplementation on 2 February 1995, but thereafter were generally not affected. In unsupplemented first-calf cows, PIP concentrations declined from 1.65 mMol/L on 9 March 1995 to 1.15 mMol/L on 8 May 1995. WS supplements did not significantly ($P>0.05$) affect PIP at on the 9 or 20 March 1995, but did increase ($P<0.001$) PIP at the 27 April 1995 and 8 May 1995.

Practical implications

1. The dry lick supplements used in this experiment had substantial effects on the LW and BCS of the cows. DS supplements fed for 20 weeks reduced LW loss during the severe dry season by 20 kg for first-calf cows, and 39 kg for second-calf cows. WS supplements increased LW gain over 10 weeks by 19 kg per cow. Effects of DS and WS supplements on LW were additive.

2. There were large effects of DS supplements on fertility of both age groups of cows during the following wet season. Pregnancy rate at weaning increased from 69% to 82% in first-calf cows, and from 52% to 79% in second-calf cows at a cost in supplements of $13 per breeder. WS supplements increased pregnancy rate of first-calf cows, but not of second-calf cows.

3. The increases in pregnancy rate were associated with increased LW of the cows post-partum and during the wet season. If cows were in "poor" body condition in the mid-wet season pregnancy rates were low, and even though WS supplements increased LW gain the effect was not large enough to have an appreciable effect on reconception. If the cows were in backward store condition in the mid-wet season, WS supplements were important to increase low LW to the threshold needed for reconception. However if cows were in "store" body condition in the mid-wet season, pregnancy rates were high even in the unsupplemented animals, and despite the effect of little WS supplements to increase cows LW, little increase in pregnancy rates was possible.

4. It is likely that the responses to the dry lick supplements were primarily due to the non-protein nitrogen (urea and ammonium sulphate) component. Metabolic measures indicated that phosphorus status of the unsupplemented cows was adequate. The amount of "bypass protein" derived from the CSM was small relative to the protein requirements of these animals, and was probably not important. However inclusion of CSM in the dry lick was probably important to increase the palatability of the dry lick mixtures, contributing to the high intakes of supplement and the low proportion of shy feeders of supplement. We expect that similar effects on pregnancy rate would occur if the LW of cows is increased by means other then supplements (eg. by reduced stocking rate or improved pastures).

Responses to urea-based supplements - Experiment 2

Effect of dry lick supplements fed during the dry season and/or the wet season on productivity of Bos indicus x Shorthorn cross breeder cows (1995/96 draft of cattle)-SWN-B821

Rob Dixon, Peter Fry, Adrian White, Geoff Fordyce and Michael D'Occhio

Summary

1. First-calf (128) and second-calf (78) Bos indicus x Shorthorn cows grazing speargrass dominant native pasture were used to examine the effect of dry lick supplements on breeder liveweight (LW) and body condition score (CS) changes, on calf growth to weaning, and on conception of the cows while lactating. Cows calved between November 1995 and early January 1996, and were mated from mid-December to late April 1996. The seasonal break occurred in August so that dry season conditions were benign.

2. Dry lick supplements were fed *ad libitum* during the dry season (DS) (July-November 1995), or during the later part of the following wet season (WS) (March-May 1996), or at both of these intervals. Control cows were not fed any supplement. Intake of DS supplements averaged 161 g DM/d before the seasonal break and 33 g DM/d after the break. Intake of WS supplements was up to 534 g DM/d during weeks 3 and 4 when a low-urea supplement mixture was fed, and 186 g DM/d during weeks 5-9 when a high-urea supplement mixture was fed.

3. From June 1995 until January 1996, unsupplemented first-calf cows gained 23 kg LW and decreased from CS 6.8 to CS 5.3. Second-calf cows gained 42 kg LW and decreased from CS 5.6 to 5.3. DS supplements did not change LW or CS.

4. During the wet season (from late January to late May 1996) lactating unsupplemented first-calf cows lost 17 kg LW and 0.5 CS units. Lactating unsupplemented second-calf cows lost 35 kg LW, and 0.3 CS units during the same period. WS supplements resulted in first-calf cows being 12 kg heavier, and second calf cows 34 kg heavier, at weaning.

5. Supplements did not affect reproductive activity. Most (91%) cows reconceived while lactating, and among these cows average interval from calving to reconception was 61 (SD 28) days.

6. Concentrations of urea and inorganic P in plasma, and of total N and total P in faeces, suggested that the unsupplemented cows were not likely to have been deficient in N during the dry season, but may have been deficient in N during the later part (March/May) of the growing season. P was not likely to be limiting at any time, and the effects of supplements fed during the wet season on LW were probably due to the N components of the supplement.

Experimental

First-calf and second-calf Bos indicus x Shorthorn cross breeder cows from the Swan's Lagoon herd were grazed in eight 100 ha paddocks during the experiment. The first-calf cows had been joined at approximately two years of age from January 1995, and 128 predicted to calve between late October 1995 and early January 1996 were used. Second-calf cows (78) had a similar history of management, but were one year older. All had raised a calf to weaning in May 1995, and were selected to calve during the same interval as the first-calf cows. Cows were joined from mid-December 1995 until late

Table 1. Mean composition of pasture samples (g/kg DM)

Sample date	OM	N	P	Ca	IVDMD	IVOMD
6 Sept 95	894	15.0	1.4	2.4	504	515
19 March 96	911	7.5	0.9	2.70	422	427

OM, organic matter; N, total nitrogen; P, phosphorus; Ca, calcium; IVDMD, in vitro dry matter digestibility; IVOMD, in vitro organic matter digestibility

Table 2. Conceptus-free liveweight of first- and second-calf cows

Class of animal and date of measurement	No dry season supp		Plus dry season supp	
	No WS	Plus WS	No WS	Plus WS
First-calf cows				
20 Jun 95	355	360	358	363
24 Oct 95	370	367	371	372
late Jan 96	394	382	379	389
early Mar 96	404	389	397	404
21 May 96	381	387	366	395
Second-calf cows				
20 Jun 95	383	369	389	367
24 Oct 95	391	377	417	391
late Jan 96	453	407	426	421
early Mar 96	442	417	445	431
21 May 96	424	435	423	429

April 1996. Calves were weaned in late May. Cows were vaccinated for botulism and leptospirosis. The cattle were allocated to 8 paddock groups each of 13-17 first-calf cows and 8-11 second-calf cows

The four treatments consisted of dry lick supplements described for Experiment 811 (above) fed during the dry season (DS) and hence also during pregnancy, and/or dry lick supplement fed during the later part of the wet season (WS) when the cows were lactating. DS were fed for 20 weeks from July 1995 until November 1995. WS supplements were fed for 10 weeks from early March 1996 when most grass species were in flower until mid-May 1996.

Pasture was sampled once during the dry season (early September 1995) and twice during the wet season (mid- March, mid- May) from areas of the paddocks and grass species observed to be utilised. Intake of supplement was measured twice weekly. Intake of supplement by individual animals was estimated once during the dry season (late October 1995) and once during the wet season (late May

Table 3. CS of first- and second-calf cows

Class of animal and date of measurement	No dry season supp		Plus dry season supp	
	No WS	Plus WS	No WS	Plus WS
First-calf cows				
20 Jun 95	6.7	6.8	6.7	6.8
24 Oct 95	5.6	5.8	5.6	5.6
late Jan 96	5.3	5.3	5.3	5.3
early Mar 96	5.0	4.8	5.0	4.9
21 May 96	4.8	5.0	4.6	5.0
Second-calf cows				
20 Jun 95	5.5	5.8	5.6	5.5
24 Oct 95	5.3	5.3	5.4	5.3
late Jan 96	5.3	5.4	5.3	5.2
early Mar 96	5.1	4.9	5.1	4.9
21 May 96	5.0	5.4	4.8	5.1

1996) using lithium marker mixed with the supplement. Measurements were made of liveweight and condition score of the heifers and cows eight times between June 1995 and weaning in May 1996. Reproductive activity was measured from progesterone concentrations in plasma in late January and early March, and from pregnancy diagnosis.

Results

1. Seasonal conditions and pasture quality

The last effective rain of the 1994/95 wet season was in mid-March, and there was a large amount of senesced pasture on offer in June 1995 at the commencement of the experiment. The was considerable rain during August (92 mm), and October (77 mm), so that the effective break of the season was during mid-August. Wet season pasture growth during December 1995 and January 1996 was typical of the Swan's Lagoon environment.

The pasture samples (Table 1) consisted largely of Indian couch, Golden beard grass and black speargrass. N content (15 gN/kg) and digestibility (515 g/kg) IVOMD in pasture sampled in September were much higher then usually observed at this time of the year, reflecting the early break to the season in August. In the mid-wet season in March 1996, N content, P content and IVOMD were 7.5, 0.9 and 427 g/kg respectively.

2. Intakes of supplement

Mean intake of the DS supplement was 71 g DM per head per day, and changed markedly during the supplementation period (Figure 1). Intakes during the first 6 weeks when pasture was senesced averaged

Figure 1. Mean intake of dry lick supplement in the 4 paddocks fed during the dry season from June to November

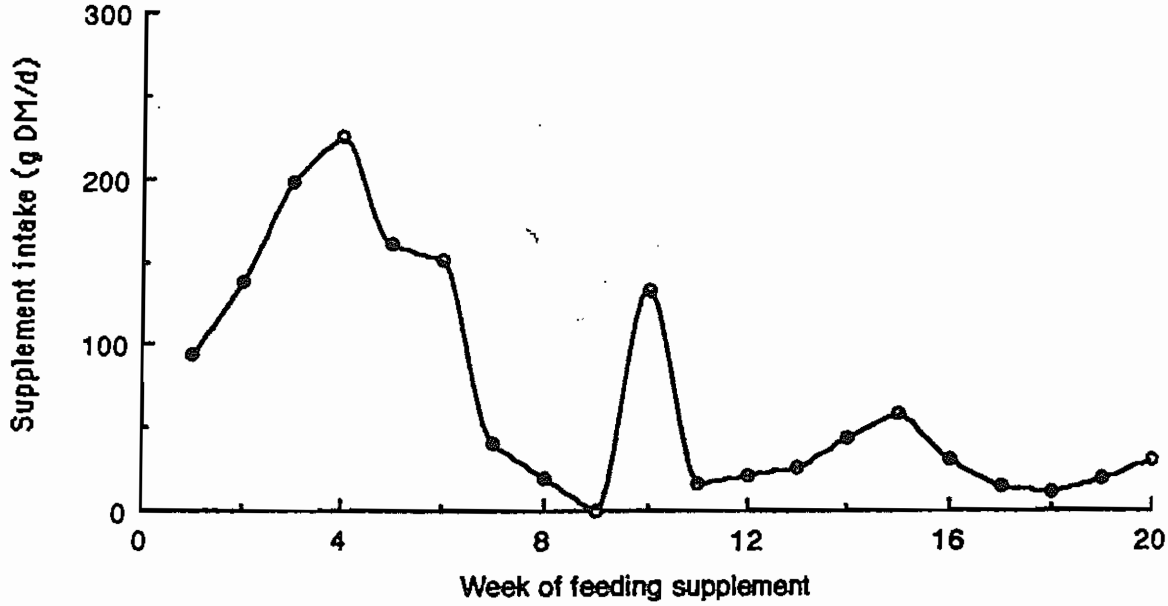


Figure 2. Mean intake of dry lick supplement in the four paddocks fed during the wet season from March to weaning in May

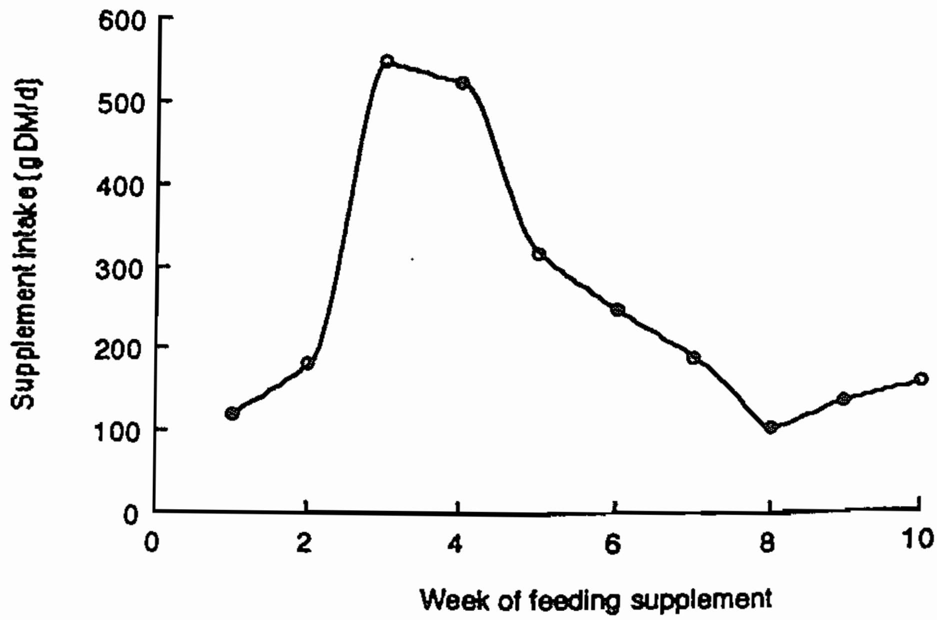


Table 4. Proportions of first-calf or of second-calf cows in various reproductive activity at two measurement windows during lactation and at weaning

Measurement	No dry season supp		Plus dry season supp	
	No WS	Plus WS	No WS	Plus WS
Window A				
Not cyc, not preg	4	4	4	7
Cycling, not preg	60	60	68	52
Pregnant	36	35	28	41
Window B				
Not cyc. not preg	0	6	6	4
Cycling, not preg	33	15	30	11
Pregnant	67	79	64	85
Weaning				
Pregnant	91	90	92	91

Window A, measurements in late January; Window B, measurements in early March.

161 g DM/d, but following the break to the season in August averaged 33 g DM/d. Intake of WS supplement increased rapidly during the first four weeks of supplementation, and averaged 534 g DM/d during weeks 3 and 4 (Figure 2). The change to the DS supplement mixture during weeks 5-9 reduced supplement intake to an average 161 g DM/d.

The variation in intake of WS supplement among individual animals measured on 20 May 1995 indicated that cows ate much more supplement than calves, both on a g/d head basis (163 g/d and 55 g/d respectively) and as a proportion of liveweight (416 and 149 mg DM/kg LW.d respectively). Variation in supplement intake among cows was similar to that observed during previous experiments (CoV 85%) and lower then the variation among calves (CoV 123%).

3. Changes in liveweight and body condition score

First-calf cows were on average 358 kg conceptus-free LW and CS 6.8 (ie "prime") in June 1995 (Tables 2 and 3). Unsupplemented first-calf cows gained 31 kg conceptus-free LW from June until January. These cows continued to gain some LW during February but lost LW from March to May, so that overall change from January to weaning in May was a loss of 17 kg conceptus-free LW and 0.5 CS.

Second-calf cows were slightly heavier (mean 377 kg conceptus-free LW) and lower in CS (mean 5.6) than first-calf cows in June 1995. Unsupplemented second-calf cows gained 57 kg conceptus-free LW from June to January (Table 4), and lost 35 kg conceptus-free LW and 0.3 CS units by weaning in May.

DS supplements had little effect on change in LW or CS of either first-or second-calf cows from June 1995 to January 1996. WS supplements had a substantial effect during March-May in first-calf cows, reducing a LW loss of 11 kg to maintenance, and in second-calf cows changing a LW loss of 21 kg to a LW gain of 13 kg. CS at weaning in May was also increased by WS supplements.

Calf growth rate was high (0.85 kg/d) and was similar for all treatments. Calf weaning weight averaged 187 kg, and also was not affected by treatment.

Table 5. Measurements in plasma (PUN and PIP, mmol/l) and faeces (total N and total P, %) of first-calf cows

	Nitrogen				Phosphorus			
	No DS supp		Plus DS supp		No DS supp		Plus DS supp	
	-WS	+WS	-WS	+WS	-WS	+WS	-WS	+WS
Plasma (mMol/L)								
29 Aug 95	6.57	6.36	6.60	6.76	1.94	1.97	1.96	2.02
24 Oct 95	5.67	5.81	5.74	5.77	2.16	2.21	2.12	2.09
22 Jan 96	3.75	3.76	2.74	3.39	1.70	0.94	1.34	1.23
1 Feb 96	2.67	2.91	2.73	3.04	1.60	1.29	1.47	1.48
28 Feb 96	1.88	2.22	1.71	1.90	1.04	0.90	1.44	1.01
7 Mar 96	1.16	1.76	1.81	2.09	1.51	0.83	1.20	0.86
21 May 96	2.98	2.43	2.58	2.98	1.52	1.89	1.69	1.75
Faeces (% N or P)								
29 Aug 95	1.48	1.40	1.37	1.39	0.24	0.18	0.22	0.18
24 Oct 95	1.44	1.39	1.32	1.44	0.24	0.17	0.22	0.19
7 Mar 96	1.33	1.17	1.15	1.24	0.20	0.17	0.19	0.17
21 May 96	1.18	1.23	1.23	1.18	0.19	0.19	0.17	0.24

4. Reproductive activity

The proportion of cows which were pregnant, which were reproductively active (ie demonstrating ovarian cycles) but were non-pregnant, or were reproductively inactive (neither cycling or pregnant) in late January and early March (Window A and B respectively), or pregnant at weaning are shown in Table 4. There were no effects of the supplementation treatments or age of the cows on the onset of reproductive activity or the proportion of cows pregnant by weaning. Average day of calving was 5 December 1995 (SD 18 days). Among those cows which reconceived while lactating, average day of conception was 3 February 1996, and hence the average interval from calving to reconception was 61 (SD 28) days.

By weaning in late May 91% of cows across all treatments were pregnant. The plasma progesterone concentrations at Window A indicated that 95% of the cows were reproductively active (either pregnant or non-pregnant but cycling) by late January 1996.

5. Concentrations of N and P components in plasma and faeces

Concentrations in plasma of urea (PUN) and inorganic P (PIP) were similar across treatments, and were high for all of the measurement dates from August 1995 through to January 1996 (Table 5). PUN urea concentrations declined in late February and March to 1.18 to 2.22 m mol/L, but tended to increase again by May.

Faecal N concentrations were in the range 1.3 - 1.5 % N in August and October, these high levels presumably due to the early break to the season and high N content of pasture for this time of the year. The PIP were in the range 1.9 - 2.2 m mol/L, and thus it was likely that these pregnant cows were adequate in their P status. Faecal P concentrations also support this conclusion. During the early wet season (in January and February) PIP concentrations were in the range 1.1 - 1.5 m mol/l and thus were in the range where the cows may have been in "marginal" P status. In the later wet season (March to May) when supplements were fed, faecal N concentrations in unsupplemented animals were 1.2 - 1.3% N, the PIP concentrations of unsupplemented cows were in the range 1.2 - 1.7 m mol/L. The unsupplemented cows were therefore probably "adequate" in their P status and the response to the supplement was most likely associated with the nitrogenous components of the supplement.

Practical implications

1. The heavy falls of rain in August and October resulted in benign dry season conditions. Both first and second-calf cows gained LW during the dry season, and irrespective of supplementation averaged "store" body condition in both the late dry season (October) and the early wet season (January). As a consequence of these seasonal conditions and associated high body weights of the cows, 91% of cows reconceived while lactating. The wet season supplement increased liveweight gain of the cows, but because pregnancy rate was already very high there was no opportunity to improved fertility.

Responses to urea-based supplements - Experiment 3

Effect of dry season dry licks containing dried molasses or cottonseed meal for first-calf heifers - SWN-B823

Rob Dixon, Adrian White, Peter Fry, Geoff Fordyce and Michael D'Occhio

Summary

1. First-calf Bos indicus x Shorthorn heifers grazing native pasture were used to examine the effects of high-urea dry lick supplements during the dry season on liveweight and on subsequent fertility. Heifers calved between November 1995 and early January 1996, and were mated from mid-December to late April.

2. The seasonal break occurred in August so that dry season conditions were benign. Dry lick supplement were offered *ad libitum* from July to November, and contained 27% urea and 32% of either cottonseed meal (+CSM) or dried molasses (+MOL). Intakes of the two dry licks were similar, and were much higher for the 5 weeks before the seasonal break (126 and 143 g DM/d respectively) then for the 13 weeks after the seasonal break (40 and 50 g DM/d respectively).

3. From June until October unsupplemented heifers gained 10 kg conceptus-free LW. The cows continued to gain LW (24 kg) until early March, and then lost 29 kg LW to weaning in late May. Unsupplemented cows were at "forward store" or better body condition during the dry season, and declined to "store" body condition at weaning.

4. The proportion of unsupplemented heifers pregnant at weaning was high (92%). Progesterone concentrations in blood samples in early March indicated that almost all of the cows which reconceived were cycling by late February. Calf LW gain to weaning (0.73 kg/d) was high. There was no effect of either of the dry lick supplements on liveweight, body condition calf growth or reconception of the lactating cow. Concentrations of urea nitrogen and inorganic phosphorus in plasma, and total N and total P in faeces suggested that unsupplemented cows were not likely to have been deficient in N during the dry season, but were probably deficient in N during the later part of the wet season.

Experimental

First-calf Bos indicus x Shorthorn cross heifers from the Swan's Lagoon station herd were joined at approximately two years of age in January 1995. The heifers were grazed in twelve 40 ha paddocks between June 1995 and January 1996, and then as a single mob in a 400 ha paddock from January 1996 until weaning in May 1996. The heifers were again joined from mid-January 1996 until late April 1996. The pasture in the paddocks used from June-January consisted predominantly of native grass species, and had been fertilised with superphosphate. The paddock used from January-May was also native pasture but without previous fertilisation. Heifers were vaccinated for botulism and leptospirosis.

The three treatments consisted of no supplement, or one of two types of dry lick supplement fed from June until November. These supplements contained a high concentration of urea, and either CSM or dried molasses to increase palatability (Table 1).

Measurements were made of liveweight and condition score of the heifers six times between June 1995 and weaning in May 1996. Reproductive activity was measured from progesterone concentrations in plasma in early March, and from pregnancy diagnosis.

Table 1. Composition (g/kg) of dry lick supplements

Ingredient	Type of dry lick	
	+ Mol	+CSM
Cottonseed meal	-	320
Dried molasses #	320	-
Urea	270	270
Salt	180	180
Calcium phosphate ##	140	140
Ammonium sulphate	90	90

Palabind ## Kynophos

Table 2. Changes in liveweight and condition score of first-calf heifers either not supplemented (NIL) or supplemented during the dry season with dry licks containing dried molasses (+MOL) or cottonseed meal (+CSM)

Date	Uncorrected LW			Conceptus-free LW			CS		
	NIL	MOL	CSM	NIL	MOL	CSM	NIL	MOL	CSM
20 Jun 95	377	371	374	371	365	368	6.9	6.8	6.8
5 Sept 95	384	383	384	365	365	365	6.4	6.5	6.5
19 Oct 95	415	413	411	381	379	378	6.0	5.9	5.8
16 Jan 96	403	406	409	402	405	408	5.7	5.7	5.6
1-11 Mar 96	406	408	404	405	406	405	5.2	5.2	5.1
20 May 96	380	378	376	376	375	373	4.9	4.7	4.7

Results

Intake of the two dry licks are shown in Figure 1 and 2. Supplement intakes approached 30 g N/d for the first five weeks, but declined abruptly following rain (99 mm) in early- and mid-August. Supplement intakes increased gradually during late September and October, but again declined following rain in mid-late October.

Conceptus-free LW changed little from June to early September, increased from September until early March, and declined from early March to weaning in late May (Table 2). Body condition scores declined pro gressively, but the heifers were still in "forward store" condition through the dry season and "store" condition at weaning. Most (92%) of the heifers were cycling by late February and 86% reconceived before weaning (Table 3). There were no differences due to the dry lick treatments. Measurements of plasma urea nitrogen (PUN), plasma inorganic phosphorus (PIP) and N and P in faeces (Table 4) suggested that these heifers were adequate in their P status, adequate in their N status

Figure 1. Intake of dry lick supplement containing 32% of either CSM (o) or dried molasses (●)

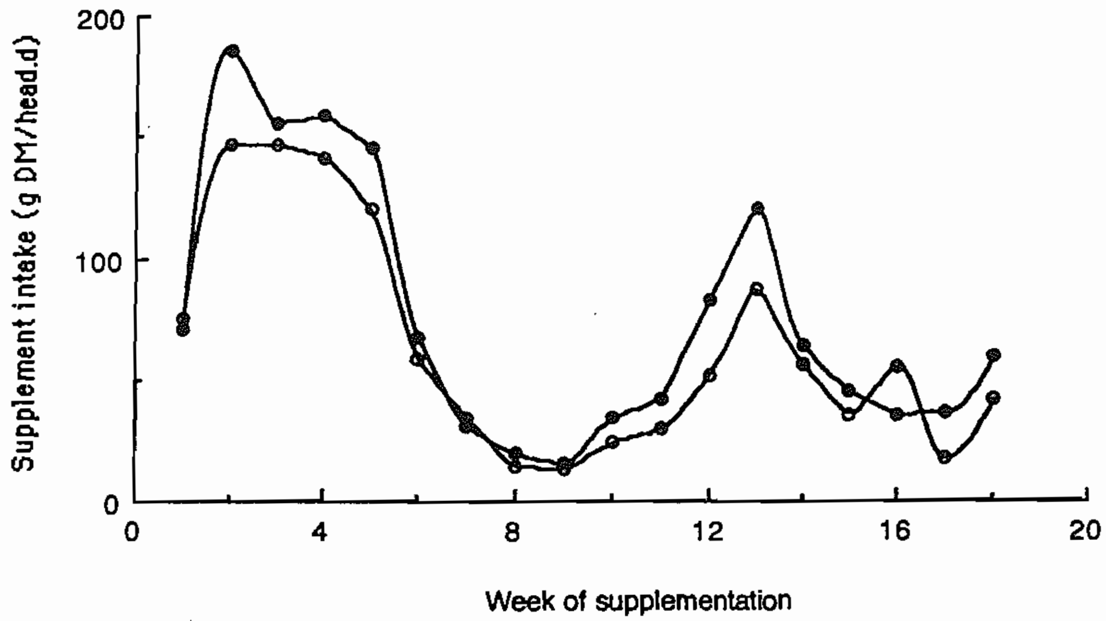


Figure 2. Intake of dry lick supplement N containing 32% of either CSM (△) or dried molasses (▲)

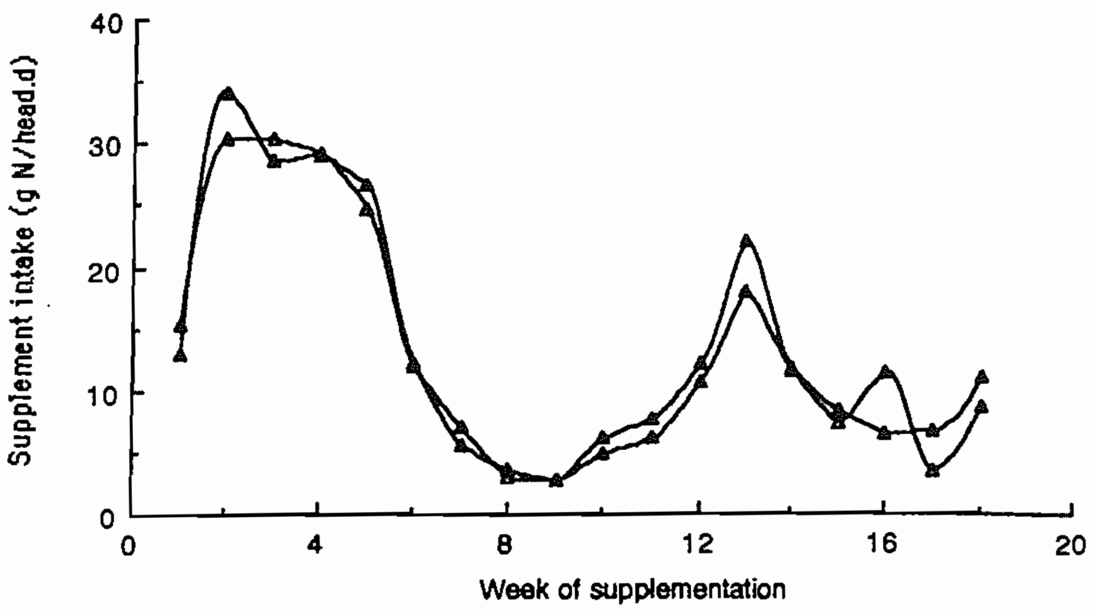


Table 3. Reconception of lactating first-calf cows before weaning and calf growth rate from mid-January to weaning. Cows had been fed no supplements (NIL) or dry lick supplements containing dried molasses (+MOL) or cottonseed meal (CSM) during the previous dry season

Measurement	Treatment		
	NIL	+MOL	+CSM
Cycling in early March (%)*	94	97	84
Pregnant at weaning (%)	92 (33/36)	91 (31/34)	75 (27/36)
Calf LW at weaning (kg)	172	170	170
Calf LW gain (kg/d)	0.73	0.74	0.73

* Determined from concentrations of progesterone in plasma

Table 4. Measurements in plasma (PUN and PIP, mmol/L) and faeces (total N, % and total P, %) of first-calf cows

Measurements	Nitrogen			Phosphorus		
	NIL	+MOL	+CSM	NIL	+MOL	+CSM
Plasma (mMol/L)						
5 Sept 95	5.59	5.86	6.15	1.78	1.92	1.84
19 Oct 95	5.55	5.53	6.45	1.95	1.90	1.80
16 Jan 96	3.26	2.71	3.12	1.67	1.56	1.62
1 Mar 96	2.38	2.34	2.76	1.62	1.64	1.55
11 Mar 96	1.03	1.23	1.54	1.82	1.66	1.54
20 May 96	3.34	2.84	3.55	1.76	1.89	1.81
Faeces (% N or P)						
5 Sept 95	1.38	1.47	1.48	0.20	0.24	0.24
19 Oct 95	1.61	1.71	1.67	0.28	0.30	0.29
11 Mar 96	1.18	1.07	1.15	0.19	0.18	0.18
20 May 96	1.05	1.03	1.11	0.17	0.19	0.20

during the dry season, but may have been deficient in N during the later wet season from March to May 1996.

Practical implications

This experiment demonstrated that following a benign dry season where first-calf heifers continued to gain liveweight, reconception rates were very high and there was no response to supplementation during the dry season with high urea dry licks.

Effect of dry season dry licks containing dried molasses or cottonseed meal for first-calf heifers - SWN-B833

Rob Dixon, Adrian White, Peter Fry, Geoffry Fordyce and Michael D'Occhio

Summary

1. First-calf Bos indicus x Shorthorn heifers (132) grazing native pasture were used to examine the effects of supplements fed from July-November during the 1996 dry season on liveweight and on subsequent fertility. Storm rain during June (45 mm) and September (27 mm) led to considerable green pick through the senesced pasture. Heifers calved between November 1996 and early January 1997, and were mated from mid-December to late April.

2. The supplements consisted of dry licks offered *ad libitum*, and contained 27% urea and 32% of either cottonseed meal (+CSM) or dried molasses (+MOL). Intakes of the two dry licks were similar, and provided 10-20 g N/head.d from July until mid-September.

3. From June until December unsupplemented heifers lost 79 kg conceptus-free LW, and decreased in body condition score from CS 6.4 to 4.1. These heifers gained LW during lactation until the following April when they were in CS 4.8. Only 10% of heifers were cycling by mid January, however 73% were either cycling or pregnant by mid-March, and 54% were pregnant by early April.

4. Supplements did not change LW, CS or reproductive performance.

5. Concentrations of urea nitrogen and inorganic phosphorus in plasma suggested that the heifers consumed adequate dietary nitrogen even in the absence of supplements, presumably due to intake of unseasonal "green pick" of high nitrogen content in the pasture.

Experimental

First-calf Bos indicus x Shorthorn cross heifers (132) from the Swan's Lagoon station herd were joined at approximately two years of age in January 1996. The heifers were grazed in twelve 40 ha paddocks between June 1996 and December 1996, and then as a single mob in a 400 ha paddock until April 1997. The heifers were again joined from early December 1996 until April 1997. The pasture in the paddocks used from June-December 1996 consisted predominantly of native grass species, and had been fertilised with superphosphate. The paddock used from December 1996 - April 1997 was also native pasture but without previous fertilisation. Heifers were vaccinated for botulism and leptospirosis.

The three treatments consisted of no supplement, or one of two types of dry lick supplement fed from June until November. These supplements contained a high concentration of urea, and either CSM or dried molasses to increase palatability as described above in Experiment 823.

Measurements were made of liveweight and condition score of the heifers four times between June and October 1996, and six times between December 1996 and the end of the experiment in April 1997. During calving from 28 October until 27 December 1996 animals were inspected 2-3 times each week to determine individual calving dates. Cows were mustered and blood sampled during mid January and late March (20 and 31 January 1997 and 14 and 27 March 1997) to determine cyclic activity from concentrations of plasma progesterone. In addition pregnancy status was determined by rectal palpation during March, April and May.

Table 1. Changes in liveweight and condition score of first-calf heifers either not supplemented (NIL) or supplemented during the dry season with dry licks containing dried molasses (+MOL) or cottonseed meal (+CSM)

Date	Uncorrected LW			Conceptus-free LW			CS		
	NIL	MOL	CSM	NIL	MOL	CSM	NIL	MOL	CSM
n	41	40	41	41	40	41	41	40	41
18 Jun 96	396	394	403	389	386	396	6.4	6.3	6.4
25 July 96	408	404	414	395	392	402	6.2	6.0	6.2
29 Aug 96	410	411	418	388	389	397	5.7	5.6	5.7
26 Sept 96	388	399	402	356	366	370	5.3	5.3	5.3
31 Oct 96	387	391	391	340	343	343	5.0	4.9	4.9
2 Dec 96	313	320	318	310	314	311	4.1	3.8	3.9
20-31 Jan 97	325	325	324	325	325	324	4.4	4.1	4.1
14-27 Mar 97	347	350	351	347	350	351	4.7	4.5	4.5
9 Apr 97	360	364	363	359	363	363	4.8	4.7	4.6

Table 2. Reproductive activity and reconception of lactating first-calf cows before weaning and calf growth rate from mid-January to weaning. Cows had been fed no supplements (NIL) or dry lick supplements containing dried molasses (+MOL) or cottonseed meal (CSM) during the previous dry season

Measurement	Treatment		
	NIL	+MOL	+CSM
Non-cycling, non-pregnant 20/1/97 (%)	90 (35/39)	87 (34/39)	95 (39/41)
Cycling, non-pregnant 20/1/97 (%)	10 (4/39)	13 (5/39)	5 (2/41)
Pregnant at 20/1/97 (%)	0	0	0
Non-cycling, non-pregnant 14/3/97 (%)	26 (10/38)	27 (10/37	29 (12/41)
Cycling, non-pregnant 14/3/97 (%)	53 (20/38)	51 (19/37)	54 (22/41)
Pregnant at 14/3/97 (%)	20 (8/41)	20 (8/40)	17 (7/41)
Pregnant at 9/4/97 (%)	54 (22/41)	48 (19/40)	54 (22/41)
Calf LW gain (kg/d)	0.81	0.81	0.88
Calf LW at 9/4/97 (kg)	138	139	146

Table 3. Measurements in plasma (urea nitrogen and inorganic phosphorus, mmol/L) and faeces (total N, % and total P, %) of first-calf cows

Measurements	Nitrogen			Phosphorus		
	NIL	+MOL	+CSM	NIL	+MOL	+CSM
Plasma						
n	12	12	12	12	12	12
25 July 96	3.43	3.43	3.54	1.71	2.17	1.95
29 Aug 96	1.97	2.69	2.93	1.81	2.11	1.94
26 Sept 96	4.89	4.98	4.95	1.99	2.46	2.22
31 Oct 96	6.06	7.21	6.32	1.51	1.71	1.61
20-31 Jan 97	5.44	5.19	5.27	1.93	2.12	1.83
14-27 Mar 97	3.88	3.73	3.31	1.87	1.88	1.70
Faeces						
25 July 96	1.08	1.25	1.20	0.17	0.22	0.21

Results

During the dry season rain during June (45 mm) and September (27 mm) led to pasture conditions where there was a large amount senesced pasture on offer, but also an appreciable amount of green pick of pasture 20-40 mm high during late June, and during September and October. The seasonal break in the small paddocks occurred on the 23 October with 43 mm rain. However, in the large paddock where the animals grazed as a single mob from December it was not until early February that there was sufficient rain to initiate wet season pasture growth.

Supplement intakes were generally in the range 10-20 g N/d during the first 13 weeks of supplementation up until mid-September. The rain on the 21 September abruptly reduced supplement intake to 3-10 g N/d. Supplement intake then gradually increased until rain in late October (43 mm) following which supplement intake declined again.

In June 1996 at the commencement of the experiment the heifers averaged 390 kg conceptus-free LW, and were in condition score between "forward store" and "prime" (Table 1). Conceptus-free LW did not change during July and August, but decreased thereafter to 310 kg in unsupplemented animals in December. Condition score decreased gradually from June to December, and cows were in "backward store" body condition (CS 4.1) in December. From December unsupplemented cows gained LW and condition score so that in April they were 359 kg conceptus free LW and "store" body condition (CS 4.8). The supplements fed through the dry season had no effect on animal LW or body condition.

In mid-January only 10% of the unsupplemented cows were cycling, and none were pregnant (Table 2). By mid-March 73% of these cows were reproductively active, and of this group 20% were pregnant. 54% of the cows were pregnant by the 9 April. Reproductive performance of the cows was not affected by the supplements during the previous dry season. Calf growth rate from January to April averaged 0.81 kg/d, and also was not affected by treatment.

Plasma urea concentrations in unsupplemented cows exceeded 3.4 mmol in July 96, and in September and October following the storm rains. The lowest concentration was observed in late August (1.97 mmol). Faecal N concentration (1.08% N) was also low at this time. Concentrations of inorganic phosphorus in blood suggested that phosphorus status of the cows was adequate, even in the absence of supplements.

Practical implications

Although the heifers in this experiment lost 20% of their liveweight and declined to "backward store" body condition during the experiment, there was no response to urea-based dry lick supplements fed during the dry season.

The most likely reason for this absence of a response was that there was storm rain during the dry season in June and September producing green pick which was available in addition to standing dry feed. The heifers presumably selectively consumed sufficient of this green pick to meet their requirements for rumen degradable nitrogen.

Responses to urea-based supplements - Experiment 5

Effect of dry lick supplements fed during the early and/or late dry season on productivity of Bos indicus x Shorthorn cross breeder cows - SWN-B841

Rob Dixon, Peter Fry, Adrian White, Geoff Fordyce and Michael D'Occhio

Summary

1. First-calf (83) and second-calf (109) Bos indicus x Shorthorn breeders grazing speargrass dominant native pasture were used to examine the effect of dry lick supplements on breeder liveweight (LW) and body condition score (CS) changes, on calf growth to weaning, and on conception of the cows while lactating. Cows calved between November 1996 and early January 1997, and were mated from mid-December to late April 1997. Rain in June and September led to considerable green pick in the pasture, but there were large differences among the paddocks where the breeders grazed.

2. Dry lick supplements were fed *ad libitum* during the early dry season (E.DS; late June-late August), or during the late dry season (L.DS; late September-mid December), or at both of these intervals. Control cows were not fed any supplement. Intake of E.DS supplements averaged 8-21 g N/d. Intake of L.DS supplements averaged 22-28 g N/d during the first four weeks of this period, and thereafter was in the range 3-13 g N/d.

3. During the dry season loss of conceptus-free LW (CF.LW) averaged 56 kg in first-calf cows (FCC) and 29 kg in second-calf cows (SCC), the greater losses in first-calf cows being associated with higher initial liveweight and body condition score. CF.LW loss in Airstrip paddocks averaged 23 kg, and in McGregor paddocks 61 kg, the greater LW loss in the latter paddock being due to differences in soil types and the amount of winter rain.

4. The dry lick supplements fed either early or late in the dry season had no apparent effect on CF.LW loss during the dry season, CF.LW in the mid wet season, or on the proportion of cows which became pregnant while lactating.

5. Fertility of the cows during the wet season was related to the CF.LW and body condition score at the end of the preceding dry season. In second-calf cows higher body reserves were related to earlier pregnancies rather than a higher pregnancy rate at weaning.

Introduction

High-urea supplements such as dry licks are often used strategically to reduce the rate of liveweight loss of breeders during the dry season, and to increase breeder fertility by maintaining higher breeder liveweight and body condition. Based primarily on experiments with growing animals, DPI recommendations are that dry lick supplementation should be commenced in the transition season or early in the dry season. However, it is common practice in the industry to commence dry lick supplementation in the mid to late dry season to reduce supplement input costs and avoid supplementation in years when it is not essential for survival of breeders.

The present experiment examined the effects of commencing dry lick supplementation early in the dry season (June) or late in the dry season (September) on breeder liveweight and subsequent fertility.

Table 1. Changes in conceptus-free LW and body condition score during the dry season, and pregnancy during the following wet season in the Airstrip and McGregor sets of paddocks

Measurement		Airstrip paddocks (Block 1)	McGregor paddocks (Block 2)
First-calf cows			
n		41	42
CF.LW 18/6/96 (kg)		384	387
Change in CF.LW to 9/12/96 (kg)		-37	-74
CF.LW late January 97 (kg)		326	320
CS 18/6/96 (kg)		6.4	6.5
Change in CS to 9/12/96		-1.8	-1.3
Pregnant	Window A (%)	10	7
	Window B (%)	41	31
	Weaning (%)	78	71
Second-calf cows			
n		54	55
CF.LW 18/6/96 (kg)		371	373
Change in CF.LW to 9/12/96 (kg)		-9	-48
CF.LW late January 97 (kg)		341	335
CS 18/6/96 (kg)		4.9	4.9
Change in CS to 9/12/96		-0.6	-1.3
Pregnant	Window A (%)	26	9
	Window B (%)	78	56
	Weaning (%)	91	84

Experimental

First-calf and second-calf Bos indicus x Shorthorn cross breeder cows from the Swan's Lagoon herd were grazed in eight 100 ha paddocks during the experiment. The first-calf cows had been joined at approximately two years of age from January 1996, and 83 predicted to calve between late October 1996 and early January 1997 were used. Second-calf cows (109) had a similar history of management, but were one year older. All had raised a calf to weaning in May 1996, and were selected to calve during the same interval as the first-calf cows. Cows were joined from mid-December 1996 until late April 1997. Calves were weaned in late May. Cows were vaccinated for botulism and leptospirosis. The cattle were allocated to eight paddock groups each of 10-11 first-calf cows and 12-14 second-calf cows.

The four treatments consisted of dry lick supplement fed during the early dry season from 24 June-27 August (E.DS), or during the late dry season from 30 August-19 December (L.DS), or at both of these intervals. The dry lick supplement contained 32% cottonseed meal, 27% urea, 18% salt, 14% kynophos and 9% ammonium sulphate, and was fed *ad libitum* twice weekly.

Measurements were made of liveweight and body condition score of the animals 10 times between June 1996 and weaning in May 1997. Reproductive activity was measured from progesterone concentrations in plasma in late-January and mid-March, and from pregnancy diagnosis.

Results

1. Seasonal conditions and pasture quality

Rain during the transition and early dry season (22 mm on 4 March, 27 mm on 20 April, 37 mm on 11 June) led to pasture conditions where there was a large bulk of senesced pasture on offer, and also a substantial amount of green pick. Further rain on the 21 September (29 mm) maintained this "green pick" through to the seasonal break on 23 November when there was 54 mm rain. However, because the amounts of this winter rain differed considerably between the two sets of paddocks used for the experiment, and due also to differences in soil types, a considerably greater amount of "green pick" was available for longer in one block of four paddocks (Airstrip) than in the other block of four paddocks (McGregor).

The differences between sets of paddocks were reflected in much greater CF.LW loss by cattle in the McGregor paddocks (on average 74 kg for first-calf cows and 48 kg for second-calf cows respectively) than in the Airstrip paddocks (37 kg for FCC and 9 kg for SCC respectively) (Table 1). Changes in body condition score followed similar trends.

2. Changes in liveweight and body condition score

The losses of liveweight and body condition during the dry season were minor in Airstrip paddocks (10% and 2% in FCC and SCC respectively), and in McGregor (19% and 13% in FCC and SCC respectively) were also small compared to those usually observed in the Swan's Lagoon environment. Also the proportion of cows pregnant at weaning in the following year (75% for FCC and 88% for SCC) were high. The most likely reason for these small losses in body reserves during the dry season, and the high subsequent fertility rate are the benign dry season pasture conditions due to the green pick which was available.

3. Supplement intake and responses to supplement

Voluntary intake of the dry lick supplement during the early dry season intake ranged from 56-138 g DM/head.d, providing 8-21 g supplementary N (Figures 1 and 2). During the late dry season intake ranged from 147-190 g DM/head.d (22-28 g N/head.d) during the first four weeks, but decreased sharply following the rain on 21 September to the range 22-86 g DM/head.d, and was negligible following the rain on 23 November.

There was apparently no effect of the supplements fed during either the early dry season or the late dry season on loss of liveweight on body condition by the animals (Table 2 and 3). Furthermore, there was little evidence of any effect of supplementation on reconception in the following year. There was some tendency for both first- and second-calf cows fed late dry season supplements to conceive earlier, and for the former age group of cows to have a higher pregnancy rate at weaning (85% versus 64%).

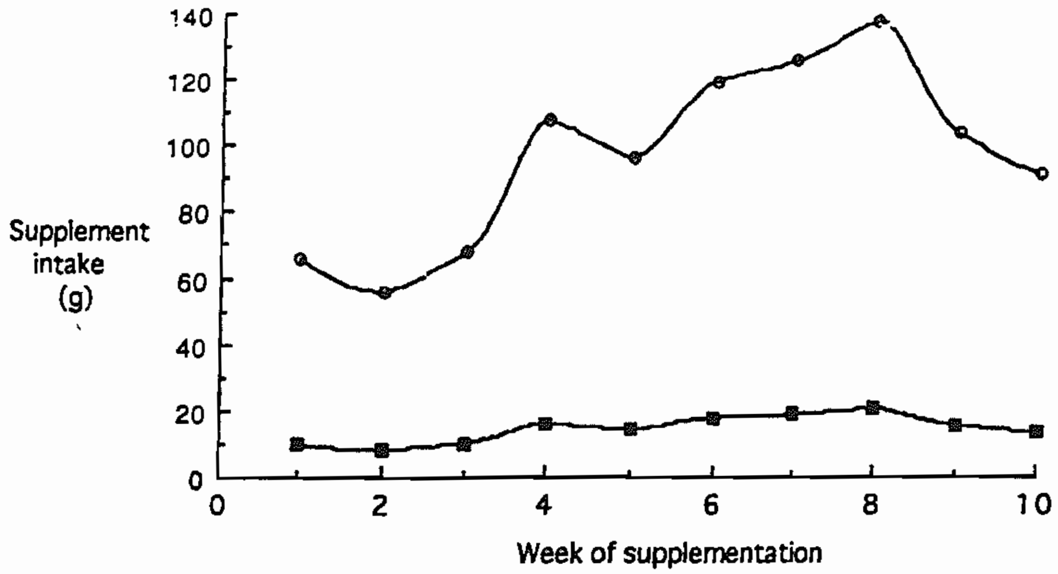


Figure 1. Intake (g/head.d) of supplement DM (○) and N (■) by breeders for 10 weeks during the early dry season commencing on 24 June 1996.

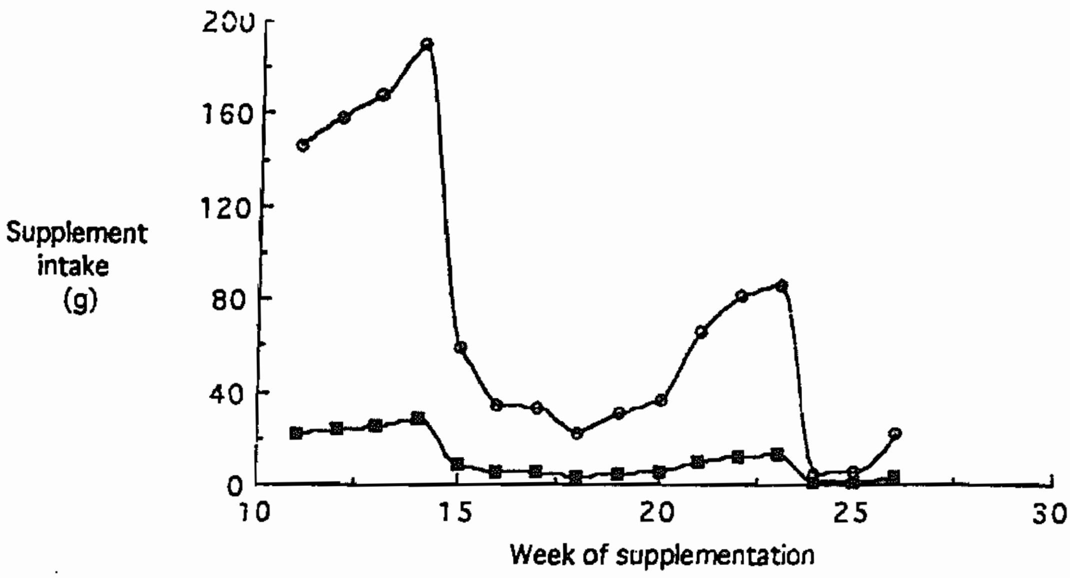


Figure 2. Intake (g/head.d) of supplement DM (○) and N (■) by breeders for 16 weeks during the late dry season commencing on 30 August 1996.

Table 2. Relationships between liveweight, liveweight change and condition score of breeders and reproductive activity during the subsequent wet season for the eight paddock groups of breeders

Measurement		LW change (kg) (June-December)			LW (kg) December			CS December		
		b	r	Sig	b	r	Sig	b	r	Sig
First-calf cows										
Late Jan	Reproductively active	-0.54	0.44	ns	0.41	0.30	ns	49	0.60	ns
	Pregnant	-0.11	0.27	ns	0.02	0.04	ns	6	0.22	ns
Mid-Mar	Reproductively active	-0.28	0.44	ns	0.21	0.30	ns	27	0.65	(-)
	Pregnant	-0.53	0.58	ns	0.45	0.44	ns	43	0.72	*
Late May	Pregnant	-0.45	0.55	ns	0.39	0.43	ns	41	0.77	*
Second-calf cows										
Late Jan	Reproductively active	-0.59	0.74	*	0.76	0.79	*	40	0.65	(-)
	Pregnant	-0.35	0.70	(-)	0.52	0.85	**	29	0.76	*
Mid-Mar	Reproductively active	-0.19	0.66	(-)	0.25	0.69	(-)	11	0.49	ns
	Pregnant	-0.56	0.75	*	0.70	0.77	*	44	0.77	*
Late May	Pregnant	-0.39	0.67	(-)	0.41	0.57	ns	22	0.49	ns

b, slope of regression equation; r, correlation coefficient; Signif, significance of linear regression relationship, (-) $P<0.10$; * $P<0.05$; ** $P<0.01$. Animals which were "reproductively active" includes those pregnant, and cycling but not pregnant.

4. Relationships between liveweight, body condition and fertility

Table 2 summarises the relationships between animal LW loss during the dry season, CF.LW and condition score at the end of the dry season with fertility of the cows during the subsequent wet season. In second-calf cows the percent reproductively active or pregnant in late January or mid-March was positively related to the liveweight and condition score in December, and negatively related to the liveweight loss during the dry season. These relationships suggest that for each additional 10 kg LW in December, the percent of pregnancies occurring by the early-mid wet season was increased by 5-7%. Similarly an increase in body condition score by 0.5 unit increased pregnancy by 15% and 22% in January and March respectively. The lower (and statistically non-significant) correlation with the percent of cows pregnant at weaning indicated that the importance of increased liveweight or body condition in December was to lead to earlier pregnancies rather than a greater total number of pregnancies up to weaning in May, 5-7 months after calving.

In first-calf cows there were similar relationships between liveweight and body condition in December, and LW loss during the dry season with subsequent fertility. However, these relationships were generally not statistically significant.

Practical implications

When there is sufficient rain during the dry season to maintain a "green pick" in the senesced pasture sward breeders are not likely to respond to urea-based supplements.

Effect of time of weaning and urea-based dry lick supplements fed during the dry season on productivity of second-calf cows - SWN-B843

Rob Dixon, Adrian White, Peter Fry and Geoff Fordyce

Summary

1. First-calf Bos indicus x Shorthorn cows grazing native pastures were weaned in April or September, and either not supplemented or fed a urea-based dry lick supplement. Measurements were made of changes in liveweight and condition score of the cows, pregnancy of the cows and growth of the calves.

2. Unsupplemented Sept-weaned cows lost 35 kg conceptus-free LW (CF-LW) from April 1997 to Jan 1998; this involved loss of 60 kg CF-LW to Oct 1997 and regain of 25 kg between Oct 1997 and Jan 1998.

3. Weaning in April instead of Sept reduced the CF-LW loss from April 1997 to Jan 1998 to 8 kg CF-LW. April-weaned cows did not change CF-LW between October and January. Urea-based supplements fed through the dry season reduced CF-LW loss of the Sept-weaned cows by 20 kg in October and 10 kg in January. They improved CF-LW status of April-weaned cows by 14 kg in October and 23 kg in January. Thus the benefit on breeder liveweight of earlier weaning was about twice the benefit of urea supplementation.

4. Fifty-four percent of the cows were already pregnant in April when the experiment commenced. During a six week mating in April and May 1997 35% (9/25) of wet cows and 78% (24/31) of dry cows became pregnant. Reconception in 1998 was high in non-lactating cows (96%; 26/27) but low in lactating cows; rates for cows calving in November and December 1997 were 0% (0/12) and 35% (6/17) in unsupplemented and supplemented September-weaned cows respectively, and 43-44% (7/16 and 6/14) in April-weaned cows.

Experimental details

First-calf Bos indicus x Shorthorn cows (122) which had successfully reared a calf until early April 1997 in Experiment SWN-B833 were used for the experiment. The cows were allocated to 10 paddock groups each of 12 cows, and half the cows in each paddock group were weaned on the 9 April. Groups of cows and calves were grazed in 40 ha paddocks of native pasture, and were mated with two bulls per paddock for 6 weeks commencing on the 24 April. The cattle were mustered at 5-7 week intervals and liveweights, body condition score and pregnancy status determined.

The treatments consisted of the early or late weaning of the cows, and supplementation with a urea-based dry lick supplement. For the weaning treatment half of the cows within each paddock were weaned on the 9 April and the remainder were weaned in mid-September. For the supplementation treatment half the paddocks were fed dry lick supplement *ad libitum* while control animals were not fed any supplement. The dry lick fed from April until early August contained 33% CSM, 30% salt, 21% Kynophos, 15% urea and 1% elemental sulphur, while the dry lick fed from early August until the break of the season contained 32% CSM, 27% urea, 18% salt, 14% Kynophos and 9% ammonium sulphate.

Table 1. Conceptus-free liveweight(CF-LW), body condition score and pregnancy of first-calf cows weaned in April or in September, and fed no supplement (Nil) or a urea-based dry lick supplement (Plus supp)

Measurement	September-weaned		April-weaned	
	Nil	Plus supp	Nil	Plus supp
n	31	30	31	30
CF-LW(kg)				
9 April 1997	369	367	356	356
15 Sept 1997	317	336	363	377
Change (9 Apr 97-15 Sept 97)	-52	-31	+7	+21
23 Oct 1997	309	329	348	370
21 Jan 1998	334	342	348	371
Change (9 Apr 97-21 Jan 98)	-35	-25	-8	+15
Body condition score				
9 April 1997	4.6	4.8	4.7	4.7
15 Sept 1997	3.4	4.0	5.1	5.1
Change (9 Apr 97 -15 Sept 97)	-1.2	-0.8	+0.4	+0.4
23 Oct 1997	3.2	3.8	4.8	5.0
21 Jan 1998	4.0	4.3	4.7	5.1
Change (9 Apr 97 -21 Jan 98)	-0.6	-0.5	+0.0	+0.4
Lactating cows pregnant during 1997				
Pregnant before 9 Apr 97	52% (16/31)	67% (20/30)	48% (15/31)	50% (15/30)
Pregnancies between 9 Apr 97 and 6 Jun 97 #	40% (6/15)	30% (3/10)	75% (12/16)	80% (12/15)
Lactating cows (calved Nov-Dec) pregnant during 1998	0% (0/12)	35% (6/17)	44% (7/16)	43% (6/14)

Calculated as % of those non-pregnant on the 9 April. Mating was for 43 days from 24 April 1997.

Table 2. Microbial protein synthesis and metabolites in plasma of first-calf cows weaned in April or weaned in September, and fed no supplement (Nil) or a urea-based dry lick supplement (Plus supp)

Measurement	September-weaned		April-weaned	
	Nil	Plus supp	Nil	Plus supp
Microbial protein synthesis (g N/d)				
20 May 97	233	211	189	185
19 Jun 97	230	210	172	170
6 Aug 97	142	149	117	122
15 Sept 97	127	126	103	106
23 Oct 97	116	116	84	90
Plasma urea conc (mM/L)				
20 May 97	1.1	1.5	1.7	1.7
19 Jun 97	1.5	1.8	1.6	1.6
6 Aug 97	1.7	1.9	1.4	1.5
15 Sept 97	2.5	2.4	1.8	2.2
23 Oct 97	1.6	2.1	1.3	1.7

Results

Intake of dry lick supplement averaged 74 g DM/head.day. Thus intake of urea averaged about 19 g/head.day and was much lower than the recommended amount for breeders of 45-60 g urea/head.day.

Both earlier weaning of the cows in April and feeding the urea supplement improved the liveweight status and the body condition of the cows (Table 1). Importantly the effects appeared to be additive rather than these being an interaction between time of weaning and supplementation. Both had beneficial effects on the cows, but there was little evidence that the effect was different when they were given in combination rather than alone.

During the 5 months unsupplemented lactating cows on average lost 52 kg CF-LW and 1.2 CS units, and unsupplemented dry cows gained 7 kg CF-LW and 0.4 CS units. Hence early weaning of the cows in April resulted in cows 59 kg heavier in September, or an improvement in CF-LW status of 12 kg per month.

Urea supplements reduced CF-LW loss of lactating cows from 52 kg to 31 kg, and increased CF-LW gain of weaned cows from 7 kg to 21 kg. Thus the benefit of the supplementation was 18 kg CF-LW over the 5 month period, equivalent to 3.5 kg per month. There was evidence that the greatest LW responses of cows was in paddocks where liveweight loss of unsupplemented cows was most severe. In the various paddock blocks liveweight loss of unsupplemented lactating cows ranged from 17 kg to 47 kg, and the benefit due to supplementation ranged from zero up to 40 kg; the largest responses to supplement were in the blocks of paddocks with the greatest liveweight loss in the absence of supplements.

In 1997 few lactating cows (35%) conceived from late April until early June. However the majority (78%) of the cows weaned in early April 1997 did conceive during this six-week mating period. This was expected since the cows were on average in "store" condition, and the effects of weaning to initiate reproductive activity are well known. In 1998 96% (26/27) of non-lactating cows reconceived during the mating from January until April. However rates were low in lactating cows. Rates for cows calving in November and December 1997 were 0% (0/12) and 35% (6/17) in unsupplemented and supplemented September-weaned cows respectively, and 43-44% (7/16 and 6/14) in April-weaned cows. Reconception was even lower in cows that calved in January or later.

Microbial protein synthesis was greater in lactating cows than in dry cows through 1997, and declined as the dry season progressed (Table 2). This is consistent with lower intakes of pasture by non-lactating cows, and declining pasture intake as the dry season progressed.

Practical implications

Information to compare the responses of breeders to various management options such as early weaning or urea-based dry lick supplements is essential to decide which management option is most appropriate and economical under a variety of herd situations.

Responses to urea-based supplements - Experiment 7

Effects of urea-based dry lick supplements fed to breeders during pregnancy on cow and calf performance (SWN-B836)

Rob Dixon, Adrian White and Peter Fry

Summary

1. Twenty-five mature breeders were held in yards during the last 4-5 months of pregnancy and fed low quality native grass hay alone or supplemented with a urea-based dry lick. After calving cows grazed pastures consisting primarily of native grass species, and measurements were continued for 8 months of lactation.

2. During the last 4 months of pregnancy cows fed hay alone consumed approximately 0.7 kg of hay per 100 kg liveweight and lost 0.84 kg liveweight per day. Supplement increased hay intake by 30%, and reduced liveweight loss to 0.45 kg/d.

3. Feeding the dry lick supplements during pregnancy did not affect calf birth weight, but increased milk production and calf liveweight during early lactation.

4. Plasma progesterone concentrations in the cows were measured during lactation to determine reproductive activity.

Introduction

In the northern Australian environment breeder cows often lose a substantial proportion (e.g. up to 35%) of their body weight during the dry season due to under-nutrition. This mobilisation of body weight has major effects on the ability of the breeder to reconceive during the following wet season. Low breeder liveweight at the commencement of the following wet season is often a major cause of low fertility. In addition to direct effects on breeder liveweight, increased nutrition during the late dry season can increase fertility of breeders (ie. the spike-feeding phenomena), apparently independently of changes in liveweight of the breeder.

Most of the present information on responses of the crossbred breeder to nutritional and management manipulations in the northern environment is based on observations of breeders where liveweight, body condition scores, and changes in these parameters, have been used to define the status of the animal. However it is clear from previous work with sheep that during prolonged under-nutrition loss in liveweight underestimates the loss in body energy reserves. The present study was undertaken to obtain a better understanding of changes in both liveweight and body energy reserves of a breeder going through severe liveweight loss during the dry season, and regain of liveweight and lactation during the subsequent wet season.

Experimental procedures

Twenty-five mature Bos indicus x Shorthorn (Fn) breeders of the Swan's Lagoon genotype were used, and were either 3 or 4 years of age at the commencement of the experiment. The cows grazed stylo based pasture from July 1995 to February 1996, and then until early July 1996 an 8 ha paddock of native pasture. In early July the cows were moved to pens, and were fed low quality native grass hay until

Table 1. Changes in liveweight, body condition score and intake of hay and dry lick supplement measured during two 7 day phases in cows in late pregnancy

Measurement	Hay alone	Hay + supplement
n	12	11
Liveweight (kg)		
Day 194 (12 July 1996)	439	427
229 (16 Aug 1996)	408	410
263 (19 Sept 1996)	398	408
295 (21 Oct 1996)	353	381
LW change (kg/d)	0.84	0.45
Condition score		
Day 194 (12 July 1996)	5.6	5.5
229 (16 Aug 1996)	5.1	5.0
263 (19 Sept 1996)	4.7	5.0
295 (21 Oct 1996)	3.9	4.6
CS change	-1.7	-0.9
Intake (19-26 Aug 1996)		
Hay (g DM/kg LW.d)	7.37	9.68
Supplement (g DM/kg LW.d)	0.00	0.91
Total (g DM/kg LW.d)	7.37	10.59
Intake (11-18 Oct 1996)		
Hay (g DM/kg LW.d)	6.98	9.05
Supplement (g DM/kg LW.d)	0.00	0.92
Total (g DM/kg LW.d)	6.98	9.97

early December 1996. The cows were mated from mid-January until late April 1996, and were pregnancy tested in April and July. The cows calved during October-December 1996, and most calved in late October and early November.

In early July the cows were allocated by stratified randomisation based on stage of pregnancy and body condition score to two treatment groups. The treatments were imposed from 16 July until the 2 December 1996, and consisted of diets of hay alone, or of hay supplemented with a dry lick supplement fed *ad libitum*. The hay consisted of native pasture species, predominantly speargrass, baled in the mid-dry season the previous year, and the hay contained 0.4% N, 0.06% P, 0.26% Ca and an in vitro matter digestibility of 32.6%. The dry lick supplement contained 26.7% cottonseed meal, 22.5% urea, 16.7% dried molasses, 15.0% salt, 11.7% kynophos and 7.5% ammonium sulphate.

The cows were fed the pasture hay *ad libitum* either as long hay from group hay feeders each containing a 200-300 kg round bale, or during two phases (2 to 26 August and 2 to 18 October) when the cows were held in individual pens as chopped hay from feed bunks. During the two phases when the cows were held in the individual pens they were fed 10-30% in excess of previous intake. Fresh hay was fed and residues collected three times each week. Dry lick supplement was also fed *ad libitum* to those cows allocated to this treatment.

On the 3 December 1996 after most of the cows had calved, all animals were moved to a 100 ha paddock containing stylo-based pasture. On the 3 January 1997 and after the seasonal break the animals were moved to graze pastures containing predominantly native grass species, and for the following 7 months were rotationally grazed in 4 x 40 ha paddocks..

Table 2. Effects of feeding dry lick supplements to cows during mid and late pregnancy on date of birth, birth weight (when recorded), subsequent milk production and calf live weights

Measurement		No supplement	Plus supplement
Calf date of birth	n	12	10
	Average date	15 Nov 1996	11 Nov 1996
Calf birth weight	n	7	8
	Weight (kg)	22	23
Cow liveweight (kg)			
n		12	8
11 Dec 1996		340	340
4 Mar 1997		409	396
15 May 1997		433	416
28 Jul 1997		432	420
Cow body condition score			
n		12	8
11 Dec 1996		3.3	3.9
4 Mar 1997		4.8	5.0
15 May 1997		5.2	5.4
28 July 1997		4.9	5.1
Milk production			
n		11	8
12 Dec 1996		3.9	4.6
5 Mar 1997		5.0	6.4
14 May 1997		3.5	3.8
29 Jul 1997		2.4	2.4
Calf liveweight (kg)			
n		12	10
11 Dec 1996		40	50
4 Mar 1997		113	123
13 May 1997		171	180
28 July 1997		217	225

At frequent intervals during pregnancy measurements were made of the liveweight and body condition score of the animals, and of intake of hay and supplement during the two phases when they were held in individual pens. Date of calving and when possible calf birth weight were recorded.

During lactation and until 28 July 1997 measurements of liveweight and body condition score of the cows and of calf liveweight were made at frequent intervals. Each 5-7 milk production by the cows was measured using weigh-suckle-weigh procedures. Commencing 42 days after parturition plasma progesterone concentrations were measured at 7-11 day intervals to determine the onset of ovarian activity.

Results

In early February 1996 the cows ranged from "forward store" to "fat" body condition, but this declined to an average body condition of 5.6 (between "store" and "forward store") by early July when the cows were moved to the pens and fed hay. All the cows were pregnant by July.

From July until late October the cows fed hay alone lost 0.84 kg/d of uncorrected LW and were in "backward store" body condition at the end of this period (Table 1). The dry lick supplements reduced this uncorrected LW loss to 0.45 kg/d, and the cows were 0.8 unit higher in body condition score. Intake of the hay fed alone was similar during the two intake measurement phases (7.0 - 7.4 g hay/kg liveweight/d), and this low intake is consistent with the rapid liveweight loss which was observed. The cows consumed 0.4 kg dry lick supplement/d which would have provided 47 g nitrogen/d. Supplements increased hay intake by approximately 30%, and total DM intake by approximately 43%.

Supplementation during pregnancy did not affect birth weight of the calves, although these weights were lower than usually observed for the Swan's Lagoon herd. Cows gained liveweight and body condition score during the 8 months of lactation, and there was some evidence for greater compensatory gain in the cows which had not been fed the supplements. Cows not fed supplements gained 78 kg and 1.5 CS units during the wet season from 11 December 1996 until 2 April 1997, while previously-supplemented cows gained only 63 kg and 1.3 CS units during the same period. The differences between previous treatments were maintained during the transition season from 2 April until 28 July.

Supplementation during pregnancy increased milk production from December to March, but the difference appeared to decline thereafter (Table 2). Calves from previously-supplemented cows were also 8-10 kg heavier from 11 December until the following July. Although these calves were on average 4 days older, this supports the evidence that milk production, and in particular early milk production, was increased by the previous supplementation and the better body condition of these cows at calving.

Practical implications

The large differences in rate of loss of liveweight and of body condition due to feeding the urea-based dry lick supplement demonstrates that this type of supplement can have major benefits for the conservation of liveweight of breeders consuming low-quality roughage. Supplementation during pregnancy led to higher milk production and increased calf growth during early lactation, presumably due to the higher body condition score of the breeders at calving.

Responses to urea-based supplements - Experiment 8

Rumen microbial protein production in heifers fed speargrass hay and dry lick or M8U supplements - SWN-B828

Chris Samson, Rob Dixon, Adrian White, Peter Fry, Dianne Burling & Prof. John Ternouth

Summary

1. Feed intake and the microbial protein production in the rumen were measured in weaner heifers held in pens and fed low-quality native grass hay fed alone, or supplemented with two types of high-urea dry lick or M8U. Microbial protein production was measured from excretion of purine derivatives in urine.

2. Hay intake was increased by approximately 25% by each of the supplements. Thus total dry matter (DM) intake was increased by approximately 30% by the dry lick supplements and 75% by the M8U supplement. Microbial protein flow from the rumen was increased from 12 g N/d to 23-24 g N/d when dry licks were fed, and to 43 g N/d when M8U was fed.

3. These results show that there are large increases in rumen microbial activity when either high-urea dry lick or M8U supplements are fed. Also the results support the concept that the value of cottonseed meal (CSM) in dry licks is to make the dry lick more palatable and hence achieve more appropriate intakes of inorganic N and P, rather than there being any specific effect of a small amount of CSM.

Introduction

The benefits of high-urea dry lick supplements for cattle grazing dry season pasture are primarily achieved by increasing the rumen microbial activity, thus increasing the supply of microbial protein to the animal and allowing greater digestion and higher intake of roughage. However, there is also considerable anecdotal evidence from producers that inclusion of cottonseed meal (CSM) into dry lick mixtures increases the response of cattle to a dry lick.

There are three likely explanations for any benefits to including CSM in dry licks:

(a) Inclusion of CSM increases the palatability and therefore the intake of the dry lick mixture, and thus sufficient supplement is consumed to obtain the maximum animal response. Also increased palatability of the dry lick may reduce the proportion of non-consumers of supplement in the mob, and reduce the variation within the mob in supplement intake.

(b) The CSM in the dry lick provides "bypass protein" which escapes digestion in the rumen and provides additional protein to the small intestine. However, the amounts of "bypass protein" provided in the dry lick are small in comparison to the flow of microbial protein out of the rumen and to the small intestine, eg. 150 g dry lick containing 30% CSM would provide approximately 50 g CSM, ie. approximately 22 g CSM protein, i.e. approximately 14 g bypass protein from CSM. If a breeder grazing dry season pasture supplemented with NPN consumes approximately 2% liveweight of pasture, microbial protein flowing to the small intestine might be about 325 g/d (assuming a digestible organic matter intake of 2.5 kg/d, and production of 130 g microbial crude protein/kg digestible organic matter intake). Hence, if the response to the CSM in the dry lick is due to the "bypass protein" component, we have to assume that a small (<5%) increase in crude protein supply to the small intestine has a large effect on intake of roughage and on the productivity of the animal. This does not seem very likely. In conclusion it is <u>not</u> likely that benefits of including protein meal into dry lick are due to a "bypass protein" effect.

(c) The CSM in the dry lick provides a slow release form of nitrogen for microbial growth, and also provides the nitrogen in a form (eg. peptides, amino acids) which leads to improved efficiency of microbial growth and microbial protein production.

An experiment measured the microbial protein production from the rumen when heifers were fed low-quality native grass hay alone, supplemented with dry lick containing CSM or dried molasses, or supplemented with M8U. If beneficial effects of inclusion of CSM into dry lick are associated with an increase in the efficiency of activity of the rumen microbial system, this should result in greater rumen microbial protein production with the dry lick containing CSM than that containing dried molasses.

Experimental

Twenty-four Bos indicus x Shorthorn cross heifers, initially 10-14 months and 208 kg liveweight, were held in individual pens. During Period 1 (Weeks 1-3) all heifers were fed native pasture hay *ad libitum*. During Period 2 (Week 4-6) the same hay was fed *ad libitum*, and five heifers were fed one of the following treatments:

T1 Nil supplement
T2 Offered 150 g/d dry lick containing dried molasses
T3 Offered 150 g/d dry lick containing CSM
T4 M8U supplement fed *ad libitum*

The hay had been baled during the later part of the dry season, and was of low quality (0.45% N and 31% in vitro organic matter digestibility). M8U contained 73.4% dry matter and 6.0% N. The dry lick supplements (Table 1) contained a high level of inorganic N (27% urea and 9% sulphate of ammonia) with either CSM or dried molasses.

Table 1. Ingredients and composition of the two dry lick supplements

Ingredient	Dry lick type	
	CSM-DL	MOL-DL
CSM	32	0
Palabind (dried molasses)	0	32
Urea	27	27
Salt	18	18
Dicalcium phosphate #	14	14
Sulphate of ammonia	9	9
Composition		
DM content	81.1	84.0
N content	20.7	18.4

Kynophos.

Intake of hay and supplements was measured during both Period 1 and 2. During the last week of each period (Weeks 3 and 6) samples of urine were collected twice daily for four days. The concentrations of purine derivatives and of creatinine in urine were used to calculate the microbial protein flow from the rumen to the small intestine.

Table 2. Intakes of hay and supplement dry matter, and microbial protein synthesis, during Period 2 in heifers fed hay alone or with supplements

Measurement	Treatment			
	Hay	CSM-DL	MOL-DL	M8U
Dry matter intake				
Hay	2.75	3.43	3.41	3.40
Supplement	0	0.10	0.16	1.75
Total	2.75	3.53	3.57	5.15
Microbial nitrogen flow (g N/d)	12.1	23.7	22.8	42.5
Microbial nitrogen flow (g N/kg DM intake)	4.4	6.7	6.4	8.2

Results

Hay intake during Period 1 averaged 2.3 kg DM/d, and microbial protein production averaged 10.4 g N/d or 4.5 g N/kg DM intake.

In heifers fed hay alone during Period 2, intake and microbial protein production were similar to Period 1 (Table 2). Both dry lick supplements increased hay intake by 24%, while microbial N flow from the rumen was increased much more, from 12.1 g N/d to 22.8-23.7 g N/d or by approximately 90%. This was associated with both the increase in DM intake, and an increase in the amount of microbial protein per kg of dry matter intake.

M8U supplement did not increase hay intake more than the dry lick supplements, but because 1.75 kg DM of this supplement was consumed (equivalent to 2.4 kg wet M8U), total DM intake was increased to 5.15 kg DM/d or 90% higher than the unsupplemented control heifers. Microbial protein flow was also increased to approximately 3.5 times the control diet. This increase was presumably due to both the higher intake of total DM on this diet, and an increase in digestibility of this DM associated with the high digestibility of the M8U.

Practical implications

This experiment demonstrated that large increases in roughage intake occur in penned animals when high-urea dry lick supplements or M8U supplements are fed with low-quality hay similar to the native pasture available during the dry season. This has also been shown in many previous experiments.

There were large increases in rumen microbial synthesis due to both high-urea dry lick supplements and M8U supplement, however there was no evidence that inclusion of CSM rather than dried molasses in the dry lick resulted in higher microbial protein production. This experiment supports the concept that the benefits of including protein meals such as CSM into dry lick are primarily due to improved palatability of the dry lick and cattle consuming more appropriate levels of supplementary urea N and phosphorus. The high microbial synthesis when M8U supplements are fed was expected from the high digestibility of the molasses in the rumen, and demonstrate that there is a large increase in protein supply to the animal with this supplement.

Rumen microbial protein production in heifers fed speargrass hay and supplements of urea - SWN-B840

Maree Bowen, Rob Dixon, Adrian White, Peter Fry, Dianne Burling and Prof. John Ternouth

Summary

1. Feed intake and the microbial protein production in the rumen were measured in weaner heifers held in pens and fed low-quality native grass hay alone, or with four levels (8, 16, 32 and 64) g urea per day. Microbial production by the rumen was measured from excretion of purine derivatives in urine.

2. Intake of hay when fed alone was low (1.77 kg/d or 10.7 g/kg liveweight/d). Hay intake was increased linearly by increasing amounts of supplementary urea and was increased by 20% (to 12.8 g/kg liveweight/d) at the highest level of urea supplementation.

3. Microbial N synthesis was 20.8 g N/d or 11.7 g N/kg DM intake in heifers fed hay alone, and increased linearly with provision of supplementary urea. The highest level of supplementary urea increased microbial N synthesis by 65% when expressed per day and by 31% when expressed per kg DM intake. This occurred even though the concentration of ammonia in rumen fluid of heifers fed hay alone was 91 mg NH_3-N/L and hence was expected to be adequate for microbial synthesis.

Introduction

The benefits of high-urea dry lick supplements for cattle grazing dry season pasture are primarily achieved by increasing the rumen microbial activity. This allows greater digestion and higher intake of the pasture and increases the supply of microbial protein to the animal. However, there is little information to define the response of cattle to various levels of urea supplementation under north Qld dry season conditions. Present recommendations are based on a series of feeding trials done by Winks and colleagues at Swan's Lagoon in the 1970's, and on expectations of the amount of rumen degradable nitrogen required for digestion of dry season pastures of very low protein content.

An experiment measured the microbial protein production from the rumen when heifers were fed low-quality native grass hay alone, or supplemented with several levels of urea the highest of which was expected to exceed the requirements of the animal for urea.

Experimental

Twenty-seven Bos indicus x Shorthorn (F_n) heifers, 10-14 months of age, 186 kg liveweight and 4.9 body condition score which had been grazing wet season native pasture, were held in yards as a group and fed native pasture hay. After 14 days the heifers were moved to individual pens and dietary treatments commenced. Heifers were fed hay *ad libitum* alone (T1), or supplemented with 8 (T2), 16 (T3), 32 (T4) or 64 (T5) g urea per day. All animals were fed a mineral mixture (P, S and trace minerals) in approximately 20 g M3U (molasses and 3% urea). The additional urea was mixed with up to 60 g M3U and was fed separately to the hay. Hay was fed three times each week and residues collected. The hay had been baled during the late dry season and contained 0.31% N.

Table 1. Intake of DM and N, microbial flow from the rumen estimated from urinary excretion of purine derivatives, and concentrations of urea in plasma and ammonia in rumen fluid

Measurement	Treatment				
	T1 (0)	T2 (8)	T3 (16)	T4 (32)	T5 (64)
n	7	5	4	5	5
Dry matter intake (kg DM/d)					
Hay	1.77	1.84	1.76	1.97	2.25
Supplement	0.03	0.04	0.06	0.10	0.19
Total	1.80	1.88	1.82	2.07	2.44
N intake (gN/d)					
Hay	5.5	5.7	5.5	6.1	7.0
Supplement	0.4	3.8	8.0	15.8	29.5
Total	5.9	9.5	13.5	21.9	36.5
Microbial N flow (g N/d)	20.8	22.1	20.7	27.0	34.4
Microbial N flow (g N/kg DM intake)	11.7	12.0	11.7	13.7	15.3
Plasma urea (mg N/L)					
4 h	86	131	193	263	289
21 h	90	131	181	217	265
Rumen ammonia (mg N/L)	91	112	150	133	180

Urea supplements were fed for 4 weeks. During week 3 urine samples were collected twice daily for four days. Concentrations of purine derivatives and of creatinine in urine were used to calculate the microbial protein flow from the rumen to the small intestine. During week 4 rumen fluid samples were taken by stomach tube, and plasma was sampled 4 h and 21 h after feeding urea supplements.

Results

Some of the heifers, particularly three fed 64 g urea per day, did not consume all of the supplementary urea. Nevertheless mean intakes of supplementary N (which included a small amount of N from the M3U) approached the intended intakes.

In the absence of urea supplement hay intake was 1.77 kg DM/d, or 10.7 g DM/kg LW.d (Table x). Provision of urea supplement increased hay intake to 2.25 kg/d, or 12.8 g DM/kg LW.d. Hay intake was linearly related to the amount of urea fed. Microbial N flow from the rumen was 20.8 g N/d or 11.7 g N/kg DM intake in heifers fed hay alone, and this also increased linearly in response to supplementary urea. The highest level of supplementary urea increased microbial N flow per day by 65%, and microbial flow per kg DM intake by 31%.

In heifers fed the hay alone, both rumen ammonia concentrations (91 mg N/L) and plasma urea concentrations (86 and 90 mg N/L) were high. This rumen ammonia concentration would usually be considered adequate for microbial protein synthesis. Nevertheless rumen ammonia concentration, plasma urea concentration and microbial protein synthesis (both per day and per unit feed intake per day) were all substantially increased by the supplementary urea.

Although the urea supplement increased hay intake, the increase was much smaller than the 20-50% increases usually observed with similar hays. It appears that the low hay intake and the consequent low energy intake led to rapid liveweight loss, and that this mobilisation of muscle tissue causes high plasma urea concentrations and sufficient recycling of plasma urea to the rumen to meet most of the requirements for rumen degradable N by the rumen microorganisms. Nevertheless, supplementary urea increased linearly hay intake and microbial protein synthesis demonstrating that further response of the animal to supplementary urea did occur even when plasma urea concentrations and rumen ammonia concentrations were high.

Practical implications

The experiment shows that the benefits of urea supplementation of low quality dry season pasture are linear over a wide range of urea intakes.

Main

Research

Report

Tasks 2 and 3

Experimentation on

supplement delivery systems

4. Tasks 2 and 3. Experimentation on supplement delivery systems.

The objective of Task 2 was to improve knowledge of how to achieve target intakes of supplements fed *ad libitum*, while also achieving low variability in supplement intake among animals in the mob and a minimum proportion of cattle which consume little or no supplement (ie. shy-feeders).

The objective of Task 3 was to improve knowledge of the consequence of the siting and design of supplementation points on intake and variability of intake of supplements, and on the grazing patterns of cattle.

4.1 Importance of the problem

The need to be able to achieve target intakes of supplements by cattle managed in extensive grazing situation is obvious. There are decades of research on the optimal amounts of nutrients required in various circumstances. However, to use this information and to provide nutrients in supplements most cost-effectively managers need to be able to achieve target intakes of supplement by cattle for a wide range of circumstances. During the wet season the most common problem is insufficient intake of supplement, particularly of mineral supplements such as phosphorus. During dry season conditions problems and inefficiencies may be associated with either inadequate or excessive intake of supplements.

Previous work with both cattle and sheep indicates that the proportion of shy-feeders (consuming for example less than 25% of target intakes) can be very high (eg. > 50%). Theoretical calculations of the consequences of high variability of a supplement based on urea suggest that efficiency of utilization of supplements can be decreased by 20-40% by high variability within the mob. Furthermore, if a sub-group of poor-producing animals (a "tail") develops in the mob due to shy-feeding behaviour the economic consequences may be much more severe than the simple loss of production of these animals.

Previous studies which have measured variability of intake of supplement by individual animals have generally examined a single supplement fed under one set of circumstances. To improve management systems it is clearly important to understand the factors which determine the variability in supplement intake and then to develop management strategies to alleviate any inefficiencies.

4.2 Experimental approach

The approach which we adopted was to work with small groups of animals in small paddocks during the early stages of the project, and to extend these observations to larger mobs of cattle and paddocks more typical of northern commercial properties during the later stages of the project. This was done since we considered that we would achieve more rapid progress by working initially in closely controlled situations and where replicated treatments could be imposed, and where the resources and operating costs required were much lower. Hence in Years 1 and 2 a series of experiments examined the importance of previous exposure of animals to supplements, class of supplements, and palatability of dry lick supplements on intake, variability of intake and the proportion of shy-feeders. In Years 2 and 3 similar measurements were made with larger mobs (eg. 80-200 head).

4.3 Description of experiments

Relevant experiments and brief description of each experiment.

4.3.1 Control of supplement intake, proportions of shy-feeders and variability in intake of a range of supplements used in the northern industry.

(i) E813 A. (p. 80). Effect of supplement type (M8U, CSM, dry licks and blocks) on variability of supplement intake by heifers 18-24 months of age.
(ii) E813 B. (p. 84). Effects of various additives for molasses supplements on intake and variability in intake by heifers 18-24 months of age.
(iii) E822 B. (p. 86). Effect of inclusion of cottonseed meal in dry lick supplement on intake and variability of intake by weaners during their first dry season.
(iv) E882 C. (p. 88). Effects of previous experience of supplements and inclusion of cottonseed meal in dry lick supplement on supplement intake by weaners during their first dry season..
(iv) E829. (p. 91). Effects of previous exposure of yearling heifers to supplements and palatability of dry lick supplement on intake and variability of intake under wet season conditions.
(vi) E813 C. (p. 93). Variability in intake by heifers of salt/kynophos dry lick supplement fed in large paddocks during the wet/early dry season - Year 1.
(vii) E830. (p. 96). Variability in intake by heifers of dry lick supplements fed in large paddocks during the wet/early dry season - Year 2.
(viii) E813E. (p. 114). Distribution of intake of a low-palatability molasses/urea/phosphoric acid supplement in a mob of cows and calves.

4.3.2 Training cattle to improve acceptance of low-palatability supplements

(i) E815. (p. 101). Training weaners to consume dry lick supplements - Year 1.
(ii) E822 A. (p. 107). Further studies on training weaners to consume dry lick supplements - Year 2.
(iii) E842. (p. 110). Effect of early exposure of cattle as weaners to dry lick supplement on their subsequent intake of dry lick supplement as 3-year-old steers.
(iv) E830. (p. 96). (Section above). Variability in intake by heifers of dry lick supplements fed in large paddocks during the wet/early dry season - Year 2.

4.3.3 Development of molasses-based wet licks containing high concentrations of urea and phosphoric acid.

(i) E813D. (p. 112). Preliminary observations on intake of wet licks based on molasses and containing high levels of urea and phosphoric acid to control intake.
(ii) E813E. (p. 114). Distribution of intake of a molasses/urea/phosphoric acid supplement in a mob of cows and calves.

4.3.4 Design of supplementation points.

(i) E816. (p. 118). Trough space and design effects on supplement intake.
(ii) E832. (p. 123). Design of shelter sheds for wet season supplementation.

4.3.5 Siting of supplementation points.

(i) E824. (p. 126). Effect of distance of supplementation site from water on supplement intake.
(ii) E837. (p. 129). Siting of supplementation points. Effects on supplement intake and paddock use by small groups of cattle.
(iii) E839. (p. 131). Wet season supplementation of cattle. Effects of siting on intake and paddock use by a large mob of cattle.

4.4 Main conclusions from the research

4.4.1 Consequences of changing supplement types and mixtures

(i) A general relationship was observed between the palatability of supplement and both the proportion of shy-feeders and the variability in supplement intake within a mob.

Experiments in Years 1 and 2 with small mobs of cattle in small paddocks (E813A, E813B, E815, E822A, E822B, E822C, E829) showed that the variability of intake and the percent of non-consumers of supplement was low for high-palatability supplements such as CSM, concentrates or molasses-based supplements such as M8U. However, variability of supplement intake was much higher for dry lick or block supplements, and in some experiments the percent of non-consumers was also high. For example in one experiment (813A) the variation, expressed as a coefficient of variation (CoV), was similar and acceptably low (about 30%) for M8U supplement fed *ad libitum* and for cottonseed meal fed with a generous trough space allowance. Also all animals consumed these supplements. In contrast the variation for a dry lick (based on salt, urea, calcium phosphate and cottonseed meal) or for solidified molasses-based blocks was much greater (CoV about 70-105%) than for the M8U and cottonseed meal supplements. There was some adaptation whereby this high variation in intake of dry licks and block decreased with time of exposure to the supplements, but variation was always much higher than for M8U and cottonseed meal. Also an appreciable proportion of animals did not consume dry licks or blocks at all. Similar results were observed in experiment E815 when weaners were fed dry lick or M8U supplement. When average intake of dry lick supplement was less than about 50 g/d in an adult animal, the percent of non-consumers was linearly related to supplement intake. Percent of non-consumers decreased from 100% (by definition) at nil average intake to about 30% at an average intake of 50 g/d of supplement. Variability among those animals which did consume supplement was not affected by supplement intake, and coefficient of variation was in the range 60-100%.

Later experiments (E813C, E830 and E813E) extended this work to larger mobs of cattle grazing paddock sizes more typical of commercial property situations. In general the results from these larger mobs is in agreement with the earlier experiments. Additional evidence that intake of supplement was one of the principal factors affecting the variability of supplement intake was obtained from an experiment where a mob of cows and calves were fed a molasses-based supplement made unpalatable by addition of phosphoric acid. Although variability of M8U-type supplements was generally low, the variability of the molasses-phosphoric acid supplement was high and comparable with that of dry licks when supplement intake was similar. This supports the hypothesis that the variability in supplement intake and the proportion of shy-feeders is related primarily to the voluntary intake of the supplement fed *ad libitum*, rather than to the type of supplement *per se*.

(ii) Voluntary intake of dry lick supplement is generally increased as the supplement is made more palatable eg. by inclusion of CSM in the mixture. For example in experiments E822B and E829 inclusion of cottonseed meal as 30% of a dry lick increased voluntary intake of the supplement by 28% and 93% respectively. However the intake of dry lick supplements fed *ad libitum* is determined by the palatability of the supplement relative to the palatability of available pasture, rather than any absolute measure of supplement palatability. In many of the experiments of the project it was observed that supplement intake decreased following rain which produced more palatable pasture, and only increased again slowly as pasture dried off and declined in quality. Also to achieve a given intake of supplement a much more palatable supplement was needed during the wet season than during the dry season.

Supplement intake can be increased by making the supplement more palatable eg. with dry licks by addition of ingredients such as cottonseed and molasses, or salt in situations where cattle find salt palatable. Alternatively supplement can be made less palatable by addition of ingredients such as ammonium sulphate (Granam fertiliser) or excess salt. More palatable supplement is needed when wet season pasture is available than when only sensed dry season (and therefore low palatability) pasture is available.

4.4.2 Effects of previous experience and training on intake of supplement

Observations and experience with humans, sheep and other species of animals indicates the importance of learning in the young animal on its subsequent food preferences and acceptance of novel foods. It follows that exposure of young cattle to low palatability supplements early in life may improve acceptance and intake of such supplements later in life, and may reduce the proportion of animals in a mob which are "shy-feeders" or consume little or no supplement.

(i) In two experiments (E815 and E822A) several training programs for calves and weaners were investigated as means to increase intake of low palatability dry lick supplements by weaners during their first dry season. Procedures investigated were provision of palatable supplements based on cottonseed meal to calves before weaning, in the yards during a 10-day weaning phase or for three weeks in the paddock following weaning. Also the effect of increased handling of weaners by a stockman during the 10-day weaning phase in the yards was investigated.

Although provision of highly palatable supplements increased acceptance and intake by the weaners of low palatability supplements when they were initially provided, the differences due to training disappeared within several weeks. Also variability of intake of dry lick supplements remained high and unchanged with a coefficient of variation typically 60-90%.

(ii) The consequences of supplementing weaners with dry lick for several months during their first dry season on intake of dry lick supplement in their second dry season was investigated in experiment E829. Previous experience did not affect intake of supplement by the 15-18 month old animals. In a second experiment of similar design (E842), exposure of steers to dry lick supplement as weaners did not affect their intake of supplement as 3-year-old cattle.

(iii) From the above experiments we conclude that there will generally be little benefit of training of weaners in the yards where a dry lick of at least moderate palatability is going to be fed, and where cattle are quiet in temperament and accustomed to a fair degree of handling. The principal benefit of training young cattle is likely to be to teach cattle to investigate supplement feeders and not to be fearful of approaching such equipment in the paddock. The importance of this will presumably depend on the temperament of the cattle.

In two experiments (E813A and E830) there was evidence that previous experience with supplementary feeds did influence intake of a low palatability dry lick supplement. In E813A heifers with previous experience consumed more supplement. However previous exposure was confounded with liveweight of the heifers, so the differences between groups of heifers may have been associated with dominance-subordinate relationship within the mob associated with animal size rather than due to experience. More definitively, in experiment E830 sub-groups of 2-year-old heifers which some months previously had been fed either dry lick supplements or feedlot diets based on NaOH-treated bagasse consumed about twice as much of a dry lick supplement. These results contrasted with those obtained in the other experiments described above. We cannot provide an explanation for the differences between experiments. We conclude that training and familiarisation of cattle to supplements and to some specific flavours may have a role in increasing acceptance of supplements by cattle. For example where acceptance problems occur, exposure of weaners to palatable supplements is likely to be helpful.

4.4.3 Development of wet licks based on molasses and containing high concentrations of urea and phosphoric acid

Dry licks and blocks are obviously often used by the industry to provide urea N and P supplements. However a major problem is that intake, particularly under wet season pasture conditions, is often too low to provide required target amounts of urea or phosphorus. Roller drum systems may give better control of intake, but both capital and operating costs are high. Intakes of M8U and M12U are too high for these supplements to be used strategically to reduce liveweight loss, and also a phosphorus source may also be needed.

Experiments in the 1950's (Beames 1960) showed that molasses/urea mixtures containing up to M50U could be fed without mortalities, at least in small paddock situations. Intake of urea tended to remain constant as urea concentration was increased from M8U to M50U, but the amount of urea consumed was much more than the animal can utilise effectively. It is also known that acids, such as hydrochloric or phosphoric acid reduce feed intake, including *ad libitum* intakes of molasses-urea type mixtures (Lindsay *et al.* 1983). Recently (and since the present experimental work was conducted) a liquid supplements based of molasses and using the principle of acidity to control intakes has become available as commercial products in southern Queensland. However since this technology is not public information it is not available to cattle producers who wish to mix their own supplements rather than purchasing the mixed product, and is not available at all in central Queensland or northern Australia.

Preliminary observations (E813-D) were made on development of wet licks supplements based on molasses, high levels of urea and phosphoric acid. The objective was to develop a molasses-based liquid supplement to primarily provide urea N and phosphorus which can be fed in open-troughs and where voluntary intake is controlled at low levels by the sour acidic taste of the mixture. This would be comparable to the established molasses-urea roller drum system where intake of the supplement is restricted by access and tongue-fatigue. However an open-trough system would have major potential advantages over the roller-drum systems in reduced capital and operating costs.

Observations suggested that when molasses/urea/phosphoric acid mixtures containing up to 22% urea and 12% phosphoric acid were fed to breeders, supplement intakes were in the range 50-200 g per breeder per day and there were no cases of urea toxicity. However further work on this technology is needed before it can be recommended for use on commercial properties.

A recommendation of the Mid-term Review of the project in April 1996 was that this work area should not be continued during the remainder of project DAQ.098. Therefore there was no further development of this technology.

4.4.4 Design of supplementation points

(i) Little information is available on the importance of the amount of trough space, and the configuration of that trough space, on supplement intake by cattle under extensive grazing conditions. The estimate of "adequate trough space" given by McCosker and Winks (1994) in the book "Phosphorus Nutrition of Beef Cattle in Northern Australia" is 50 cm per 25 head (page 59), but the authors also state (personal communication) that this is a best guess based on very little information.

In experiment E816 groups of young cattle were fed palatable M8U supplement with various trough space allocations. There were only small differences between the various trough space allocations used in the experiment. Higher intakes and liveweight gains were achieved by placing individual troughs some distance (3 m or 10 m) apart. This suggests that the standard of 50 cm per 25 head may introduce a level of competition in the mob which reduces intake of a supplement fed *ad libitum*. However, there do not appear to be any simple behavioural characteristics which can be used to identify when problems are likely to occur or which individual animals are likely to be non-consumers of supplement.

(ii) Traditional open-sided supplement shelter sheds (ie. with a roof but no sides) are economical but fairly ineffective when there is wind with rain. This is particularly important for providing phosphorus supplements as dry licks during the wet season. A shed enclosed on 3 sides which can be set up with the opening away from the most likely direction of rain provides much better weather protection for dry lick type supplements. Furthermore, such a shed built onto a feeder with a hopper capacity of several tonnes would be effective to provide supplements to a mob of cattle for many months through the wet season. Such sheds have been used in the past by a few producers, but we know of no information on their efficacy. One potential problem is that some cattle may be reluctant to enter a 3-sided closed shed. If this does occur the proportion of shy feeders of supplement in the mob, and the variability in supplement intake, are likely to increase.

An experiment (B831) examined the consequences of using enclosed 3-sided shelter sheds rather than the traditional open-sided shed on animal behaviour, intake and variability of intake of supplements. This experiment indicated that enclosed shelter sheds providing improved weather protection do not adversely affect supplement intake, or distribution of supplement intake, at least in small mobs of cattle.

4.4.5 Siting of supplement points on supplement intake and grazing patterns

(i) Two experiments (E824 and E837) were conducted to determine the effect of siting of supplements close to water or distant (1.5-2.0 km) from water on supplement intake and variability of intake. These experiments were conducted with small groups of cattle in long, narrow paddocks. In the first experiment the supplement was M8U and in the second experiment lick blocks. Variability of intake within the mob was apparently not affected by whether supplements were sited near to or distant from water. Siting of the supplement distant from water reduced average supplement intake by 20-30%. This was a lesser effect than we had expected from anecdotal evidence, and suggests that siting alone is of limited value to control intake of supplements.

(ii) The effect of siting of supplements on the grazing behaviour of cattle was examined in one experiment (E837) with small groups of animals in long, narrow paddocks, and in a second experiment (E839) with a mob (about 200 head) of cows, calves and steers grazing a 700 ha paddock. Dry lick supplements were fed during the wet and transition season and close to and distant from the permanent water. Observations were made of the areas of the paddock grazed by the cattle. In general the observations indicated that the parts of the paddock grazed by the cattle depended on pasture species and the stage of pasture growth on the various soil types. The cattle only consumed supplement when the supplementation points were sited near where they were grazing anyway. Different results may occur if cattle have a strong appetite for the supplement (eg. if the animals have salt hunger and the supplement contains a high level of salt, or if the supplement is very palatable), but a low palatability supplement apparently has little if any effect on the parts of the paddock utilised by the cattle.

4.5 Reports of individual experiments

The reports of the individual experiments conducted in Task Areas 2 and 3 follow.

Supplement delivery systems - Experiment 1

Effects of supplement type on variability of supplement intake - SWN-B813-A

Rob Dixon, Bev Gelling, Dave Smith and Carol Petherick

Summary

1. Brahman cross heifers (160) grazed senesced native speargrass pasture and were offered four types of supplement (cottonseed meal (CSM), M8U, dry licks (DL) and blocks). Intake of supplement by individual animals was measured using lithium as a marker after 5 and 9 weeks of supplementation. In addition variability of intake of dry lick supplement was measured after 22 weeks at the end of the following wet season. The variation in supplement intake among individual animals within a mob was lower for CSM and M8U (CoV 26-31%) than for the dry lick or block supplements (CoV 69-105%). All heifers offered CSM or M8U supplement consumed supplement, but 1/40 and 5/40 did not consume the dry lick or block supplements respectively.

2. The results suggest that the proportion of shy-feeders in a mob, and the variation in supplement intake, are much higher for less palatable supplements. Both of these factors were reduced with time of exposure of the animals to the supplement, but variation remained high with dry lick and block supplements of low palatability.

Introduction

For maximum benefit to be obtained from supplements it is obviously necessary to achieve intakes of required amounts of supplementary nutrients by all animals in the mob. The most common methods of providing supplements is to provide M8U type supplements in open troughs, or dry licks or blocks, and depend on the addition of ingredients such as salt and urea, or on the hardness of blocks, to limit intake of the supplement to the required amount. However, intakes of supplement are often very different to those required. Intakes are frequently too low when green pasture is available, and may often be excessive during the dry season when pasture quality and availability are low.

Even when average intake of a mob is satisfactory, a number of studies have observed wide variation in intake of supplement by individual animals. Where breeder cattle grazing tropical tallgrass pastures were supplemented with blocks, one study with cattle grazing tropical tallgrass pastures in the Northern Territory observed that 20% of lactating mature cows and 40% of lactating first-calf cows or dry cows did not consume appreciable amounts of supplement. Also some cattle consumed up to five times the average intake. Such wide variation in supplement intake leads to inefficient supplement utilisation, particularly for P and non-protein N supplements, where no further animal response is likely to occur when requirements have been provided.

The following experiments were part of a series to understand the factors determining intake of supplement, and variability of intake within mobs, when various types of supplements are offered to cattle.

Experimental

Bos indicus x Shorthorn cross (>F2) heifers, 17-20 months of age in June 1994, were used. These heifers were from two herds, one seasonally mated and one continuously mated, on Swan's Lagoon Research Station. The experiment was conducted from 10 June 1994 until the 27 September 1994 using

160 heifers, and was continued from the 2 November 1994 until 4 April 1995 with a subgroup of 40 of the heifers. On 10 June 1994 160 heifers were mustered from a large native pasture paddock and weighed. The heifers were allocated by stratified randomization based on LW and herd of origin to eight groups each of 20 heifers. Mean LW was 260 kg (SD 32 kg, range 209-361 kg) and mean body condition score was 5.8 (range 5-7).

The eight 40 ha paddocks used consisted of native pasture. Supplementation treatments commenced on the 22 July 1994, and were continued under dry season conditions until the 27 September 1994. In addition the dry lick supplements (T3) were fed during the wet season from 2 Nov 1994 until 5 April 1995. The treatments consisted of four types of supplements as follows:

- T1, Cottonseed meal (CSM) fed at the equivalent of 0.5 kg air-dry per heifer per day, and fed in two equal amounts twice each week.
- T2, A molasses-urea supplement (M8U) fed *ad libitum.*
- T3, A dry lick supplement (DL) based on salt, urea, CSM and kynophos fed *ad libitum.*
- T4, A solidified block supplement (Blocks) based on molasses, urea, kynophos and salt fed *ad libitum.*

The supplements were all fed in troughs near the water point. CSM was fed in three troughs, each 1.2 x 0.6 m and placed 10 m apart. The M8U and the blocks were fed in two troughs 0.8 x 0.6 m placed 10 m apart in each paddock. The dry lick was fed in a single open-ended trough (2.0 x 0.5 m).

The dry lick mixture fed from day 18 of the experiment contained, (g/kg) salt 390, urea 300, CSM 150, kynophos 150 and sulphur 10. During the first 17 days the heifers were fed a mixture of CSM and salt, followed by gradual introduction of kynophos and urea. Dry lick supplements were fed twice each week, and residues removed and weighed at the same time. The blocks fed from day 18 contained (g/kg), on an air-dry basis, molasses 494, urea 99, kynophos 62, salt 62, bran 62, calcium oxide 148 and magnesium oxide 74. The blocks were prepared by mixing ingredients in a cement mixer and allowing setting in moulds. A series of block mixtures containing various levels of calcium oxide were fed during the first 16 days, but these blocks were considered to be too soft. Thereafter magnesium oxide was included, and these blocks were satisfactory.

Lithium sulphate was mixed with the supplements which were fed on 25 August 1994 and on 27 September 1994 after 35 and 68 days respectively of supplementation.

From 27 September 1994 until 2 November the 160 heifers were used for another experiment. On 2 November 1994 the two groups of 20 heifers fed dry lick supplement from 22 July 1994 until 27 September 1994 were returned to the paddocks to which they had been allocated previously. In order to reduce stocking pressure, from the 1 December 1994 each group had access to two 40 ha paddocks. Two bulls were introduced to each paddock group on the 20 December 1994, and remained in the group for the remainder of the experiment. The dry season dry lick mixture described above was provided *ad libitum* from 11 November 1994 until the 26 December 1994. Storm rain on this day washed the supplement from the open troughs in which it had been fed, and effectively terminated this dry season dry lick supplementation regime. Attempts were made during January and early February to continue dry lick supplementation, but there was negligible intake of supplement. Routine feeding of supplements was recommenced on 1 March 1995 and continued until the 4 April 1995 without serious interruption by rain. The dry lick mixture fed during March and April 1995 contained (g/kg air dry), CSM 373, salt 300, kynophos 210, urea 100 and sulphur 7. Lithium-labelled dry lick, was fed on the 4 April 1995.

Table 1. Intakes (air dry) of supplements, variation in supplement intake and number of non-consumer heifers measured on two occasions using lithium-labelled supplements

Measurement	Supplement			
	CSM	M8U	Dry lick	Block
Intake (g/hd/d)				
Weeks 1-5	500	1257	175.5	119.8
Weeks 6-10	500	1172	144.8	96.8
Weeks 1-10	500	1214	160.2	108.3
Weeks 18-22	-	-	92.4	-
Lithium measurements				
CoV M1 (25 Aug 1994)	31	28	80	105
M2 (27 Sept 1994)	31	26	69	81
M1+M2 (mean)	31	22	63	79
M4 (3 April 1995)	-		59	-
No. of non consumers in mob				
M1 (25 Aug 1994)	0/40	0/40	2/39	8/40
M2 (27 Sept 1994)	0/40	0/40	1/40	5/40
M1+M2	0/40	0/40	0/40	3/40
M4	-	-	2/40	-
Liveweight				
LW (19 July 94) kg	264	265	261	265
LW (28 Sept 94) kg	271	257	261	256
LW change (kg/d)	0.11	-0.11	0.00	-0.12
LW (2 Nov 94)	-	-	257	-
LW (4 April 95)	-	-	356	-
LW change (kg/d)	-	-	+0.64	-
Body condition score				
CS (19 July 94)	5.7	5.9	5.9	5.8
CS (28 Sept 94)	5.3	5.1	5.1	5.0
CS change	-0.4	-0.8	-0.8	-0.8
CS (2 Nov 94)	-	-	4.8	-
CS (4 Apr 95)	-	-	7.0	-
CS change	-	-	+2.2	-

M1, measurement 1; M2, measurement 2; M4, measurement 4.

Results and discussion

The CSM supplement was readily consumed by the heifers. There was little variation between weeks in intake of M8U during the 10 weeks when this supplement was fed, and mean intake was 1.21 kg per head per day (Table 1). Intake of dry lick from week 4-10 ranged from 918 to 1117 g per head per week, and averaged 160 g per head per day. During the wet season, from week 18-22, average intake was 92 g per head per day. Intake of blocks from weeks 4-10 ranged from 415 to 977 g per head per week, and averaged 108 g per head per day.

The variation in supplement intake among individual heifers, expressed as a coefficient of variation (CoV) for all animals fed the same treatment, ranged from 26-31% for heifers fed CSM and M8U, and from 59-105% for heifers fed dry licks or solidified blocks (Table 1). The CoV of intake of dry lick and block supplements tended to decrease with experience of the animals to the supplements. For dry lick supplement the CoV was 80% after 5 weeks, 69% after 9 weeks, and 59% after 22 weeks of experience. Similarly for block supplement the CoV were 105% and 81% after 5 and 9 weeks respectively.

The proportion of animals which did not consume supplements at all also differed between supplement types. All heifers consumed at least some CSM or M8U. However, after 5 weeks 5% (2/39) of heifers did not consume dry lick, and 20% (8/40) of heifers did not consume any block on the day the lithium-labelled supplement was offered. After 9 weeks of experience of these supplements, the proportion of heifers which did not consume dry licks and blocks decreased to 3% and 13% respectively.

Practical implications

The results of Experiment 1 indicate that the variation in supplement intake was reasonably low and quite acceptable when M8U was fed *ad libitum*, or when CSM was fed with a generous trough space allowance. However variation in supplement intake was quite high for dry lick and block supplements, even when appreciable levels of cottonseed and molasses respectively were included. The amounts of cottonseed meal or molasses included in these supplements was more than would often be used in the industry. It seems likely that where lower proportions of the palatable cottonseed meal or molasses ingredients are used, the variability in supplement intake among individuals in the mob will be even greater than observed in the present experiment.

The variation in supplement intake measured in these experiments was large enough to have introduced considerable inefficiency into the use of these supplements.

Exposure of animals to the supplement for long periods tended to reduce the variability in supplement intake. However even after 6 months experience of supplement, variability of dry lick supplement intake was unacceptably high.

Supplement delivery systems - Experiment 2

Effects of various additives for molasses supplements on intake and variability of intake - SWN-B813B

Rob Dixon, Bev Gelling and Carol Petherick

Summary

1. One hundred and sixty Brahman cross heifers which had been fed one of four types of supplements during the previous 10 weeks during Experiment SWN-813A were used. The heifers grazed senesced native pasture, and during a 23 day period were offered supplements based on molasses with various additives (8% urea, 12% urea, 8% urea plus monensin, 8% urea plus meatmeal) to reduce intake.

2. Intake of M8U supplement was 1.90 kg/head.d, and supplement intake was reduced to 1.31 - 1.41 kg/head.d by inclusion of additiònal urea to make M12U or by inclusion of monensin or of meat and bone meal in the M8U.

3. Variability of supplement intake was low and there were no non-consumers of supplement when M8U, M12U or M8U plus monensin were fed. There was some evidence that inclusion of meat and bone meal in M8U increased the variability of supplement intake and the proportion of non-consumers, but the two mobs of heifers in the two paddocks behaved quite differently.

Introduction

This experiment was one of a series to understand the factors determining variability in intake of supplements within mobs when various types of supplements are offered to cattle. Specifically the variability of supplement intake and number of non-consumers of supplement within a mob fed molasses-based supplements was measured when palatability of the supplement was reduced by a high concentration of urea, by monensin or by meat and bone meal.

Experimental

Bos indicus x Shorthorn cross (Fn) heifers (160) approximately 22 months of age grazed 8 x 40 ha paddocks of native pasture. From July until September the heifers were used in an experiment (SWN-813A) were one of four supplements (CSM, M8U, dry lick or blocks) was fed to groups of heifers. Heifers were reallocated to one of four molasses supplements ad lib for 3 weeks durıng the late dry season. The supplements consisted of the following mixtures:

- T1, M8U
- T2, M12U
- T3, M-R. Monensin (Rumensin Premix) was mixed with M8U at the concentration of 120 mg monensin per kg for the first 16 days. and 180 mg monensin per kg during days 17-23.
- T4, M-MM. Meat and bone meal was mixed with the M8U at 2.5% during week 1, 5% during week 2 and 10% during week 3.

Intake of supplement by individual animals was measured at the end of the three week period using lithium marker mixed with the supplement.

Results

On average the heifers weighed 261 kg and were in "store" body condition. They consumed 1.90 kg/head.d of the M8U supplement, and intake tended to increase during the feeding period (Table 1). Supplement intake was reduced to 1.31-1.41 kg/head.d by additional urea to make M12U, or by inclusion of monensin or of the meat and bone meal.

Table 1. Intakes of air-dry supplements, variation in supplement intake and number of non-consumer heifers

Measurement	Supplement			
	M8U	M12U	M-R	M-MM
Intake (kg/head.d)				
Week 1	1.43	1.23	1.28	0.93
Week 2	2.02	1.38	1.59	1.22
Week 3	2.27	1.33	1.36	1.90
Mean	1.90	1.31	1.41	1.35
Supplement intake				
Coefficient of variation (%)	39	37	39	57
No non-consumers	0/40	0/40	0/40	6/40

The variation in intake of supplement was similar for the M8U, M12U or molasses supplement containing monensin (coefficient of variation (CoV) 37 - 39%), and all of the heifers in these mobs consumed supplement. When heifers were fed molasses containing meat and bone meal, the two groups of heifers behaved quite differently. In one paddock, variability in intake (CoV 32%) was similar to the other supplements and all of the heifers consumed supplement. However in the second paddock group 6/20 heifers did not consume any supplement, and the variability (CoV 82%) was high.

Practical implications

When voluntary intake of a molasses-based supplement was restricted by high levels of urea (as M8U or M12U) or monensin, variability of supplement intake was low and satisfactory, and there were no non-consumers of supplement. The consequences on variability of intake of including meat and bone meal are not clear, since the two paddock groups behaved quite differently. There is some evidence that there may be a high variability in supplement intake and a high proportion of non-consumers of the supplement, but since meat and bone meal can no longer be recommended as a supplement for cattle it is not an issue for the industry.

Supplement delivery systems - Experiment 3

Effect of inclusion of CSM in dry lick supplement on intake and variability of intake by weaners - SWN-B822B

Rob Dixon, Peter Fry and Carol Petherick

Summary

1. Weaner heifers were fed one of four types of dry lick supplement. For Treatment 1 the dry lick contained 64% salt, 30% urea and 6% sulphate of ammonia. For Treatments 2, 3 and 4, 8% 16% or 32% of the salt in the mixture was replaced by CSM.

2. Intake of dry lick tended to increase with increasing amounts of CSM in the supplement. Intake was 40 g DM/head.d in weaners fed Treatment 1, and 42, 47 and 51 g DM/head.d for Treatments 2, 3 and 4 respectively.

3. The variation in supplement intake within groups of weaners, and the proportion of non-consumer weaners in each group were measured after 4 weeks and 10 weeks using lithium marker mixed with the supplement. The variation was not affected by the type of dry lick supplement.

Introduction

Previous experiments have shown that the variability in supplement intake within a mob is much lower for palatable supplements (eg. CSM, M8U or M15U) than for low palatability dry lick supplements based on salt, urea and kynophos. Hence palatability of a supplement may have an important effect on the variability in intake of dry lick supplements.

The objective of the present experiment was to examine the intake, and variability in intake, of a dry lick supplement based on urea and salt, as increasing levels of CSM were included to increase palatability.

Experimental

Brahman x Shorthorn weaners (120) previously used for SWN-B822A were reallocated at random to 12 paddock groups each of 10 animals. The weaners grazed 18 ha paddocks of native pasture, and were offered one of four dry lick supplements. For Treatment 1 the dry lick contained (g/kg) salt 640, urea 300 and ammonium sulphate 60. For Treatments 2, 3 and 4, 80, 160 and 320 g/kg of the salt was replaced by CSM.

Dry lick supplements were fed for 10 weeks, and lithium marker was mixed with the supplement fed during weeks 4 and 10 to measure variability in supplement intake.

Results

The results for the intake of the dry lick supplements, the variability in intake and the proportion of non-consumers of supplement are given in Table 1. Increasing amounts of CSM progressively increased the intake of the supplement, but only from 40 g DM/head.d to 51 g DM/head.d. There was no effect of inclusion of CSM on either the variability of intake of dry lick supplement, or on the proportion of non-consumers of supplement.

Table 1. Intake, variability of supplement intake and percentage of non-consumers of supplements when weaners were fed dry lick supplements containing 0, 8, 16 or 32% of CSM

Measurement	Percent CSM in dry lick			
	0	8	16	32
n	30	30	30	30
Supplement intake (g DM/d)	40	42	47	51
Variability of intake (CoV,%)				
Week 4	82	135	87	78
Week 10	87	110	96	95
Non consumers (%)				
Week 4	17	30	12	15
Week 10	10	23	13	14

Practical implications

Including CSM in dry licks fed to weaners with considerable previous experience with supplements increased intake of the supplement, but did not have any discernible effect on the distribution of supplement intake within the mob, or on the proportion of non-consumers of supplement.

Supplement delivery systems - Experiment 4

Effects of previous experience of supplements and inclusion of CSM in dry lick supplement on supplement intake by weaners - SWN-B822C

Rob Dixon, Peter Fry and Carol Petherick

Summary

1. Weaner heifers with previous experience of dry lick supplement, or similar weaners without previous exposure, were fed a dry lick of low palatability (salt, urea and ammonium sulphate) or a dry lick of higher palatability containing 32% CSM.

2. During the first 3 weeks supplement intake was higher for weaners which both had previous experience and were fed the more palatable dry lick, but by weeks 5-9 intakes of dry lick were similar for all the treatment groups.

3. After 4 weeks of supplementation there was lower variability in intake and a lower proportion of non-consumers in groups of experienced weaners. After 10 weeks of supplementation the inexperienced weaners fed the high palatability dry lick reduced variability of intake and proportion of non-consumers to be similar to experienced weaners. However, variability and proportion of non-consumers remained high for inexperienced weaners fed the low palatability supplement.

4. This experiment indicates that both previous experience and inclusion of CSM in dry lick for weaners improved intake and reduced problems of variability of intake.

Introduction

The present trial examined the importance of both previous exposure to supplement and palatability of supplement on intake, variability of intake and the proportion of non-consumers of dry lick supplement by weaners.

Experimental

Brahman x Shorthorn cross weaners heifers from the Swan's Lagoon herd and with two histories of management were used in the experiment. Sixty weaners which had been used during Expt SWN-B822A were allocated at random to 6 paddock groups each of 10 head. In addition 28 weaner heifers which had been weaned at the second round muster in August, and whose only experience of supplements was to be fed molasses-based supplements for two weeks in the yards during weaning, were allocated at random to 4 paddock groups each of 7 head. The trial commenced late September and finished early December.

The weaners were grazed in 18 ha paddocks of native pasture which contained considerable green pick, and were fed *ad libitum* one of two formulations of dry lick supplement. A low palatability dry lick contained 64% salt (Flossy Fine feed grade), 30% prilled urea and 6% granulated sulphate of ammonia (Granam). A high palatability dry lick contained 32% salt, 32% cottonseed meal, 30% urea and 6% granulated sulphate of ammonia. These supplements were fed in open-ended troughs near water.

During Week 4 and Week 10 a lithium marker was mixed with the supplement to identify those weaners not consuming any supplement, and to measure variability in supplement intake.

Results

All the paddock groups of weaners consumed some dry lick supplement, even during the first week the supplement was fed. However during the first three weeks weaners with previous experience of dry lick supplement and also fed the higher palatability dry lick consumed more supplement (52 g DM/head.d) then the weaners exposed to the other treatments (35-36 g DM/head.d) (Table 1). However, this difference between treatments did not persist, and from Weeks 5-9 supplement intakes were similar for the four treatments (49-60 g/head.d).

Table 1. Intake, variability of supplement intake and percentage of non-consumers of supplement when weaners with or without previous experience of dry lick supplements were fed low or high palatability dry licks

Measurement	Without experience		With experience	
	Low palatability	High palatability	Low palatability	High palatability
n	14	14	30	30
Supplement intake (gDM/d)				
Week 1-3	35	35	36	52
Week 5-9	60	59	49	53
Variability of intake (CoV,%)				
Week 4	157	124	82	78
Week 10	106	69	87	95
Non-consumers (%)				
Week 4	50	33	17	15
Week 10	36	14	10	14

After 4 weeks of supplementation variability in supplement intake was higher for those weaners without previous exposure (CoV of supplement intake average 141% and 80% respectively), and also the proportion of non-consumers of supplement was higher (average 42% and 16% respectively). There was also a tendency for groups of weaners fed the low palatability dry lick to have a higher variability in supplement intake (CoV average 119% and 101% respectively) and a higher proportion of non-consumers (average 34% and 24% respectively).

In groups of weaners with previous exposure to supplements, the variability in supplement intake and the proportion of non-consumers in groups of weaners with previous exposure were similar after 4 weeks and 10 weeks. However the inexperienced weaners tended to adapt during the experiment, and the extent of adaptation depended on the type of dry lick. After 10 weeks inexperienced weaners fed the high palatability dry lick containing CSM had a similar variability of supplement intake and a similar proportion of non-consumers to the experienced weaners. However, in groups of inexperienced weaners fed the low palatability dry lick, both variability in supplement intake (CoV 106%), and the proportion of non-consumers (36%) remained high.

Practical implications

Both the previous exposure of weaners to dry lick supplements and the inclusion of CSM into the dry lick supplement had effects on intake of the dry lick supplement. Both previous exposure of weaners to dry lick supplement, and higher palatability of the dry lick reduced the variability of intake of dry lick supplement and reduced the proportion of non-consumers. However, when inexperienced weaners were fed a low palatability dry lick, even after 10 weeks variability of supplement intake and the proportion of non-consumers of supplement (36%) remained high.

Supplement delivery systems - Experiment 5

Effects of previous exposure of yearling cattle and palatability of dry lick supplement on intake and variability of intake under wet season conditions - SWN-B829

Rob Dixon, Adrian White, Peter Fry and Carol Petherick

Summary

1. Yearling heifers with either little or extensive previous experience of supplements were fed dry lick supplements of low or high palatability during the wet and transition seasons.

2. Including CSM in the dry lick to improve palatability increased intake from 41 to 79 g DM/head.d, but there was no effect of either previous experience of the heifers or inclusion of CSM on variability of supplement intake. The proportion of non-consumers of supplement tended to be higher with dry lick without CSM (4/50) than when CSM was included (1/60).

Introduction

This experiment examined the relative importance of palatability of a dry lick supplement, and previous experience of young cattle to a supplement, on intake and variability of intake for wet-transition season native pastures.

Experimental

Yearling heifers (60) from the Swan's Lagoon herd which had been used in previous experiments where dry lick supplements had been fed for all of the dry season following weaning at first round (Expts SWN-B822A and SWN-B822B), or 60 similar heifers that had been fed supplements only briefly during weaning in the yards were used. Twelve paddock groups each of 10 animals were allocated to the four treatments. The treatments consisted of with or without previous experience of supplements and low or high palatability dry lick supplements. The low palatability dry lick supplement contained 44.8% salt, 31.3% calcium phosphate (Kynophos), 22.4% urea and 1.5% elemental sulphur. The high palatability dry lick supplement contained 33% CSM, 30% salt, 21% calcium phosphate, 15% urea and 1% elemental sulphur. Supplements were fed from early-February until mid-June 1996. The lithium marker technique was used to identify non-consumers and to measure variability of supplement intake.

Results

One paddock group of heifers experienced in intake of supplements and allocated to the low palatability dry lick had very low and erratic intakes of supplement. However, since this was thought to be due to characteristics of this paddock these observations were excluded from the results presented.

Intake of the dry lick supplement containing CSM was, on average, higher than for the dry lick which did not contain this ingredient (79 and 41 g DM/head.d) (Table 1). Thus because of the differing amounts of calcium phosphate and urea in the dry licks, heifers offered the high palatability dry lick consumed approximately 30% more phosphorus and urea N.

Only a small proportion of heifers were non-consumers of supplement, but this did tend to occur more when low palatability supplements were fed. When lithium marked supplements were fed 4/50 heifers

Table 1. Liveweight gain and intake of supplement, and variability of these measurements in heifers with little (Naive) or prolonged previous exposure (Experienced) to supplements, and fed dry licks of low or high palatability

Measurement	Low palatability		High palatability	
	Naive	Experienced	Naive	Experienced
n	30	30	30	30
LW gain, mean (kg/d)	0.50	0.51	0.51	0.47
CoV (%)	12.3	14.1	12.1	17.9
Supplement intake (gDM/h/d)	51	37	85	74
Variability of intake (CoV, %)				
Week 7	67	83	60	96
Week 11	68	69	55	58

were non-consumers of low palatability supplements and 1/60 heifers were non-consumers of the high palatability supplements. The variability of supplement intake was not affected by either previous experience of the heifers with supplements, or by the type of dry lick supplement. CoV in the range 55-96% was similar to that observed in previous experiments with the same types of dry lick supplements. Also liveweight gain, and variability in liveweight gain within paddock groups were similar across all treatments.

Practical implications

Although inclusion of CSM in a wet season dry lick supplement was effective to increase intake of the supplement and of inorganic N and P, there was no effect on variability of distribution of supplement in the mob. Also in these yearling heifers previous exposure as weaners to dry lick supplements had little effect on the extent to which the heifers consumed the supplements during the wet-transition season.

Supplement delivery systems - Experiment 6

Variability in intake by heifers of salt/kynophos dry licks supplement fed during the wet/early dry season - SWN-B813-C

Rob Dixon, Ian Batterham and Ian Porch

Summary

1. Two mobs of 98 and 102 two-year-old heifers grazed native pasture during the wet and transition seasons, and were offered dry lick supplement containing various ratios of salt and kynophos. Intake of dry lick supplement was much greater for the mob of heifers which had been previously fed supplements.

2. Lithium marker was used to measure intake of supplement by individual heifers during April and June. Between 19% and 81% of cattle consumed supplement, and among consumers of supplement variation in supplement intake was high (CoV 90% to 210%).

Introduction

In other experiments on Swan's Lagoon the variability of supplement intake has been measured in small mobs of cattle (eg. 10-20 head) grazing in small paddocks. To compare results in small and large groups of animals a trial was undertaken with mobs each of approximately 100 head of 2 year old heifers grazing 400-500 ha paddocks.

Experimental

From March-June dry lick supplements were fed to 194 heifers and 8 bulls grazing in two paddock groups. Mob A consisted of 98 heifers selected at random from those available from Experiments SWN-813A and B, and which had been exposed to supplements during the preceding four months (ie. a "supplement-experienced" mob). Mob B consisted of 22 heifers from Experiments SWN-813A and B and the 74 similar heifers. The latter heifers had grazed native pasture during the preceding dry season, and had been previously exposed to supplements only during weaning in the yards. Mob B was considered as a "supplement naive mob". Four bulls of similar age to the heifers were introduced into each mob in late January.

The two mobs of heifers and bulls grazed two native pasture paddocks, designated BONK and KELK, each of approximately 500 ha. From the 31 January until the 12 April 1995 (Period 1) Mob A (the "supplement-experienced" mob) grazed BONK paddock, while Mob B (the "supplement-naive" mob) grazed KELK paddock. On the 12 April 1995 the mobs of cattle were exchanged so that Mob A grazed KELK paddock and Mob B grazed BONK paddock. Period 2 was the from 12 April 1995 to the 22 June 1995.

Dry lick supplements were fed to both mobs of cattle from the 1 March 1995 until the 22 June 1995. The dry lick supplement consisted of various mixtures of salt (flossy fine feed grade) and kynophos. The dry lick mixture fed *ad libitum* in KELK paddock during both Period 1 and 2 (i.e. to both Mob A and Mob B) consisted of 670 salt:330 kynophos. This mixture was also fed initially during Period 1 to the "supplement experienced" Mob A of cattle in BONK paddock, but this mob rapidly and consistently consumed an offered allocation of 100 g per head per day (7 g P per day), greatly in excess of expected requirements of these animals for P. In an attempt to reduce dry lick intake and ensure an *ad libitum* level of supplementation the proportion of salt in the dry lick mixture was progressively decreased. Proportions in the dry lick offered were 330 salt:670 kynophos during weeks 2, 3 and part of week 4,

Table 1. Intake and distribution of intake measured with lithium marker, of dry lick supplement in two mobs of cattle in two paddocks

Week of supplementation	Paddock and mob	
	Mob A (experienced)	Mob B (naive)
PERIOD 1	in BONK paddock	in KELK paddock
Supplement intake		
Weeks 1 + 2	98*	5
Weeks 3 + 4	60*	7
Weeks 5 + 6	85	6
All cattle		
n	102	100
Lith supp intake (g)	114	9
CoV (%)	238	394
Consumer cattle		
n	83 (81%)	19 (19%)
Lith supp intake (g)	143	43
CoV (%)	209	156
Non-consumer cattle		
n	19 (19%)	81 (81%)
PERIOD 2	in KELK paddock	in BONK paddock
Supplement intake		
Weeks 1 + 2	29	42
Weeks 3 + 4	30	32
Weeks 5 + 6	22	26
Weeks 7 + 8	19	19
Weeks 9 + 10	24	21
All cattle		
n	95	97
Lith supp intake (g)	24	10
CoV (%)	151	213
Consumer cattle		
n	53 (56%)	32 (33%)
Lith supp intake (g)	44	31
CoV (%)	92	92
Non consumer cattle		
n	42 (44%)	65 (67%)

Amounts of supplement fed not sufficient to ensure *ad libitum* intake.

200 salt:800 kynophos for part of week 4, 100 salt:900 kynophos for part of week 5, and 50 salt:950 kynophos for the remainder of week 5 and for week 6.

Each mob were fed the dry lick supplements in a single 820 x 560 mm trough in an open-sided shelter shed near the permanent water. In BONK paddock this was the only water supply, but in KELK paddock water was also available from a creek until April 1995. Lithium marker was mixed with the dry lick supplement fed at the end of each period, was used to measure intake of supplement by individual heifers.

Results

Reducing the proportion of salt in the dry lick mixture fed to Mob A in BONK paddock during Period 1 to make the mixture less palatable was partially successful to reduce intake and achieve *ad libitum* intake of supplement.

There were large differences in intake of dry lick supplement both between paddocks and between mobs of heifers (Table 1). Dry lick intake was higher in BONK paddock than in KELK paddock, and appeared to be higher for Mob A than for Mob B. The combined effects of previous experience with supplement and grazing in the BONK paddock resulted in dry lick intake ten times greater than for the naive mob in KELK paddock (mean intakes 69 g/head per day and 6 g/head per day). Supplement intakes were similar in the two paddocks during Period 2 when Mob B grazed BONK paddock and Mob A grazed KELK paddock. The observation that intake increased immediately from 6 g/d to 42 g/d when Mob B was moved from KELK to BONK paddock, and that intake decreased immediately from 85 g/d to 29 g/d for Mob A with the reverse movement, suggests an immediate effect of the paddock on supplement intake. By the commencement of Period 2 Mob B had been offered dry lick for 6 weeks and therefore had the opportunity to learn to consume dry licks. The observation that they apparently did not learn to consume as much dry lick as Mob A suggest complex factors associated with the previous experience of the animals and the extent to which some animals in the mob learn from other animals.

The proportion of cattle in each mob which consumed dry lick (Table 1) appeared to be higher for Mob A which had extensive experience of supplements. In April 81% of this mob consumed supplement, and in June 56%. In contrast in Mob B only 19% of the mob consumed supplement in April, and 33% in June. Within Mob B, the proportion of non-consumers was similar in the 22 heifers which had been exposed, and for the 74 heifers not exposed to supplements during the previous dry season. Among the cattle which did consume supplement, variability was very high in April (CoV 209% and 156%) and tended to be lower in June (CoV 92% for both groups).

Practical implications

1. The observation of large differences between paddocks and between mobs of cattle in dry lick intake is in agreement with much industry experience.

2. The proportion of non-consumers of supplement appeared to be associated with average supplement intake, suggesting that this proportion is likely to be high when supplement intakes are low.

3. The much higher proportions of non-consumers animals than observed in most small paddock trials could have been associated with any of a number of factors. However, caution is needed in extrapolation of results obtained in small mob/small paddock situations to large mobs grazing large paddocks.

Supplement delivery systems - Experiment 7

Variability in intake by heifers of dry lick supplement fed during the wet/early dry season - SWN-B830

Rob Dixon, Adrian White, Peter Fry and Carol Petherick

Summary

1. Two mobs of 129 (Mob P) and 87 (Mob Q) two-year-old heifers grazing native pasture during the wet and transition seasons were offered dry lick supplement containing various ratios of salt, kynophos and cottonseed meal. The heifers in Mob P had previously been exposed to four different regimes of supplementation and those in Mob Q to one regime. Intake of the supplement by the paddock groups ranged from negligible intakes shortly after rain, up to 60 g/head.d.

2. Lithium marker was used to measure intake of supplement by individual heifers on two occasions during April and June. Between 35% and 85% of various groups of heifers did not consume any lithium-labelled supplement. Among consumers of supplement the coefficient of variation (CoV) of supplement intake ranged from 65-156%.

Introduction

Most studies which have examined the variability in intake of supplement in mobs of cattle have considered small mobs (eg. 10-20 head) grazing in small paddocks. To extend comparisons between small and large groups of animals a trial was undertaken with larger mobs of 2-year-old heifers grazing 400-500 ha paddocks. The design of the study was similar to one conducted the previous year (SWN-B813C described in the 1996 Annual Report).

Experimental

From late February until mid-April, and from mid-May until mid-June, dry lick supplements were fed to two mobs of two-year-old heifers. Mob Q consisted of 87 heifers selected at random from a mob of heifers which had grazed native pastures since birth, and whose only previous exposure to supplements had been for 1-2 weeks in the yards at weaning when they were fed a molasses-based supplement. Mob P consisted of 129 heifers of similar age, liveweight and body condition, but which had been exposed to four regimes of supplementation prior to the experiment. One sub-group of 46 heifers (P-nil) had the same history as Mob Q, and since weaning had grazed with the latter heifers as a single group until the commencement of the experiment. A second sub-group of 20 heifers (P-b/m) also had the same history as Mob Q until 3 months before the present study commenced, but had also been fed in pens a diet based on NaOH-treated bagasse and molasses for X weeks. A third subgroup of 40 heifers (P-M8U) had been fed M8U supplement for four months during the dry season preceding the experiment. A fourth sub-group of 24 heifers (P-DL) had been fed dry lick supplements (based on salt, urea and CSM) for five months during their first dry season post-weaning, and 15-21 months before the present study commenced. The heifers were mated with 8 two-year-old bulls (5 for Mob P and 3 for Mob Q) from late January until mid-April.

The two mobs of heifers and bulls grazed two native pasture paddocks, designated CD.TY and EF.TY, each of approximately 500 ha. From the 31 January until the 18 April 1996 (Period 1) Mob P (the "mixed" mob) grazed CD.TY paddock, while Mob Q (the "supplement-naive" mob) grazed EF.TY paddock. On the 18 April 1996 the mobs of cattle were exchanged so that Mob Q grazed CD.TY paddock and Mob P grazed EF.TY paddock. Period 2 was from the 19 April 1995 to the 18 June 1996.

Dry lick supplements were fed to both mobs of cattle from the 28 February 1996 until the 18 April 1996 during Period 1, and from 17 May 1996 to 17 June 1996 during Period 2. The dry lick supplement fed during Period 1 consisted of salt (flossy fine feed grade) (67%) and kynophos (calcium phosphate) (33%). The dry lick supplement fed during Period 2 consisted of 33% CSM, 30% salt, 21% kynophos, 15% urea and 1% elemental sulphur.

Each mob was fed the dry lick supplements in a single 820 x 560 mm trough in an open-sided shelter shed near the permanent water. In EF.TY paddock this was the only water supply, but in CD.TY paddock water was also available from a creek until April 1996. Lithium marker mixed with the dry lick supplement fed on one day at the end of each period was used to measure intake of supplement by individual heifers.

Results

Ad libitum intake of supplement appeared to be similar for both the paddock groups of cattle and for both the paddocks. During the eight weeks of Period 1 intake increased from low levels during the first two weeks of feeding (3-8 g DM/head.d) to 25-33 g DM/head.d during week 7 (Table 1). This increase in intake may have been associated with either the changes in pasture as the season progressed, or with changes in the heifers such as increased experience of the supplements, or to a combination of pasture and animal factors. Intake of supplement during Period 2 (29-79 g DM/d; weeks 12-16) was higher than in Period 1. The dry lick supplement fed during Period 2 contained 33% cottonseed meal, and the higher intake may have been associated with higher palatability of this supplement than of the salt/kynophos mixture fed during Period 1, as well as the changes in pasture and longer experience of the cattle with such supplements. The intake of both the unlabelled and the lithium-labelled supplement during weeks 16 and 17 was lower than in the preceding weeks, probably due to rain at this time. Under both experimental conditions and on commercial properties intakes of dry lick supplements often decline abruptly with rain events, and then increase again gradually over several weeks.

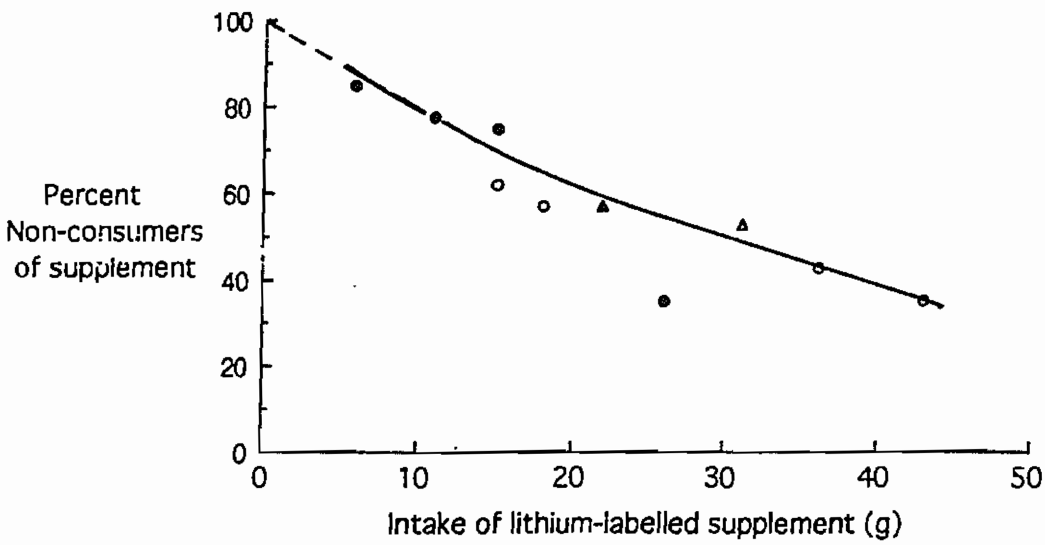


Figure 1. Relationship between the percent of non-consumers of supplement and intake of lithium-labelled supplement fed on one day to Mob P in Period 1 (○) and in Period 2 (●), or to Mob Q in Period 1 (△) and in Period 2 (▲).

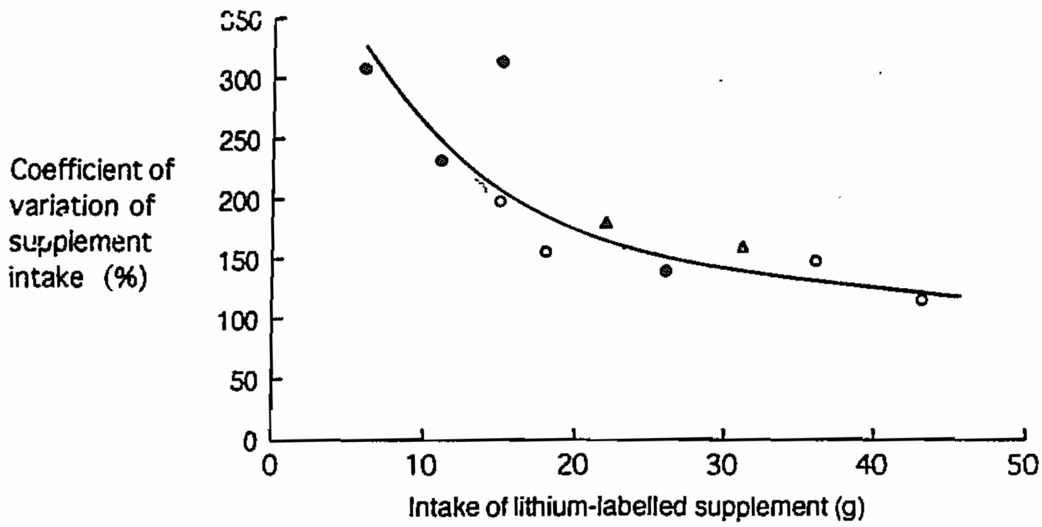


Figure 2. Relationship between the variation in supplement intake among all animals and the intake of lithium-labelled supplement fed on one day to Mob P in Period 1 (○) and in Period 2 (●), or to Mob Q in Period 1 (△) and in Period 2 (▲).

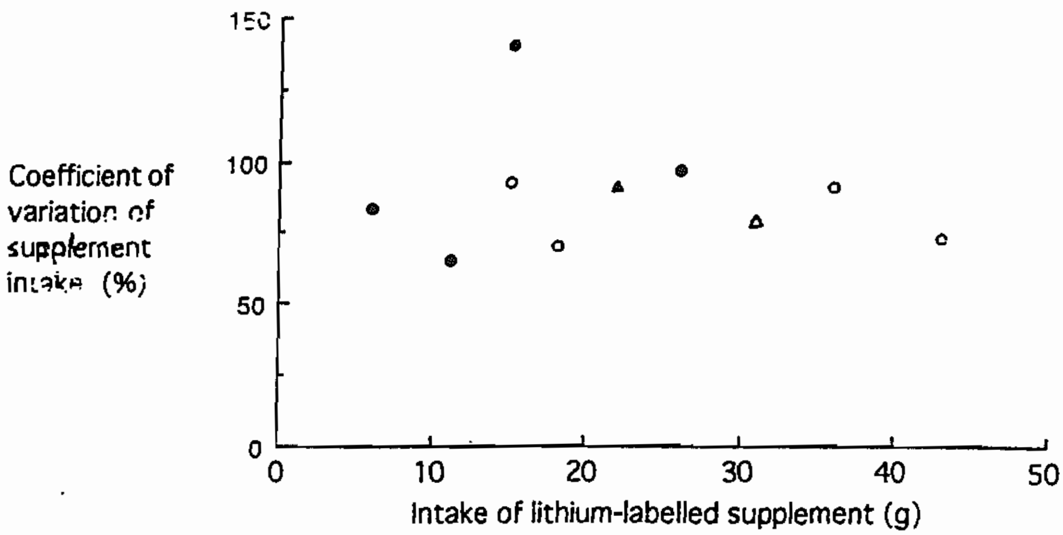


Figure 3. The variation in supplement intake among consumer animals and the intake of lithium-labelled supplement fed on one day to Mob P in Period 1 (○) and in Period 2 (●), or to Mob Q in Period 1 (△) and in Period 2 (▲). There was apparently no relationship between these variables.

Table 1. Intake of supplements (g DM/head.d) by the two paddock groups of heifers. Lithium-labelled supplements were fed for 10 h on one day during week 8 and week 17. (No supplements were fed from week 9 to week 11).

Intake	Mob P	Mob Q
Period 1	CD.TY paddock	EF.TY paddock
Week 1	7	6
2	3	8
3	12	12
4	20	19
5	23	19
6	24	21
7	25	33
Lithium labelled supplement	26	31
Period 2	EF.TY paddock	CD.TY paddock
Week 12	40	51
13	56	79
14	55	72
15	51	54
16	29	35
Lithium labelled supplement	13	22

When the cattle were considered as the two paddock groups the proportion of non-consumers of supplement (53 to 72%) and the variation amongst individuals in intake of lithium-labelled supplement (CoV 159 to 243%) appeared to be similar for the two groups of cattle and for the two periods (Table 2). However, within Mob P the supplementation history of the heifers influenced both intake of supplement and the proportion of non-consumers, and tended to influence the variation in supplement intake within groups. In both Period 1 and 2 heifers previously fed NaOH-treated bagasse-based diets (P-b/m) or dry lick supplement (P-DL) consumed more supplement. Also during Period 2 the proportion of P-DL heifers which were non-consumers (35%) was lower than for the other groups (75-85%). The proportion of non-consumers and the variability in supplement intake across all animals decreased with increasing supplement intake, and within this experiment the relationships tended to be curvilinear (Figures 1 and 2). The CoV of supplement intake among those animals which did consume supplement was in the range 65-141%, and was apparently not related to supplement intake (Figure 3).

Practical implications

The proportion of non-consumers of supplement, and the variation in supplement intakes were much larger in the present experiment than in other experiments where small groups of cattle grazing small paddocks were fed similar supplements. It appears that poor efficiency in utilisation of supplements due to non-consumption or a high variation in supplement intake is most likely to occur when average intakes of supplement per paddock group are low, such as less than 50 g/head.d.

Table 2. Liveweight, body condition score, intake and variation in intake of supplement measured using lithium-labelled supplement fed on two occasions to two paddock groups of cattle

Measurement		MOB P								MOB Q	
		Mean of all heifers	P-Nil	P-M8U	P-b/m	P-DL	Bulls	sem	Prob	Mean of all heifers	sem
n		129	46	40	20	23	5	-	-	87	-
LW	(18/4/96)	374	381[b]	367[a]	368[a]	377[ab]	487[c]	5.4	**	377	2.9
	(24/6/96)	382	388[bc]	374[a]	376[ab]	388[bc]	-	4.1	*	396	3.0
CS	(18/4/96)	5.8	5.8[bc]	5.8[bc]	5.7[b]	5.9[c]	5.2[a]	0.09	**	5.7	0.03
	(24/6/96)	6.3	6.3	6.2	6.3	6.5	-	0.08	ns	6.4	0.04
Supp intake (g/d)	(18/4/96)	26	18[ab]	15[a]	43[c]	36[bc]	60[d]	10.1	**	31	5.4
	(24/6/96)	13	11	6	15	26	-	5.7	ns	22	
Variation in supp intake (CoV%) (all cattle)	(18/4/96)	161	156	198	117	149	-	-	-†	159	-
	(24/6/96)	243	233	309	314	140	-	-	-†	181	-
Non-consumers of supp (%)	(18/4/96)	53	57	62	35	43	40	-	ns#	53	-
	(24/6/96)	72	78[b]	85[b]	75[b]	35[a]	-	-	**#	57	-
Variation in supp intake (CoV%) (consumer cattle only)	(18/4/96)	85	70	93	73	91	-	-	†	80	-
	(24/6/96)	97	65	84	141	97	-	-	-†	91	-

Treatments were compared using the chi-square test
† No statistical comparisons were possible

Supplement delivery systems - Experiment 8

Training weaners to consume dry lick supplements. SWN-B815

Rob Dixon, Carol Petherick, Dave Smith and Bev Gelling

Summary

1. Calves were exposed to a palatable supplement before weaning and/or at weaning in the yards and the effects on intake of palatable or unpalatable supplements later in life were examined.

2. The animals exposed to a palatable cottonseed meal (CSM) based supplement in the paddock before weaning ate the same supplement more readily when in the yards at weaning. However, the difference was small and probably not of practical importance.

3. After weaning and while grazing native pasture in June, calves previously exposed to the palatable CSM-based supplement ate it a little more readily than those calves with no previous exposure. However, as observed earlier in the yards at weaning, the difference due to the previous exposure was small. A marker was included in one meal of this CSM-based supplement, and the appearance of the marker in blood used to estimate how much supplement individual animals actually consumed. The variation in intake of supplement was reduced by exposure of the animals to supplement either pre-weaning or in the yards at weaning, and was halved by exposure of the animals at both of these times.

4. After three weeks of supplementation in the paddock with the palatable CSM-based supplement, all weaners were changed (cautiously, and over several weeks) to an unpalatable dry lick supplement containing 30% urea. Intake of dry lick supplement over 16 weeks from July to October was satisfactory, and averaged 100 g/weaner/day. Exposure to the same palatable supplement in the paddock for 1 month after weaning was apparently effective training of the weaner to eat dry lick supplement. Intake of dry lick was not affected by the previous exposure to the palatable supplement before weaning or in the yards at weaning. Marker was included in dry lick supplement after 4 and 9 weeks. Variation among individuals in supplement intake was much greater with the dry lick than observed previously with the CSM-based supplement, but was not affected by early exposure of the animals to supplement.

Introduction

When unpalatable supplements such as high-urea dry licks or blocks are fed, a substantial proportion (eg. up to 20-40%) of the mob may be "shy feeders" and consume negligible amounts of supplement. Also, among those cattle that do eat supplement, supplement intake can vary widely between individuals from low levels to perhaps 5 times the average intake for the mob. This unequal intake of supplement leads to inefficient supplement use.

It is likely that experience in early life and hence behaviour learnt by the young animal will influence whether cattle consume adequate amounts of less palatable supplements.

The following experiment is the first of a series to develop management procedures intended to reduce the proportion of "shy supplement feeders" in the mob, to reduce the variation in intake of supplements among individual animals in the mob, and to achieve target intakes of less palatable supplements.

Experimental details

One hundred and twenty-one Brahman crossbred calves from the Swan's Lagoon herd were used. As part of another experiment three of six paddock groups (each paddock group consisting of 20-25 cows and calves) were supplemented with 3 kg/d of a palatable cottonseed meal (CSM)-based supplement (2.0:0.8:0.2, CSM: sorghum grain: Megalac rumen inert fat plus minerals) from mid-January 1994 until early March 1994. In mid-January the calves ranged in age from newborn to 11 weeks of age.

The calves were weaned in May 1994. They were divided into 12 yards, the group from each of the six paddocks being divided into two. During Phase 1 of 13 days all calves were fed hay ad lib, and half the calves (6 of the 12 pens) were also fed daily 0.5 kg/d of the palatable CSM-based supplement. Of the 6 pen groups fed supplements, 3 were from paddocks which had been fed supplements pre-weaning, and 3 had no exposure to supplements pre-weaning. At the end of the 13 day weaning phase the groups of calves were transferred to 12 x 18 ha experimental paddocks of native pasture with a heavy body of senesced pasture on offer. During Phase 2 for 24 days (June 94) all paddocks were fed (2 x week) an allocation of palatable CSM-based supplement equivalent to 0.35 kg/calf/day. At the end of this 24 day period the weaners were fed a meal of the CSM-based supplement containing lithium salts as a marker of intakes of supplement by individual animals. The weaners were mustered, weighed and blood sampled the following day, and the concentrations of lithium in blood used to calculate the intakes of supplement by individual animals.

Table 1. Sequence of treatments imposed on the animals

Pre-weaning	Phase 1 In yards at weaning	Phase 2 3 weeks in paddock	Phase 3 16 weeks in paddock
No supplement	No supplement Supplement	Supplement	Dry lick
Supplement	No supplement Supplement	Supplement	Dry lick

For Phase 3, the supplement was changed to a dry lick. This was done carefully and gradually over several weeks, to avoid the possibility that calves accustomed to eating rapidly a palatable supplement would eat too much of a high-urea dry lick and suffer urea toxicity. Specifically, the calves were fed small amounts of CSM/salt (50:50) or later CSM/salt/kynophos/S (50:34:15:1) for 2 weeks. Five and then ten percent urea was introduced in week 3. A high urea dry lick mix (CSM:salt:kynophos:S:urea, 15:38:15:1:30) was fed ad lib from week 4). No mortalities occurred. This high-urea dry lick supplement was fed for 16 weeks. Lithium marker was mixed with the dry lick fed after 5 weeks and 9 weeks, and intake of supplement by in dividual animals measured as described above.

Results

Calves from paddock groups which had been fed supplements pre-weaning in January-March 94 were 11 kg heavier at weaning, due, presumably, to both the greater milk production of the cows and intake of some supplement by the calves. Calves exposed to supplements in January-March 94 rapidly consumed palatable CSM-based supplement in the pens immediately it was offered, whereas those that had no previous experience of supplements took 2-3 days to learn to eat and consume all the allocated amount. However, there was no effect of providing supplements or previous exposure to supplements on the LW gain of the calves during the 13 day weaning phase.

When the weaners were moved to the paddocks, those groups which had had no experience of the palatable CSM-based supplement either in the paddock with their mothers or in pens at weaning were slower to start consuming their CSM-based supplements, but within a week of offering the new regime weaners consumed all of the allocated supplement.

Table 2. The effect of exposure of calves to supplements before weaning or for 13 days after weaning on subsequent intake of concentrate or dry lick supplements in the paddock after weaning

Measurement	No supplements before weaning		Plus supplements before weaning		sem	Significance		
	No supp at weaning T1	Plus supp at weaning T2	No supp at weaning T3	Plus supp at weaning T4		Pre-W	In pens	Int
Intake of dry lick supplement (g DM/d)								
Week 1-3	105	120	96	105	15.3	ns	ns	ns
Week 4-15	90	103	94	112	13.0	ns	ns	ns
Liveweight (kg)								
Weaning	180	178	189	191	2.5	**	-	-
End of Phase 1	182	181	189	193	3.3	*	ns	ns
End of Phase 2	175	175	183	188	4.2	*	ns	ns
End of Phase 3	171	174	185	182	4.7	*	ns	ns

The frequency distribution of individual intakes of concentrate supplement measured using the lithium marked supplement is shown in Figure 1. The variation in supplement intake among the animals tended to be greater for weaners which were not exposed to supplements either pre-weaning or in the feedlot (T1, CoV 42%) than for weaners which had been exposed at one of these intervals (T2 and T3, CoV 29 and 32% respectively). The lowest variation was observed with weaners which had been exposed both pre-weaning and in the feedlot (T4, CoV 23%). Intake of supplement by individual weaners was correlated ($P<0.001$) with the LW of the weaners, and was described by the equation $Y = 239 + 5.5 X$, ($r = 0.32$, $n = 117$), where Y was the intake of supplement (g/d) and X was the LW of the weaners (kg).

Intake of dry lick supplement on a paddock basis was on average 100 g per weaner per day, and did not differ due to the previous history of exposure to supplements. Variation among individual animals in intake of dry lick supplement, measured using the lithium-marked supplement, was not affected by the previous histories of exposure to supplements. The coefficient of variation (CoV) of distribution of supplements for all animals was 69%, and the frequency distribution is shown in Figure 2.

The weaners lost LW, and on average lost 38 g/d or 6.6 kg from weaning until the end of the period when dry licks were fed (Table 1). Previous treatments did not affect the rate of LW loss, and the higher weaning LW associated with pre-weaning supplementation was maintained through to the end of the experiment.

FIGURE 1. Frequency distribution of intake of concentrate supplement for all weaners at the end of Phase 2. Each category represents a 100 g increment in intake (ie category 10 represents the weaners which consumed 900-1000 g supplement per meal).

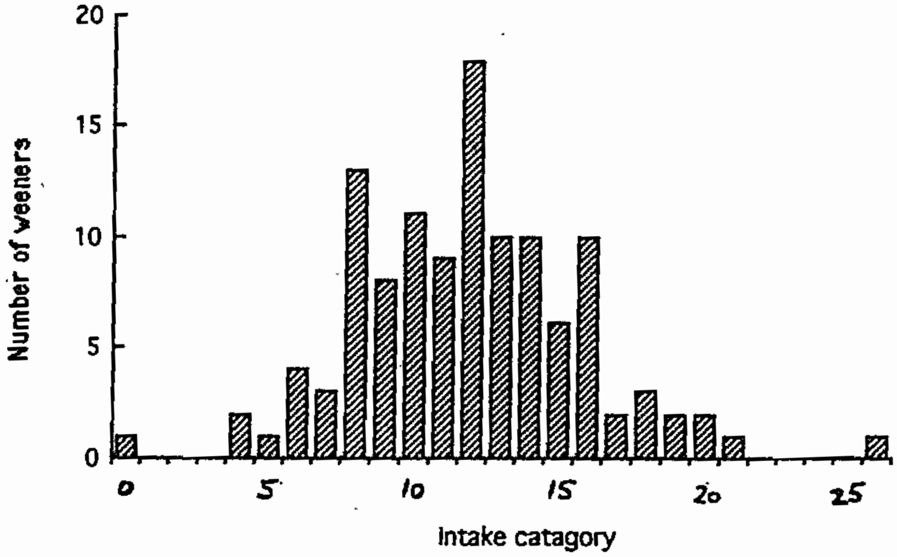
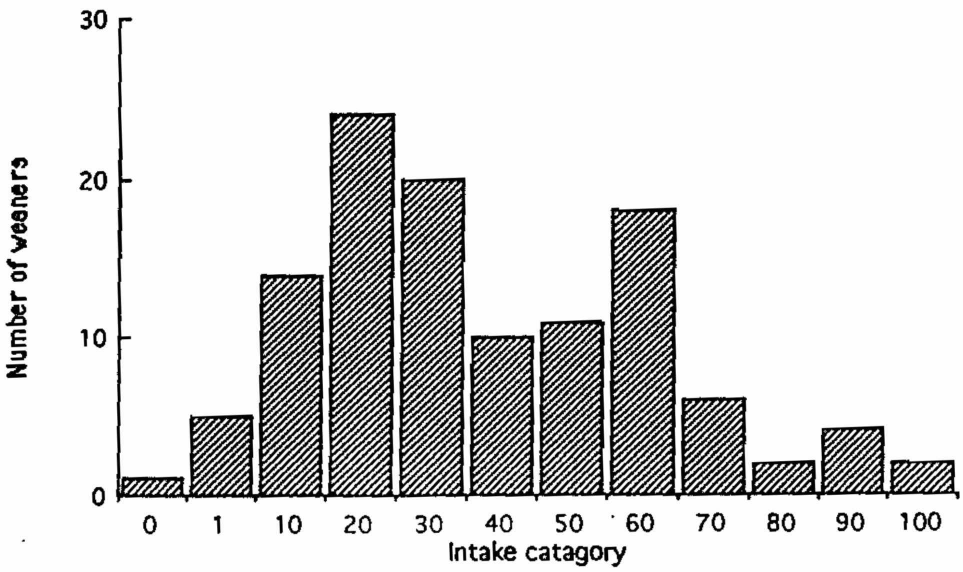


FIGURE 2. Frequency distribution of intake of dry lick supplement for all weaners measured on two occasions during Phase 3. The zero category represents non-consumers of supplement, and each other category represents a 10 g increment in intake (ie category 30 represents the weaners which consumed 20-30 g supplement per day).



Discussion

Previous exposure of the weaners to the concentrate supplement improved their acceptance of the same supplement both during Phase 1 in the feedlot following weaning, and during Phase 2 in the paddock. This is in agreement with observations in sheep that early exposure to a block, cereal grain or protein supplement improved subsequent acceptance of the same or a similar supplement. However in the present study, both in the feedlot and in the paddock, the groups of weaners without previous experience of the concentrate supplement also consumed virtually all of this supplement within four days of its introduction. The important effect of previous exposure to the concentrate supplement was to reduce the variability of supplement intake within groups of weaners, even after all weaners had been fed the supplements for 3 weeks during Phase 2. The coefficient of variation of supplement intake was reduced from 42% in weaners exposed to concentrate supplement only during Phase 2, to 23% in weaners which had been exposed to the supplements for seven weeks pre-weaning and two weeks in the feedlot post-weaning. The effects of exposure for these times pre-weaning and post-weaning were apparently similar and additive; variation in intake of weaners exposed at either of these times was intermediate between groups given no exposure or exposure at both times.

A number of factors probably contributed to the ready acceptance by these weaners of the concentrate supplement. Firstly, the supplement, based on CSM and sorghum grain, was one which would usually be readily accepted by experienced animals. Secondly the sorghum hay roughage available in the feedlot, and the dry season pasture available in the paddock, were of low quality, and voluntary intake was probably low. It has been clearly shown that intake of low palatability supplements consisting of salt-CSM mixtures is inversely related to roughage intake. In the present study the low quality of the available roughage probably contributed to the ready acceptance of the concentrate supplement. Thirdly the animals used in this experiment had all had experience both pre-weaning and during the experiment of drinking water from troughs, and during Phase 1 had exposure to empty feed bunks and the opportunity to see other weaners eating supplement from troughs. Exposure of lambs to empty feed troughs has been shown to increase subsequent acceptance of supplements fed in troughs. Also the animals in the present experiment had had considerable pre-weaning exposure to stockmen and vehicles during frequent paddock inspections, had been mustered and handled five or six times through yards before weaning, and were from a herd selected for quiet temperament.

When all weaners were fed dry lick supplement *ad libitum* in the paddock during Phase 3, no effects of previous experience of concentrate supplements were detected in terms of either intake of supplement per paddock group or distribution of intakes of supplement among individual animals in the groups. Group intakes of supplement, which averaged 100 g per head per day, provided amounts of supplementary urea which were very similar to the intended target intake of 30 g urea per head per day. However the variation in intake of dry lick supplement (CoV 69%) was much larger than for the concentrate supplement during Phase 2.

Previous experiments and observations at Swan's Lagoon Research Station and numerous observations by producers, indicate that it is often difficult to obtain target intakes of dry lick mixtures based on salt, urea and calcium phosphates by mobs of cattle. This is particularly a problem during the wet season and the early dry season before pasture quality declines severely. Furthermore even if mean intake of supplement by the mob is satisfactory, measurements of intakes of molasses-urea or block supplements by individual animals indicate wide variability within most mobs and in some situations a substantial proportion of cattle which do not eat supplements at all. Estimates of the proportion of non-consumers in mobs of cattle fed dry lick or block supplements under extensive grazing conditions in northern Australia have ranged from 3% to 40%. Age and previous experience of animals to supplements seem to be at least two of the important factors determining the proportion of non-consumers.

In the present study there were satisfactory intakes per paddock of dry lick supplement, and only a very low proportion of the weaners were non-consumers of dry lick supplement. There seem to be two likely explanations for these satisfactory intakes when in many other situations intake per paddock has been lower than required. Firstly in the present study all the weaners were fed the concentrate supplement for 3 weeks during Phase 2, and the majority of the weaners were also fed the concentrate supplement either pre-weaning and/or in the feedlot. This exposure to concentrate supplement probably provided an effective training period for the weaners to subsequently consume the dry lick supplement. Secondly, the dry lick supplement contained 150 g/kg CSM. This amount of CSM may have been sufficient to improve the palatability of the dry lick supplement, and to enhance intake. There is evidence from sheep that the flavour and attractiveness of a dry lick type supplement has an important effect on the proportion of animals in the group which are non-consumers of supplement. Twenty-six percent of a flock of sheep were non-consumers of a mineral mixture containing only sodium and potassium chlorides, but no non-consumers were observed when the mineral mixture contained some molasses as an attractant.

Practical implications

The results suggest that providing a palatable supplement before weaning or in the yards at weaning reduced the variability of intake of palatable supplements in the paddock after weaning. Providing the palatable supplement during and for several weeks after weaning may have contributed to later acceptance and satisfactory intakes by the weaners of an unpalatable high-urea dry lick. No mortalities due to excess intake of urea occurred when the change-over from the palatable supplement to the dry lick supplement was done carefully and cautiously over several weeks. When weaners were exposed to the palatable supplement for one month after weaning, there was apparently no additional benefit from exposure to palatable supplement at 2-4 months of age before weaning, or during weaning in the yards.

Supplement delivery systems - Experiment 9

Further studies on the training of weaners to consume dry lick supplements - SWN-B822A

Rob Dixon, Ian Porch and Carol Petherick

Summary

1. Calves were exposed to various procedures pre-weaning, during a 20 day weaning phase in the yards, or for 37 days in the paddock after weaning through the yards to identify procedures to increase intake of low palatability dry lick supplements during the dry season. Procedures involved exposure to humans and to a variety of concentrate supplements in the yards, or provision of a palatable CSM supplement in the paddock.

2. None of the procedures examined had long-term effects on intake of dry lick supplements. Feeding CSM did increase intake of dry lick supplement by 59% for two weeks, but the effect then disappeared.

3. Lithium marker measurements indicated low variability in the mob in intake of the CSM supplement (CoV 24%), but a much higher variability in intake of dry lick supplement (CoV 70-86%) irrespective of previous training.

Introduction

A previous experiment (SWN-B815) showed that although exposure of calves to a palatable concentrate supplement reduced variability of intake of this supplement, it did not affect variability in intake of a low palatability dry lick supplement.

The present experiment examined a number of procedures for training calves, while held in the yards for weaning, on subsequent intake, and variability in intake, of low palatability dry lick supplement.

Experimental details

Brahman x Shorthorn cross calves (120) from the Swan's Lagoon herd weaned at first-round muster were used. Most (100) of these calves were from the Expedition herd and had not been handled before weaning. The remaining 20 calves were from an experimental group, and had been mustered and handled through yards six times before weaning. Six treatments were used during, or shortly after, a 20 day weaning phase through the yards:

- T1, Fed hay only in the yards with minimum exposure to humans.
- T2, Fed hay only in the yards and with a high level of exposure to humans.
- T3, Fed hay and concentrate supplements in the yards and with minimum exposure to humans.
- T4, Fed hay and concentrate supplements in the yards and with a high level of exposure to humans.
- T5, Fed hay only in the yards and with minimum exposure to humans (ie same as T1 in the yards), then fed palatable CSM supplement in the paddock for 37 days.
- T6, Fed hay only in the yards with minimum exposure to humans (i.e. same as T1 in the yards, but a high level of exposure to humans pre-weaning.

The 100 calves from the Expedition herd were used for T1-T5, and the calves from the experimental group for T6.

During the 20 day weaning phase the calves were held in the yards in four groups consisting of calves in T2, T3 and T4, and a combined group of T1, T5 and T6. For minimum exposure to humans calves were held in yards 3 km from frequent human activity, and were exposed to humans for about 30 minutes each day for routine feeding and checking. These calves were 'tailed' three times, each for approximately 2 hours. For the high level of exposure to humans the calves were "handled" by stockmen nine times, each time for about 15 minutes. This handling consisted of standing quietly in the yards with the calves until they had settled down, and then walking quietly through the mob. Also these yards were close to a frequently used road, and other cattle were worked on several occasions in another part of the yards. These calves were 'tailed' on four occasions.

Lucerne hay was fed *ad libitum* to all groups of calves, on the ground for treatments T1, T2, T5 and T6, and in hay feeders for treatments T3 and T4. These two latter treatments were also fed various concentrate supplements *ad libitum* (sorghum grain and CSM (800:200), sorghum grain, CSM and salt (760:190:50) and molasses, urea and CSM (907:3:90)).

Following this weaning phase groups of 10 weaners were grazed in 18 ha paddocks. Treatments T1-T4 and T6 were fed dry lick supplement *ad libitum.* The dry lick consisted of (g/kg) salt 370, urea 300, CSM 150, kynophos 150 and elemental sulphur 30. Treatment T5 were fed the equivalent of 350 g CSM per head per day in two equal meals twice each week. After 35 days of supplementation, lithium marker was mixed with the supplement and used to measure variability of supplement intake. Following this measurement the T5 weaners were fed dry lick instead of CSM. Variability of supplement intake was again measured in mid-August.

Table 1. Intake and variation in supplement intake. (Treatment T5 was fed CSM from Week 1-6, and dry lick from Week 6-12. All other treatments were fed dry lick from Week 1-12).

Measurement	T1	T2	T3	T4	T5	T6	Signif
Intake (g/d)							
Week 1-3	51	29	32	34	120	46	ns
Week 4-6	44^{a}	38^{a}	43^{a}	35^{a}	350^{b}	42^{2a}	***
Week 7	46^{a}	54^{a}	57^{a}	46^{a}	80^{b}	49^{a}	*
Week 8	64^{a}	75^{a}	74^{a}	73^{a}	113^{b}	70^{a}	**
Week 9	63	74	71	59	52	53	ns
Week 10	62	61	66	61	55	57	ns
Week 12	51^{b}	69^{c}	40^{ab}	41^{ab}	47^{ab}	33^{a}	*
CoV (CSM)	-	-	-	-	24	-	
CoV (DL)	79	70	57	68	73	86	ns

Results

The high level of exposure of the calves to stockmen and human activity had an appreciable effect on the behaviour of the calves by the end of the weaning phase in the yards. These calves were quieter and showed less fear of stockman.

All groups of weaners consumed dry lick supplement during the first week it was offered in the paddock. Intake of dry lick averaged 39 g/head per day during the first six weeks providing 12 g urea per day (Table 1). Intake of dry lick supplement was not affected by previous exposure of the weaners to supplements, or to the varying levels of handling or exposure to human activity pre-weaning (T5) or in the yards during weaning (T1-T4).

Feeding CSM in the paddock for 37 days following weaning in the yards had several effects. Firstly, the variation within the mob in intake of CSM was much lower (CoV 24%) for the CSM than for the dry lick supplement (CoV 72%). This was clearly an effect of the type of supplement, since when the same group of weaners were later fed dry lick supplement the variability was similar to that for the other treatment groups. Secondly, the weaners adapted to consume their allocation of CSM more slowly than for dry lick supplement. No CSM was consumed during the first week it was offered, and all of the CSM was not consumed until Week 4. Thirdly, providing the CSM supplement had a short-term effect during weeks 7 and 8 to increase by 59% the intake of dry lick supplement. However, dry lick intake was similar to the other treatments from weeks 9-12. Presumably the animals consumed more of the dry lick initially because they were accustomed to eating the palatable CSM, but this effect disappeared within several weeks.

Practical implications

Intake of low palatability dry lick supplements by weaner cattle during the dry season was not affected by training of the calves or by providing concentrate supplements during weaning in the yards, or by frequent handling of the calves pre-weaning. Providing a palatable concentrate supplement in the paddock after the weaners had been turned out to graze did cause a short-term increase in intake of dry lick supplement, but had no effect in the long term.

Under the conditions of the experiment training of weaners in the yards did not have much effect on acceptance and intake of dry lick supplements. However, these effects may still be important in the commercial property situation with cattle of different temperament and large paddocks.

Supplement delivery systems - Experiment 10

Effect of early exposure as weaners on subsequent intake of dry lick supplement by 3-year-old steers - SWN-B842

Rob Dixon, Peter Fry, Adrian White and Carol Petherick

Summary

1. Forty No. 4 steers were either not supplemented or fed a high urea dry lick supplement for five months post-weaning in 1994. Subsequently all of the steers were fed a dry lick supplement from February to July 1997 when they were 3.0- 3.5 years of age.

2. Intake of dry lick supplement by the 3-year-old steers was not affected by whether they had been fed dry lick supplement for five months post-weaning.

Introduction

There is considerable evidence from experimental trials with both cattle and other species, and from producer anecdotes, that one of the factors influencing acceptance of supplements by cattle is the extent to which they have had previous experience of the same or similar supplements and of feed troughs.

The present trial was undertaken to determine whether feeding a urea-based dry lick supplement to cattle during their first dry season after weaning influenced the extent to which they consumed a similar dry lick supplement as adult cattle.

Experimental details

Brahman x Shorthorn steers from the Swan's Lagoon herd which had been weaned at the first-round muster in 1994 were used for the experiment. In July 1994, 40 of these steers were allocated to 8 paddock groups (5 per paddock group) and each of these groups was grazed with 25 breeders (19 heifers in their first pregnancy and 6 cows in their second pregnancy) in a 100 ha paddock of native pasture. Four of the paddock groups were fed *ad libitum* from July to November 1994 a dry lick supplement containing 31.8% cottonseed meal, 27.3% urea, 18.2% of salt, 13.6% kynophos and 9.1% ammonium sulphate. Intake of supplement averaged 175 g DM/head.day. The other four groups were not fed measurements of intake of supplement by individual animals using lithium marker mixed with the supplement indicated that intake of supplement by the steers was approximately 50% of that of the heifers and cows, and that all the steers in supplemented paddocks consumed at least some supplement.

From November 1994 until February 1997 the steers grazed native pastures and did not have access to any supplements. However, often water was available only from troughs.

In February 1997 the steers were re-allocated to the 8 paddock groups in which they had grazed in 1994 and these groups grazed in 8 x 40 ha paddocks. Pasture available consisted of predominantly native species, and the paddocks had been fertilized with superphosphate some 10 years previously. For 20 weeks from 3 March 1997 to 22 July 1997 all paddock groups were fed *ad libitum* a dry lick supplement containing 44.8% salt, 31.3% kynophos, 22.4% urea and 1.5% elemental sulphur. Fresh supplement was offered and supplement residues were collected weekly. Dry matter contents of offered and refused supplements were determined to measure supplement intake. The supplement was fed in open-sided sheds (3 m x 3 m roof) which provided limited protection of the supplement from rain. Liveweight and body condition score of the steers was measured at the beginning and end of the supplementation period.

Results

The steers were on average 451 kg LW and CS 5.8 on 20 February 1997 at the beginning of the supplementation phase, and 587 kg LW and CS 6.0 on 24 July 1997 at the end of the supplementation phase. Hence the steers gained 136 kg liveweight/d through this 5 month period.

Intake of supplements (Figure 1) was apparently not affected by the exposure of the steers to supplement when they were weaners. Intakes increased gradually to 70 g/head.d at week 8, and then declined sharply from weeks 8-11. This decrease, and the fluctuations during subsequent weeks, were probably due primarily to 24 mm rain during week 7, 8 mm rain during week 9 and 45 mm rain during week 15. Decreases in intake of low palatability supplements during and shortly after rain have often been observed in other trials on Swan's Lagoon as well as being reported in anecdotes from producers.

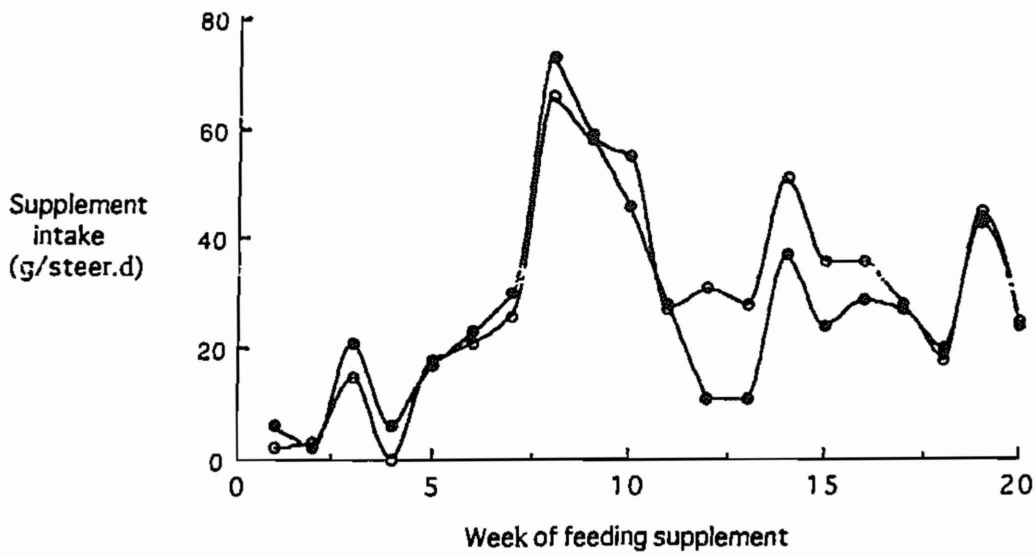


Figure 1. Intake of dry lick supplement (g DM/head.d) by 3-year-old steers which either had little previous exposure to supplements (o) or which had been previously fed dry lick supplement for five months post-weaning (●).

Practical implications

This trial suggests that exposure of cattle to low palatability dry lick supplements during their first dry season post-weaning has little effect on the extent to which they consume similar supplements when they are adult cattle. However the cattle used in the present study were generally of quiet temperament and had been exposed to water troughs and to supplement in yards for 10-14 days when they were weaned. These factors may have improved their acceptance of low palatability dry lick supplements. This trial does not exclude the possibility that early exposure to supplements may improve acceptance of supplements by cattle with little experience of stockmen and to supplement

Preliminary observations on intake of wet licks containing molasses and high levels of urea and phosphoric acid. SWN-B813-D.

Rob Dixon and Ian Porch

Summary

When dry breeders were offered *ad libitum* in open troughs a wet lick mixture, M-50U-25PA (consisting of 100 kg molasses, 50 kg urea, 50 kg water and 25 kg food grade phosphoric acid) they consumed 150 g/d which provided 33 g urea and 4 g P. No urea toxicity or other animal health problems were observed.

Wet lick mixtures based on molasses and containing high levels of urea and phosphoric acid seem promising to provide urea N and P as strategic supplements. However more work, particularly to evaluate risk of urea toxicity, is required before such wet lick mixtures can be recommended for use by producers.

Introduction

Dry licks and blocks are obviously extensively used to provide urea N and P supplements. However one problem is that intake, particularly under wet season pasture conditions, is often too low to provide required target amounts of urea and P. Roller drum systems usually give better control of intake, but both capital and operating costs are high. Intakes of M8U and M12U are too high for these supplements to be used strategically to reduce liveweight loss, and also a P source may also be needed.

Experiments in the 1950's (Beames 1960; Proc. ASAP 3: 86-92.) showed that molasses/urea mixtures containing up to M50U could be fed without mortalities, at least in small paddock situations. Intake of urea tended to remain constant as urea concentration was increased from M8U to M50U, but the amount of urea consumed is much more than the animal can utilise effectively. It is also known that acids, such as hydrochloric or phosphoric reduce feed intake, including *ad libitum* intakes of molasses-urea type mixtures (Lindsay *et al.* 1983; In 1983 Swan's Lagoon Annual Report.).

It may be possible to use urea, phosphoric acid or other compounds to reduce palatability of molasses mixtures sufficiently to obtain low (eg. 50-200 g/d) *ad libitum* intakes of molasses-based supplements. If so then it may be possible to develop wet lick systems similar to dry lick systems or blocks to provide urea N and/or P. Hence our objective is to develop a wet lick providing urea N and P supplements which can be fed *ad libitum* in open troughs, and were the supplement intake is controlled by the adverse flavours of the high concentrations of urea and acid.

Experimental details

Ten No. 1 and ten No. 2 breeders were allocated by stratified randomization based or age and body condition score to two 100 ha native pasture paddocks. The cows were 2-3 months pregnant, had been fed dry lick supplements during the previous twelve months, and had recently had their calves weaned. Cows were allocated to the paddocks on the 11 May 1995, and various supplements were fed from the 26 May 1995 until 16 June 1995.

Table 1. Wet lick mixtures containing molasses (M), urea (U) and phosphoric acid (PA) fed during the trial. Intakes of wet lick, urea and P are also given.

Mixture	Proportion of mixture		Ad lib intake	Ad lib intake of:	
	Urea (%)	PA (%)	(g/head/day)	Urea (g/d)	P (g/d)
M-12U-14PA	9.52	11.11	>500	>48	>14
M-12U-18PA	9.23	13.85	>500	>46	>18
M-20U-20PA	12.5	12.5	>500	>63	>16
M-30U-20PA	16.7	11.1	>500	>84	>14
M-40U-25PA	19.5	12.2	300	59	10
M-50U-25PA	22.2	11.1	150	33	4

A series of mixtures of molasses, urea and phosphoric acid as shown in Table 1 were fed, the mixture being change twice each week. The mixture M-50U-25PA means that 50 kg urea (U) was dissolved in 50 kg hot water and mechanically mixed with 25 kg phosphoric acid (PA) and 100 kg molasses. The phosphoric acid consisted of food grade orthophosphoric acid containing 26 kg P per 100 kg acid.

The amount of molasses remaining was measured when the new batch of molasses was fed twice weekly. Thus if all of the offered molasses mixture had been consumed when the next batch was fed, intake per day was not known but was more than 500 g per head per day.

Results

The intake of each of the wet lick mixtures, and the amounts of urea and P this supplement would have provided, are shown in Table 1. When the wet lick mixtures contained up to 17% urea plus 11% phosphoric acid (M-30U-20PA), intake of the mixture (>500 g/d) was much greater than the target intake of 50-200 g/d.

Intake of wet lick was reduced to 300 and 150 g/d when urea concentrations were 20% or 22% and phosphoric acid were increased (M-40U-25PA or M-50U-25PA) respectively. The latter mixture provided about 33 g urea and 4 g P per day, within the target range needed to supply the urea N and P requirements of breeders grazing pasture deficient in N and P.

No animal health problems were observed during the trial. However urea toxicity problems may occur if animals are hungry when the wet lick is fed, or if rain water sits on the wet mix mixture and cattle can drink a concentrated solution of urea.

Practical implications

We do not have sufficient experience with these wet lick mixtures, particularly in relation to their safety, to be able to recommend whether they are suitable for use in a commercial property situation. However the technology appears promising and we intend to continue developing molasses-based wet licks with minimum amounts of molasses, as an option to provide urea N and P.

Supplement delivery systems - Experiment 12

Distribution of intake of a molasses/urea/phosphoric acid supplement in a mob of cows and calves. SWN-B813-E

Rob Dixon, Adrian White, Ian Porch and Dave Smith

Summary

1. A mob of 133 breeder cows (consisting of 85 wet mature cows, 11 dry mature cows and 23 heifers), 90 calves and 4 bulls grazed a 500 ha paddock and were fed a supplement based on molasses, urea and phosphoric acid. Intake of supplement by individual animals was measured using lithium marker mixed with the supplement.

2. Wet cows consumed more supplement than dry cows (0.33 *vs* 0.15 g/kg LW respectively), and a lower percentage of wet cows were non-consumers of supplement (38% *vs* 62%).

3. Age of the animals influenced intake, but not the percent non-consumers or variability of intake of supplement. Old cows, heifers and suckling calves consumed 0.15-0.20 g supplement/kg LW, while cows 3 to 6 years of age consumed 0.34-0.36 g supplement/kg LW. Most of the calves which consumed supplements were the progeny of cows which consumed supplements.

4. The results indicate that the percent non-consumers and the variability of supplement intake were high for the molasses-urea-phosphoric acid supplement which was used.

Introduction

Previous experiments during DAQ.098 have indicated that the proportion of non-consumers of supplement and the variability of supplement intake among individual animals is high when cattle consume dry lick supplements, and particularly when average voluntary intakes of such supplement is low. However the proportion of non-consumers has been negligible and the variability low (e.g. CoV 20-40%) when molasses-based supplements such as M8U or M15U have been fed.

In the present trial the palatability of a molasses-based supplement was reduced by adding phosphoric acid to the mixture, and the variability of supplement intake measured to determine whether the low variability previously observed with molasses-based supplements is a characteristic of all molasses-based supplements, or whether it was due in previous experiments to the higher voluntary intake of these supplements than of dry licks.

Experimental details

A mob of 133 mixed-age breeder cows and 95 calves were fed *ad libitum* in open troughs wet lick supplements based on molasses, urea and phosphoric acid. The molasses was fed in three 100 litre 560 mm diameter drums placed together under a shelter shed and sited near the only water point in the paddock. Commencing on the 4 April 1995 the cattle were offered M-8U-22PA (100 kg molasses, 8 kg urea and 22 kg phosphoric acid) supplement. Then from the 20 April the cattle were offered M-12U-12PA, and after two weeks lithium marker was mixed with the supplement to measure intake of supplement by individual animals.

Table 1. Liveweight, body condition score, intake and variation in intake of supplement measured using lithium-labelled supplement fed on 3 May 1995

Group of cattle	n	LW	CS	Supplement intake		% non-consumers	Co V (g/d)		Co V (g/kg/LW)	
				g/d	g/kg LW		All cattle	Consumer cattle	All cattle	Consumer cattle
All cows	120	488	6.7	133	0.28	44	170	109	176	113
Lactational groups of cows										
- wet cows	85	492	6.6	161[b]	0.33[b]	38[a]	156	109	160	112
- dry cows	34	478	7.9	65[a]	0.15[a]	62[b]	192	95	203	99
Age groups of cattle										
- 7 y.o. cows	28	586	6.6	97	0.18[a]	46	185	118	185	118
- 4-6 y.o. cows	40	511	6.4	172	0.34[b]	30	123	87	125	89
- 3 y.o. cows	29	417	6.1	155	0.36[b]	48	205	132	203	130
- 2 y.o. heifers	23	420	7.9	80	0.20[a]	61	181	83	184	86
- calves (suckling)	90	172	-	28	0.15[a]	52	197	116	191	111
Bulls	4	604	7.0	-	-	50	-	-	-	-

Table 2. The numbers and percentages (in parenthesis) of calves which consumed supplements classified according to whether their dam consumed supplements, and intake and variability of intake by calves

Measurement	Lactating cows	
	Consumers (n=50)	Non-consumers (n=28)
Number of non-consumer calves	15 (19%)	24 (31%)
Number of consumer calves	35 (45%)	4 (5%)
Supplement intake by calf (g/d)	67	26
Co V of supplement intake by calf	105	184

Co V based on supplement intake calculated as g/d.

Results

If it is assumed that calves consumed negligible supplement, average intake by adult cattle of the M-8U-22PA was 58 g per head per day of the wet mixture. Similarly average intake by adult cattle of M-12U-12PA was 174 g per head per day of the wet mixture. Hence the breeders consumed 4 g urea and 3 g P per head per day of the first supplement, and 12 g urea and 4 g P per head per day of the second supplement. These intakes were much lower than would be expected for M8U or M12U even during the transition season when the supplements were fed. Hence it appears that inclusion of the phosphoric acid in the molasses supplement was effective to restrict voluntary intake.

The supplement intakes, percentage of non-consumers of supplement and the variability of supplement intake are shown in Table 1. Wet (ie. lactating) cows consumed more supplement than dry cows (0.33 versus 0.15 g/kg LW). Also a lower proportion of wet cows were non-consumers of supplement (38% versus 62%), but the variability in intake of supplement among the consumer animals was similar for these two classes of cattle.

The age of the animals influenced how much supplement they consumed, although there were no significant effects on the proportion of non-consumers of supplement or the variability of supplement intake. Old cows (7 years of age), heifers pregnant with their first calf and suckling calves had, per unit of liveweight, similar intakes of supplement in the range 0.15-0.20 g/kg LW. Intakes of cows aged between 3 years and 6 years were significantly higher (0.34-0.36 .g/kg LW).

The intake of supplement by a calf was influenced by whether the dam was a consumer of supplement (Table 2). Overall 50% of the calves were non-consumers of supplement, which compares with 38% of the lactating cows being non-consumers. Ninety percent (35/39) of the calves which did consume supplement were the progeny of cows which consumed supplement. In contrast, among the non-consumer calves 38% (15/39) were the progeny of cows which consumed supplements. Furthermore the intake of supplement by the calves was correlated with the intake of supplement by the cows as follows:

$$\text{Calf intake (g/d)} = 12.7 + 0.11 \text{ Cow intake (g/d)}$$

$$\text{Calf intake (g/kgW}^{0.75}\text{.d)} = 0.26 + 0.22 \text{ Cow intake (g/kgW}^{0.75}\text{.d)}.$$

Practical implications

1. The percent non-consumers and variability of intake of the molasses-urea-phosphoric acid supplement which was used was high, and comparable with the percentage of non-consumers and variability observed with dry lick supplements under similar circumstances. This suggests that the principal factor determining the percent non-consumers and variability is the amount of supplement consumed. Low percentages of non-consumers and low variability associated with M8U supplements is probably because voluntary intake of these supplements were high.

2. When supplement was fed at a single site to a mob of 133 breeder cows, bulls and calves, some sub-groups of cattle consumed up to twice as much per kg liveweight as other groups. The lower intake of dry cows may reflect the lesser need of these cows for nutrients. The lower intake of heifers and calves may be because these age groups of animals are often among the least dominant animals in a mob. The low intake of the old cows is surprising when the older animals in the mob are often dominant, and presumably some other factors were involved.

Supplement delivery systems - Experiment 13

Trough space and design effects on supplement intake - SWN-B816

Carol Petherick, Bev Gelling and David Hirst

Summary

1. The effect of feeding space allocation and design of trough on intake of M8U by small groups of weaner heifers was investigated.

2. Four trough designs were used; a single trough with an opening measuring 300 mm x 300 mm (S), three of these same troughs placed end to end (E-E), three of these troughs placed 3 m apart (3 x 3) and three troughs placed 10 m apart (3 x 10).

3. The behaviour of the cattle at the troughs (social interaction and time spent feeding by individuals) was recorded at intervals over a period of approximately 3 months during the dry season.

4. Records were kept of group supplement intakes and estimates of individual supplement intake were made using a lithium-tracer technique, which involved mustering the cattle to yards three times at monthly intervals to take blood samples. Liveweights were also recorded on these occasions.

5. Group intake of supplement, throughout the experiment, was lowest on the E-E treatment, and highest on the treatment 3x3 for the first 5 weeks, and the 3x10 treatment thereafter. However, the differences were not statistically significantly different.

6. Coefficients of variation for the individual intakes ranged between about 26 and 56, with most being between 35 and 45. Treatment did not affect variability in individual intake.

7. Although not statistically significantly different, liveweight gains were lowest on the S treatment and highest on the 3 x 3 treatment.

8. The greatest number of agonistic interactions took place on the S treatment.

Introduction

Beef cattle grazing northern pastures are often provided with supplementary feed, in order to minimise body weight loss, during periods when plants are dormant or during drought. Intake of the supplement can be variable between individuals which reduces the cost effectiveness of providing the supplement, as well as lowering the productivity of the herd. Variability appears to be influenced by a number of factors, such as the form in which the supplement is provided (e.g. dry licks, blocks, liquid etc.) and presumably involves factors relating to physical form and palatability, availability and quality of pasture, 'class' of animal, previous experience of the animals, as well as the way in which the supplement is presented to the animals. It is this latter factor which this study aimed to investigate.

There is an enormous amount of literature, across a wide range of species, indicating that social relationships play a role when there is competition for resources. It is also generally believed that the so-called 'dominant' individuals will have better access to the resource and will exclude or restrict access to that resource by so-called 'subordinate' animals. There is also evidence in the literature that trough space and design influence the degree to which social relationships can exert an effect on food intake.

Experimental details

One hundred and twenty Brahman crossbred weaner heifers, weighing 145 kg on average, from the Swan's Lagoon herd were used. The heifers were allocated to eight paddock groups (15 animals in each). The animals were given a period of 3 weeks to become used to their new paddocks before observations started. During this period, the heifers were habituated to the presence of the observer riding a 4-wheeled motorcycle (4WB).

Each paddock contained a single water trough and supplement (M8U) was available *ad libitum* from troughs placed adjacent to the water trough. Four designs of supplement trough were investigated, each being based on a 44 gallon drum divided in half horizontally, with an opening measuring 300 mm x 300 mm in the top. The treatments were:

(i) a single trough (S)
(ii) three troughs placed next to each other (in contact) (E-E)
(iii) three troughs placed 3 m apart (3 x 3)
(iv) three troughs placed 10 m apart (3 x 10).

Observations of the behaviour of the cattle were carried out on four consecutive days of the working week, for two successive weeks. Four paddock groups were observed each day for one hour. The first observation period commenced between 07.15 h and 08.00 h, the second between 08.30 h and 09.15 h, the third between 09.40 h and 10.40 h and the fourth between 10.50 h and 11.50 h. This variation simply reflected the amount of time it took the observer to travel between paddocks and locate animals.

All observations were carried out by a single observer seated on a 4WB. When any animal was feeding on the supplement, the following were recorded:

- the identity of the animals
- the type and number of agonistic behaviours
- the identity of the individuals involved in agonistic interactions
- the outcome of the interactions
- the identity of animals feeding on the supplement
- the approximate length of feeding bouts by individuals.

Agonistic behaviours are aggressive behaviours, such as butting and pushing, and submissive behaviours, such as when an animal moves away from an approaching individual.

During the week following the last of the observation days, the heifers were fed M8U which contained lithium sulphate (LiM8U), in order to estimate individual intakes of supplement. The supplement was continuously available to the cattle on a single day from approximately 6.30 h to 15.30 h. On the following morning the cattle were mustered to yards for weighing and blood sampling. The cattle were then left relatively undisturbed for one week. Thus, one complete repeat of the experimental protocol took 4 weeks, and the above procedure was repeated a further two times.

Results

Few statistically significant differences were found, but the data show some interesting trends which warrant further investigation with follow-up studies.

Time spent feeding on M8U was shortest on repeat 1 and longest on repeat 2 for all treatments. Time spent feeding was shortest on treatment E-E (Table 1).

Table 1. Average time spent feeding by individuals (sec)

Treatment	Repeat 1	Repeat 2	Repeat 3	Overall
S	97	159	112	122
E-E	62	124	106	97
3 x 3	82	148	122	117
3 x 10	88	156	121	122

The effect time of day on the time spent feeding was significant ($P<0.01$) with the means being 164.3, 123.9, 99.6 and 91.3 sec for observation periods 1 to 4 respectively.

Table 2 shows the treatment trends for intakes across repeats; throughout the study intakes were lowest on treatment E-E, with little difference between the others. Intake across treatments tended to be lowest on repeat 1.

Table 2. Average M8U intake (kg/head/day)

Treatment	Repeat 1	Repeat 2	Repeat 3	Overall
S	0.85	0.83	0.96	0.88
E-E	0.71	0.78	0.79	0.76
3 x 3	0.92	0.95	0.90	0.92
3 x 10	0.79	0.93	0.95	0.89

The trends for intakes of LiM8U are shown in Table 3. Overall, the intake was lowest in the E-E treatment and highest in the 3 x 10 treatment. This is a similar result to the M8U intakes, but it can be seen that, overall, intakes were lower when lithium was fed.

Table 3. Average LiM8U intake (kg/head/day)

Treatment	Repeat 1	Repeat 2	Repeat 3	Overall
S	0.47	0.77	0.68	0.64
E-E	0.37	0.54	0.61	0.50
3 x 3	0.50	0.60	0.85	0.65
3 x 10	0.64	0.67	0.79	0.70

Table 4 shows the coefficients of variation (Co V) for intakes of the M8U on the treatments. Variability ranged from a Co V of 26.4 to 55.6, with most between 35 and 45. Treatment had no significant effect on variability in intake.

Table 4. Coefficients of variation for individual intakes of LiM8U

Treatment	Repeat 1	Repeat 2	Repeat 3	Overall
S	37.7	45.6	41.4	41.6
E-E	39.3	26.4	46.3	37.3
3 x 3	35.8	55.6	36.6	42.7
3 x 10	53.0	36.9	43.1	44.3

The trends for weight changes across treatments are shown in Table 5. The best gains were achieved on treatment 3 x 3 and the worst on treatment S.

Table 5. Average liveweight changes during repeats

Treatment	Repeat 1	Repeat 2	Repeat 3	Overall
S	+0.4	+2.6	-0.8	+2.2
E-E	-1.5	+4.5	+1.7	+4.7
3 x 3	+0.3	+4.2	+2.7	+7.2
3 x 10	-1.1	+5.5	-0.3	+4.1

Although not different statistically, the greatest number of interactions were on the S treatment and least on the E-E treatment, as shown in Table 6.

Table 6. Average number of agonistic interactions (/head/hour)

Treatment	Repeat 1	Repeat 2	Repeat 3	Overall
S	5.1	4.0	6.4	4.9
E-E	1.6	1.9	3.9	2.5
3 x 3	2.4	4.2	5.0	3.9
3 x 10	2.8	4.7	3.5	3.7

Discussion

Although not statistically significantly different, there was a consistent trend for supplement intakes to be reduced on the E-E treatment, with little difference between the other treatments. This trend occurred on measures of average group intake for both M8U and LiM8U, and the average time spent feeding. This finding across a number of measures suggests that it was a real effect and not some artefact of the experiment.

Treatment effects on liveweight changes did not directly mirror intakes, gains were non-significantly lowest on the S treatment and greatest on the 3 x 3 treatment. The numbers of agonistic interactions were also highest on the S treatment and lowest on the E-E treatment. It is possible that the cattle on the S treatment wasted energy in these activities, thus reducing their efficiency.

Supplement intake was lowest on repeat 1 (0.82, 0.87 and 0.90 kg/head/day for repeats 1 to 3 respectively). This was anticipated for two reasons, although the cattle had had previous experience of eating M8U from troughs, it would have taken them some time to locate and eat the supplement in a new environment and, secondly, as the dry season progressed, the pasture senesced further with a concomitant reduction in nutritional quality, which would have necessitated an increase in supplement intake over time. These trends were also reflected in liveweight changes, with the greatest loss of weight being on repeat 1, and repeat 2 showed the best gains, presumably due to the declining quality of the pasture by repeat 3.

Average daily intakes were lower for LiM8U, with a similar reduction seen across treatments (27%, 34%, 29% and 33% on treatments S, E-E 3x3 and 3x10 respectively). This reduced intake was not entirely anticipated as, although the LiM8U was available in the paddocks for only approximately 9 hours, compared to the continuous availability of the M8U, previous experience with cattle on the station suggested that the bulk of feeding on supplement would be performed during the hours it was available. it is possible that the reduced intake was caused by the cattle detecting the lithium in the M8U and consuming less due to the novel taste. Certainly, intakes were lowest on repeat 1 and increased over repeats, and although never matching the average daily intake of M8U, there was no evidence of any aversion being developed to the LiM8U.

The variability in individual intake, as assessed by the levels of lithium in plasma samples was somewhat greater than has been found in other research on Swan's Lagoon using M8U. Treatment did not affect variability in intake in any consistent way, although it was lowest on treatment E-E.

Time spent feeding on the supplement was influenced by the time of day, with most being spent during the first observation period of the day and decreasing on successive periods. This reflects the daily routine of the cattle, coming to water and supplement early in the morning, resting in the vicinity of the feed and water, with animals feeding occasionally and then moving away from the troughs to graze.

Practical implications

Feeding space allocation and trough design can affect the average intake of a palatable supplement by, and the weight gains of young cattle grazing native pasture. Reducing feeding apace and forcing animals in to close proximity appears to reduce supplement intake and have adverse effects on liveweight gain. Higher intakes and weight gains were achieved by placing individual troughs at some distance (3 m or 10 m) from each other. It is suggested that these results may arise from the increased levels of activity and social interactions between individuals when they are forced in to close proximity to feed. However, feeding space allocation and trough design may have minimal effects on the variability of individual intakes.

Supplement delivery systems - Experiment 14

Design of shelter sheds for wet season supplementation of cattle - SWN-B832

Jayne Kuskie, Carol Petherick, David Hirst and Rob Dixon

Summary

1. The effect of two designs of shelter sheds (closed and open) on cattle behaviour and intake of M8U and dry lick supplements by small groups of cattle during the wet season were investigated. The supplements were fed from a feeder with space for one animal to eat at one time.

2. Shed design did not affect average intake, intake variability or liveweight gains. There were no significant relationships between social dominance of the cattle, intake or liveweight gains.

3. The closed shed did not appear to have adverse effects on intake variability and is likely to provide better protection of the supplement from rain.

Introduction

Grazing cattle in Australia are often provided with supplementary feeds to improve their weight gain or prevent weight loss when feed quality is poor. The animals lose weight when there is a lack of metabolisable energy, protein and/or essential minerals in the pasture or a shortage of pasture. If cattle are to be supplemented during the wet season then it is important to protect the feed from rain to prevent spoilage. The type of shed most often used is an open-sided shed consisting of a roof on a frame. However, when rain is accompanied by gusts of wind such a shed provides little protection for the supplement from rain. A shed which is enclosed on three of its four sides would provide better protection of the supplement, but cattle low in the peck-order or social hierarchy may be reluctant to enter it because it would limit their visual field and they would be unable to see the approach of more dominant animals which may attack them. Reluctance to enter the shed by some animals is likely to increase the proportion of shy-feeders and to increase variability of supplement intake. Both of these factors would reduce the cost-effectiveness of providing the supplement.

Experimental details

The experiment was conducted in six small (18 ha) paddocks, which had a single water trough at one end. Sixty No. 5 steers were allocated to six paddock groups (10 per group) on the basis of liveweight. These cattle had no previous experience of shelter sheds, but had received a molasses-based supplementary feed during weaning.

Two shed designs were compared. The ‘open shed’ consisted of a metal frame supporting a flat metal roof. The ‘closed shed’ had a flat metal roof and was totally closed on three sides by metal sheeting that extended from the roof to ground level. The sheds were randomly allocated to the six paddocks and positioned about 20m from the water troughs.

During Period A, for 40 days in January and February 1966, M8U was fed from half a forty-four gallon drum with a top opening of 300 mm x 300 mm. The supplement was only available for six to eight hours each day, the feeders being covered with lids overnight. Behavioural observations were conducted on the cattle at various times during this period in order to determine the social hierarchy within each paddock group and determine the length of time the cattle spent feeding. Daily intakes of the supplement in each paddock, liveweight changes and individual intakes (using lithium sulphate as a tracer) were also determined.

During Period B, for 4 weeks during March and April 1996, the steers were fed a dry lick supplement *ad libitum*. The dry lick contained 44% salt, 31.8% calcium phosphate (Kynophos), 22.7% urea and 1.5% yellow sulphur. Measurements were made of the group intakes of the supplement and at the end of the period lithium marker was mixed with the dry lick to measure individual intake of the supplement.

Results

1. Period A

There were no statistically significant differences between the two shed designs in any of the variables measured. Means and standard errors for the closed and open sheds are shown in Table 1.

The daily intakes of M8U on a paddock basis, showed very little variation. The largest difference between the means for each paddock was 2.5 kg/paddock/day. Although not statistically different, cattle tended to spend longer feeding in the open sheds.

Table 1. Effect of shed design on intakes, time spent feeding and liveweight gains.

Parameters	Closed		Open	
	Mean	Standard error	Mean	Standard error
LW gain (kg)	41.83	1.35	43.70	1.09
Individual intakes of supplement (kg/day)	1.18	0.06	1.19	0.07
Paddock intakes of supplement (kg/day)	12.46	0.92	13.28	0.87
Feeding time (bout length in min)	0.97	0.61	2.14	1.09

There was a significant effect of paddock on liveweight gain (P=0.036). This was due to a single paddock, where the animals were using a closed shed. Paddock did not affect individual intake of supplement.

Table 2. Relationships between time spent feeding, dominance, intakes and liveweight gains

Parameters	R^2 (%)	Probability
LWG & DV	0.1	0.829
LWG & individual intake	2.4	0.237
LWG & feed time	9.6	0.016
Individual intake & feed time	0.0	0.874
Feed time & DV	2.4	0.237

DV, dominance value; LWG, liveweight gain (kg); Individual intake (kg/day); Feed time (bout length in min).

There were no significant relationships between time spent feeding, dominance value, individual intakes of supplement and liveweight gains (Table 2).

2. Period B

Intakes of the dry lick supplement were not affected by the type of shed, being 155 g DM/head.d from the closed sheds and 128 g DM/head.d from the open sheds. All of the steers consumed some supplement and the variability of intake was similar for the closed and open sheds (Co V 69% and 55% respectively).

In summary, there was a trend for animals to spend longer feeding in the open than closed sheds, but shed design had no effect on supplement intake or liveweight gains. There were no significant correlations between liveweight, dominance, intakes and time spent feeding. Previous research on a variety of species indicates that dominance has most effect when resources are limited. This suggests that, in the current study with 10 animals per feeder, access to the supplement for 6 to 8 hours a day was sufficient for all animals to have the opportunity to feed without undue competition.

Practical implications

This experiment shows that the use of an open or closed shed had no effects on supplement intake and liveweight gains. Cattle appeared not to be inhibited from using the closed shed, but the supplement was available for relatively long periods of time and so competition for it would have been low. Although further studies are needed with larger numbers of animals and in larger paddocks, the results suggest that as a closed shed provides better protection of the supplement it would be the best design to use during the wet season.

Supplement delivery systems - Experiment 15

Effect of distance of supplementation site from water of supplement intake-SWN-B824

Rob Dixon, Adrian White and Carol Petherick

Summary

1. Four paddock groups, each of 10 yearling heifers, were fed M8U from a trough sited adjacent to the water trough or approximately 1.4 km away.

2. Siting the M8U supplement 1.4 km from the water point reduced ($P<0.05$) intake of the supplement from 0.84 to 0.67 kg/head.d.

3. These results suggest that although the siting of supplement some distance from water does reduce intake of molasses-based supplements, the change is not large enough to be very useful to control intake.

Introduction

It has been argued by some producers and manufacturers of lick blocks that intake of blocks can be reduced by increasing the distance between the supplementation point and water by up to 1-2 km, and that good control of supplement intake can be achieved. It has also been suggested that careful siting of supplement points can be used to change grazing pressure in various parts of large paddocks. Consequences of this management manipulation on supplement intake are obviously important.

The following experiment was set up to examine the effects of distance from water on the intake of M8U supplement.

Experimental details

In June 1995 40 *Bos indicus* x Shorthorn heifers, approximately 14-20 months of age, were allocated by stratified randomization based on liveweight to four paddock groups. Average liveweight was 226 kg (SD 14, range 186-248 kg), and average condition score was 6.2 (SD 0.5, range 5-7). The four groups of heifers were allocated at random to four native pasture paddocks each approximately 1500 m x 330 m, and with the only water supply from a trough at one end of the paddock.

The experimental design was originally planned to consist of four periods each for three weeks, with two treatments (a molasses-urea (M8U) supplement fed close to or distant from water) imposed during Periods 1 and 2, and two further treatments (dry lick fed close to or distant from water) imposed during Periods 3 and 4. However, heavy falls of rain in August during Period 2 disrupted the feeding schedule and caused a drastic reduction in M8U intake. Consequently M8U was not fed in weeks 5 and 6, Period 2 was continued until week 14, and during Period 3 measurements with M8U were continued. Thus only measurements with M8U supplement were made, and pasture on offer during Periods 2 and 3 was more representative of later wet season pasture than dry season pasture.

The treatments which were compared consisted of M8U fed approximately 30 m from water, or at the opposite end of the long narrow paddocks and approximately 1.4 km from water. The M8U was fed ad libitum in two 560 mm diameter drums for each paddock group.

Fig 1. Intake of M8U supplement fed at water (o) or distant from water (●)

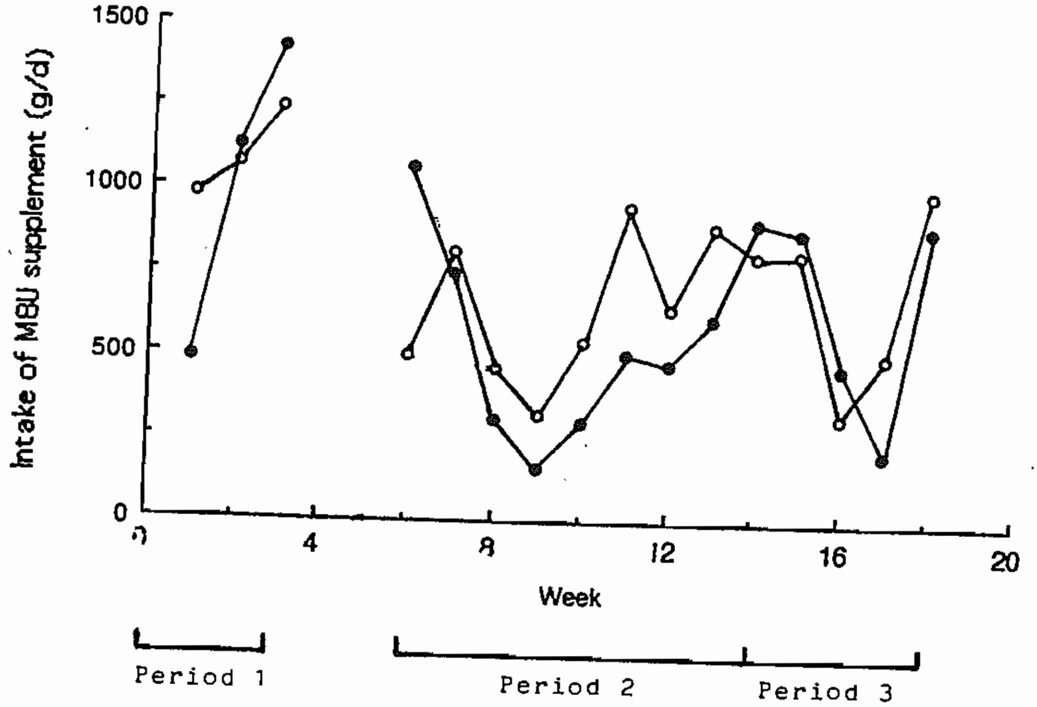
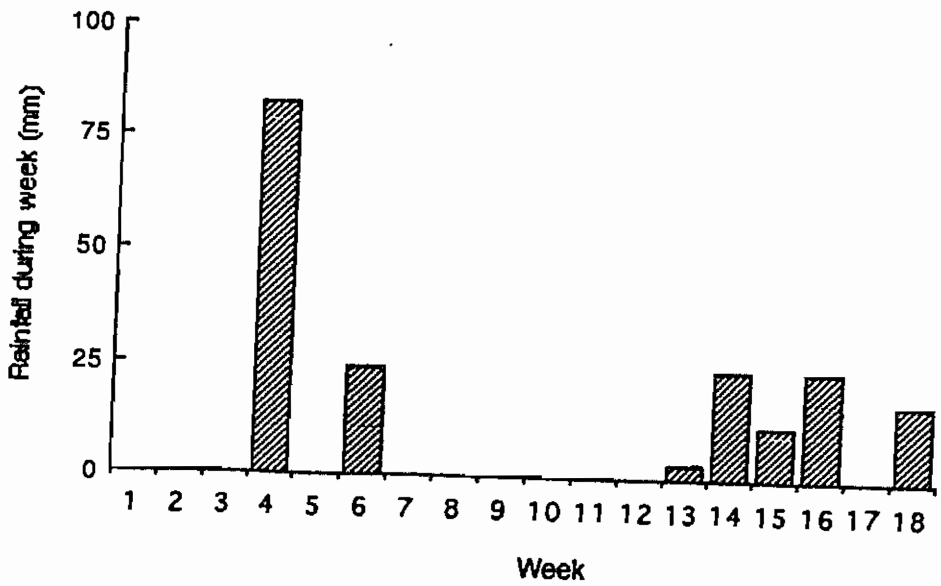


Fig 2. Rainfall during the experiment



Results

Intake of M8U and rainfall are shown in Figures 1 and 2.

The M8U intakes during the last three weeks of each period were reduced ($P<0.05$) from 1.06 kg/head.d during Period 1 to 0.68 kg/head.d during Period 2 and 0.53 kg/head.d during Period 3. The interaction between treatment x period was not significant ($P>0.05$). The intakes during Period 1 were typical of those observed with this type of animal grazing dry season native pasture. The lower intakes during Periods 2 and 3 are in agreement with previous observations that although cattle will eat M8U when some green material is present in native pastures, intakes are appreciably lower than during the dry season.

Siting the M8U supplement 1.4 km from the water point reduced ($P<0.05$) intake of the supplement from 0.84 to 0.67 kg/head.d. However, although this reduction in intake was statistically significant, it was only by 20%. Much larger reductions in intake would often be required in commercial property situations to achieve target intakes of M8U supplement.

Practical implications

Siting M8U supplementation points some distance from the water point reduced supplement intake, but the magnitude of this reduction is probably insufficient for it to be used to adequately control intake in many commercial property situations. However, there may be other benefits to siting supplement points distant from water such as by influencing grazing pressure in various parts of large paddocks.

Siting of supplement points: effects on supplement intake and paddock use by small groups of cattle -B837

Carol Petherick, Peter Fry, Bob Mayer and Rob Dixon

Summary

1. Dry season lick blocks were placed either adjacent to the water trough (N) or approximately 1.8 km from it (F). These treatments were replicated three times with groups of 10 No. 5 steers grazing long, narrow paddocks (1800 m x 200 m) for 3 months.

2. Average group intakes of supplement were reduced by about 29% on the F compared to N treatment. There was a tendency for the cattle to gain more weight or lose less on the N compared to F treatment.

3. Siting had little effect on paddock use by the cattle or on individual variation in individual intakes of supplement. However the variability of intake of supplement and the number of non-eaters of supplement on F increased after rainfall.

Introduction

It has been stated by some producers and manufacturers of supplementary feed that control of supplement intake can be achieved by varying the distance between the supplement site and watering points. It has also been suggested that siting of supplement points can change grazing patterns, taking pressure off over-used areas and encouraging cattle to move to under-used areas of the paddock. However, there is little objective information to evaluate these suggestions.

Experimental details

Sixty No. 5 steers (about 21 months of age), averaging 335 kg liveweight were allocated on the basis of liveweight to six paddock groups. The work was conducted in long, narrow paddocks (1800 m x 200 m) each of about 36 ha, with a single water trough located at one end (the front) of the paddock. There were two treatments: a commercial dry season lick block (20% urea, 33% molasses, 3% cottonseed meal and 6% salt) was placed either adjacent to the water trough (about 25 m away) (N) or at the far end of the paddock at a distance of about 1.8 km from the water trough (F).

A switch-back design, of three monthly periods, was used with each treatment being imposed on three paddock groups during each period. Group intakes of block were recorded daily and cattle were weighed and condition scored monthly. For 12 days during each monthly period, the position in the paddock of the cattle and their behaviour were recorded at 8.30 h, 12.00 h and 15.30 h daily. At the end of each monthly period, individual intakes of supplement were measured using a lithium marker technique. About 28 mm of rain fell during the second monthly period.

Results

Supplement siting had little effect on the way cattle used the paddock, with most animals being found grazing the front half of the paddocks at 8.30 h, resting near the water trough at 12.00 h and either resting near the water trough or grazing the middle of the paddocks at 15.30 h.

Intakes of block were reduced by about 29% when the block was placed far from the water trough than when adjacent to it (Table 1). During the first month, liveweight gains were greater when the block was near to the water. In the second month less weight was lost when the block was near the water trough, but in the third month there was no difference in liveweight changes on the two treatments (Table 1).

Table 1. Average group intakes (g/h.d) and average liveweight changes (kg) of steers with supplement near to (N) or far from (F) the water trough

Measurement	Period 1	Period 2	Period 3
Group intake N	138	163	212
F	115	95	150
Weight change N	16.5	-15.9	23.2
F	9.5	-20.5	23.0

The individual variation in intake was not affected by treatment, but during period 2 the variation nearly doubled compared to periods 1 and 3 (Table 2). The number of non-eaters of supplement also increased markedly during this period when the block was far from the water trough. These effects were probably due to the rainfall at this time.

Table 2. Variability in individual intake (CoV %) and proportion of non-eaters of supplement when supplement was near to (N) or far from (F) the water trough

Measurement	Period 1	Period 2	Period 3
Variability N	49.6	80.0	46.6
F	48.9	91.7	43.5
Non-eaters N	2/60	2/60	1/60
F	1/60	8/60	2/60

Practical implications

At least in small paddocks with small groups of cattle, the siting of supplementary feed has little effect on the way in which cattle use the paddock. It is probable that siting of water has a stronger influence on cattle movements than siting of supplement. It is also possible that cattle will be influenced by the movements of others in neighbouring paddocks.

Siting the supplement near to the water trough leads to higher intakes, which may, in turn affect liveweight changes. Siting appears not to influence the variability in individual intake, but rainfall appears to do so. It appears that following rainfall, some cattle will not walk to get to supplement, but will eat it if it is near the water trough.

The relatively small differences in intake obtained when blocks are placed adjacent to the water and when placed some distance from it, together with variation in intake over time and between paddocks suggests that siting is unlikely to adequately control intake in many commercial property situations.

Supplement delivery systems - Experiment 17

Wet season supplementation of cattle: effects of siting on intake and paddock use -B839

Carol Petherick, Derek Holroyd, Adrian White, Rob Dixon, Keith Jeppesen and Rob Young

Summary

1. The effect siting of supplementation points on average supplement intake, variability of intake and paddock use was studied in a group of approximately 200 cattle grazing a 700 ha paddock. A dry-lick supplement was provided in three troughs which were positioned close together, adjacent to the water trough (W) for the first 3 weeks of the study, and in three troughs dispersed in the paddock and distant from the water trough (D) for the following 12 weeks of the study. Heavy rainfall occurred during this latter 12 week period.

2. Average intakes were greater on D than W, which may have been due to the siting of supplementation points or the weather/pasture conditions.

3. Siting of supplementation points did not affect the proportion of non-eaters or individual variability of supplement intake.

4. Cattle continued to eat supplement during the wet weather providing the supplement was sited in areas in which the cattle spent most of their time.

Introduction

In north Australia, cattle are often provided with wet season supplementary feed containing phosphorus to improve liveweight gains. However, inefficiencies in supplementation arise because there can be high variability in supplement intake between individuals in a mob, and this variability appears to increase after rainfall. Rain also tends to lead to an overall decrease in supplement intake.

For ease, supplementary feed tends to be placed at or close to the water trough, but this can result in excessive pasture use in that area, with under-utilisation of other areas of the paddock.

Work has been conducted on supplement intake and paddock use using small groups of cattle in small paddocks, but we need to establish whether or not similar results are obtained with large groups of cattle in large paddocks. With this aim in mind, an unreplicated, observational study was conducted.

Experimental details

The study was carried out on a herd of approximately 110 cull cows, their calves and a variable number (up to 17) of cattle from a neighbouring property which were grazing a 700 ha paddock. The paddock comprised three land-form types: zone 1 - undulating, zone 2 - sand-flats and zone 3 - hills (see Figure 1). A single water trough serviced the paddock (in the south-east corner on undulating land), although varying amounts of surface water were present in creeks throughout the study period. The study ran from January to April 1997, with the rainfall for this period being shown in Table 1.

Table 1. Rainfall (mm) during experimental period

January	February	March	April	Total
116	306	247	0	669

The supplementary feed (60% cottonseed meal, 25% Kynophos and 15% salt) was fed out in three troughs which were protected from the weather by open-sided sheds.

The original plan for the experiment had been to have three 3-week periods, with the supplement troughs being close together and near the water trough (W) in the first and last periods, but with them dispersed and distant from the water trough (D) in the middle period. We had planned to incorporate lithium sulphate into the supplement at the end of each 3-week period and muster the cattle for blood sampling to obtain a measure of individual intakes of the supplements. However, heavy rainfall (see Table 1) resulted in the cattle failing to eat the supplement and we were also unable to muster cattle from the paddock at the planned times. As a result, in the first phase of the study the three supplement troughs were adjacent to the water trough (no more than 50 m from it and no more than 100 m from one another) for a period of 3 weeks (in January). The troughs were then moved to be widely separated and distant from the water trough, but adjacent to well-established cattle pads (see Figure 1). These sites were selected as they were in areas of reasonable pasture which was not being heavily grazed. We hoped to draw the cattle into these areas. This second phase of the study lasted 10 weeks (February, March and early April). For the final phase of two weeks, supplement trough 1 was moved to position 1a in Figure 1, because cattle were eating little supplement. Lithium sulphate was included in the supplement during weeks 3 (end of phase 1) and 15 (end of phase 3) and the cattle were mustered for blood sampling at these times. Paint-bars (cattle marking paint applied to bars which surrounded the supplement trough) were placed at the supplement troughs during the periods that the lithium supplement was fed to determine whether this was an accurate method for distinguishing supplement eaters from non-eaters. Twice daily, between 6.00 and 8.00 h, and 12.00 and 16.00 h, two or three times each week, the location of the cattle was recorded on maps of the paddock.

Results

Results suggest a greater variability in average group intake of supplement during phase 1 and 3 than during phase 2. This may have been due to the siting of the supplement or the weather conditions and its effect on the land and pasture. During phase 2 there was very heavy rainfall and the cattle moved to higher, rocky ground. Coincidentally, this type of country was where supplement trough 1 had been sited, and the cattle congregated in the general vicinity of this trough and continued to eat supplement from it during this wet period. However, as the lower ground began to dry out and green pasture began to show, the cattle moved from the hills to the undulating country at the east of the paddock and supplement intake fell-off. It was at this point that we decided to move the supplement to where the cattle were to see if they would increase their intake of it. This is, indeed, what happened.

Preliminary analysis indicates that average supplement intakes (when lithium supplement was fed at week 3 and week 15) were considerably higher when the troughs were dispersed and at a distance from the water trough, than when close to it (Table 2). Individual variability in intake for cows and the cattle from the neighbouring property was greater when the troughs were dispersed and distant, than when close, but the opposite trend was seen for calves (Table 2). These results could have been influenced by time, as for the first lithium measure few calves consumed supplement, but more ate supplement at the end of the trial when they were about 3 months older (Table 2). The proportion of non-eaters of supplement amongst the cows and neighbour's cattle changed little over the trial, although variability increased (Table 2). The increase in the supplement intakes of adult animals may have been due to the fact that at the end of the trial, although there was some green growth of pasture, the bulk of it (estimated at about 70%) was in a seeding state. This contrasts to about 80% of the pasture being in a vegetative state early in February (just after the first lithium measure). Additionally, because the cattle had decreased their supplement intake following the rainfall, we moved the supplement to where the cattle were spending most of their time. This, too, may have contributed to the increase in supplement intake at the second lithium measure.

Figure 1. Contour map and diagram of study paddock to show positions of water trough and supplementation points

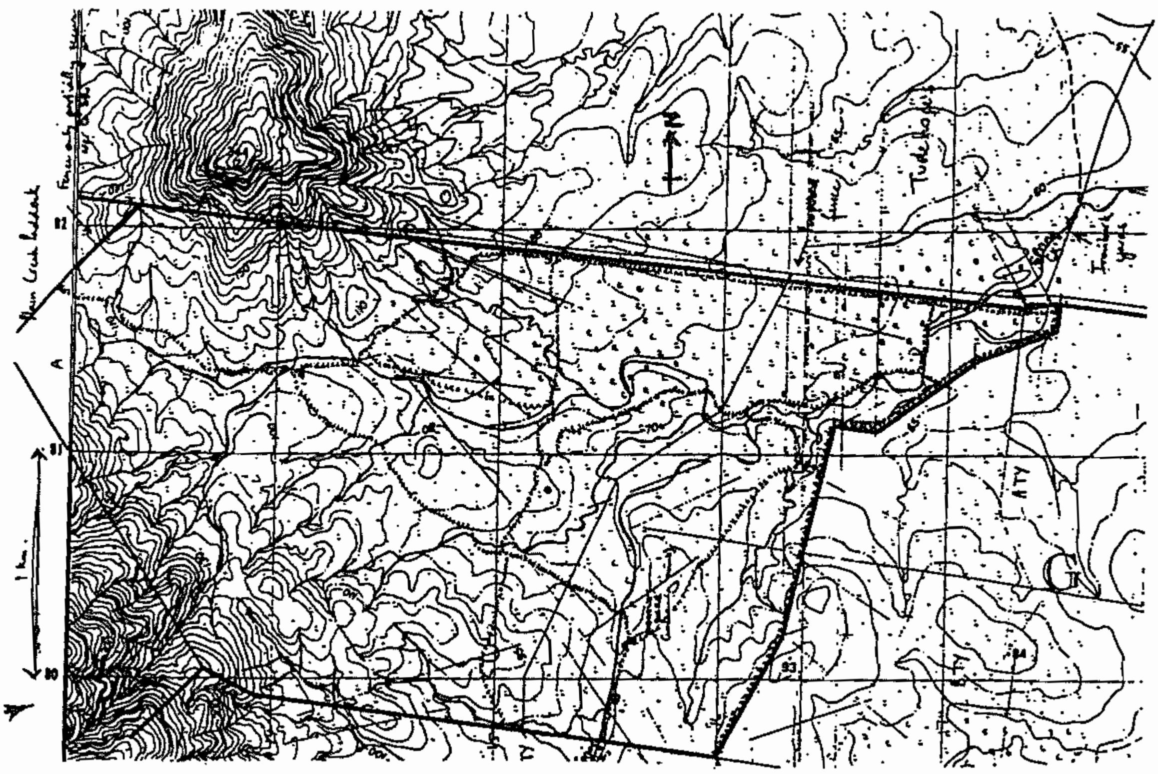


Figure 2. Top, a contoured map of the study paddock and below, supplement placements for the away from water treatment. Trough 1 was relocated to the site of Trough 1a in the second last week of the "far from water" period. For the "close to water" period, all three supplement troughs were located within 50m of the water point.

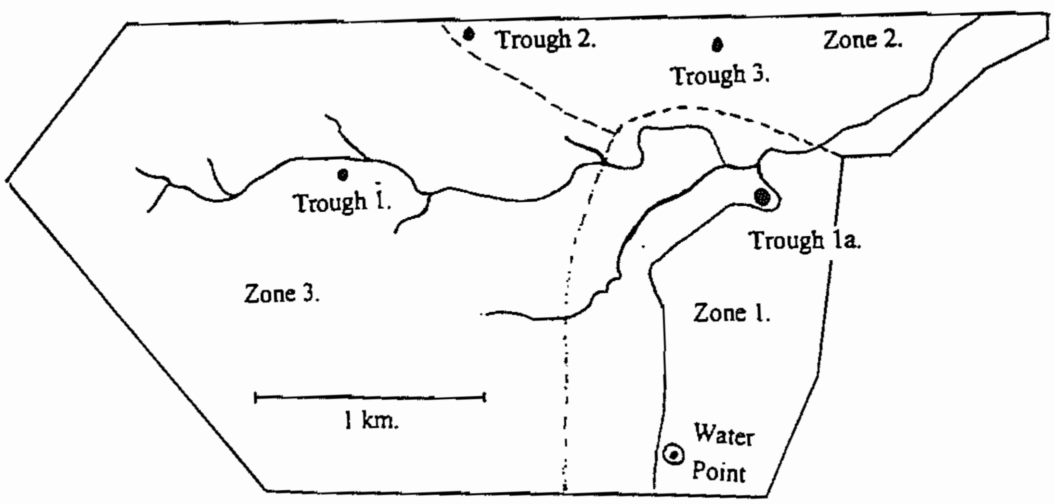


Table 2. Average lithium supplement intakes (g/32 h period), variability (CoV %) and percentage of non-eaters when supplement sites were close together at the water trough (W) and when dispersed and distant from the water trough (D)

	Cows W	Cows D	Neigh. W	Neigh. D	Calves W	Calves D
Intake	80	160	44	134	8	88
Variability	135	164	155	196	175	110
Non-eaters	44%	48%	41%	45%	82%	27%

The paint-bars proved to be an unreliable method for identifying eaters and non-eaters of supplement as the proportion of paint-marked cattle differed greatly to the proportions obtained using the lithium marker technique (Table 3). At the first lithium measure the cattle were mustered during rain and some of these errors arose because the paint was removed by wet pasture. However, the weather was not wet at the second lithium measure. Other errors may arise because curious cattle may reach over or under the bars, and get marked with paint, even though they do not actually eat any supplement.

Table 3. Percentage of eaters of supplement as identified by the lithium marker and paint-bar methods when supplement sites were close together at the water trough (W) and when dispersed and distant from it (D)

Method	Cows W	Cows D	Neigh. W	Neigh. D	Calves W	Calves D
Lithium	56%	52%	59%	55%	18%	73%
Paint-bar	17%	32%	18%	23%	21%	22%

Practical implications

The observations from this study suggest that it is possible to encourage cattle to use lesser-used areas of a paddock and to increase average supplement intakes by using multiple supplementation points during relatively dry conditions. However, the weather and pasture condition has a major impact on intakes and paddock use by cattle. Cattle will continue to consume supplement during wet weather providing the supplement is located where the cattle are spending most of their time, but intakes will fall if the supplementation point does not coincide with where they are grazing and camping. There appears to be little effect on individual variability in intake and the proportion of non-eaters by having several supplementation points dispersed through the paddock compared to supplementing near the water trough.

Main

Research

Report

Tasks 4 and 5.

Economic assessment

and comparison of urea-based supplements

with other management options

to improve breeder fertility.

5. Tasks 4 and 5. Economic assessment and comparison of urea-based supplements with other management options to improve breeder fertility.

The objective of Task 4 was to evaluate, in a generalized form, the economic viability of using urea-based supplements for the breeder herd, and to evaluate the benefits of improved supplement delivery systems.

The objective of Task 5 was to compare the various short-term strategies (ie. strategies which are implemented within an annual cycle) available to the producer to increase breeder herd productivity.

5.1 Approach

Since the single most important factor influencing breeder fertility and mortality is breeder body condition status in the late dry and early wet seasons, management options were compared by their cost-effectiveness to achieve acceptable breeder liveweight at this time of the year (Figure 5.1.).

There are clearly difficulties with the assumption that, in the absence of reproductive disease, breeder fertility and mortality can be described as a function of breeder body condition late in the dry season. As discussed in more detail in the Draft Management Package breeder fertility can be reduced by severe loss of breeder body condition during the dry season and breeder nutrition during lactation. Nevertheless, until improved quantitative models can be developed to describe the effects of nutrition at various times on breeder fertility we propose that the simplified model is the best available option.

Breeder body condition late in the dry season can be improved by:
(i) increased body condition at the end of the wet season (depending primarily on pasture quality, seasonal conditions, time of calving, phosphorus supplements), and
(ii) reduced rate of loss of body condition through the dry season (depending primarily on pasture quality, seasonal conditions, timing of weaning, urea supplements).

The strategy of using survival supplements (eg. M8U) to avert mortalities in years when there is a delayed seasonal break allows deferment of decisions until seasonal conditions are known and thus expenditure on supplements to be made only in those years when essential.

The conceptual model described in Figure 5.1 was used to compare the alternative management strategies (eg. phosphorus supplements, earlier weaning, survival supplements) available to managers. It has been assumed that dissimilar strategies could be compared on the basis of their efficacy and cost-effectiveness to improve body condition of the breeder late in the dry season. Such a comparison is necessary for managers to make best-bet decisions and choose the most appropriate management options for a specific situation.

The process of economic analysis has included:
(i) Construction of a spreadsheet model (BREEDMOD) to improve prediction of the consequences of management strategies on breeder mortality and breeder fertility from dry season under-nutrition. This has been comparing the efficacy of management strategies to maintain breeder body condition, thus allowing comparison of dissimilar strategies (eg. urea supplementation and early weaning) and comparison between climatic regions.
(ii) Economic analysis of the cost-effectiveness of management strategies to increase weaning rate and reduce breeder mortality involved use of the BREEDCOW model to calculate gross margins and other financial parameters.

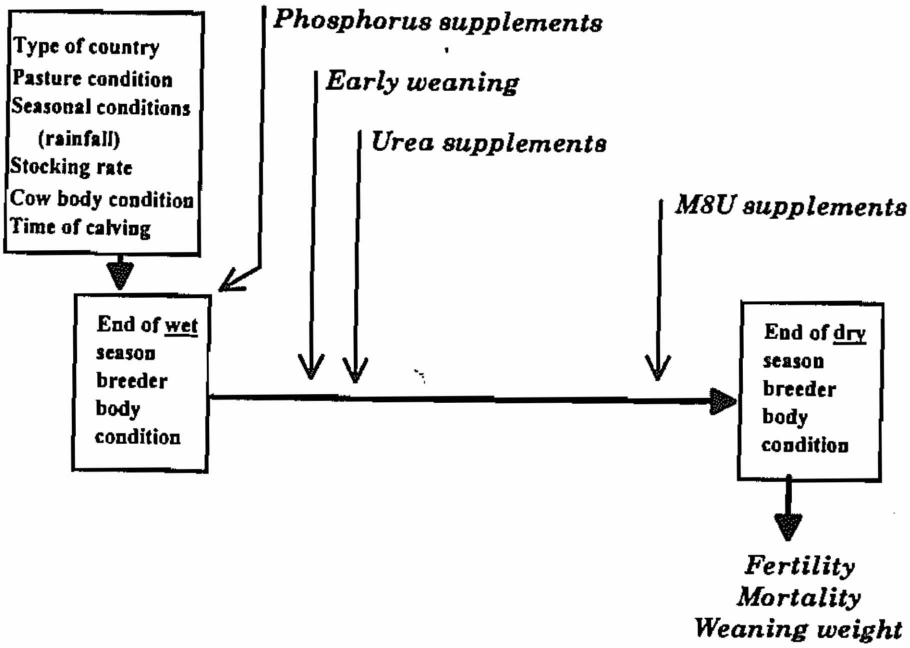


Figure 5.1 A schematic representation of the factors influencing breeder productivity in a semi-arid environment. It is assumed that fertility and mortality are determined primarily by breeder body condition at the end of the dry season and by the timing of the seasonal break. Breeder body condition at the end of the wet season may be increased by pasture management and phosphorus supplements in phosphorus deficient areas. Rate of loss of breeder body condition during the dry season may be reduced by weaning or by urea-based supplements. Alternatively survival supplements (eg. M8U) can be fed late in the dry season to avert mortality.

(iii) The economic consequences of other aspects of implementing supplementation systems (eg. weight profile of the weaner crop, risk management, the efficacy of supplement delivery systems) are discussed.

This economic analysis should be read in conjunction with the Management Package which is being produced by the project team. This package discusses the importance of breeder body condition for mortality and fertility, and the application of various strategies to alleviate the dry season under-nutrition of the breeder. This is the principal cause of low breeder herd productivity in the seasonally dry tropics of northern Australia. It is recognised that there are many potential errors first in estimating the effects of management strategies on breeder body condition, and second on predicting fertility and mortality from breeder body condition. Nevertheless this procedure has been adopted because we consider it the most likely way in which generalisations can be made between very different climatic and property situations.

5.2. Main conclusions

(i) The economic benefits of supplementation strategies for the breeder herd in the northern Australian environment should be considered from a number of aspects, only some of which can be readily evaluated as financial changes. Benefits can be considered firstly as changes in weaning rate and mortality, secondly as changes in weaner weight and the timing of weaning, and thirdly from the perspective of risk management.

(ii) To address the benefits to breeder herd productivity as weaning rate and breeder mortality a spreadsheet model (BREEDMOD) was developed to evaluate in a generalised form the consequences of breeder body condition in the late dry season on mortality and fertility of the breeder herd. This model depends on the premise that breeder productivity is primarily a function of breeder body condition in the late dry season. Estimates were made of the consequences of supplementation strategies on breeder productivity for various probabilities of the timing of the seasonal break and for herds at low, medium or high historical productivity. The BREEDCOW model was then used to estimate financial changes (eg. gross margin) for a range of herd situations and supplement input costs.

(iii) The changes in gross margin indicated that where dry season urea supplementation reduced breeder mortality this strategy was highly cost-effective. Where these urea supplements were provided as dry licks and only increased weaning rate there was little change in gross margin, supplementation costs being almost as great or even greater than the additional income..

(iv) Changes in gross margin of the breeder herd due to strategic supplementation were highly dependent on supplementation costs to achieve an increase in the breeder body condition at the end of the dry season. The estimated cost to increase breeder body condition by one unit (ie. from "backward store" to "store" condition) ranged from about $7 (for efficient water medication) to $15 (for dry licks where it is difficult to achieve target intakes) to $30 (for some lick blocks). When urea-based supplements reduced breeder mortality they were highly cost-effective with, for example, increases in gross margin of up to $11 per animal equivalent. Where the only benefit valued was increased number of calves weaned, and supplementation was assumed to cost $15 per breeder per annum, the increases in gross margin were generally small (eg. $-5 to $+2 per animal equivalent). Where supplementation costs can be reduced (eg. with water medication systems) the benefits of dry season urea supplementation strategies on weaning rates were highly cost-effective. Conversely where supplement costs were high (eg. due to provision of urea in commercially manufactured blocks), the costs of dry season urea supplementation was not likely to recovered from the additional cattle sales.

(iv) Dissimilar management strategies (dry season urea supplementation, wet season phosphorus supplementation, 'survival' supplementation late in the dry season with M8U, early weaning) were compared on the basis of their cost and efficacies to increase breeder body condition late in the dry season.

The economic analysis suggested that increases in gross margin were fairly similar for the three principal management options which can be applied within the annual seasonal cycle (ie. for urea-based supplements during the dry season, phosphorus supplements during the wet season and early weaning).

(v) The importance of increases in weaner weight at the end of the wet season and growth rate in early life of the animal will depend on the age of turnoff and the target market. Where turnoff is primarily as mature grass-fed bullocks these are likely to be of lesser importance. Conversely with young turnoff (eg. store, export, feedlot finishing) and where the producer actually receives a higher return for young heavy cattle, early-life growth will be important. Similarly improvement in nutritional management of the breeder herd usually increases the proportion of calves born in the early wet season, with important benefits for weaning weight at the end of the wet season, homogeneity of the weaner crop and easier management of the breeder herd. Although the magnitude and importance of these benefits will vary widely with the specific property situation and are difficult to value, they are nevertheless real benefits from improved nutrition of the breeder herd.

(vi) Benefits to improved management which were not valued in this economic assessment included:

(a) a tighter calving pattern earlier in the wet season leading to lines of weaners at first-round muster which are heavier and more similar in age and liveweight,

(b) fewer breeders lactating after first-round muster and during the dry season in continuously mated herds,

(c) much greater management flexibility in the event of a light or failed wet season and higher cull cow values because breeders are in better body condition year-round.

(vii) Important benefits from improved nutritional management of the breeder herd include increased management flexibility and a reduction in risk associated with delayed seasonal breaks or failed wet seasons. If breeders are in good body condition in the late dry season, then the range of possible management options is much wider (eg. as sale, agistment), decisions less frequently have to be made under pressure, and the risk of severe operating or capital losses (as breeder deaths or forced sale at low prices) is reduced. This improved management of risk is difficult to value.

(viii) The economic benefits from improved technology for supplement delivery include allowing the option to implement a supplementation strategy if and when desired, minimising the cost of supplements and reducing the variation in productivity among cattle within the mob. Knowledge of some aspects of supplement delivery systems (eg. siting of supplementation points) is also necessary to resolve potential conflicts between supplementation strategies and sustainable land use.

(ix) In conclusion economic evaluation of supplementation strategies to improve nutritional management of the breeder herd should be related to the entire range of management strategies available to improve the nutritional status of the herd. Some benefits from improved breeder nutrition will be direct. Others, while important, will be indirect and difficult to value.

5.3 Detailed description of the economic analysis

5.3.1 Form of the benefits which may follow from improvement in the nutrition of the breeder herd.

(i) Breeder mortality. As discussed in the Management Package breeder mortality is often much higher than is commonly recognised by producers, and averages about 10% per annum in northern Australia. Under-nutrition during the dry season in association with pregnancy and/or lactation is a major cause, although of course not the only cause, of these high mortality rates.

(ii) Breeder fertility. From a breeder herd perspective this is usually best estimated as the weaning rate, and more specifically as the percent of calves weaned per 100 cows originally mated and retained. As discussed in the Management Package, in the dry tropics of northern Australia the primary limitation to weaning rate is the delay for lactating cows to become pregnant after calving. This is primarily related to the body condition of breeders at the time of mating. Even in the continuously-mated systems usually used in northern Australia it is the body condition of the breeder during the wet season which is critical.

(iii) Although mortality and fertility are of primary concern, there are also other less direct benefits to increasing the plane of nutrition and the body condition of breeders in the dry tropics of northern Australia. These include:

(a) By maintaining the breeder herd in better body condition through to the late dry season, a much more flexible management response is possible when there is a delayed break to the wet season or a failed wet season. For example, if breeders are in good body condition major decisions about how to deal with a drought situation (by sale of cattle, seeking agistment, etc.) can be delayed until the seasonal outlook is clearer (e.g. in late January). Also, if breeders are in good body condition they can be sold immediately, their sale price is likely to be much higher regardless of the time of the year, and they can be transported for sale or agistment easily.

(b) Better body condition of breeders will be associated with tighter calving patterns, a much higher proportion of calves born during the early to mid wet season at the most desirable time of the year, improved calf growth rates and heavier weaners. Although difficult to value, these will all contribute to easier and more efficient management of the breeder herd and higher value of the weaner crop.

(c) Higher fertility rate of the breeder herd allows a much more rigorous culling of the breeder herd for a wide range of reasons including fertility, growth, conformation to a desired type or as a simple means to eliminate cows due to calve out-of-season.

5.3.2 Approach to economic analysis of breeder fertility and mortality responses

(i) Results from experiments in DAQ.098 and elsewhere were used to estimate:

(a) the changes in breeder fertility due to changes in the end-of-dry-season breeder liveweight and body condition and,

(b) the response as breeder body condition to urea supplements fed during the dry season.

(ii) A spreadsheet model (BREEDMOD) was developed to estimate the breeder fertility response to increasing the "end-of-dry-season" breeder liveweight and body condition. This model was used to predict on a generalised basis the decrease in mortality and the increase in fertility due to increased end-of-dry-season body condition.

Herds were considered which calved between November and February, which historically had low, medium, high levels of productivity, and for 4 seasonal break dates (mid-October, mid-November, mid-December and mid-January). For the expected profile of seasonal breaks in three zones (coastal, Dalrymple, harsh) the average mortality and fertility, and the consequences for increasing breeder body condition in the late dry season mortality and fertility, were estimated from the model.

(iii) The BREEDCOW model was used to calculate the changes in herd numbers and herd profile, and the changes to gross margin and return on capital, due to improvement of the end-of-dry-season body condition of the breeder herd.

(iv) Dissimilar management strategies were compared on the basis of the respective costs to increase the end-of-dry-season breeder body condition. The management strategies which were compared were:

(a) increasing end-of-wet-season (ie. start of dry season) breeder liveweight,

(b) supplementation with urea-based supplements through the dry season,

(c) early weaning,

(d) feeding "survival" supplements in the late dry season to avoid excessive mortality.

5.3.3. *Input variables used to calculate the model BREEDMOD*

(i) Relationship between breeder body condition and fertility

The relationship between breeder body condition and breeder liveweight has been discussed in detail in the Management Package developed for DAQ.098. It has been assumed that one condition score unit (on a 9 point scale) is equivalent to 30 kg liveweight.

For the purposes of the economic analysis it was assumed that all breeders which are going to calve in a specific year will do so from early November until late February. This was a convenient simplification by the model of the actual situation in continuously-mated herds, although by expanding the size of the spreadsheet by a factor of 10-20 the model could accommodate cows calving at any time of the year. The simplification was considered justified since even in continuously-mated herds most cows will calve at this time of year. Also as herd fertility improves into the desirable 70-90% weaning rate, results from a number of PDS and research sites indicates that there will be a strong shift towards most cows calving during the optimal November to February period.

The model predicts fertility of lactating cows as a curvilinear function of breeder body condition in the early wet season, which is equivalent to the start-of-mating body condition (SOM-CS). The function used for high fertility herds (presently producing a 70% weaning rate) was:

$$\text{Weaning rate} = 0 + 15\ (\text{SOM-CS}) - 0.3\ (\text{SOM-CS})^2$$

This function states that the percentage of lactating cows which become pregnant and produce a calf to weaning age increases by 15% units for each increase in body condition score (1-9 scale) of the breeder at the start of mating, with accommodation that the relationship must be curvilinear (since weaning rate obviously cannot exceed 100%). The function was calculated as the "best fit" to the experimental data reviewed in the Management Package, and also agrees with correlations derived from the major breeder experiments conducted during DAQ.098.

No completely satisfactory means was found to allow quantitatively for the adverse effects on breeder fertility of severe under-nutrition during previous dry seasons. In the Management Package it was estimated that this effect could often reduce fertility by up to 20% units, and "spike-feeding" in the late dry season to correct this problem has increased pregnancy rates by up to 15-20%. In constructing the model this problem was addressed by using different coefficients in the curvilinear function to predict pregnancy rate of the lactating cow. In "historically low fertility herds" weaning rate was reduced by 20%, and in "historically medium fertility herds" weaning rate was reduced by 10%. This change in prediction is consistent with present understanding of the physiology of the breeder and with observation that nutrition of weaner heifers and of breeders during the dry season will often be poor in those areas and on those properties where weaning rate is low (eg. 50% as assumed for the "low herd" in the model).

The percentage of non-lactating non-pregnant cows becoming pregnant and producing a calf to weaning age was assumed to be 90%, irrespective of the body condition score of the cow in the late dry season.

The plane of nutrition during the wet season can have appreciable effects on the reconception of the lactating cow. As discussed in the Management Package it appears that the cow generally has to be in positive energy balance to become pregnant, so during poor wet seasons pregnancy rate will be reduced. For two reasons no attempt has been made to allow for variation between years in nutrition during the wet season. Firstly the primary purpose of the model predication is to improve understanding of the consequences of management during the dry season. The nutrition during the subsequent wet season will at best have to be predicted as a long-term average for the region, and therefore between-year variation in the subsequent wet season nutrition will be of little relevance to management decisions during the previous dry season. Secondly because the breeder body condition versus fertility relationship described in the Management Package was derived from experiments during many years, uncertainty in the estimation of breeder fertility includes variation between years in wet season nutrition in the environment where the experiments were done.

(ii) Relationship between breeder body condition and mortality

The mortality of breeders during the following month due to under-nutrition during the late dry season was predicted as:

Mortality rate (%) = 100 - 34 (CS) for CS<3

Hence if breeders are in body condition score of 3 or greater (on a 9-point scale) (ie. in "poor" body condition or better the model assumes that none will die due to under-nutrition during the following month. Among breeders in CS 2 ("very poor" body condition) 32% will die within a month, and among breeders in CS 1 ("emaciated" body condition) 66% will die within a month.

Physiological status (ie. as dry, pregnant, lactating) is accommodated as more rapid loss of body condition by late pregnant and lactating cows leading up to monthly period when the prediction was made of the breeder mortality.

(iii) Rate of liveweight/body condition loss during the late dry season until the seasonal break

This is considered as an input variable in the model.

For most calculations of the model it has been assumed that dry cows until the last month of pregnancy are losing 0.4 kg per day or 0.4 body condition units per month. It has been assumed that during late pregnancy and early lactation the breeder is losing 1.25 kg per day or 1.25 condition score units per month. These rates of loss have been calculated by assuming that during the late dry season the dry breeder consumes 2% liveweight of dry pasture, that the late pregnant/lactating breeder consumes 2.5% liveweight of pasture, and that the pasture contains 5 MJ ME per kg. Also that the energy derived from liveweight loss of the cow is 20 MJ ME per kg. These rates of loss agree reasonably with actual measurements of liveweight loss of breeders grazing abundant dry season standing feed at Swan's Lagoon at this time of the year.

If dry pasture has become scarce or if it has been damaged by spoiling rain or frost it is likely that pasture intake will be substantially lower than the above values, and the rate of liveweight loss will be substantially increased. At zero pasture intake a dry cow should theoretically be losing 1.5-2.0 kg liveweight per day, and a cow in late pregnancy/early lactation 2.5-3.0 kg liveweight per day. Conversely where cattle are consuming substantial browse the rate of cow liveweight losses is likely to be lower.

It is assumed that no true liveweight loss (ie. loss other than that due to changes in gut fill) occurs from two weeks after the seasonal break.

(iv) Date of the seasonal break

The model calculates the consequences for breeder mortality and fertility for four dates for the seasonal break: ie. mid-October, mid-November, mid-December and mid-January. Since the likelihood of seasonal breaks obviously changes with region, with major consequences for mortality and fertility, the 10-year average mortality and fertility has been calculated for three profiles of seasonal breaks (Table 1). Profile A is intended to be typical of the northern coastal speargrass zone with probabilities of the seasonal break occurring from October to February being 20%, 30%, 30% and 10% for respective months. Profile B was intended to be typical of the more inland areas of north Queensland (eg. Dalrymple shire), and Profile C of the harsh zone further inland.

Table 1. Percent likelihood of seasonal breaks occurring in each month from October to January for three regions (northern coastal speargrass zone, Dalrymple shire and harsh inland zone)

Region	Month of the seasonal break			
	October	November	December	January
Profile A (Coastal speargrass)	30	30	30	10
Profile B (Dalrymple shire)	25	25	30	20
Profile C (Harsh inland zone)	0	15	20	65

(v) Profile of breeder body condition score in the late dry season

A series of profiles of body condition of breeders in the late dry season and at the commencement of the critical period of liveweight loss is shown in Table 2. We know of no useful data where these measurements have been made in the late dry season in breeder herds ranging in fertility levels. The values used were arrived at as best estimates and by an iterative process which also gave calculated fertility rates in accord with approximate rates of 50%, 60% and 70% weaning rates in low, medium and high fertility herds respectively.

Table 2. Profile of body condition score of breeders in the late dry season on the 1 November

Body condition status		Present fertility level of the herd		
		Low	Medium	High
Pregnant breeders				
Condition	6	0	20	35
	5	5	25	35
	4	25	15	10
	3	25	5	0
	2	5	5	0
Non-pregnant breeders				
Condition	6	40	30	20

5.3.4 *Changes in breeder herd mortality and fertility due to increased body condition of all age group of breeders in the late dry season*

An example of the inputs and outputs of a specific run of the BREEDMOD spreadsheet is shown in Table 3. The results demonstrate the large impact of the timing of the seasonal break on both mortality and fertility. For example, in a historically medium productivity herd, delaying the break from mid-October until mid-January increased mortality of lactating cows from 0% to 12%, and decreased fertility of lactating cows from 54% to 27%.

Table 3. Example of the inputs and outputs of the BREEDMOD spreadsheet model to predict effects on mortality and fertility of increasing body condition of the breeder herd in the late dry season

	A	B	C	D	F	G	H	I	J	K
1	Inputs (Medium fertility herd)				Outputs (Medium fertility herd)					
2										
3	Condition score at 1 Nov	Condition score	Percent of herd							
4	Pregnant breeders	6	20							
5		5	25		Seasonal break	Mortality %	Fertility %	Mortality %	Fertility %	
6		4	15			(wet cows)	(wet cows)	(all cows)	(all cows)	
7		3	5							
8		2	5		15-Oct	0	54	0	65	
9	Dry breeders	6	30		15-Nov	2	47	2	60	
10	total		100	70	15-Dec	6	38	4	54	
11					15-Jan	12	27	8	46	
12	Calving distribution	Nov.	25							
13		Dec	25		10-Year mean	4	45	3	58	
14		Jan	25		Profile A					
15		Feb+Mar	25							
16					10-Year mean	5	42	3	57	
17	Rate of loss of CS before break:				Profile B					
18	Before calving (CS/month)		0.4							
19	After calving		1.25		10-Year mean	9	32	7	50	
20	Pregnancy rate during mating (%)		Y= -10 + 15 (SOM-CS) - 0.282 (SOM-CS)^2		Profile C					
21	Mortality rate (%)		Y= 100 - 34 (CS) for CS<3							
22	Slope of mortality rate		34							
23	(Note that mortality is based on CS at the beginning of the month)									
24	Time of seasonal break	Oct	Nov	Dec	Jan					
25	Profile A (Coastal)	30	30	30	10					
26	Profile B (Dalrymple ?)	25	25	30	20					
27	Profile C (harsh)	0	15	20	65					
28										
29	Modification in CS in Nov	0								
30										
31										

Table 4. Predicted changes in breeder mortality and fertility for herds in three climatic zones due to increases of up to one unit in breeder body condition late in the dry season

Breeder condition score and climatic profile	Low		Medium		High	
	Mortality	Fertility	Mortality	Fertility	Mortality	Fertility
Base level productivity						
Profile A	5	48	3	58	0	68
B	6	46	3	57	0	66
C	14	41	7	50	1	58
Breeder condition increased by 0.33 condition score						
Profile A	3	50	2	61	0	71
B	4	49	2	59	0	69
C	9	43	5	52	0	61
Breeder condition increased by 0.67 condition score						
Profile A	2	53	1	64	0	75
Profile B	2	51	2	62	0	73
Profile C	6	45	3	55	0	65
Breeder condition increased by 1.0 condition score						
Profile A	1	55	1	67	0	78
B	1	54	1	65	0	76
C	3	48	2	58	0	68

Climatic profiles A, B and C refer to differing probabilities of when the seasonal break will occur as described in the text.

Table 4 shows the predicted changes in mortality and fertility of low, medium and high-producing herds calculated using BREEDMOD for improvements in end-of-dry-season breeder condition score in three climatic profiles. The base level productivity is that without any additional management inputs, and this has been compared with the productivity when breeder herd body condition has been increased by up to one unit eg. from "backward store" to "store" body condition. In low-producing herds there were large reductions in mortality (up to 11% units) and increases in fertility of about 7% units. In high-producing herds there was no potential to reduce mortality, but fertility was increased by 10% units.

5.3.5 *Changes in gross margin with supplementation of all age groups of the breeder herd during the dry season to reduce breeder body condition losses*

In the first instance the cost-effectiveness of feeding urea-based supplements during the dry season to the entire breeder herd was examined. For these analyses it was assumed that breeder body condition at the end of the dry season could be increased by one body condition unit by feeding $15 per breeder of a urea-based dry lick supplement through the dry season. Also it was assumed that the supplement cost to increase breeder body condition by 0.33 CS was $4, and to increase breeder body condition by 0.67 CS was $8. This non-linearity of amount of supplement and animal response was estimated from the shape of the curve of growth responses to increasing amounts of urea supplement (Management Package section 3.6.4). The evidence that these responses are likely to occur is discussed in the Management Package. In the northern speargrass zone this response is only likely to occur during severe dry season conditions, but in the harsh zones even larger responses (eg. up to 1.5 body condition score units) are likely with these inputs of urea supplement. Type of supplement delivery system will also have a major impact on the cost to achieve increases in breeder body condition. This is discussed further in Section 5.3.6 below.

Table 5 shows the inputs and outputs for the BREEDCOW model for a low-fertility herd, without supplementation or with the three increments of supplementation. These inputs and outputs are shown when turnoff of cattle is primarily at either 18 months of age (eg. as stores or live export) or as 4-year-old bullocks. Tables 6 and 7 show similar estimates for herds which are historically at "medium" and "high" levels of productivity.

The analyses shown in Tables 5, 6 and 7 are obviously highly dependent on the assumed sale prices for the various classes of cattle and on the changes in mortality and fertility which can be achieved for supplement inputs of between Nil and $15 per breeder. The results shown in the tables should therefore be considered only as a guide to the likely changes in gross margin and capital invested in the herd. Calculations using best estimates of current prices and returns are highly recommended for specific property and cattle market situations.

In herds without additional supplementation the gross margins from bullock production were much higher than for store turnoff for the low-producing herd ($50 versus $35 per AE), somewhat higher for the medium-producing herd ($69 versus $61 per AE) and fairly similar for the high-producing herd ($86 versus $83). This is in agreement with previous estimates of gross margins from bullock and store turnoff in northern herds. Bullock production is more profitable in low weaning-rate herds, but store production is likely to become the better alternative as weaning rate is increased. Furthermore in the estimates shown gross margin increased substantially with the change from the low- to high-producing herd, but again this is highly dependent on the additional variable costs required to achieve this increase in productivity on a specific property.

The increases in gross margin due to feeding supplements to increase breeder body condition was substantial in the low-producing herd (from $50 to $61 per AE for bullock production, a similar increase for store production). This was primarily due to the decrease in breeder mortality rate and an associated 35% increase in cull cow sales. In the herds which were historically medium or high-producing herds and where breeder mortality was already low, the change in gross margin due to feeding supplements was negligible or there was even a small decrease. Although the number of both female and male cattle sold was increased by the supplement input, the increased income was only slightly greater than the supplement feeding costs. It should also be noted that the small increase in gross margin also depended on increased sale price of cull cows expected from larger frame size and better body condition at the time of sale. There are likely to be some benefits from supplementation, particularly in the 'medium' and 'high' producing herds, which are not included in the BREEDCOW analyses but which would increase income and reduce management costs. Specifically, improved body condition of cows is likely to move the calving interval to the more desirable time of the year, increase weaning weight and improve homogeneity of lines of weaners. These are all useful attributes and will tend to increase the value of the weaner crop.

Table 5. Changes in cattle numbers, cattle sales and gross margins when up to $15 per breeder per year of supplements are used to increase productivity of an historically low-producing herd of 2000 AE in the Dalrymple shire (46% weaning, 12% breeder mortality)

Estimate of cattle numbers/sales/economic parameters		Turnoff of 4 y.o. bullocks and cull cows				Turnoff of stores and cull cows			
		Base level production	Increase in end-of-dry season breeder liveweight			Base level production	Increase in end-of-dry season breeder liveweight		
			+10 kg	+20 kg	+30 kg		+10 kg	+20 kg	+30 kg
Cattle numbers	Total cattle (number)	1953	1935	1922	1910	1959	1938	1920	1912
	Females mated (number)	856	835	824	807	1081	1081	1085	1077
	Heifers retained (number)	196	168	148	128	248	218	194	180
	Calves/cows mated (%)	46	49	51	54	46	49	51	54
	Calves/cows surviving (%)	52	54	55	57	52	54	55	57
	Breeder deaths - poverty (%)	6	4	2	0	6	4	2	0
	- other (%)	6	6	6	6	6	6	6	6
	- total (%)	12	10	8	6	12	10	8	6
	Weaner deaths (%)	13	10	8	6	13	10	8	6
Cattle sales	Steers sold (number)	155	170	179	190	207	232	247	266
	Steer price ($)	600	600	600	600	300	300	300	300
	Cull cows sold (number)	48	53	59	65	61	68	78	82
	Cull cow price ($)	300	310	320	330	300	310	320	330
	Young heifers sold (number)	0	36	63	90	0	47	82	111
	Young heifer price ($)	200	200	200	200	300	300	300	300
	(Female/total) sales (%)	24	34	40	45	23	33	39	42
	(Turnoff/total) sales (%)	10	13	16	18	14	18	21	24
Costs and returns	Additional supplement cost per breeder ($)	0	4	8	15	0	4	8	15
	Gross margin ($/AE)	50	55	58	61	35	40	43	44

Supplements are fed to weaners, yearlings and breeders. It is assumed that $15 of supplement is required to increase end-of-dry season breeder body condition by one unit (30 kg).

Table 6. Changes in cattle numbers, cattle sales and gross margins when up to $15 per breeder per year of supplements are used to increase productivity of an historically medium-producing herd of 2000 AE in the Dalrymple shire (57% weaning, 7% breeder mortality)

Estimate of cattle numbers/sales/economic parameters		Turnoff of 4 y.o. bullocks and cull cows				Turnoff of stores and cull cows			
		Base level production*	Increase in end-of-dry season breeder liveweight			Base level production*	Increase in end-of-dry season breeder liveweight		
			+10 kg	+20 kg	+30 kg		+10 kg	+20 kg	+30 kg
Cattle numbers	Total cattle (number)	1917	1911	1912	1908	1988	1977	1977	1967
	Females mated (number)	788	777	760	743	1009	1009	997	993
	Heifers retained (number)	133	124	121	111	288	271	268	251
	Calves/cows mated (%)	57	59	62	65	57	59	62	65
	Calves/cows surviving (%)	61	63	66	68	61	63	66	68
	Breeder deaths - poverty (%)	3	2	2	1	3	2	2	1
	- other (%)	4	4	4	4	4	4	4	4
	- total (%)	7	6	6	5	7	6	6	5
	Weaner deaths (%)	7	6	6	5	7	6	6	5
Cattle sales	Steers sold (number)	194	200	205	213	261	273	284	299
	Steer price ($)	600	600	600	600	300	300	300	300
	Cull cows sold (number)	59	62	61	64	76	81	80	85
	Cull cow price ($)	350	360	370	380	350	360	370	380
	Weaner heifers sold (number)	92	106	115	130	106	128	141	166
	Weaner heifer price ($)	200	200	200	200	300	300	300	300
	(Female/total) sales (%)	44	46	46	48	41	43	44	46
	(Turnoff/total) sales (%)	18	19	20	21	22	24	26	28
Costs and returns	Additional supplement cost per breeder ($)	0	4	8	15	0	4	8	15
	Gross margin ($/AE)	69	70	70	70	61	61	60	59

*Base level achieved with $10 supplement per weaner per year. Supplements are fed to weaners, yearlings and breeders. It is assumed that $15 of supplement is required to increase end-of-dry season breeder body condition by one unit (30 kg).

Table 7. Changes in cattle numbers, cattle sales and gross margins when up to $15 per breeder per year of supplements are used to increase productivity of an historically high-producing herd of 2000 AE in the Dalrymple shire (66% weaning, 2% breeder mortality)

Estimate of cattle numbers/sales/economic parameters		Turnoff of 4 y.o. bullocks and cull cows				Turnoff of stores and cull cows			
		Base level production*	Increase in end-of-dry season breeder liveweight			Base level production*	Increase in end-of-dry season breeder liveweight		
			+10 kg	+20 kg	+30 kg		+10 kg	+20 kg	+30 kg
Cattle numbers	Total cattle (number)	1894	1895	1897	1898	2007	2007	2007	2006
	Females mated (number)	736	721	700	686	959	949	936	926
	Heifers retained (number)	93	91	89	87	315	312	308	304
	Calves/cows mated (%)	66	69	73	76	66	69	73	76
	Calves/cows surviving (%)	67	70	74	78	67	70	74	78
	Breeder deaths - poverty (%)	0	0	0	0	0	0	0	0
	- other (%)	2	2	2	2	2	2	2	2
	- total (%)	2	2	2	2	2	2	2	2
	Weaner deaths (%)	3	3	3	3	3	3	3	3
Cattle sales	Steers sold (number)	226	231	238	243	302	312	326	336
	Steer price ($)	600	600	600	600	300	300	300	300
	Cull cows sold (number)	74	72	70	69	98	97	94	93
	Cull cow price ($)	350	360	370	380	350	360	370	380
	Weaner heifers sold (number)	150	158	167	174	187	198	215	227
	Weaner heifer price ($)	200	200	200	200	300	300	300	300
	(Female/total) sales (%)	50	50	50	50	48	49	49	49
	(Turnoff/total) sales (%)	24	24	25	26	29	30	32	33
Costs and returns	Additional supplement cost per breeder ($)	0	4	8	15	0	4	8	15
	Gross margin ($/AE)	86	86	86	84	83	82	81	78

*Base level achieved with $10 of supplements for weaners plus $10 for first-calf cows per animal per year. Supplements are fed to weaners, yearlings and breeders. It is assumed that $15 of supplement is required to increase end-of-dry season breeder body condition by one unit (30 kg).

5.3.6 Consequences of changing the cost of providing urea supplements through choice of the supplement delivery system

As discussed in the Management Package the cost of strategies to supplement with urea or phosphorus or to care for early weaners can vary widely depending on the supplement delivery system used and the infrastructure available on the specific property. In the BREEDCOW calculations a cost of $15 per breeder was assumed, and this was calculated as the cost of feeding high-urea dry lick supplements containing some cottonseed meal and providing 30-60 g urea per head per day for 5 months. To provide this amount of supplementary urea an efficient water medication system may halve the cost to about $7 per breeder, while feeding commercially manufactured lick blocks (eg. 20% urea blocks costing $800 per tonne) could increase the cost to more than $30 per breeder. Similarly the costs of providing phosphorus can range widely from situations where cattle will eat appropriate amounts of a kynophos/salt dry lick, to the cost of such a lick with cottonseed meal or molasses to increase intake, to commercially-manufactured blocks. For example to provide 10 g P per breeder per day for 6 months could cost from $7 to $30 per breeder.

Table 8. Consequences on gross margin of increasing the cost of supplements ($ per breeder per year) to increase end-of-dry season breeder condition score by one condition score unit for herds presently at low, medium and high levels of production and with bullock turnoff

Management strategy	Expected gross margin ($ per AE)		
	Low	Medium	High
<u>No supplement input</u> (ie. accept present production without supplementation)	50	69	87
<u>Supplement input costing</u>:			
$7 per breeder per year	66	77	90
$11	63	74	<u>88</u>
$15	61	<u>72</u>	86
$20	57	69	838
$25	54	66	80
$30	<u>51</u>	63	77

The change in gross margin in a medium-productivity herd selling bullocks as the cost to increase end-of-dry-season breeder condition by one body condition score increases from $7 to $30 per breeder is shown in Table 8. These estimates of gross margin indicate that for a low-production herd the cost of supplementation to increase breeder body condition by one unit in the late dry season can increase to about $30 per breeder per year before it becomes uneconomical to use supplements to increase productivity. However, with the medium-productivity herd the cost of supplementation can increase to only about $15 per breeder, and with the high-productivity herd to only about $11 per breeder for supplementation to be profitable. Two issues may change this conclusion. Firstly the calculations assume that the one body condition unit increase in the breeder body condition in the late dry season does in fact occur in response to supplements. Where supplements are fed in inappropriate circumstances (eg. feeding urea supplements when there is green pick from storm rain) much lower breeder body condition responses are likely, and the supplement program is less likely to be profitable. Conversely where responses to supplement are greater than the one body score condition unit (eg. in the harsh zone) more could be spent on supplements. The second issue is that there may be benefits in addition to those valued in the BREEDCOW calculations (eg. heavier weaners, tighter and earlier calving intervals, reduced risk in managing the herd) which are considered important for the specific property situation. The cost of the improved nutritional management not recovered as increased cattle sales may be considered as the cost of achieving easier management of the breeder herd or reducing the risk of severe drought losses.

5.3.8 Consequences of feeding some sub-groups of the breeder herd

It may often be desirable to feed only that part of the breeder herd which is likely to be most responsive to supplements. For example cows suckling their first calf are well known to be a "problem" animal within the breeder herd, due primarily to their greater needs for nutrients for growth as well as for lactation. Also there may be large differences between paddock groups of breeders. In general the greatest responses to supplements is likely to be in those paddocks or with those breeder groups which are in the poorest body condition, particularly when body condition of breeders is decreasing to the extent that the risk of death from prolonged under-nutrition becomes appreciable.

The economic analysis in such situations can be done using the procedures described above for the entire herd with the changes in gross margin applicable to the subgroup of breeders where the management changes are made.

5.4 Which management strategy should be used to improve breeder nutrition and productivity?

Decisions about which strategy (or strategies) is optimal for a specific property will obviously depend on numerous factors including:

(i) Historical and present productivity of the breeder herd in relation to what the manager considers are appropriate and realistic target levels for the specific situation. The "no change" decision may be the "best-bet" decision.

(ii) Likelihood of deficiencies in phosphorus, sulphur or other minerals for growth during the wet season. In phosphorus deficient areas, phosphorus supplements are likely to be the highest priority strategy.

(iii) Likelihood of rain during winter and spring to alleviate or exacerbate the dry season conditions. The probability of winter and spring rain is much higher in coastal than in inland areas, and in southern than in northern areas. This can be estimated from rainfall records and from climatic forecasting by, for example, using the Rainman package.

(iv) Probabilities of when the seasonal break will occur.

(v) Amount and quality of pasture available at the end of the wet season and the seasonal outlook.

(vi) The body condition of the breeder herd at the end of the wet season.

(vii) At the end of the wet season the number and age profile of calves, and the expected distribution of calving by pregnant cows.

(viii) Whether early weaning is appropriate. Early weaning should only be considered in circumstances where resources (eg. as labour, supplements, etc.) are available to care for the early weaners.

(ix) Relative costs of long-term low level strategies compared with survival feeding strategies.

(x) The outlook for markets.

(xi) The cash-flow and debt situation of the breeder herd as a business.

(xii) The approach of the manager to risk.

As discussed in the Management Package there are three obvious short-term management options to increase end-of-dry season breeder body condition on a specific property in a specific year. These are:

(i) Urea supplements fed during the dry season to reduce breeder liveweight loss,

(ii) Early weaning by manipulation of both the time of weaning and, in a continuously-mated herd, the age/weight of weaning.

(iii) Improving breeder body condition at the end of the wet season eg. by feeding phosphorus, sulphur or sodium supplements during the wet season.

Given the complexity of the above factors influencing the "best-bet" decision it is difficult to make generalisations. However, we would like to emphasise that we believe in most circumstances the simpler and low-input management changes should be carefully considered before higher-input management changes. Control of diseases such as botulism, investment in fencing to allow at least some segregation (eg. of weaners, heifers, cattle for sale) and effective culling management usually involve low input and can result in major increases in herd productivity.

Among the higher input options discussed in detail in the management package, it is likely that in areas which are "deficient" or "very deficient" in phosphorus, sulphur or sodium, provision of these nutrients to the herd should be addressed as the next priority. This will usually involve a supplementation program, if possible supplementing during the season of pasture and cattle growth. When feeding such supplements urea should also be included in the supplement during the late wet season. The additional cost to include the urea will be low in relation to the benefits. If wet season supplementation with phosphorus is not possible and phosphorus supplements have to be fed during the dry season then urea should definitely be included in the supplements.

When the phosphorus issue has been addressed the next decision will be to decide between early weaning, urea supplementation and survival feeding strategies. In coastal areas with highly variable severity and length of dry seasons and ready access to molasses the "survival feeding when required" strategy may often be the best. It may be more cost-effective when averaged over a number of years than a long-term low level strategy commenced early in each dry season. For example, this strategy has been used in combination with early weaning for the Swan's Lagoon breeder herd over the last decade, and has produced low mortalities and high branding rate at acceptable supplementation costs (see Appendix 3). Alternatively in more inland areas where the probability of rain in winter and spring is low and the cost of survival feeding very high, if any supplements are used the long-term low level strategy is more likely to be appropriate.

Table 9 compares the major factors likely to influence the appropriateness of a particular strategy, and our best estimates of the consequences for breeder liveweight. This approach assumes that the breeder liveweight or body condition status is the key determinant of breeder productivity, and that if different strategies improve breeder body condition to similar extents they will have similar effects to increase fertility and decrease mortality.

5.5 Consequences of supplementation on grazing pressure

One assumption made during the above economic analysis was that the stocking capacity of the property (as Animal Equivalents; AE) does not change as supplementation strategies are adopted. However pasture intake is likely to increase by 10-30% during the period when urea or phosphorus supplements are fed, thus increasing grazing pressure and arguably reducing the number of AE which can be stocked.

If the provision of strategic supplements means that the number of AE of the herd must be reduced by up to 30% this would have important consequences for the changes in gross margin in response to supplements. Fewer cattle would mean a proportionately lower gross margin. However, for several reasons the number of cattle may not have to be reduced, or at least not by 30%;

(i) Urea supplements are applied only during the dry season and the number of cattle will only have to be reduced if all of the available dry standing pasture (ie. except the vegetation cover required for Landcare reasons) is used by the end of the dry season. Usually much of this dry feed will be wasted anyway on tropical tallgrass native pastures.

Table 9. Comparison of the principle factors influencing the appropriateness of various strategies, and their expected benefits and costs, for improving nutrition of the breeder herd

Strategy	Principal factors affecting appropriateness of the strategy for a specific situation	Likely benefits	Likely costs
Adjust stocking rate	1. Susceptibility of the land type and pasture types to degradation 2. Variability between years in rainfall 3. Preparedness to accept uncertainties of a policy of "trading in cattle" depending on the season 4. Attitude of the manager to risk	1. Benefit will be highly dependent on the existing stocking rate 2. Highly dependent on seasons and markets	1. If the herd is reduced the return per head must be increased to break-even
Phosphorus supplementation	1. Phosphorus status of the country 2. Preparedness and practicability of setting up a supplementation program 3. Potential use of other management options to reduce the phosphorus requirement of the herd	1. Breeder liveweight can be increased by up to 60 kg at the end of the wet season and perhaps 30 kg at the end of the dry season 2. Decrease in mortality 0-15% 3. Increase in fertility 0-15%	1. Up to $12 per breeder per year supplementary feed costs plus labour
Early weaning	1. Cost and infrastructure to manage early weaners 2. Preparedness to accept management of early weaners 3. Proportion of early weaners in the total weaner crop	1. Reduce breeder liveweight loss during the dry season by about 10 kg for each month earlier that the breeder is weaned 2. Decrease in mortality 0-20% 3. Increase in fertility 5-15%	1. Supplementation cost of up to $50 per head to feed an early weaner from first-round muster for the entire dry season 2. Highly dependant on the proportion of early weaners in herd
Urea supplementation	1. Likelihood of prolonged dry seasons with little winter/spring rain 2. Preparedness to set up a supplementation program	1. Reduce breeder liveweight loss during the dry season by up to 30 kg in the intermediate zones and 50 kg in the harsh zones 2. Decrease mortality 0-10% 3. Increase fertility 0-20%	1. Cost ranges from about $8 to $30 per breeder per year depending on delivery system (water medication, dry licks, blocks)
Crisis supplementation with M8U or grain	1. Cost of molasses and grain 2. Availability of infrastructure to mix and feed 3. Variability between years in the timing of the seasonal break	1. Major reductions in breeder mortality in severe dry seasons 2. Little benefit for fertility	1. Cost of $10 per breeder per month

(ii) Urea supplements are likely to increase intake of low quality, low palatability pasture which would not be consumed if the cattle were not supplemented.

(iii) There is some evidence that supplemented cattle will graze large paddocks more uniformly then unsupplemented cattle. A commonly observed syndrome is that when cattle become weak they will remain near the water points and overgraze these areas rather than utilising the entire paddock.

(iv) Phosphorus supplements will increase pasture intake during the pasture growing season when there is the opportunity for increased pasture growth to replace that consumed.

(v) Cattle which are heavier at the end of the wet season due to phosphorus supplements will consume less pasture during the dry season.

(vi) The calculation of stocking rate as AE usually ignores any consequences of the time through the year of sale of cattle, even though this will have a major impact. For example bullocks or cull cows which are growing faster will usually be sold earlier in the season, thus dramatically reducing their requirement for pasture.

(vii) Survival supplements import feed energy to the property, thus reducing the AE required from pasture.

In a specific property situation it may be possible to satisfactorily estimate the effect of a supplementation strategy on the AE which will be utilised during various seasons of the year. Where this is possible the BREEDCOW calculation of gross margins could be done with adjustment of AE for the property, or adjustment of the AE designated for each class of cattle in BREEDCOW, thus improving the estimation of the effects of supplementation strategies on profitability.

5.6 Reliability of the predictions of cost-effectiveness of management changes

The approach which has been adopted in this report to quantitatively predict fertility and mortality in the breeder herd from breeder body condition in the late dry season has not, as far as we are aware, been used previously. The general relationship between breeder body condition in the late dry season and breeder mortality and fertility has been known in a qualitative manner for decades. Despite the errors and uncertainties associated with these quantitative predictions we consider that this approach has the greatest likelihood of allowing general predictions of responses of breeders to improvements in nutritional management across the many climatic regions of northern Australia.

Comparison of the increases in fertility with increases in the end-of-dry-season body condition of breeders observed during DAQ.098 experiments at Swan's Lagoon and discussed in Section 3 above suggest that the increases in fertility predicted from increases in breeder body condition are fairly conservative.

The largest body of evidence to support the assumed relationship between end-of-dry-season breeder body condition and fertility is in the experiments summarised in the Collation Report (Appendix 3) indicating that reconception rate of lactating breeders is likely to increase by about 5% units for each 10 kg increase in breeder liveweight at the start-of-mating (Appendix 3; Table 3.1, page 6), or for each 10 kg of breeder liveweight loss alleviated by dry season urea supplements (Figure 3.1, page 22 above). For *Bos indicus* crossbred genotypes grazing poorer country in northern Australia we would expert one body condition unit (on a 9 point scale; eg. 'backward store' versus 'store') would be equivalent to about 30 kg of liveweight in a breeder.

The equation used to estimate breeder mortality in BREEDMOD was based on the observations that if breeders are in "emaciated" or "very poor" body condition then mortality rates are high, particularly with animals in late pregnancy and early lactation. We are not aware of any useful experimental data which can be used to improve this prediction, and generation of such results would present obvious difficulties from perspectives of both cost and animal welfare.

5.7 Economic benefits from improving supplement delivery systems

As discussed in the Management Package (Section 5.1) in the extensive grazing systems of northern Australia supplements will generally have to be fed *ad libitum*. Characteristics of the supplement (eg. palatability of the supplement relative to pasture) will have to be manipulated to achieve sufficient intake. Excessive supplement intake is usually avoided by making the supplement less palatable, or by using feeding systems where supplement intake can be reduced by tongue-fatigue of the animal.

The economic benefits from improving supplement delivery systems can be considered in relation to the principal objectives in designing supplement delivery systems (Management Package Section 5.1). These objectives are:

(i) To achieve the target intake of the specific nutrient (or nutrients) required eg. 50 g urea or 25 g calcium phosphate. Usually this will be calculated as the average intake of supplements by the mob per day, per week or per month. The cost-effectiveness of the response to supplements is usually highly dependent on the amount of supplement consumed, and is usually represented as a dose-response curve. Usually the amount of supplement required for greatest cost-effectiveness is less than that required for the maximum animal response as, for example, growth rate.

The shape of the animal response curve to increasing amounts of supplement will have important consequences for achieving target intakes of nutrients. The shape of this curve will differ for various types of supplement. For example, with urea or phosphorus supplements animal response usually occurs only up to a threshold level of supplementary nutrient, and there will be a lower response to larger amounts of supplement (ie. a bent-stick model). Conversely with molasses or protein meals the animal response is more likely to be proportional to the amount of supplement consumed.

The importance of achieving a specific target intake will depend on the type of animal response required eg. to reach a threshold level of nutrition to survive and/or reconceive, compared to liveweight gain in finishing animals where higher than target supplement intake may be compensated by earlier turnoff.

In the extreme situation where it is difficult to achieve any intake of supplements such as phosphorus during the wet season, the economic cost of unsatisfactory delivery systems may be considered as the increased profitability which could have been achieved from the supplementation strategy. Alternatively if phosphorus supplements have to be fed during the dry season because satisfactory intakes cannot be achieved during the wet season, the economic cost may be considered as the lower biological efficiency of feeding the phosphorus during the dry rather than the wet season.

(ii) To minimise the proportion of animals in the mob which are shy-feeders consuming little or no supplement. The importance of this will vary with the reasons for feeding the supplements. For example if the principle objective is to stop mortality and the animals die if they do not consume any supplement, the proportion of shy-feeders will be very important. Alternatively if the objective of supplementation is to finish some animals for earlier turnoff, and the animals which do not consume any supplement involve little extra cost, the presence of some shy-feeders may be of little consequence.

(iii) To minimise the variability of supplement intake within a mob of cattle. This is an extension of (i) and (ii) above. Although the average intake by the mob may be appropriate and there may be an acceptably low proportion of shy-feeders, there may be high variability within the mob in supplement intake. This will have consequences for the supplement dose ingested by individual animals and these supplement intakes in relation to the dose-response curve of supplement intake and animal response. Calculations based on a bent-stick shape of the dose-response curve to urea or a mineral indicate that efficiency of supplement use (expressed as animal response per unit of supplement fed) will be reduced by up to 20-30% by high variability.

(iv) To minimise the cost of supplement per unit of the specific nutrient (or nutrients) required in a specific situation. The issue must be addressed of what specific nutrient(s) are required in the specific situation, and the purpose of the other ingredients. For example, ingredients such as salt, grain, cottonseed meal and molasses are often included in dry lick mixtures fed during the dry season, and where the important nutrient is urea N. If these ingredients are essential to achieve the target intake of urea then they no doubt need to be included as part of the cost of feeding urea. However, it is important that the role of each component of the supplement be recognised and valued accordingly.

Providing supplements as blocks has many advantages, but such blocks usually contain low concentrations of the specific nutrient required for a specific situation. Hence the advantages of using a system such as a commercially-manufactured block must often be balanced against a higher cost per unit of urea N or phosphorus.

The most effective way to minimise the cost of carrier ingredients for urea or sulphur supplementation is to use water medication systems where the cost of supplements can be drastically reduced (eg. 50% of the cost a dry lick system). However, the cost of water medication supplementation systems will be heavily dependant on the existing infrastructure and control of water points on the property. The capital cost to set up a water medication unit is about $2 000. If this unit can use existing centralised water supply systems to supplement up to several thousand cattle the capital cost per head will be low. Conversely, if a medication unit is needed for each water point, and if additional fencing, pipelines, tanks and troughs are needed, the capital cost per head will be high and may make this system inappropriate.

(v) The opportunity for the manager to separate and manage differently sub-groups of animals which require better nutrition (either because they are in a different physiological state or because they are not eating sufficient supplement) and animals which can tolerate a lower plane of nutrition.

5.8 Concluding comments

The model of breeder productivity discussed in this report provides a basis for evaluating dissimilar management strategies to improve the nutritional status of the breeder herd. Herd models such as BREEDCOW are the most useful means to compare the financial consequences of changes in fertility and mortality. Substantial increases in gross margin can be expected when improved nutritional management reduces mortality due to undernutrition. Gross margin remained fairly stable when the principal benefit of the improved management by supplementation was increased weaning rate, although this was highly dependant on the supplement input costs. Even where gross margin was not increased, improved nutritional management may be worthwhile for the less tangible benefits of improved risk management, tighter calving patterns at a more desirable time of the year and heavier weaners.

Main

Research

Report

Task 6.

Development of Management packages

and Technology Transfer

Success in achieving objectives

Impact on the industry

6. Task 6. Development of Management packages and Technology Transfer

6.1 A monograph collating past information on breeder herd productivity and supplementation systems was prepared early in the project and is also attached as Appendix 3. This monograph was widely circulated.

6.2 A comprehensive management package discussing the nutritional management of the breeder herd has been developed. This was based on present and past experimentation and trials, and experience in the industry. This document is written at a level suitable for extension officers and other technical staff servicing the cattle industry, and for leading-edge producers. An advanced draft version has been circulated among QBII staff and industry representatives (producers and feed industry) for comment and discussion, and copies have also been sent to the Meat Research Corporation. This will be further developed for publication as a book.

6.3 Many opportunities have been taken to present information developed during the project to groups of producers at field days (to small groups on seven occasions and at the North Queensland Field Days), to the North Qld Beef Research Committee, to the Swan's Lagoon Committee of Management (which includes several producer members) and at the Emerald Meat Profit Day. Material has been extensively made available in publications for industry (eg. Swan's Lagoon Research Report, Northern Muster newsletter, NAP3 News). Copies of the most important articles are attached (Appendix 2). Also information has been incorporated into presentation material for QBII/MLA Nutrition Workshops and published in proceedings of scientific conferences.

7. Success in achieving objectives

The objectives of the project to improve breeder herd productivity and management are obviously a continuation of many decades of R, D & E and many previous projects in this area of the cattle industry. It would be presumptuous to claim that any one project with modest budget (MRC budget $270,000 over 3 years) and personnel resources will solve all the problems of the industry in a broad area such as that addressed. The success of the project in meeting objectives can only be reasonably judged with consideration of the magnitude of the issues involved and the available resources.

The specific objectives of the project were outlined in Section 2.2 (p.13 and Table 2.1).

7.1 Success in achieving specific objective (a) "to further develop supplementation technology to improve the cost-effectiveness of using supplements to increase the performance of the breeder herd".

(i) The actual increases observed in Experiment 811 (1994 dry season and 1994/95 wet season) targets and the cost of the supplement inputs to achieve the increases are shown in Table 7.1. Productivity of unsupplemented first-calf cows was comparable with the "High herd" category, while unsupplemented second-calf cows were intermediate between the "Medium herd" and "High herd" categories. The lower productivity of the second-calf cows than of first-calf cows in this experiment was the reverse of that usually seen in industry, but was presumably due to the much lower liveweight and body condition score of the second-calf cows at the beginning of the experiment in June 1994, and is a consequence of the relative management of heifers and first-calf cows in that specific situation.

(ii) When strategic supplements were fed during both the dry and wet seasons the increases in pregnancy rate of lactating first-calf and second-calf cows of 18% and 42% respectively, the reduction in medium anoestrus period of 1.3 months, the body condition of cows in the late dry or late wet seasons and increase in calf weaning weight all exceeded the specific targets (Section 2.2, p 14, Table 2.1). However, it is important to note that these large increases in productivity were achieved during and following a dry season which was severe for the northern coastal speargrass zone.

(iii) In Experiment E843 (1996 dry season) the benefit of dry season urea supplements on breeder liveweight and body condition (ranging from 0.3 to 0.6 condition score units) was comparable with the target increase of 0.5 body condition score unit, but this was achieved with input of urea-based supplement of only $9 per breeder. Thus the supplement cost was only 70% and 50% of the costs of feeding urea-based supplement during the dry season, or during both the dry season and the wet seasons respectively, in Experiment E811.

(iv) In the 1995 and 1996 dry seasons (Experiments E821, E823, E833and E841) there was no response by the breeders to the urea-based supplements fed during the dry season. This absence of a response was related to the out-of-season rain in July to September during these years. These experiments were valuable to demonstrate the limitations to urea-based supplements, and that responses are not likely to occur under such seasonal conditions.

(v) Experiments where urea-based supplements were fed during the late wet seasons of 1995 and 1996 demonstrated substantial effects of such a supplement to increase breeder liveweight gain at this time. This increased liveweight gain increased fertility of breeders in lower body condition, but not fertility of breeders in at least "store" body condition. The benefit of wet season supplementation for the latter subgroups of breeders was to increase body reserves before the dry season.

Table 7.1 Effects of the supplementation options used in the experiment E811 to increase various production parameters

Parameter	Base level (No supps)	Supplement Option 1 (Plus wet season supps only)	Supplement Option 2 (Plus dry season supps only)	Supplement Option 3 (Plus both dry and wet season supps)
Supplementation cost (Per breeder for annual cycle)	0	$4.50	$13.00	$17.50
Production parameter				
Breeder mortality				
First-calf cows	3/37	4/35	1/39	0/38
Second-calf cows	1/12	0/12	0/12	0/12
Pregnancy rate at 6 months post-partum (%)				
First-calf cows	68	74	76	86
Second-calf cows	50	50	64	92
Weaning rate from second and later parity cows (%)	N/A	N/A	N/A	N/A
Medium anoestrus period (months)				
Combined data from first- and second-calf cows	4.3	3.7	3.3	3.0
Mean body condition of lactating cows at the end of wet				
First-calf cows	5.1	5.5	5.7	6.0
Second calf cows	4.7	5.4	5.6	5.7
Body condition of cows late in dry season				
First-calf cows	4.3	4.1	4.6	4.9
Second-calf cows	3.3	3.2	4.1	4.4
Proportion of pregnant cows $\leq$ *CS4 in late dry season (%)*				
First-calf cows	57	-	26	-
Second-calf cows	95	-	54	-
Calf liveweight at end of wet season (kg)				
Combined data from first- and second-calf cows	163	170	169	174

N/A. Insufficient number of animals available to calculate this value satisfactorily.

(vi) Measurements of microbial protein synthesis made during both field and pen experiments allowed direct and sensitive comparisòns of the consequences of urea-based supplements for a wide range of circumstances.

(vii) Clear evidence was obtained that the benefits of including cottonseed meal into dry licks are primarily due to increased voluntary intake of low-palatability urea-based supplements rather than due to any direct effect of the small amount of cottonseed meal or rumen digestion or microbial protein synthesis.

(viii) A general model to describe breeder productivity from breeder body condition and an analysis of the economic consequences of short-term management manipulations (strategic supplements, survival supplements, weaning) were developed. This achieved the objectives of providing a generic description and allowing generalised economic analysis of supplementation and other technologies on breeder herd productivity.

7.2 Success in achieving specific objective (b) "to improve supplement delivery systems to achieve target intakes of supplement and reduce variability of supplement intake per animal and to identify the benefits on the environment of improved siting of supplement feeding sites".

(i) Experiments have defined the main factors affecting voluntary intake of low palatability supplement fed *ad libitum* to grazing cattle, the proportion of shy-feeders of supplement and the variability in supplement intake amongst those animals which do consume supplement. Palatability of supplement relative to available pasture is the principal factor determining voluntary supplement intake. Previous experience of animals with supplements has some role, but effects are generally short-term. The proportion of shy-feeders is closely related to average supplement intake, the proportion typically being high and increasing rapidly as average supplement intake declines below about 50 g per head per day. Siting of supplements distant from water points had some influence on supplement intake but did not affect the proportion of shy-feeders or variability in supplement intake.

(ii) Information on supplement delivery systems from experimentation and industry experience has been collated and published. This allows better-informed comparisons of optional delivery systems for specific circumstances.

(iii) The technology which has been developed and summarised allows improvement in supplement delivery systems by:
(a) selecting the most appropriate system for the specific property situation,
(b) adjusting palatability of supplement mixtures to increase/decrease supplement intake,
(c) manipulating siting of supplementation points, and
(d) ensuring some early exposure of cattle to supplements (eg. as weaners).

(iv) It was shown that it is generally difficult to change grazing behaviour by cattle by changing siting of low palatability supplements.

8. Impact on the industry

1. The project has collated and summarised information, both experimental and from the industry, on breeder herd productivity and supplement delivery systems in northern Australia. This has been made available as a monograph (see Appendix 3) and is also being prepared for publication as a comprehensive management package in a book form.

2. Experimentation on urea-based supplements for breeders has indicated the seasonal conditions under which urea-based supplements will increase breeder herd productivity, demonstrated that the increases in breeder herd productivity can be large during severe dry seasons, and provides an explanation for the much greater responses by cattle in the northern Australian environment than in the southern environment.

3. A framework has been developed to evaluate and compare the consequences of short-term strategies (urea-based supplements, phosphorus supplements, weaning, survival supplements or improved nutrition from pasture) on breeder herd productivity. This framework also formed the basis of economic evaluation of urea-based supplements, and can be extended to also evaluate other possible management options to increase breeder herd productivity.

4. Experimentation during the project has defined the principal factors influencing voluntary intake of supplements provided *ad libitum* to grazing cattle. This technology applies to the southern as well as the northern cattle industry.

5. The impact of the project on breeder herd production in northern Australia will clearly be highly dependant on the profitability of the northern cattle industry, and in particular the demand for young cattle for live export or as stores. When sale prices for young cattle return to buoyancy the project provides a basis for producers to decide whether to implement short-term strategies to increase breeder herd productivity. It also provides a basis to select between strategies to achieve cost-effective increases in productivity.

9. Intellectual property

There is no intellectual property arising from this project which we expect could be patented.

We recommend that all of the results and management packages arising from or developed during the project be made freely available to the industry.

10. Data and information storage

All experimental results will be retained in the DPI until publication is complete. Following publication those data sets which may be useful in the future (eg. data from breeder experiments may be useful for modelling) will be retained.

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11. Recommendations

11.1 Recommendations to industry

11.1.1 Breeder nutrition

(i) Urea-based supplements should be considered as only one of a series of possible strategies to improve breeder body condition. The benefits of different strategies will usually be additive. The flow diagram presented in this report provides a valuable means to compare strategies.

(ii) At current costs and cattle prices the direct returns from inputs of strategic urea-based dry season supplements are highly profitable where they reduce breeder mortality from under-nutrition. Returns will be much lower if the only benefit is an increased weaning rate. However there are additional indirect benefits from improving breeder nutrition in the forms of reduced risk and greater management flexibility for the breeder herd. These benefits would often justify increased inputs.

(iii) Economic returns from urea-based supplements are highly sensitive to supplement input costs. Thus the cost of supplementation must be minimized.

(iv) Substantial animal responses to urea-based supplements can be expected to occur during severe dry seasons with a late seasonal break. Responses can be expected in lactating cows from the time of seeding of native grasses. However when there is sufficient storm rain to grow a "green pick" during the dry season there is not likely to be a response to urea supplements. It follows that urea-based supplements are likely to be most appropriate for regions where;

- (a) long-term rainfall records indicate that there is a low likelihood of storm rains during the dry season, and a low likelihood of an early break to the wet season,
- (b) in circumstances where breaker mortality from under-nutrition is likely to be high in the absence of intervention.
- (c) where there is a substantial body of dry standing feed.
- (d) where M8U supplementation systems are not appropriate.

(v) The best combination of management strategies will by highly dependent on the circumstances of specific herds and the preparedness of individual managers to implement various management options.

(vi) Current general recommendations for amounts of supplementary urea should be retained (eg. 45-60 g urea per breeder per day during the late dry season; half these amounts during the late wet/early dry season). However animals will respond to a wide range in intakes of supplementary urea, and lower or higher amounts of urea supplement may often be appropriate to achieve a target animal response. Also urea intakes different to recommendations may be acceptable where it is difficult or expensive to achieve target intakes of supplementary urea.

11.1.2 Supplement delivery systems

(i) It is clearly important to minimise supplement costs per unit of protein or phosphorus. Where it is possible to use water medication efficiently (eg. properties with centralised water reticulation systems already in place and where water quality is acceptable) supplement costs are low and economic returns high. Supplement delivery by dry lick systems could be up to twice the cost per head of water medication, and by some commercially-manufactured lick blocks could be up to four times the cost per head of water medication systems.

(ii) Intake of dry lick supplements fed free choice is determined primarily by the palatability of the supplement compared to the palatability of available pasture. Hence supplement intake can be manipulated by making the dry lick supplement more palatable by addition of ingredients such as salt (in 'salt-hungry' country), cottonseed and molasses, or less palatable by addition of ingredients such as ammonium sulphate (eg. Granam fertiliser) or excess salt.

(iii) Training and familiarisation of cattle to supplements and to some specific flavours is likely to have some role in increasing acceptance of supplements by cattle. For example where acceptance problems occur, exposure of weaners to palatable supplements is likely to be helpful.

(iv) The proportion of shy-feeders and variability in supplement intake in a mob are inversely related to average supplement intake by the mob. To avoid major inefficiencies supplementation systems should be designed so that average supplement intake is at least 50 g/head.day.

(v) Feeding supplements in 3-sided sheds or similar structures providing good weather protection is not likely to change the proportion of shy-feeders.

(vi) Feeding supplements distant from water has some effect to reduce supplement intake and is not likely to change the proportion of shy-feeders.

(vii) There appears to be little opportunity to change grazing pastures and paddock utilisation by siting of low palatability supplements, although it may be possible to do so with supplements which cattle find highly palatable.

11.2 Recommendations for further R, D & E.

11.2.1 Publication of Management Package

A comprehensive Management Package was developed during the project. This should be published as a professionally-prepared high quality publication comparable with the Phosphorus Manual.

11.2.2 Breeder herd nutrition

(i) The proposed framework for comparing management options to increase breeder productivity (Figure 1.1 p. 5; Figure 5.1 p. 138) and the spreadsheet model (BREEDMOD, section 5.3 p. 141- 155) for predicting quantitatively consequences of increased breeder body condition on productivity should be developed further.

In the first instance this could be done by reexamination of historical data and further consideration of the ability of late dry season pasture to meet the nutrient requirements of breeders. It may be also possible to integrate the model predicting breeder productivity from breeder liveweight to the best estimates of pasture availability and quality and probabilities of rainfall (eg. using RAINMAN and GRASP DSS models).

Satisfactory quantitative prediction of breeder productivity from breeder liveweight or body status also requires an improved understanding of the consequences of both pre-partum and post-partum nutrition on breeder fertility for the genotypes and range of nutritional conditions commonly encountered in northern Australia. For example, in the pre-partum cow although we know that severe liveweight loss during the dry season reduces subsequent fertility, we need to know which elements are important (eg. minimum breeder body condition, rate of loss of body condition, etc) and to predict the extent of the depression in fertility for various scenarios of breeder body condition loss. Similarly, improved understanding of nutrition or fertility is needed for the post-partum *Bos indicus* breeder. There is evidence that this breeder must be in positive energy balance for ovarian activity to recommence, and increasing nutrition during early lactation has little effect. However, there is evidence that increasing nutrition during mid-lactation increases ovarian activity of breeders in lower body condition status.

(ii) Improved prediction of the responses of breeders to various amounts of supplementary urea for various pasture and animal conditions is needed. Faecal nitrogen concentration used alone is not a satisfactory predictor. NIR analysis of faeces is a promising technique. However even if NIR analysis of faeces can be developed to provide an acceptable prediction of ingested dietary protein, other factors also need consideration. For example the dose-response of breeders to increasing amounts of supplementary urea, pasture selection and the quantitative importance of urea recycling needed to be better defined. The present project has shown that increases in pasture intake occur over a much wider range of urea intakes than had previously been thought. Also the proportion of leaf in selected senesced pasture is likely to be an important factor influencing the animal response to supplementary urea, but no data is available.

11.2.3 Supplement delivery systems

(i) An improved understanding of the factors which determine palatability of a supplement under specific conditions is needed to design supplement mixtures to achieve target intakes. Salt is the most widely used ingredient to attract cattle to consume supplements or, when included at high concentrations, to restrict supplement intake. However, we cannot predict salt appetite and do not understand the circumstances under which cattle will be "salt hungry". Similarly, definition of the importance of known and novel ingredients and attractants to modify palatability and control intake during both the wet and dry seasons is needed.

(ii) Wet licks based on molasses and containing urea (or other slow-release forms of non-protein nitrogen) and phosphorus, and where voluntary intake is controlled by acidity of the mixture, would have many advantages for the northern industry. It has been shown in principle during DAQ.098 and also by work in the 1950's that this is possible. Advantages include reduced labour and better use of existing infrastructure (by handling strategic supplements as M8U survival supplements are already handled), more predictable use of molasses (which in the future will likely be purchased most economically under forward contracts), and by allowing frequent changes to supplement mixtures to regulate intake.

(iii) It was established that in small mob situations the proportion of shy-feeders in mobs is inversely related to supplement intake. Also feeder access and habituation to flavours in supplements were implicated. More information is needed for larger mobs of cattle.

(iv) Delivery of phosphorus supplements during the wet season will remain a major practical problem for many commercial properties. The available evidence suggests that although dry season feeding of phosphorus supplements seems to alleviate phosphorus deficiency, the supplementary phosphorus fed at this time is likely to be used with lower efficiency. The efficacy and efficiency of feeding phosphorus during the dry, and of restricting intakes of phosphorus supplements by infrequent feeding, need to be known to make decisions on these practices commonly used in the industry.

11.2.4 *Consequences of supplementation strategies for sustainable rangeland management*

Progress has been made on this issue during DAQ.098, but given the importance of this issue for sustainable rangeland management more information is clearly needed. For example, the anecdotal evidence that cattle fed urea-based supplements utilise large paddocks more evenly would, if found to be correct, mean that such supplements are likely to be beneficial for both cattle production and rangeland sustainability. Similarly the limited evidence that supplemented cattle are less selective in the pasture species which they consume when grazing would, if correct, indicate that strategic supplementation may reduce declines in palatable species in rangelands.

12. Conclusions

Project DAQ.098 has substantially advanced the understanding of the role of management options, and in particular urea-based supplements and supplement delivery systems, to increase breeder productivity in the dry tropics of northern Australia.

- The project has collated and extensively reviewed available information on supplementation and weaning management of the breeder herd in this environment. This material is being prepared for publication as a comprehensive Management Package suitable for technical personnel servicing the northern cattle industry and for "leading-edge" producers.

- A conceptual framework, based on the fundamental relationships between breeder body status with fertility and mortality, was developed to compare the efficacy of dissimilar management strategies (eg. urea-based supplements during the dry season, phosphorus supplements during the wet season, early weaning, M8U survival supplements) and to link breeder and pasture productivity. Although this framework is at present principally qualitative, it provides a basis to build quantitative predictions of breeder performance, and to utilise historical information and best-available pasture and weather forecasting Decision Support Systems. The most important phase of this conceptual model (ie. breeder body condition during the late dry season) was developed into a spreadsheet model (BREEDMOD) to estimate quantitatively, for a range of circumstances, the consequences on breeder fertility and mortality of using management options to increase breeder body status. However, there are serious inadequacies in our ability to predict fertility from breeder liveweight and liveweight pathways. Changes in herd gross margin were used to evaluate the economic consequences of using management strategies such as urea supplements.

- The project has greatly improved understanding of the circumstances in the northern cattle industry where it is most appropriate to use urea-based supplements, and the likely increases in breeder productivity. Urea-based supplements are likely to be most appropriate where breeder mortality from under-nutrition is high, where there is a low likelihood of winter rain and where early weaning and survival supplementation strategies are not appropriate.

- Systems to deliver strategic supplements to cattle grazing under extensive conditions were investigated with scientific rigour. Considerable progress was made to understand how target intakes of supplements can be achieved in the paddock.

Main

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Project Publications

13. Project Publications

13.1. Reports for industry

Rob Dixon, Geoffry Fordyce, Carol Petherick, Ken Murphy and Michael D'Occhio (1998). Increasing breeder herd productivity by improved nutritional management. In Meat Profit Day Handbook, Emerald. April 1998. pp 31-33. (Also a Handout used with Poster Display). **(copy attached, Appendix 2).**

Rob Dixon (1998) Breeder nutrition vital for beef productivity. *NAP News* Newsletter Number 7

Rob Dixon, Adrian White, Peter Fry, Geoffry Fordyce and Michael D'Occhio (1997). Effects of dry season dry licks containing dried molasses or cottonseed meal for first-calf heifers. *Swan's Lagoon Research Report 1997.*

Rob Dixon, Peter Fry, Adrian White, Geoffry Fordyce and Michael D'Occhio (1997). Effect of dry lick supplements fed during the early and/or late dry season on productivity of Bos indicus x Shorthorn cross breeder cows. *Swan's Lagoon Research Report 1997.*

Rob Dixon, Adrian White, Peter Fry and Geoffry Fordyce (1997). Effect of weaning and urea-based dry lick supplements fed during the dry season on productivity of second-calf cows. *Swan's Lagoon Research Report 1997.*

Maree Bowen, Rob Dixon, Adrian White, Peter Fry, Dianne Burling and Prof. John Ternouth (1997). Rumen microbial protein production in heifers fed speargrass hay and supplements of urea. *Swan's Lagoon Research Report 1997.*

Rob Dixon, Adrian White and Peter Fry (1997). Effects of urea-based dry lick supplements fed to breeders during pregnancy or cow and calf performance. *Swan's Lagoon Research Report 1997*.

Rob Dixon, Adrian White, Peter Fry and Carol Petherick (1997). Variability in intake by heifers of dry lick supplement fed during the wet/early season. *Swan's Lagoon Research Report 1997.*

Rob Dixon, Adrian White, Ian Porch and Dave Smith (1997). Distribution of intake of a molasses/urea/phosphoric acid supplement in a mob of cows and calves. *Swan's Lagoon Research Report 1997.*

Rob Dixon, Peter Fry, Adrian White and Carol Petherick (1997). Effect of early exposure as weaners on subsequent intake of dry lick supplement by 3-year old steers. *Swan's Lagoon Research Report 1997.*

Carol Petherick, Peter Fry and Rob Dixon (1997). Siting of supplement points: Effects on supplement intake and paddock use by small groups of steers. *Swan's Lagoon Research Report 1997.*

Rob Dixon, Ian Porch and Carol Petherick. (1996). Further studies on the training of weaners to consume dry lick supplements. pp. 33-36, *Swan's Lagoon Research Report 1996.*

Rob Dixon, Peter Fry and Carol Petherick. (1996). Effect of inclusion of CSM in dry lick supplement on intake and variability of intake by weaners. pp. 37-38, *Swan's Lagoon Research Report* 1996.

Rob Dixon, Peter Fry and Carol Petherick. (1996). Effect of previous experience of supplements and inclusion of CSM in dry lick supplement on supplement by weaners. pp. 39-41, *Swan's Lagoon Research Report 1996.*

Rob Dixon, Adrian White, Peter Fry and Carol Petherick. (1996). Effect of previous exposure of yearling cattle and palatability of dry lick supplement on intake and variability of intake under wet season conditions. pp. 42-43, *Swan's Lagoon Research Report 1996.*

Rob Dixon and Bev Gelling. (1996). Effect of various additives for molasses supplements on intake and variability of intake pp. 44-46, *Swan's Lagoon Research Report 1996.*

Rob Dixon, Ian Batterham and Ian Porch. (1996). Variability in intake by heifers of salt/kynophos dry lick supplement fed during the wet/early dry season. pp. 47-50, *Swan's Lagoon Research Report 1996.*

Rob Dixon, Peter Fry, Adrian White, Geoff Fordyce and Michael D'Occhio. (1996). Effect of dry lick supplements fed during the dry season and/or the wet season on productivity of Bos indicus x Shorthorn cross breeder cows: Second draft of cattle. pp. 52-62, *Swan's Lagoon Research Report 1996.*

Rob Dixon, Peter Fry, Adrian White, Geoff Fordyce and Michael D'Occhio. (1996). Effect of dry licks containing dried molasses or cottonseed meal for first-calf heifers. pp. 63-67, *Swan's Lagoon* Research Report *1996.*

Chris Samson, Rob Dixon, Adrian White, Peter Fry, Dianne Burling and John Ternouth. (1996). Rumen microbial protein production in heifers fed speargrass hay and dry lick or M8U supplements. pp. 68-71, *Swan's Lagoon Research Report 1996.*

Jayne Kuskie, Carol Petherick, David Hirst and Rob Dixon. (1996). Design of shelter sheds for wet season supplementation of cattle. pp. 73-75, *Swan's Lagoon Research Report 1996.*

Rob Dixon, Adrian White and Carol Petherick. (1996). Effect of distance of supplementation site from water on supplement intake. pp. 76-77, *Swan's Lagoon Research Report 1996.*

Carol Petherick, Peter Fry and Rob Dixon. (1996). Siting of supplement points: Effects on supplement intake and paddock use by small groups of steers. pp. 79-81, *Swan's Lagoon Research Report 1996.*

Rob Dixon and Carol Petherick. (1995). Training weaner calves to eat dry lick supplements *Northern Muster* 52: 14-15.

Rob Dixon, Ian Porch, Bev Gelling, Geoff Fordyce and Michael D'Occhio. (1995). Effect of dry lick supplements fed during the dry season and/or the wet season on productivity of Bos indicus x Shorthorn cross breeder cows: First draft of cattle. pp. 28-42, *Swan's Lagoon Research Report 1995.*

Rob Dixon, Bev Gelling, Dave Smith and Carol Petherick. (1995). Effect of supplement type on variability of supplement intake. pp. 43-47, *Swan's Lagoon Research Report 1995.*

Rob Dixon, Ian Batterham and Ian Porch. (1995). Variability in intake of salt/kynophos dry lick supplement fed during the wet/early dry season. pp. 48-51, *Swan's Lagoon Research Report 1995.*

Rob Dixon and Ian Porch. (1995). Preliminary observations on intake of wet licks containing molasses and high levels of urea and phosphoric acid. pp. 52-54, *Swan's Lagoon Research Report 1995.*

Rob Dixon, Adrian White, Ian Porch and Dave Smith. (1995). Observations on the distribution of intake of a molasses/urea/phosphoric acid supplement by cows and calves. pp. 55, *Swan's Lagoon Research Report 1995.*

Rob Dixon, Carol Petherick, Dave Smith and Bev Gelling. (1995). Training weaners to consume dry lick supplements. pp. 56-63, *Swan's Lagoon Research Report 1995.*

Rob Dixon (1995).Effects of dry lick supplements on breeder productivity. *Northern Muster* 50:15-16. **(copy attached, Appendix 2).**

Rob Dixon, Carol Petherick, Dave Smith and Bev Gelling. (1994). Training weaners to consume dry lick supplements. pp. 116-120, *Swan's Lagoon Research Report 1994*

13.2 Conference publications to date arising from the project (copies attached).

M. Bowen, R.M. Dixon, A. White and J.H. Ternouth. (1998). Rumen microbial synthesis in heifers fed low-quality hay and increasing levels of urea. *Proceedings of the Australian Society of Animal Production.* 22: 290.

R.M. Dixon and J.C. Petherick. (1996). Intake distribution of a range of supplements offered to grazing Bos indicus cattle. *Proceedings of the Australian Society of Animal Production* 21: 442.

R.M. Dixon, I. Porch, M. D'Occhio and G. Fordyce. (1996). Effects of dry season and wet season supplementation on fertility of Bos indicus cross cows. *Proceedings of the Australian Society of Animal Production* 21: 441.

R.M. Dixon, C. Samson, A. White and J.H. Ternouth. (1998). Effects of urea or molasses-urea supplements on rumen microbial synthesis in heifers fed low-quality hay. *Proceedings of the Australian Society of Animal Production.* 22: 282.

R.M. Dixon, D.R. Smith, G. Fordyce and M. D'Occhio. (1996). Effects of post-partum supplementation on fertility of Bos indicus cross first-calf cows. *Proceedings of the Australian Society of Animal Production.* 21: 440.

R.M. Dixon, A. White, P. Fry and J.C. Petherick. (1998). Intake of dry lick supplement is influenced by supplement palatability but not by previous experience. *Proceedings of the Australian Society of Animal Production.* 22: 284.

J.C. Petherick, P. Fry and R. M. Dixon (1997). Trough arrangement, space allocation and supplement intake of cattle grazing native pasture. Proceedings of the 31st Congress of the International Society for Applied Ethology, editors P.H. Hemsworth, M. Spinka & L. Kostal. Research Institute of Animal Production, Prague, Czeh Republic. p. 105.

J.C. Petherick, P. Fry, R.J. Mayer and R.M. Dixon. (1998). Effects of lick-block siting on supplement intake and behaviour of cattle. *Proceedings of the Australian Society of Animal Production.* 22: 291.

13.3 Reviews associated with the project

R.M. Dixon et al. (1998). Supplementation and weaning management of the breeder herd in the dry tropics of north Australia. A management package. Approximately 100 pages. (Draft presently being circulated for comment and revision).

R.M. Dixon and C.R. Stockdale. (1997). Associative effects between forages and grain: Consequences for feed utilisation. A review prepared as a contract to the GRDC and submitted to the *Australian Journal of Agricultural Research* for publication.

R.M. Dixon and P.T. Doyle. (1996). Straw and low quality roughages as drought feeds. In *A User's Guide to Drought Feeding Alternatives.* eds J.B. Rowe and N. Cossins, pp. 61-74. The University of New England. **(copy attached, Appendix 2).**

R.M. Dixon. (1995). Collation of recent information on productivity and use of supplements for breeders in the marginal and harsh regions of northern Australia. Report to the MRC. (61 pages). **(copy attached, Appendix 3).**

R.M. Dixon. (1995). Animal husbandry for dryland areas. The feed supply system and feed technology. Invited paper presented at a conference on agricultural development, Kupang, Indonesia, December 1995. Proceedings in preparation by editors.

13.4 Proposed publications arising from the project

It is intention of the project team to publish all of the experimented work arising from the project as scientific journal papers. These will follow from the brief reports which have been published as 1-page papers in conference proceedings and as part of the Swan's Lagoon Research Report. The final decisions on the structure of papers and the journal will be made after draft papers have been prepared. The *Australian Journal of Experimental Agriculture* is the most likely journal for the majority of the papers. Likely titles of papers and experiments in each are as follows:

13.4.1. Dixon et al.

- Effects of urea supplements on productivity of Bos indicus cross breeders in the semi-arid tropics. (One or two major papers reporting the five major breeder experiments).
- Effects of early weaning and urea supplements on productivity of Bos indicus cross breeder cows in the semi-arid tropics. (Paper reporting Expt 843).
- Effects of urea supplements on rumen microbial protein synthesis in heifers and cows consuming low quality tropical pasture. (Paper reporting Expt 840 and part of Expt 811).
- Intake distribution of a range of supplements consumed by Bos indicus cross heifers.

(Paper reporting Expt 813 and 829).

- Effect of previous experience and supplement palatability on intake of supplements by weaner Bos indicus cross cattle. (Paper reporting Expt 815 and Expt 822).
- Intake and distribution of supplement intake by Bos indicus cross cattle. (Major paper using results from Expts 811, 821, 823, 833 and 841).
- Variability by yearling heifers in intake of dry lick supplement. (Paper reporting results from Expt 813C, 813D and 830).
- Distribution of intake of a molasses based supplement in a mob of cows and calves. (Paper from Expt 813E).

13.4.2. Petherick et al.

- Influence of trough design and space allocation on the intake of supplementary feed by weaner beef cattle grazing native pasture. (Paper reporting Expt 816). Draft prepared.
- Effect of siting of supplement points on intake and paddock use by small groups of steers. (Paper reporting Expt 837).
- Design of shelter sheds for wet season supplementation of cattle. (Paper reporting Expt 831).
- Effect of siting of supplement points on intake and paddock use by cows and calves in a large paddock. (Paper reporting Expt 839).

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Appendices

14.1 Appendix 1. Key to experiments.

Experiment	Title and description	Page
E811	Effect of dry lick supplements fed during the dry season and/or the wet season on productivity of *Bos indicus* x Shorthorn cross breeder cows (Draft 1, 1994/95)	25
E813-A	Effect of supplement type on variability of supplement intake	80
E813-B	Effect of various additives for molasses supplements on intake and variability of intake	84
E813-C	Variability in intake of dry lick supplements fed to large mobs of heifers (Draft 1, 1995)	93
E813-D	Intake of molasses-based supplements containing high levels of urea and phosphoric acid	112
E813E	Variability in intake of molasses/urea/phosphoric acid supplements by cows and calves	114
E815	Training weaners to consume dry lick supplements (Experiment 1, 1994)	101
E816	Trough space and design effects on supplement intake	118
E821	Effect of dry lick supplements fed during the dry season and/or the wet season on productivity of *Bos indicus* x Shorthorn cross breeder cows (Draft 2, 1995/96)	37
E822-A	Training weaners to consume dry lick supplements (Experiment 2, 1995)	107
E822-B	Effect of inclusion of CSM in dry lick supplement on intake and variability in intake by weaners	86
E822-C	Effect of previous experience of supplements and inclusion of CSM in dry lick supplement on supplement intake by weaners	88
E823	Effect of dry season dry lick supplements containing cottonseed meal or dried molasses for first-calf heifers (Draft 1, 1996/97)	44
E824	Effect of distance of supplementation site from water on supplement intake (Experiment 1)	126
E828	Rumen microbial protein production in heifers fed speargrass hay and dry lick or M8U supplements	65
E829	Effects of previous exposure to supplements and supplement palatability on variability in intake of dry lick supplements	91

Appendix 1. Key to experiments.....Continued.

Experiment	Title and description	Pages
E830	Variability in intake of dry lick supplements fed to large mobs of heifers (Draft 2, 1996)	96
E832	Design of shelter sheds for wet season supplementation of cattle	123
E833	Effect of dry season dry lick supplements containing cottonseed meal or dried molasses for first-calf heifers (Draft 2, 1996/97)	48
E836	Effects of urea-based supplements fed to breeders during pregnancy on cow and calf performance	61
E837	Siting of supplement points: Effects on supplement intake and paddock use by small groups of steers	129
E839	Siting of supplementation points: Effects on supplement intake and paddock use by a large mob of cows and calves	131
E840	Rumen microbial protein synthesis in heifers fed low-quality hay and increasing levels of urea	68
E841	Effects of dry lick supplements fed during the early dry and/or late dry season on productivity of *Bos indicus* x Shorthorn cross breeder cows	52
E842	Effect of previous experience on intake of dry lick supplement by bullocks	110
E843	Effects of time of weaning and urea supplements on dry season liveweight loss and productivity of *Bos indicus* cross cows	57

14.2 Appendix 2.

Copies of key publications arising from the project.

MEAT
PROFIT DAY

Emerald

Agricultural College

Tuesday 7 April 1998

"Meeting the Millennium – opportunities for the future"

CQ Beef Research Committee

Meat Research Corporation

Developing a role for legumes in Central Queensland's beef production systems

The problem

Beef production in central Queensland relies heavily on grass pasture supplemented with forage crops on the better soils. The grass pastures are either seasonally low quality native grasses in the east (eg. black speargrass pastures) or pure grass pastures (eg. buffel grass) on formally fertile 'brigalow' and 'downs' clay soils. With the former, soil fertility and production are inherently low. With the brigalow and downs soils, the original high fertility and high productivity has declined due to fertility rundown under pure grass monoculture.

The research, development and extension process

In recognition of the need to stabilise soil fertility and to increase the protein deficiency of grass pastures on all soils, R,D&E Institutions (DPI, CSIRO, Universities), with assistance from Funding Bodies (MRC, GRDC) and the grazing industry, have set about finding and developing forage and ley legumes adapted to the range of environments. In the last decade, there has been a combined effort between stakeholders via a number of R&D projects, to introduce, classify, evaluate, select, develop, release and promote productive legumes in sustainable grazing and farming systems.

The process has included:

- the planned introduction and classification of several thousand pasture accessions from tropical countries by CSIRO and DPI with funding support from agencies like the Meat Research Corporation (MRC)
- the systematic, agronomic evaluation of legume accessions in small plots at strategic environment sites throughout Queensland in the MRC supported COPE (Coordinated Pasture Plant Evaluation) project conducted by CSIRO and DPI
- promising accessions identified in COPE screening underwent advanced evaluation for specific purposes (eg. perennial pasture legumes for duplex and clay soil, ley legumes in farming systems). Project examples were the CSIRO, DPI, University of Queensland projects to select legumes to complement or replace stylo on the lighter soils should it succumb to anthracnose disease. These project are:
  - the Backup Legume (BUL) project supported by MRC
  - the Legumes for Clay Soil (LCS) project supported by MRC
  - the Ley Legumes for the Northern Grain Belt project supported by the Grains Research and Development Corporation (GRDC)
  - the Australian Council for International Agricultural Research (ACIAR) funded project to evaluate *Leucaena* species throughout the world.
- the involvement of beef producer groups in the demonstration and commercial evaluation of new legumes as a means of gaining their adoption. This was effected by the Producer Demonstration Site (PDS) and Producer Initiated Research and Development (PIRD) projects with funding from MRC and facilitation input from R&D agencies and consultants.
- concurrent seed increase to allow uninterrupted evaluation of new lines, research production difficulties and to assist the commercial seed industry with seed production from new cultivars. This is done by DPI's Seed Production Unit at Walkamin with some funding from industry groups like MRC and GRDC.

A sample of the highlights

1. Initial evaluation of over 1000 forage legume accessions was achieved at 11 strategic sites.
2. Advanced testing of 50 legumes in the BUL project resulted in the release of Reid and Kretschmer joint vetches.
3. Advanced testing of 150 legumes in the LCS project highlighted the role of *Desmanthus virgatus* cv. Jaribu (a mixture of cvv. Bayamo, Marc and Uman), Caatinga stylo (cv. Unica and Primar) and butterfly pea cv. Milgarra.
4. The Ley Legume Project has identified highly promising ley legumes for both cooler southern areas (medics) and the northern areas (*Macroptilium bracteatum*).
5. Testing of 25 lines of *Leucaena* on brigalow clay soils supported the release of the cultivar Tarramba.
6. Grazier demonstration and promotion via the PDS and LCS project, of all new pasture legumes in the region including the widely used stylos.
7. Development of the most efficient tropical seed production industry in the world.

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Increasing breeder herd productivity by improved nutritional management

Productivity of the breeder herd (eg. as fertility, liveweight of weaners and time of weaning, sale of cull cows) is obviously critical to profitability. There can be many causes of low productivity. However, on the poorer classes of country in northern Australia, the primary cause is usually under-nutrition of the breeder cow, particularly during the dry season.

If the weaning rate from the breeder herd is to be in the desirable range of 70-90%, a large proportion of breeders will have to become pregnant while they have a small calf at foot and are lactating. Although it is often difficult to get *Bos indicus* or *Bos indicus-cross* cows to cycle before weaning, this is usually due to low body condition of the breeder.

The importance of **breeder body condition** on **fertility** is well known. Lactating *Bos indicus* breeders generally have to be in at least "store" condition before they start to cycle.

Furthermore, under-nutrition during previous dry seasons can cause physiological damage to the cow which also reduces fertility. However, in most seasons, it is difficult to provide the necessary level of nutrition for breeders running on poorer classes of country for them to be in good body condition when they have a small calf at foot. Breeder body condition clearly depends on class of country, seasonal conditions and stocking rate. It can also be improved by management options such as supplementation (eg. phosphorus, urea) to remedy nutritional deficiencies, or by weaning the calf to reduce the demand on the cow for nutrients.

Phosphorus supplements are only useful if the soils and pasture are low in phosphorus and the cow cannot obtain enough phosphorus from grazing. Phosphorus supplements should, if possible, be fed during the wet season, and will increase liveweight gains and mild output of breeders at this time. The amount needed depends on the extent to which the class of country is deficient in phosphorus and on the type of animal (more is needed by lactating and/or growing animals) but is typically 5 gms P per day.

Urea and sulphur supplements are one way of providing protein to the breeder when pastures are deficient in this nutrient (ie. during the dry season). The cost of supplementary protein from urea is much lower than from protein meals (eg. cottonseed meal). However, the response of the breeder to urea supplements (eg. fed as dry licks, roller drums) is generally small. Urea supplements may slow down the rate of loss of body condition by breeders during the dry season, but will seldom stop this loss completely. What it can do is keep breeders in better body condition so that "crisis" situations in the late dry season are less likely to occur. On poorer classes of country, some response of cattle to urea supplements can be expected from the time of seed set in the grasses, providing there is little or no green pick in the pasture from winter/spring rain. Breeders typically need 30-60g urea per day.

Weaning has been used in the industry for decades, and there is the old adage that weaning the calf is the best possible way of supplementing a breeder. About 30kg in liveweight (or the difference between "backward store" and "store" body condition in a breeder) can be saved by weaning a breeder three months earlier than usual. This is why **early weaning** (usually meaning weaning calves down to 3-4 months of age and early in the dry season) has such a major effect to maintain breeder body condition. The cost is that the 20-30% of the total weaners which are small weaners need extra management and nutrition to avoid stunting of growth and long-term damage to their productivity. This usually means feeding substantial amounts of molasses, protein meal or grain supplements to these small weaners until the next wet season. Early weaning should only be done when the resources are available to care for the early weaners.

Two **other management options** need to be considered.

1. Having breeders in good body condition at the end of the wet season improves their chances of getting through the dry season without problems by using their body fat to compensate for under-nutrition.
2. In areas with access to molasses and where the time of the seasonal break is erratic, the best option may be to feed **'crisis' supplements** (eg. M8U) only in those years when it is essential, rather than invest in urea supplements or early weaning every year.

Achieving target intakes of supplement by grazing cattle can often be difficult. Supplements usually have to be fed free choice, and there are often problems that cattle eat too little or too much. Even when the average intake is correct, there may be many shy-feeders. Established systems for providing supplements (eg. dry licks, blocks, water medication, roller-drum lickers and M8U) each have their advantages and disadvantages. Recent research has been improving understanding of how to achieve target intakes and avoid having shy-feeders.

Assessment of the **financial consequences of management changes** to improve breeder productivity is obviously important. Sometimes "no change" will be the "best bet" decision. Given the diversity of the factors influencing the profitability of management changes each situation should, if possible, be considered separately. One of the best ways to evaluate the likely economic consequences of management changes is with the BREEDCOW and DYNAMA computer software packages which have been designed for this purpose. These are no more difficult to use than most packages used for financial record keeping.

In summary, there are a number of possible management strategies to improve the nutritional status of the breeder, cow and increase breeder herd productivity. In general, the benefits are directly related to the cost-effectiveness of improving breeder body condition.

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Stanbroke

Meat quality of Brahman-derived beef: results from CRC Northern Crossbreeding Project

Background and industry context

This project is part of an overall CRC breeding strategy to identify, by progeny test, the sires, breeds and crosses of Australian beef cattle best suited to the meat quality specifications of our domestic and export markets. The experiment uses nine sire breeds (Brahman, Santa Gertrudis, Charbray, Belmont Red, Charolais, Limousin, Hereford, Angus and Shorthorn) mated to Brahman cows. The offspring from each sire are allocated to finishing on northern pasture, northern feedlot or southern feedlot and to domestic, Korean and Japanese slaughter weights. Meat Research Corporation has provided additional funds from NAP3 to complete the project.

Specific project objectives are:

By June 1999:

- identify sires and sire breeds which rank highly for net feed conversion efficiency, as well as carcase traits, such as marbling and retail beef yield
- identify the most profitable F1 genotypes for grain and grass finishing for domestic, Korean and Japanese market specification in northern environments
- estimate the differences between Estimated Breeding Value (EBV) bases of different breeds so that EBVs can be compared across breeds
- determine the accuracy with which EBVs predict performance of crossbred offspring
- improve the industry's ability to compete for the quality-based Asian markets and to meet the targets of the Meat Standards Australia grading scheme.

Industry participation

This project has widespread industry support. Brahman females (1,000) for the experiment were donated to the CRC by the cattle companies listed here and by Queensland Department of Primary Industries.

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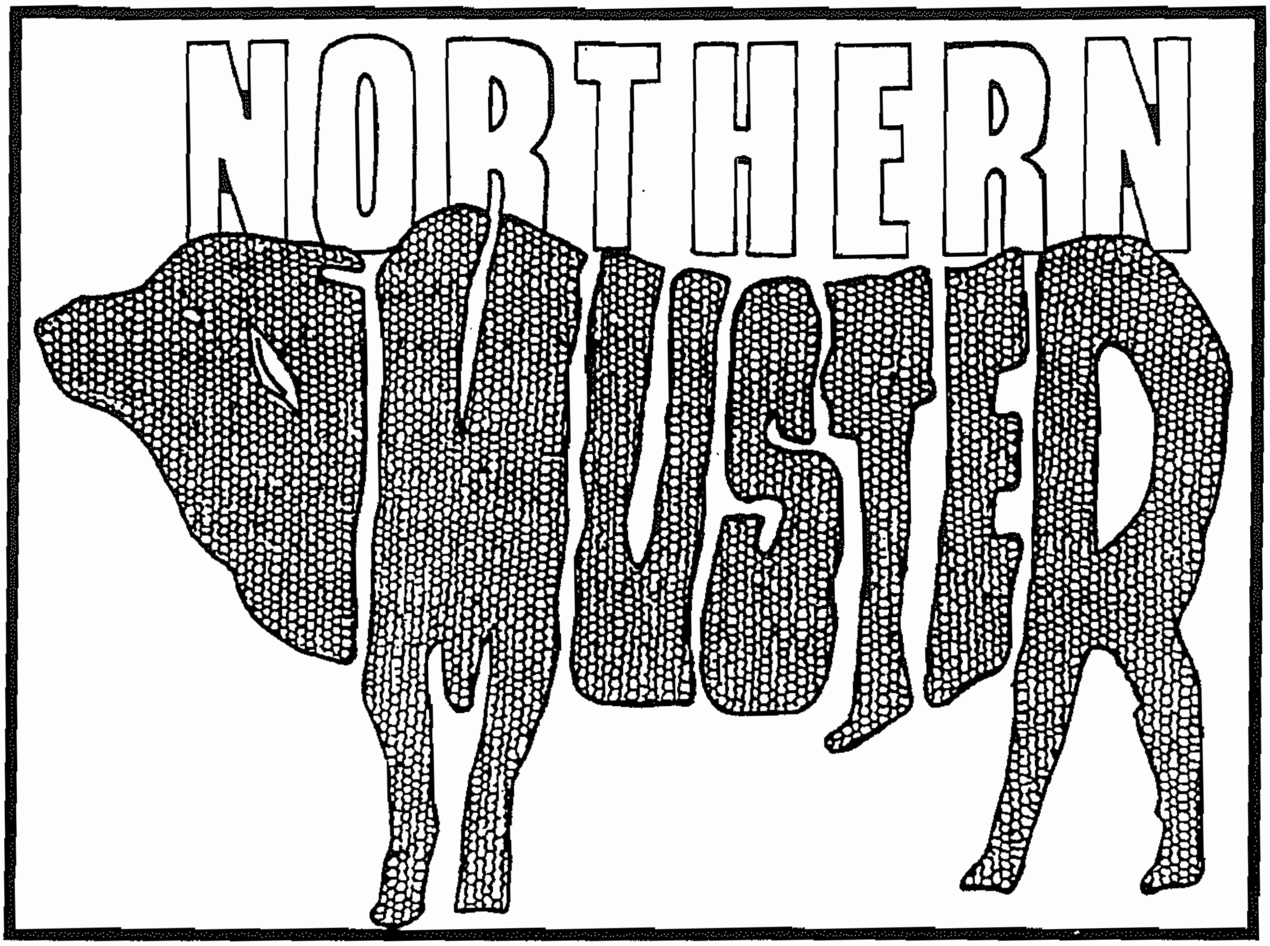

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SWAN'S LAGOON UPDATE

EFFECTS OF DRY LICK SUPPLEMENTS ON BREEDER PRODUCTIVITY

A major experiment with breeders at Swan's Lagoon during 1994/95 measured the effects on breeder productivity of dry lick supplements fed for 20 weeks during the dry season (July-November) or for 10 weeks during the wet season (March-May), or at both these times. The first- and second-calf cows used in the experiment calved from November 1994 to January 1995.

The dry lick supplements were typical of those used in industry, and were based on cottonseed meal, salt, urea, kynofos and ammonium sulphate. Supplement intakes averaged 175 g per head per day during the dry season, and 116 g per head per day during the wet season. Since the unsupplemented cows were adequate in phosphorus, the responses to the supplement were due to the nitrogen component of the supplements.

Supplement costs were approximately $13.00 per breeder for the dry season supplementation and $4.50 per breeder for the wet season supplementation.

Severe dry season conditions resulted in large liveweight losses by unsupplemented breeders (Table 1). Dry season supplements reduced liveweight loss of breeders by 20-40 kg. Crisis M8U supplementation would not have been necessary for supplemented animals, but was necessary to avoid a high mortality rate in the unsupplemented group of cows. The higher liveweight at the end of the dry season due to supplementation was largely preserved through to weaning in the following May.

Wet season pasture growth and quality were considered 'normal' for the area. Dry lick supplements fed from the time of pasture seed set in early March until weaning in May resulted in an additional 10 kg liveweight gain of the breeders while lactating.

Both dry and wet season supplements improved liveweight status of the breeders. The benefits of supplements on survivability of the breeder, increased conception rates, and increased calf liveweight at weaning can all be explained in terms of increased body reserves and plane of nutrition of the cows. First-calf cows fed supplements during both the wet and dry season were 30 kg, and second calf-cows were 50 kg, heavier at weaning. Also weaning weight of calves in May 1995 was 11 kg heavier in group fed supplements during both the dry and wet seasons.

Dry season supplements resulted in a greater proportion of both age groups of cows cycling or pregnant from January onwards. When no wet season supplements were fed, pregnancy rate at weaning was increased by 8% (from 68% to 76%) in first-calf cows, and by 14% (from 50% to 64%) in second-calf cows.

Feeding supplements during both the dry season and the wet season gave large increases in pregnancy rate. Pregnancy rate of first-calf cows increased by 18% (from 68% to 86%), and pregnancy rate of second-calf cows increased by 42% (from 50% to 92%).

Feeding wet season supplements without feeding dry season supplements gave a 6% increase in pregnancy rate (from 68% to 74%) in first-calf cows, but had no effect in second-calf cows. The different responses were associated with the body condition of the cows. Cows in "poor" body condition in February 1995 had a low pregnancy rate (26%) and although wet season supplements did increase liveweight, not enough to have much effect on pregnancy rate. Cows in 'store' body condition or better in February had a high pregnancy rate (92%), and so there was little opportunity for supplements to increase pregnancy rate. The response to wet season supplements was with cows which were in "backward store" body condition in February. The increase in liveweight due to supplements was in the liveweight range where pregnancy was affected and wet season supplements increased pregnancy rate from 61% to 81%.

Overall there were large effects of the dry lick supplement fed during either the dry season or the wet season. However, these were associated with severe dry season conditions during 1994. Responses to the dry lick supplements are likely to be much smaller with moderate dry season conditions.

ROB DIXON, DPI SWAN'S LAGOON (077 849170)

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SWAN'S LAGOON UPDATE

Table 1. Effects of the supplementation options to increase liveweight and pregnancy rate of breeders

Parameter	Class of cow	Base level (No supps)	Supplement		
			Option 1 (Plus wet season supps only)	Option 2 (Plus dry season supps only)	Option 3 (Plus both dry and wet season supps
Supplementation cost (per breeder for annual cycle)		0	$4.50	$13.00	$17.50
Production parameter					
Liveweight at beginning of dry season in June (kg)	FCC SCC	407 356	411 341	412 345	403 356
Liveweight at end of dry season in December (kg)	FCC SCC	325 294	320 282	339 317	347 337
Liveweight at end of wet season in May (kg)	FCC SCC	363 340	377 358	370 349	397 392
Pregnancy rate of lactating cows in May (%)	FCC SCC	68 50	74 50	76 64	86 92
Calf liveweight at weaning in May (kg) - combined data		163	170	169	174

FCC, first-calf cows

SCC, second-calf cows

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EFFECTS OF DRY SEASON AND WET SEASON SUPPLEMENTATION ON FERTILITY OF *Bos indicus* CROSS COWS

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Supplements providing principally inorganic N and/or P are often fed to breeder cows in the harsher environments of northern Australia to reduce breeder mortality and increase productivity (McCosker and Winks 1994). However, the responses to such supplements fed at various times of the year are not well understood. The present experiment examined the liveweight (LW) and fertility responses of *Bos indicus* cross breeders to dry lick supplements fed during the dry season (DS) and/or during the later part of the wet season (WS).

First-calf (FCC) and second-calf (SCC) *Bos indicus* x Shorthorn females were grazed in 8 x 100 ha paddocks at Swan's Lagoon from June 1994 until weaning in May 1995. The animals calved between late October 1994 and mid-January 1995, and were mated from December 1994 to April 1995. Four treatments were imposed in a replicated 2x2 factorial design consisting of dry lick supplements fed *ad libitum* during the DS from July to November 1994, and/or during the late WS from March to May 1995. DS supplements contained 32% cottonseed meal, 27% urea, 18% salt, 14% calcium phosphates and 9% ammonium sulphate. WS supplements contained 33% cottonseed meal, 30% salt, 21% calcium phosphates, 15% urea and 1% sulphur. Measurements were made each 6-8 weeks of LW and body condition score (CS). Pregnancy status and time of conception were determined by rectal palpation. Data were analysed for main effects and interaction effects by AOV.

Table 1. LW change (kg) from June 1994 to the early wet season (January 1995) or weaning (May 1995), and pregnancy rate at weaning (%) for first-calf (FCC) (n 139) and second-calf (SCC) (n 45) cows not supplemented (Con), fed supplements only during the wet season (WS), only during the dry season (DS), or during both the dry and wet seasons (DS+WS)

Measurement	Parity	Con	WS	DS	DS+WS	SEM	Significance Parity	DS	WS
LW change from June 1994 to:									
January 1995	FCC	-123	-116	-110	-79	15	**	**	-
	SCC	-99	-71	-59	-39				
May 1995	FCC	-44	-34	-41	-6	12	***	*	**
	SCC	-16	+17	+12	+37				
Pregnant at weaning	FCC	68	74	76	86	11	ns	*	ns
	SCC	50	50	64	92				

Interactions of DSxWS supplements were not significant (ns). * , $P<0.05$; ** , $P<0.01$; *** , $P<0.001$.

In June 1994 FCC were 408 (SEM ± 3) kg and CS 7.2 (SEM ± 0.1), while SCC were 350 (SEM ± 7) kg and CS 5.2 (SEM ± 0.1). Intake of DS supplement averaged 175 g/h.day, and intake of WS supplement averaged 116 g/h.day. On average DS supplement reduced LW loss of FCC from 120 kg to 95 kg, and LW loss of SCC from 85 kg to 49 kg (Table 1; $P<0.01$). WS supplement tended ($P>0.05$) to increase LW gain from 19 kg to 29 kg. DS supplement increased pregnancy rate at ($P<0.05$), and there was a tendency ($P>0.05$) for WS supplement to increase pregnancy rate. The higher pregnancy rates when supplements were fed could be explained in terms of higher post-partum LW of these cows.

The experiment demonstrated that dry lick supplements providing predominantly inorganic nutrients can have large effects to reduce LW loss of breeders during the dry season, increase LW gain during the later part of the wet season and to increase the pregnancy rate of lactating breeders.

McCOSKER, T. and WINKS, L. (1994). "Phosphorus Nutrition of Beef Cattle in Northern Australia" (Qld Dept of Primary Industries: Brisbane).

EFFECTS OF UREA OR MOLASSES-UREA SUPPLEMENTS ON RUMEN MICROBIAL SYNTHESIS IN HEIFERS FED LOW-QUALITY HAY

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Supplements based on urea or molasses-urea are widely used in the northern cattle industry to reduce production losses and mortalities due to under-nutrition during the dry season (Dixon and Doyle 1996). Dry licks based on urea, salt and cottonseed meal are often used as strategic supplements to reduce rate of liveweight loss, while molasses-urea mixtures are more often fed to maintain growth or as a 'crisis' supplement for survival. The present experiment examined changes in voluntary intake and microbial protein synthesis of young cattle fed low-quality hay and either dry lick or molasses-urea supplements.

Twenty-four *Bos indicus x* Shorthorn cross heifers, initially 10 to 14 months and 208 kg mean liveweight, were held in individual pens. During Period 1 (weeks 1 to 3) all heifers were fed hay *ad libitum*. During Period 2 (weeks 4 to 6) heifers were allocated to four treatments. Hay was fed alone (Nil) or supplemented with dry licks containing either cottonseed meal (DL-CSM) or dried molasses (DL-MOL). The fourth treatment consisted of a molasses-urea supplement (M8U; 7.4% urea). Dry licks contained 27% urea, 18% salt, 14% calcium phosphate, 9% ammonium sulphate and 32% of either cottonseed meal or Palabind® dried molasses (Molasses Products Co., Bundaberg). The hay (0.45% N and IVOMD 31%) consisted of native grass species baled during the late dry season. The concentrations of purine derivatives and creatinine in urine collected twice daily for four days during weeks 3 and 6 were used to measure rumen microbial N synthesis (Chen and Gomes 1992).

During Period 1 hay intake was 2.26 kg dry matter (DM)/d, and microbial nitrogen synthesis 5.0 g N/d or 2.1 g N/kg DM intake. In heifers fed hay alone during Period 2, intake and microbial N production were similar to Period 1 (Table 1). Both types of dry lick and M8U supplement tended ($P<0.10$) to increase hay intake by about 30%. Dry licks increased ($P<0.01$) microbial N synthesis per kg DM intake by 77 to 92%. M8U supplement increased total DM intake by 96%, the increase being associated with increased intake of hay as well as the intake of 1.74 kg M8U. Microbial nitrogen synthesis per day and per kg DM intake was also higher than for the other diets, presumably due to both the higher intake of total DM and the higher digestibility of molasses than of hay. The similar rumen microbial N synthesis with the two dry lick supplements suggested that any benefits of including protein meals in dry licks are due to factors other than changes in rumen microbial activity. In conclusion the experiment showed that both urea-based dry lick and M8U supplements can lead to large increases in protein supply to the small intestine in heifers fed hay of comparable quality to senesced native pasture.

Table 1. Intakes of hay and supplement and synthesis of microbial nitrogen by the heifers

	Treatment					
Measurement	Nil	DL-CSM	DL-MOL	M8U	s.e.m.	Significance
Intake: Hay (kg DM/d)	2.64	3.39	3.51	3.44	0.237	ns
Supplement (kg DM/d)	0	0.12	0.13	1.74	-	-
Total (kg DM/d)	2.64a	3.51b	3.64b	5.18c	0.272	***
Microbial nitrogen flow (g N/d)	6.8a	17.0b	16.2b	36.0c	2.03	***
Microbial nitrogen flow (g N/kg DM intake)	2.6a	5.0b	4.6ab	7.0c	0.67	**

Values within rows with different superscripts differ significantly ($P<0.05$); n.s. not significant; ** $P<0.01$; *** $P<0.001$.

CHEN, X. B. and GOMES, M. J. (1992). Occasional publication, (Rowett Research Institute : U.K).
DIXON, R. M. and DOYLE, P. T. (1996). *In* 'A Users Guide to Drought Feeding Alternatives', (Eds J. Rowe and N. Cossins) p.61. (The University of New England : Armidale).

RUMEN MICROBIAL SYNTHESIS IN HEIFERS FED LOW-QUALITY HAY AND INCREASING LEVELS OF UREA

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In the semi-arid tropics of northern Australia urea supplements can substantially reduce liveweight loss during the dry season (Dixon and Doyle 1996). Predictions of optimal amounts of supplementary urea are based primarily on experiments where intake and liveweight change have been measured with similar roughages. The present experiment measured the changes in voluntary intake and rumen microbial N synthesis of young cattle fed low-quality hay and a range of levels of supplementary urea.

Twenty-seven *Bos indicus* x Shorthorn heifers (186 kg mean liveweight and 10 to 14 months of age) which had been grazing wet season pasture were held in yards and fed hay as a group. After 14 days the heifers were moved to individual pens and dietary treatments commenced. Heifers were fed hay *ad libitum* alone (T1), or hay supplemented with 8 (T2), 16 (T3), 32 (T4) or 64 (T5) g urea per day. All animals were fed a mineral mixture (P, S and trace minerals) in 15 g M3U (molasses and 3% urea). Urea supplement was mixed with up to 100 g M3U and was fed separately from the hay. Fresh hay was fed and residues were collected three times each week. The hay had been baled from native pasture during the late dry season and contained 0.31% nitrogen (N). During week 3 of urea supplementation urine samples were collected twice daily for four days, and concentrations of purine derivatives and of creatinine in urine were used to calculate the microbial N flow from the rumen (Chen and Gomes 1992). During week 4 rumen fluid samples were taken *per os* and jugular blood was sampled four hours and 21 hours after supplements were given.

Table 1. Intake of dry matter (DM), microbial N synthesis in the rumen and concentrations of urea in plasma and of ammonia in rumen fluid

Measurement		Treatment (g urea/d)					Regression	
		T1(0)	T2(8)	T3(16)	T4(32)	T5(64)	r	Significance
n		7	5	4	5	3	-	-
Hay intake (kg DM/d)		1.79	1.74	1.67	1.94	2.36	0.48	*
Total intake (kg DM/d)		1.82	1.77	1.72	2.04	2.55	0.59	**
Microbial N flow (g N/d)		20.8	22.1	20.7	27.0	34.4	0.65	***
Microbial N flow (g N/kg DM intake)		12.0	12.5	12.1	13.4	13.7	0.20	ns
Plasma urea (mg N/L)	4 h	109	131	193	263	322	0.85	***
	21 h	108	131	181	217	288	0.81	***
Rumen ammonia (mg N/L)	21 h	91	112	150	133	188	0.73	***

ns, not significant; * $P<0.05$; ** $P<0.01$; *** $P<0.001$

Three heifers did not consume all of their allocated supplement. T1 heifers consumed only 1.82 kg DM/d but rumen ammonia (91 mg N/L) was expected to be sufficient for microbial N synthesis. Urea supplements increased hay intake and microbial N synthesis indicating that microbial activity was increased. The increase in hay intake due to urea supplement tended to be smaller than the increases observed previously with similar hays. The heifers fed T1 on average lost 0.6 kg liveweight/day during the experiment. It appears that N derived from tissue catabolism elevated plasma urea concentrations, and that plasma urea recycled to the rumen maintained rumen ammonia concentrations in the range usually considered adequate for microbial synthesis. Nevertheless the increases in hay intake and microbial N synthesis indicated that the heifers did respond to urea supplements.

CHEN, X. B. and GOMES, M. J. (1992). Occasional Publication, Rowett Research Institute, U.K.
DIXON, R. M. and DOYLE, P. T. (1996). *In* 'A Users Guide to Drought Feeding Alternatives', (Eds J. Rowe and N. Cossins) p.61. (The University of New England : Armidale).

INTAKE DISTRIBUTION OF A RANGE OF SUPPLEMENTS OFFERED TO GRAZING *Bos Indicus* CROSS CATTLE

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Supplements are often fed to grazing cattle. However, an appreciable proportion of cattle in a mob may not consume any supplement, and there may be a large variation in supplement intake among those animals that do consume supplement (Nolan *et al.* 1974; Eggington *et al.* 1990). The present experiment examined whether variability in supplement intake differed with the type of supplement and experience of animals to the supplement when grazing dry season pasture.

Bos indicus x Shorthorn cross heifers (160), initially 17-20 months of age, were allocated by stratified randomization to 8 paddock groups each of 20 head. Two paddock groups were fed 1 of 4 supplements: (i) cottonseed meal (CSM); (ii) molasses-urea (M8U); (iii) dry lick (DL); and (iv) solidified blocks (Blocks). M8U, DL and Blocks were offered *ad libitum*, and intake was calculated from amounts offered and refused. CSM (0.5 kg/hd.day) was fed in two equal amounts twice each week. M8U contained (g/kg) wet molasses 926 and urea 74, while DL contained salt 390, urea 300, CSM 150, calcium phosphates 150 and sulphur 10. Blocks contained (g/kg) molasses 494, CaO 148, urea 99, MgO 74, calcium phosphates 62, salt 62 and bran 62. Lithium sulphate marker was mixed with the supplements fed on one day after 5 weeks and 10 weeks to determine supplement intakes by individual animals.

Table 1. Intake (g/hd.day), proportion (%) of non-consumers of supplement and coefficient of variation (%) of supplement intake after 5 and 10 weeks of supplementation

Measurement	CSM	M8U	DL	Blocks	Significance
Intake					
Weeks 1-5	500	1257	176	120	-
Weeks 6-10	500	1172	145	97	-
Non-consumers[A]					
Week 5	0	0	4	19	ns
Week 10	0	0	1	15	ns
Coefficient of variation					
Week 5	31^a	29^a	85^b	105^b	*
Week 10	28^a	26^a	71^b	83^b	**

Within row means with different superscripts differ significantly (P<0.05).
[A] Adjusted means were derived from arcsin transformed data.

There were no non-consumers of CSM or M8U. After 5 weeks 3/40 of the heifers did not consume any DL, and 8/40 did not consume any Blocks. The proportion of non-consumer heifers tended to be lower after 10 weeks of exposure to supplements. The coefficient of variation (CoV) of supplement intake ranged from 26-31% when heifers were fed CSM or M8U, and was greater (P<0.05; 71-105%) when heifers were offered DL or Blocks. CoV of DL and Blocks tended to be lower after 10 weeks than 5 weeks of exposure to the supplements.

This experiment demonstrated that the proportion of non-consumers of supplement, and the variation in supplement intake within a mob, was greater for low palatibility DL and Block supplements than for more palatable M8U when these supplements were fed *ad libitum*. The proportion of non-consumers of supplement and the variation in supplement intake were similar for M8U fed *ad libitum* and for a restricted amount of CSM supplement fed at intervals with adequate trough space.

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NOLAN, J.V., BALL, F.M., MURRAY, R.M., NORTON, B.W. and LENG, R.A. (1974). *Proc. Aust. Soc. Anim. Prod.* **10:** 91-4.

INTAKE OF DRY LICK SUPPLEMENT IS INFLUENCED BY SUPPLEMENT PALATABILITY BUT NOT PREVIOUS EXPERIENCE

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In the northern cattle industry urea and mineral supplements are usually fed *ad libitum* as dry licks or blocks. However, it is often difficult to achieve target intakes, and a proportion of cattle may not consume any supplement (Dixon and Doyle 1996). An experiment examined the effect of previous experience of cattle with such supplements on voluntary intake of two types of dry lick supplement.

Bos indicus x Shorthorn (Fn) heifers (120) initially 13 to 15 months of age and 216 (s.d.±16) kg mean liveweight were used. All heifers had been fed molasses-based supplements for 7 to 14 days while being held in yards at weaning nine months previously. Sixty of the heifers had no other experience of supplements, and 60 had been fed a dry lick supplement based on urea, salt and cottonseed meal for five months post-weaning. The heifers were allocated by stratified randomization to 12 paddock groups, and these were allocated to four treatments in a 2x2 factorial design. The factors consisted of previous experience of dry lick supplements and low or high palatability dry lick supplements. Palatability was considered to be the relative acceptability of the feed. The low palatability dry lick contained 45% salt, 31% calcium phosphate (Kynophos), 22% urea and 1.5% elemental sulphur. The high palatability dry lick contained 33% cottonseed meal, 30% salt, 21% calcium phosphate, 15% urea and 1% elemental sulphur. Supplements were fed from early-February until mid-June 1996. A lithium marker technique (Suharyono 1992) was used to measure supplement intake by individual heifers after 7, 11 and 17 weeks.

Table 1. Intake (g DM/head/day), proportion of non-consumers (%) and coefficient of variation (c.v.%) of intake of dry lick supplements

		Low palatability		High palatability		Significance		
Measurement		Naive	Experienced	Naive	Experienced	S	E	SxE
Supplement intake		51	37	85	74	**	ns	ns
Non-consumers	Week 7	2	28	0	1	ns	ns	ns
	Week 11	1	54	0	1	ns	ns	ns
	Week 17	7	47	5	2	(-)	ns	ns
coeff.var.	Week 7	67	70	60	97	ns	ns	ns
	Week 11	68	73	55	58	ns	ns	ns
	Week 17	72a	150b	93a	66a	(-)	ns	*

S, type of supplement; E, degree of experience; ns, not significant; (-) $P<0.10$; * $P<0.05$; ** $P<0.01$

Intake of the dry lick supplement was increased by inclusion of cottonseed meal in the mixture (79 and 44 g DM/head/day) (Table 1). Thus heifers offered the high palatability dry lick consumed 30% and 50% more supplementary P and N respectively. The proportion of non-consumers of supplement (average 12%) and the c.v. of supplement intake (average 77%) were generally not affected by the treatments. However, both the proportion of non-consumers and the variability in supplement intake within groups were inversely related to the intake of lithium-labelled supplement. When average intake by a paddock group exceeded 50 g/day the proportion of non-consumers was always less than 5%, but at lower intakes the proportion of non-consumers averaged 34% (range 7 to 54%). In conclusion including cottonseed meal in the dry lick increased voluntary intake of supplement. Also the proportion of non-consumers and the variability of supplement intake were highest when average supplement intake by groups was low.

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Trough Arrangement, Space Allocation and Supplement Intake of Cattle Grazing Native Pasture

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Grazing cattle are often provided with supplementary feed in order to increase productivity. Intakes of supplement can be highly variable, and this reduces the cost effectiveness of the supplement. This study examined the effects of different feeding space allocations and trough arrangements on the intake of a molasses/urea supplement (M8U) by small groups of young heifers grazing native pasture during the dry season in a semi-arid, tropical environment. Brahman x Shorthorn heifers, approximately 6 months of age and weighing, on average, 145 kg, were allocated to eight paddock groups (15 head/group). The supplement consisted of 93% molasses and 7% urea and was fed in troughs 550 mm in diameter and 450 mm high with a top opening of 300 mm^2. The treatments, of which there were 2 replicates, were: (i) a single trough (S), (ii) three troughs placed in line, in contact with each other (E-E) (iii) three troughs placed 3 m apart (3x3) and (iv) three troughs placed 10 m apart (3x10). The experimental design consisted of 3 periods each of 1 month and all measurements were repeated in each period. Supplement intakes were measured on a group basis each week and individually by a lithium marker technique. Observations were made on time spent feeding and agonistic interactions. Across all measures, intakes tended to be lowest on treatment E-E (e.g. average M8U intake was 0.76 kg/head/day on E-E vs. 0.89 kg/head/day on 3x10). The number of agonistic interactions tended to be greatest on treatment S (on average 4.9/head/hour on S vs. 3.7/head/hour on 3x10). Coefficients of variation of supplement intake ranged from 37% to 44% and was not affected by treatment.

J.C. Petherick, P. Fry and R. M. Dixon (1997). Effect of siting of supplementary feed on intake and paddock use by beef cattle. Proceedings of the 31st Congress of the International Society for Applied Ethology, editors P.H. Hemsworth, M. Spinka & L. Kostal. Research Institute of Animal Production, Prague, Czeh Republic. p. 105.

Effect of Siting of Supplementary Feed on Intake and Paddock Use by Beef Cattle

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Supplementary feed is provided to cattle to minimise weight loss during periods of drought or when plants are dormant. Large variability around an optimal average intake means that the cost-effectiveness of this feeding is reduced.

This study examined the effects of the siting of supplementary feed on intake and paddock use by small groups of steers. Sixty steers (average weight 335.5 kg) were allocated to six paddock groups based on liveweight. There were two treatments: (i) a dry-season lick block was sited about 25 m from the water trough (N), (ii) a dry-season lick block was placed at the opposite end of the paddock from the water trough at a distance of about 1.8 km (F). The blocks comprised approximately 33% molasses, 20% urea, 3% cotton seed meal, 6% salt, plus various minerals (e.g. calcium and phosphorus) and trace elements. A switch-back design was used with each of three paddocks receiving either treatment N or F for the first month, followed by a month on the other treatment and the original treatment during the third month.

Daily group intake of block was measured and the position in the paddock and the behaviour of the groups of steers were recorded at 8.30 h, 12.00 h and 15.30 h. At the end of each month individual supplement intakes were determined using a lithium marker technique.

Preliminary analysis suggests that supplement siting had minimal effects on the way in which cattle used the paddocks. Regardless of treatment cattle were found at or near the water trough on the first observation of the day, were resting and ruminating at the trough on the second and were grazing away from the trough on the third. Supplement intakes were higher on the N treatment than on the F treatment, with mean intakes (gm/head/day) being for month 1: N= 138, F = 115 (n.s.), month 2: N= 163, F= 95 ($p<0.05$), month 3: N= 212, F= 150 ($p<0.01$). Average liveweight gains during the first month tended to be higher ($p= 0.077$) on the N treatment (N= 16.5 kg, F= 9.5 kg, but there were no significant differences on subsequent months.

EFFECTS OF LICK-BLOCK SITING ON SUPPLEMENT INTAKE AND BEHAVIOUR OF CATTLE

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Anecdotes from producers suggest that good control of intake of lick-blocks can be achieved by varying the distance between the supplement site and watering points. It has also been suggested that siting of supplement points can change grazing patterns in large paddocks (Chapline and Talbot 1926; Ares 1953). However, there is little objective information available to evaluate these suggestions.

Sixty steers of about 21 months of age and averaging 335 kg liveweight were allocated by stratified randomisation based on liveweight to six paddock groups. The paddocks measured approximately 1800 m x 200 m, with water available only from a single trough at one end (the 'front') of each paddock. A commercial dry season lick-block (Olsson's Dry-Season 20% Urea; 20% urea, 33% molasses, 3% cotton seed meal and 6% salt) was placed either adjacent to the water trough (N) or approximately 1.8 km from it (F). A switch-back design, with three 30 day periods, was used with each treatment being imposed on the three paddock groups during each period. Group intakes of block were recorded daily, except weekends. Cattle were weighed and condition scored monthly. For 12 days during each period the position in the paddock of the cattle and their behaviour were recorded at 0830, 1200 and 1530 hours daily.

Position of the cattle in the paddocks was analysed by χ^2 tests. Supplement siting had little effect on the way in which cattle used the paddocks. Cattle were usually grazing in the front half of the paddocks at 0830 hours, resting at the water trough at 1200 hours and either resting near the water trough or grazing in the middle of the paddock at 1530 hours.

Supplement intakes were higher for treatment N than F (Table 1). Steers gained weight in Periods 1 and 3, and lost weight in Period 2. Steers given treatment N tended (P=0.07) to gain more weight or lose less than those given treatment F (Table 1).

Table 1. Average group intakes (g/head/day) and average liveweight changes (kg) (s.e. ± in parentheses) during 30 day periods of steers provided with lick-blocks near to (N) or far from (F) their water trough

		Period 1	Period 2	Period 3
Supplement intakes	N	138 (23)	163 ^{a} (16)	212 ^{c} (3)
	F	115 (23)	95 ^{b} (16)	150 ^{d} (3)
Liveweight changes	N	16.5 (2.5)	-15.9 (3.0)	23.2 (0.8)
	F	9.5 (2.5)	-20.5 (3.0)	23.0 (0.8)

Values within columns followed by different letters differ significantly; a,b at P<0.05, c,d at P<0.01

The siting of supplement points appears to have little effect on the way in which small groups of cattle use small paddocks. Supplement intakes were reduced on average by 29% by siting supplements distant from water, but large variation between paddock groups suggest that this method is not sufficiently consistent to accurately control intake. Further work with large groups of cattle in large paddocks is needed.

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Straw and Low Quality Roughages as Drought Feeds

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Summary

Cereal crop residues and dead mature pasture are often the primary feeds available to maintain stock during drought. Although of low nutritional value, their advantages are in their availability and in most circumstances their low cost. Costs for baling and transport may make straws more expensive per unit of metabolizable energy than grain or molasses.

On farms with abundant roughage of low quality, the principal issue becomes how to utilize this roughage most effectively. On farms with a shortage of any feed, the principal issue will usually be to estimate the nutritional value (particularly of energy) of the available roughage compared to purchased feedstuffs.

Constraints on the use of straw and dead mature pasture include the need to avoid over–grazing, low nutritive value and low voluntary intake, and high costs for baling, transport or chemical treatment to improve nutritional value.

Nutritive value of low quality pastures and cereal crop residues varies widely. Leaf content of straws is usually the most important characteristic determining their value. Most crop residue is utilised by grazing the stubble. Intensive selection of the more digestible parts of the stubble means animals are likely to maintain liveweight (LW) for some weeks or months after being introduced to stubbles. However, later LW losses may be severe. Availability of small amounts of green plant material after storms has a major effect on the productivity of animals grazing stubbles.

Supplements based on non–protein (NPN, *e.g.* urea) nitrogen and sulphur (NPN/S) can reduce rates of LW loss and improve reproduction rates of animals grazing stubble or dead mature pasture. Little response to NPN/S supplements may occur if:

- The quality of ingested roughage is adequate due to selection;
- Animals cannot select roughage high in leaf; and
- difficulties with delivery of supplements results in many animals consuming little supplement or there is poor synchrony of supply of substrates in the rumen.

The value of NPN/S supplements is principally to reduce mortality and to delay the need to implement alternative higher cost feeding and management strategies.

Introduction

Most of the roughage available during drought will consist of dead mature pasture or crop residues and will be of low nutritive value. In this paper we consider the use and feeding management during drought of low quality roughage, and in particular cereal crop residues to maintain sheep and cattle. These principles will also apply to residues from grain legume crops, although the amount of spilt grain is likely to be a more important issue.

Predicting the nutritional value of low quality roughage will be most important when it provides most of the feed intake. This will usually happen where the priorities are for survival and reproduction of the breeding stock and slow growth by animals in the growing-out phase.

When high growth or productivity are required low quality roughages cannot be used as the major part of the diet simply because they are too low in nutritional value. For high productivity, feeds such as grain, silage and molasses will have to be used as the basis of the diet.

The factors determining the value of low quality roughages as drought feeds will vary depending on the situation. One scenario is where a farm has abundant roughage available as dead mature pasture or crop residues, but the nutritive value is too low for the required level of animal production. The principal issue becomes how to use this roughage most effectively for survival of the breeding herd, or as part of the diet for a

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producing animal. High production rates will require high levels of molasses, grain or protein meal supplements, and will not be discussed in this paper.

A second scenario will occur where a farm has a shortage of any feed, including roughage. The principal issue becomes one of understanding the value of available straw or stubble in comparison with purchased hay or other feedstuffs.

The obvious advantages of straws and low quality roughages are their availability, and in most circumstances, their low cost. Grain production records give reasonable estimates of the amounts of straw available, since the amount of straw produced will usually be 1.0–1.5 times the amount of grain. Wheat is by far the most important crop with an average production during the last two decades of 14 million tonnes (range 9–22), followed by barley (4 million tonnes, range 2–7), oats (2 million tonnes) and sorghum (1 million tonnes). In drought years national production can be half, and presumably within regions much less than half, of average production.

The cost of straw per unit of metabolizable (ME) energy is usually, but not always, less than for grain or molasses. Stubble or dead mature pasture has no alternative value. However baling, handling and transporting straw can often substantially increase the cost of straw per unit of metabolizable energy (Table 1). For example, contractor costs for merely baling straw are likely to be $30 – $50 per tonne. With some additional costs for transport and for wastage (especially during feeding), baled straw can cost $40 – $80 per tonne and thus be more expensive per unit of metabolizable energy than grain or molasses.

Constraints

Sustainability

There will always be a need, albeit often ignored, to retain sufficient crop or pasture residues to protect soils from wind and water erosion during and/or immediately following drought, and to maintain satisfactory levels of soil organic matter. Recommended levels of retention have been established for various systems. Over–grazing, particularly during drought, may also have major adverse consequences by elimination of desirable perennial species, encouragement of woody weeds and by changing the balance of pasture species present after the drought. The consequences on pasture productivity and the sustainability of the grazing system are long–term (Scott 1995).

Low nutritive value of crop residues

Most crop residues and dead pastures are of low digestibility and contain low concentrations of nitrogen, sulphur, phosphorus and other minerals. Voluntary intake is usually low (less than 2% of LW), partly because of low digestibility (less than 55% dry matter digestibility) and nutrient content, but also because of limitations associated with physical breakdown and passage of highly fibrous material through the digestive tract. Even when digestibility and nutrient content are acceptable, palatability of the material may limit voluntary intake, *e.g.* for the thick stems of sorghum and maize. Plant anti-nutritional factors or microbial growth on crop residues (*e.g.* the fungus *Phomopsis leptostromiformis* on lupin stubble) may also be limiting factors.

The low ME content of crop residues (4 – 7 MJ ME/ kg DM) sets severe limits on their use, since even if voluntary intake can be increased to, for example 3% of LW, intake of ME will still be sufficient only for maintenance or slow growth. The extent to which this is a constraint depends on both the required type and level of production (survival, reproduction, slow LW loss, slow LW gain) and the economic consequences of achieving this in various situations.

Table 1 Comparisons of cost par unit of metabolizable energy (MJ ME) of baled straw, grain and molasses for various prices per tonne of these feeds.

Baled straw		Grain		Molasses	
$/tonne	Cents/MJ	$/tonne	Cents/MJ	$/tonne	Cents/MJ
20	0.3-0.6			60	0.7
40	0.6-1.1	100	0.9	90	1.0
60	1.0-1.7	150	1.3	120	1.4
80	1.3-2.2	200	1.7	150	1.7

Assumed contents of metabolizable energy: Straw 4-7 MJ ME/kg DM;
Grain 13 MJ ME/kg DM;
Molasses 11.5 MJ ME/kg DM.

Additional costs for transport are likely to be: Straw 0.20 cents/MJ ME per 100 km;
Grain 0.04 cents/MJ ME per 100 km;
Molassas 0.05 cents/MJ ME per 100 km.

Storage, transport and modification of crop residues

The low nutritive value and bulky nature of crop residues means it is seldom economically viable to invest in large additional costs for packaging, storage, transport, or modification. Hence, generally crop residues can be used for livestock only when produced in mixed livestock/cropping areas. Transport costs per unit of ME are much higher than for grain or molasses due to the combination of low ME content and low bulk density.

Treatment of low quality roughages, including crop residues, with alkalis has been shown to effectively increase digestibility and intake. However, considerable inputs are required to produce a feedstuff which at best only provides sufficient energy for maintenance or slow growth. Furthermore, the increase in digestibility is inversely related to the digestibility of the material before treatment and digestibility of alkali-treated roughage is seldom greater than about 55%. Other problems are that the strong alkalis such as sodium hydroxide are dangerous to handle, and in some areas the additional excretion of sodium will not be acceptable for environmental reasons.

For a treatment system to be useful under Australian conditions it will need to be simple and involve low capital investment. Injection of large round bales with aqueous ammonia or solutions of alkali seems to meet these criteria. This method of treatment of barley straw appeared to be very successful under one set of experimental conditions, with increases in intake of straw by 36% and in ME content by 53% (Stephenson *et al.* 1984). However in other experiments (Aitchison *et al.* 1986) a poor response was observed when wheat straw was similarly treated. Further work is needed.

Grazing stubbles

The most common system of using crop residues in Australia is no doubt by grazing stubbles in situ. This situation does not seem likely to change. However utilisation of crop residues by grazing introduces a number of limitations:

- Only crop residues in mixed cropping/livestock areas are likely to be used since areas engaged only in cropping do not usually have essential infrastructure such as fences and stock water;
- There will be little flexibility in the time frame during which stubble can be used, since utilisation can only be between the grain harvest and the time when the land will have to be prepared for the next crop;
- Both the quantity and the nutritional value of stubbles are likely to decline rapidly after harvest due to leaching and decay, especially with any rain. Under Western Australia conditions Purser (1982) observed that DM digestibility declined by 5 percentage units with each six weeks post–harvest. There is also the risk of complete loss of stubble by fire; and
- Only a small proportion of the total stubble can actually be consumed by stock.

Variation in the Nutritional Value of Cereal Straw

Information from feeding experiments to compare the nutritive value of straws is scarce. Hence conclusions on the nutritive value, particularly digestibility, will be drawn from laboratory measurements despite the difficulties of predicting nutritive value from such measurements.

The digestibility of straw or stubble from wheat is usually, but not always, lower than for barley or oats (Table 2). In most studies the range in digestibility within species was large, and there was overlap in value from different species. Similar data are available on cell wall concentration and composition, crude protein and mineral levels in many of these studies. The data demonstrate that there is variability in digestibility due to genetic (species, cultivar) and environmental (location, year, season) factors, to management practices (time and method of sowing and harvesting) and to laboratory procedures used to estimate digestibility. In most experiments straw digestibility has not been strongly or consistently related to agronomic characteristics. However, in some work, plant height has been related to the proportions of leaf blades and stem components, suggesting that this characteristic may be a useful indicator. In a survey of straws in SW Western Australia, Purser (1982) observed that DM digestibility of straw declined from 45% – 30% with increasing rainfall and longer growing season. Wales *et al.* (1990) observed digestibility of a single cultivar of wheat straw to range from 30 – 47% at different locations within the one season. Location can have a larger effect than cultivar on digestibility of barley straw (Capper *et al.* 1988). This is also apparent for differences between years (White *et al.* 1981; Orskov *et al.* 1990).

The major botanical fractions of wheat, barley and oat straws are leaves (blades and sheaths) and internodes, with nodes and chaff (flower head including loose husk) being minor components. The leaf blade is usually more digestible than the leaf sheath, which is more digestible than the stem (Table 3). There are also differences within stems, with digestibility of the internodes increasing from the bottom to the top of the stem. The digestibility of both the leaf and stem

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Table 2 Digestibility (%) of residues from wheat, barley and oat crops. Values in parentheses are standard deviations or ranges (Doyle 1994).

Location	Parameter	Wheat	Barley	Oats	Reference
Australia	IVOMD	36(30-45)	45(40-46)	40(34-46)	Pearce *et al.*(1979)
	NBDMD	(38-46)		(45-47)	Aitchison (1988)
		(30-36)	(42-43)	(37-44)	Aitchison (1988)
		(41-47)	(45-51)	(37-49)	Aitchison (1988)
		(28-35)	(30-37)	(26-32)	Aitchison (1988)
Canada	IVOMD	37(34-39)	38(37-40)	40(37-43)	Kernan *et al.*(1979)
	NBOMD	36(30-41)	49(44-53)	54(48-58)	Colucci *et al.*(1992)
Germany	NBDMD	41(37-46)	42(34-54)	57(49-65)	Flackowsky *et al.*(1991)
Sweden	IVOMD	47(28-58)	48(32-61)	55(40-68)	Eriksson *et al.*(1982)
UK	IVDOMD	43(3.8)	46(4.6)		Adamson & Bastiman (1984)
	IVDMD	32(27-36)	34(31-38)		Jewell *et al.*(1986)
	NBDMD	37(35-40)	50(39-61)	49(44-52)	Tuah *et al.*(1986)
	IVOMD	43	44	49	Mason *et al.*(1988)
	NBDMD	44(39-48)		38(37-41)	Shand *et al.*(1988)
	IVDOMD	42(6.4)	43(5.5)	49(6.3)	Givens *et al.*(1989)
	NBDMD	44(35-56)	47(34-61)	43(37-52)	Orskov *et al.*(1990)
	IVDOMD	37	47	46	Moss *et al.*(1990)
USA	IVDMD	39(28-40)	45(33-52)	45(40-48)	White *et al.*(1981)

IVDMD and IVOMD = in vitro dry matter and organic matter digestibility measured by rumen fluid or enzyme assays.
IVDOMD = in vitro digestible organic matter in dry matter.
NBDMD and NBOMD = nylon bag dry matter and organic matter disappearance.

Table 3 Variation in in vitro organic matter digestibility (IVOMD) of fractions of 78 samples of mature wheat plants (Winugroho 1981).

Fraction	Mean	SD	Range
Husk	53	5.0	44-66
Rachis	43	4.1	34-52
Stem internode	27	2.8	21-35
Stem node	41	3.7	34-50
Leaf blade	68	4.1	58-77
Leaf sheath	53	3.9	45-63
Stem (internode + node)	29	2.3	24-36
Leaf (blade + sheath)	59	3.7	51-68
Whole plant, excluding grain	43	2.9	36-50

component can vary with environmental conditions under which the straw is grown (Winugroho 1981). The decline in digestibility with increasing rainfall observed by Purser (1982) was associated with similar declines in the digestibility of the leaf and stem fractions.

Although it is possible to draw general conclusions that straws high in leaf are likely to be more digestible than those high in stem, it is not currently possible to predict the consequences of the complex factors associated with genotype, environment and their interactions on digestibility and nutritive value of straws and stubbles.

Making Best Use of Abundant Low Quality Crop Residue and Roughage

Maximum intake and production

A common situation is to have roughage available as a large amount of stubble or dead mature pasture, but of quality too low for target nutrient intake and animal production. Such low quality roughage can often be used most effectively by animal management procedures directed towards achieving maximum roughage intake, and/or by providing essential nutrients that promote efficient rumen digestion as well as efficient utilisation of absorbed nutrients by the animal. Advantages are that feed is utilised before it declines in quality or disappears due to trampling, decay, leaching and fire. Nutrients are in effect stored as body fat (or at submaintenance, rate of loss of body fat reserves is reduced), and the need for crisis management or high level feeding is delayed. A major disadvantage is that to achieve maximum intake and higher productivity per animal it will usually be necessary to accept a reduced efficiency of utilisation of low quality roughages. Also metabolic inefficiencies are involved in the deposition and subsequent mobilisation of body fat.

Factors limiting intake in pens

The primary determinant of ME intake of temperate pastures of low quality is usually assumed to be the digestibility. As digestibility increases from 40% – 55%, ME intake is likely to double, partly due to the increase in digestion but more importantly due to increased intake. Tropical grasses differ in that voluntary intake is also strongly influenced by the leaf/stem ratio. Intake of leaf is often 30 – 50% greater than stem material of the equivalent digestibility (Laredo and Minson 1973; Poppi *et al.* 1980). Presumably this is because the stem tissue has greater structural strength, and this limits particulate matter breakdown and passage from the rumen. Temperate pasture grass species usually have much smaller differences in structural strength, as measured by grinding energy, between the leaf and stem components.

There is appreciable evidence that voluntary intake of straws of temperate cereals such as wheat and barley is, like tropical grasses, influenced more by the leaf content of the ingested material than by digestibility *per se*. This is consistent with the observation that stem of straws is much thicker and tougher than that of most temperate pasture species. These effects are likely to be accentuated for crop residues from sorghum or maize, since the stem material of these crop species is larger and thicker than that of wheat or barley. It is often observed that ruminants, and sheep in particular, will consume little stem of sorghum or maize. Hence, although digestibility may be a fairly good determinant of ME intake of low quality temperate pastures, it is less useful for crop residues.

Voluntary intake increases with the proportion of leaf blade and leaf sheath for wheat straw (Wales *et al.* 1990) and barley straw (Capper *et al.* 1986; Rafiq *et al.* 1995) fed to sheep, and for rice straws fed to cattle (Winugroho and Sutardi 1987; Wanapat and Kongpiroon 1988). In these experiments differences between leaf and stem components in the resistance to physical breakdown (as measured by grinding energy) and in digestibility have often been confounded, since leaf is usually both higher in digestibility and lower in grinding energy than stem. However, two lines of evidence suggest that differences in the resistance to physical breakdown and therefore leaf content is the more important factor. Firstly, Asian rice straw is unusual in that digestibility of leaf is often similar to or less than that of stem, but voluntary intake of such rice straw is positively related to leaf content. Secondly, a wide range in voluntary intakes of barley straw by sheep was apparently related to straw characteristics such as leaf content rather than to digestibility (Capper 1988; Capper *et al.* 1989).

The degree of selection of straw components can also markedly affect intake. For example, when the proportion of barley straw refused by sheep in pens was increased from 20% – 75%, voluntary intake of straw was increased by 57% and ME intake by 92% (Wahed *et al.* 1990). It has also been shown that as the opportunity for selection of barley straw by sheep was increased, more leaf blade and less stem was consumed. Sheep tended to select against, rather than for, leaf sheath (Bhargava *et al.* 1988). We know of no equivalent data on the ability of cattle to select the components of fine–stemmed straws such as wheat or barley. The lesser ability of cattle than of sheep to select pasture components suggests that less selection would also occur with the cereal straws. Cattle fed in pens on a coarse-stemmed straw, finger millet *Eleusine coracana* increased voluntary intake of straw by 33% and ME intake by 52% as straw refusals increased from 15% – 43%, but no further selection occurred with higher levels of refusals (Rao *et al.* 1994).

Despite the importance of morphological composition, when straws are fed alone the content of an essential nutrient(s) may be more important than leaf content or digestibility in influencing intake. For example, Herbert *et al.* (1994) observed a close correlation between intake by sheep and the N content of barley straws when fed without a nitrogen supplement, but no relationship when the straws were fed with a nitrogen supplement. Under the conditions of this experiment neither leaf content nor digestibility characteristics were important factors determining intake.

Factors limiting intake of sheep and cattle grazing stubbles

Ruminants grazing stubbles will obviously have far greater opportunity than animals in pens to select components of the crop residue. We are not aware of any direct measurements of the degree of selection of leaf components in sheep or cattle grazing stubbles. However, shortly after harvest stubbles often contain appreciable amounts of spilt grain, and may also contain green herbage as weed growth.

The very large differences in selection and intake between grazing animals and penned animals are demonstrated in the study of May and Barker (1984). Cattle grazing barley stubble gained 0.85kg/d, or with the addition of an NPN based supplement 1.0kg/d. However, animals in pens fed the same barley stubble, but baled, lost 0.34kg/d in the absence of supplement and gained 0.19kg/d with the addition of the NPN based supplement. This experiment demonstrates the large difference between animals grazing stubble or fed nominally the same roughage in pens; both the level of production and the response to supplement were markedly affected. It is therefore necessary to examine results from grazing experiments to understand the likely responses of sheep and cattle grazing cereal stubble.

Extensive information on the intake and productivity of sheep and cattle grazing wheat, barley and oat stubbles in the southern Australian environment is provided by the series of experiments of J.B. Coombe, J.G. Mulholland and colleagues. One major conclusion was that both sheep and cattle, but particularly sheep, have the capacity to select intensively for spilt grain and for any green herbage present in the stubble. Most of the green herbage was due to growth of broad–leaf plants following storms before or during the grazing period. Availability as low as 40kg/ha of green material resulted in a diet containing more than 80% green material, and the digestibility of the selected diet was usually 20–25 percentage units higher than the average of the plant material on offer. Within the range 40–500kg green DM/ha, ME intake was well correlated with the availability of green plant material. Later comparisons between sheep and cattle showed that cattle are less able than sheep to select green material in the stubble, but even when green DM/ha ranged from 240–500kg/ha, cattle were able to select a diet containing 45% green material and 18% higher in digestibility than the total plant material on offer (Table 4).

Table 4 The proportion of green leaf and the digestibility of material present in stubble, and the porportions of each of these ingested by sheep or cattle grazing the stubble. Calculated from results of Mulholland *et al.* (1977).

Measurement	Green leaf (%)	Digestibility (%)
Stubble on offer	14	34
Ingested by cattle	64	51
Ingested by sheep	93	67

In vitro digestibility of stubble and samples of the material eaten obtained from oesophageally–fistulated sheep or cattle.

The degree of selection for green plant material by both sheep and cattle was much greater in these stubbles than has been reported for temperature pastures. Differences in sward structure and the spatial arrangement for morphological components of cereal crop residue and green herbage in the stubbles compared with temperate pasture may have enhanced selection of green herbages. However, the use of different methods to estimate green plant material present makes it difficult to compare between experiments. For example quadrats cut with a shearing handpiece as done in the above experiments will give lower estimate of green herbage availability than quadrats cut with a scalpel to ground level (P.T. Doyle, unpublished results).

In the above experiments the availability of green plant material was largely a consequence of summer storms. During drought such storms are likely to be infrequent, and sheep and cattle grazing stubbles will usually only have the opportunity to select from dead plant material. Coombe and Mulholland (1983; 1988; 1989) examined selection by sheep and cattle grazing stubbles where green plant material was eliminated as far as possible with herbicides. Sheep were still able to select a diet which was 8% digestibility units and 0.3% N higher than the plant material on offer. Similar selection was observed in cattle. This indicates that both sheep and cattle have the ability to select the stubble components of appreciably higher nutritional value than the average of plant material on offer.

There is also evidence of selection by both sheep and cattle of the leaf components of stubbles from studies of disappearance of various plant components. Such data are less satisfactory than those derived directly, because leaf in particular will be lost by shattering during grazing. Nevertheless these measurements suggest that sheep preferentially consumed spilt grain, leaf and glumes (Table 5). Measurements have been reported for cattle grazing grain sorghum stubble under North American conditions (Ward *et al.* 1979). On average over two years, 44% of the stubble disappeared during a three–month grazing period, but only 19% from ungrazed enclosures. The proportions of the morphological components suggested that the cattle selected strongly for leaf and against the stem component, with leaf comprising 76% of the ingested stubble. Similar observations for cattle grazing maize crop residues indicated an order of selection of grain, leaves and husks, stalks and then cobs (Lamm and Ward 1981).

Liveweight change of sheep and cattle grazing stubbles

Liveweight (LW) change reported for animals grazing stubbles has varied widely between trials. In general, performance of cattle at moderate stocking rates has usually been between maintenance and moderate growth (0.9kg/d) for the first 6–8 weeks of grazing, presumably associated with ingestion of spilt grain, weeds, and the nutritionally higher quality components of the stubble (Table 6). However, when grazing was

Table 5 Quantities of wheat stubble components before (January) and after (April) grazing by sheep at Merredin, WA in 1970 (H.E. Fels, unpublished results).

Component	January kg/ha	April (kg/ha)	Disappearance (kg/ha)	Percent#
Split grain	46	1	45	98
Leaf	388	125	263	68
Stem	424	328	96	23
Flower stalks	40	17	23	58
Glumes (husks)	130	33	97	75
Total	1026	504	524	51

Percentage disappearance between January and April.

Table 6 Liveweight change of cattle grazing stubble without supplement or with various supplements based on NPN/S, and with green weed growth or nominalty weed–free.

Expt	Stubble type	Supp	Duration (weeks)	LW change (kg/d)	Reference
1	Barley, weed-free	Nil	0-8	+0.9	A
		S1	0-8	+1.0	A
2	Oat	Nil	0-8	+0.5	B
3	Wheat, weedy	Nil	0-11	+0.5	C
	Wheat, weed-free	Nil	0-11	+0.1	C
	Oats, weedy	Nil	0-11	+0.6	C
	Oats, weed-free	Nil	0-11	-0.1	C
4	Oat, weed-free	Nil	0-6	+0.6	D
		S2	0-6	+0.4	D
		S3	0-6	+0.2	D
		Nil	6-12	-1.6	D
		S2	6-12	-0.5	D
		S3	6-12	-0.5	D
5	Wheat	Nil	0-11	+0.1	D
		S2	0-11	+0.1	D
		S3	0-11	+0.1	D
		S4	0-11	+0.3	D
		Nil	11-15	-1.4	D
		S2	11-15	-1.1	D
		S3	11-15	-1.4	D
		S4	11-15	-1.2	D

Supplements: S1, biuret + grain + P.
S2, molasses (300 g/d) + urea (3 g/d) + minerals
S3, molasses (300 g/d) + urea (60 g/d) + minerals
S4, urea/molasses block

References: A, May & Barker 1984; B, Smith & Warren 1986; C, Coombe & Mulholland 1988; D, Coombe & Mulholland 1989.

continued for longer periods in stubbles with little or no weed, apparent LW losses could be severe (1.3 – 1.6kg/d). ME content of the ingested diet was also low during this period of severe LW loss (*in vitro* DM digestibility 38%; Coombe and Mulholland 1989).

Wide variation in LW change has also been observed for sheep grazing stubbles (Table 7). At moderate stocking rates and with appreciable amounts of spilt grain or green plant material present, maintenance or slow growth (up to 1.4kg/month) have usually been observed. With adult sheep grazed at high stocking rates (30 sheep/ha) on stubble of low weed content, LW change has tended to range from maintenance to LW losses of up to 2.5kg/month. As with

Table 7 Liveweight change of sheep grazing cereal stubble without supplements or with various supplements based on NPN/S, and with green weed growth or nominally weed-free.

Expt	Type of sheep	Stubble type, stocking rate	Duration (weeks)	LW change (kg/month) Nil supp	Plus upp	Reference
1	W	Wheat (7.5/ha)	6	-5.6	-3.8 (S1)	A
2	A	Wheat (5/ha)	14	-2.6	-2.1 (S4)	B
3	H	Oat	14	+0.2		C
		Barley	14	+0.8		C
		Wheat	14	+0.2		C
		High stocking rate (26/ha)	14	+0.0		C
		Low stocking rate (13/ha)	14	+1.1		C
4	H	Oat	14	-0.3		C
		Barley	14	+0.6		C
		Wheat	14	+0.5		C
		High stocking rate (30/ha)	14	-0.9		C
		Low stocking rate (15/ha)	14	+1.4		C
5	H	Oat	11	-0.2		C
		Barley	11	-0.5		C
		Wheat	11	-1.2		C
		High stocking rate (30/ha)	11	-1.9		C
		Low stocking rate (15/ha)	11	+0.7		C
		Weedy	11	0.0		C
		Weed-free	11	-1.2		C
6	H	Oat, high stocking rate (30/ha)	11	-2.2	-1.1 (S5)	C
		Oat, low stocking rate (15/ha)	11	+0.1	+0.9 (S5)	C
7	H	Oats, high stocking rate (23/ha)	14	+0.3		D
		Oats, low stocking rate (11/ha)	14	-2.9		D
8	H	Wheat, weed-free (7/ha)	15	-1.3	-0.2 (S2)	E
				-1.3	-0.5 (S3)	E
				-1.3	-0.2 (S4)	E
9	A	Wheat (5/ha)	12	-2.5	-0.9 (S4)	F
10	A	Oat, weedy (20/ha)	11	+0.1	+0.2 (S2)	G
				+0.1	+1.1 (S3)	G
				+0.1	+2.1 (S4)	G
10	A	Oat, weed-free (20/ha)	11	-2.3	-0.7 (S2)	G
				-2.3	-0.2 (S3)	G
				-2.3	-1.5 (S4)	G
11	W	Wheat, pre-grazed (10/ha)	5	-1.4		H
12	H	Wheat, pre-grazed (10/ha)	14	-0.9		I
13	H	Wheat, pre-grazed (10/ha)	5	-2.9		J

Type of sheep: W, weaner; H, hogget; A, adult
Supplements: S1, molasses-urea sprayed on to pasture; S2, molasses (50 g/d) + urea (0.5 g/d) + minerals; S3, molasses (50g/d) + urea (10 g/d) + minerals; S4, urea/molasses blocks of various formulations; S5, urea + grain.

References: A, Coombe & Tribe 1962; B, Messenger *et al.* 1971; C, Mulholland *et al.* 1978a; D, Mulholland *et al.* 1976b; E, Mulholland & Coombe 1979; F, Butler 1981; G, Coombe & Mullholland 1983; H, Rowe & Ferguson 1986; I, Rowe *et al.* 1989; J, Morcombe & Ferguson 1990.

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cattle, LW loss has tended to increase late in the grazing period. Severe LW loss (1.0 to 5.6kg/month) occurred where weaner sheep grazed wheat stubble which had been grazed by other sheep following harvest (Rowe and Ferguson 1986; Rowe *et al.* 1989; Morcombe and Ferguson 1990). These rates of LW loss were presumably associated with the higher nutritional requirements and lower capacity of young sheep to consume low quality roughage, to the pre–grazing which removed spilt grain and weed, and also perhaps with absence of, or limited weed growth, during the experiments.

A difficulty with all of these measurements is that LW change in sheep grazing stubbles can be misleading as soil ingestion can be considerable. Condition scoring may be a useful complement to weighing when monitoring animal performance.

The data presented in Tables 6 and 7 are for stock grazing cereal stubbles. For sheep grazing lupin or pea stubbles LW gains early in the grazing period can be higher than for cereal stubbles. However, the feeding value of these stubbles is depleted more rapidly than that of cereal stubbles.

Strategies for Most Effective Utilisation of Stubbles

As discussed above, a characteristic of stubble grazing is that LW tends to be maintained, or lost at only a slow rate while green herbage is available in the stubble, or in weed–free stubbles for the first 2–3 months of grazing. Severe LW losses thereafter presumably coincide with the animals no longer being able to select high digestibility components. Even with high stocking rates (*e.g.* 30 sheep/ha), only a small proportion of the total stubble DM on offer will be consumed during a 3–4 month grazing period.

One strategy to increase the efficiency of utilising grazed stubble would be to minimise loss of leaf components by shattering, trampling and decay, and to maximise their ingestion. This could be achieved by high stocking rates and grazing systems which limit the area available at any one time (*e.g.* a strip grazing approach).

A second strategy would be to match the stubble quality after various grazing intervals to animal requirements. This might be done by a 'leader and follower' grazing system, with the followers being those animal groups best able to tolerate substantial LW loss. However, modified grazing systems such as these will involve greater infrastructure costs for fences and water. Issues which would have to be addressed in setting up such systems would include stocking rates, acceptable LW loss for various groups of animals, which supplements if any should be used, and timeliness.

The low utilisation of total crop residue dry matter by grazing animals is because dry matter disappearance due to decomposition and trampling usually occurs at a much greater rate than intake by the animals, and because the animals will not consume much of the stem material.

A strategy to greatly increase the amount of crop residue that is utilised to bale stubble and feed it as needed. This also avoids problems associated with timeliness of ground preparation for the next crop, and it may also be possible to graze the aftermath after baling. This strategy is likely to be particularly important for farms with a shortage of roughage. However, the reduced selection when stock are offered baled straw rather than grazing stubble means that supplementation of the straw will usually be essential and there may be insufficient ground cover to provide protection against soil erosion. A refinement of this strategy would be to modify the combine harvester to fractionate the straw into the leaf–rich and stem-rich components, and to bale the leaf–rich fraction. Issues which would have to be addressed when setting up such a system would include the cost per unit of ME of the straw, acceptable LW loss of the animals, and type and level of supplements to be used.

Another strategy would be to use conventional grazing systems and to provide supplements containing essential nutrients and additional ME. Supplements based on cereal grain or protein meals may often be the preferred option. However since these are discussed by other papers in this workshop (Rowe *et al.* 1995; Hennessy *et al.* 1995), the present discussion will be limited to supplements which provide essential nutrients for rumen digestion.

Supplementation with Nutrients for Rumen Microbial Digestion of Roughage

Delivery systems to supply NPN/S supplements

The common sources of NPN (non–protein nitrogen) and S (sulphur) are fertiliser grades of urea, sulphate of ammonia, and elemental sulphur. Much of northern Australia is also deficient in phosphorus, and common sources are feed grade calcium phosphates. Molasses has a high sulphur content.

The most common methods of providing NPN/S supplements have been by molasses/urea roller drums (Lindsay & Laing 1995) or by high-urea dry licks or blocks (*e.g.* Uramol). In northern Australia roller drums systems are now seldom used because of the high costs for the roller drum units, and for machinery and labour. Dry licks are tending to replace blocks because of their lower cost per unit of N or P. Dry licks are loose mixes of ingredients such as salt, urea, calcium phosphates, sulphate of ammonia, protein meal, grain and

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molasses. Urea is included at 30 – 40% to provide N, sulphate of ammonia to provide S as well as N, and calcium phosphates at 5 – 100% to provide P; the other ingredients are principally to make the supplement acceptable to the cattle.

Water medication, by adding soluble N or P supplements into the water supply, has two major advantages. Firstly, only the essential nutrients (as urea N and/or P) need be supplied. Secondly, if the only water available is medicated all animals must consume their supplement, and presumably the variation among animals in supplement intake is low. However, despite these advantages, and attempts over several decades to develop the technology, there has been little adoption by industry. Many of the reasons for this lack of adoption appear to be problems of engineering rather than of animal nutrition.

The two common options for medicating water are by:

- Automatic dispenser machines which add supplements to the water supply line to troughs; and
- Mechanically mixing supplements into the water in supply tanks.

Many dispenser machines have been developed, but most are not sufficiently reliable under extensive conditions. Two machines which have gained some acceptance by industry are the 'Dositron' and the 'Norprim' both of which dispense concentrated solutions. Problems can occur with mixing urea into supply tanks with the settling out in the bottom of the tank of a cold, high density layer of water containing a high concentration of urea; this solution of concentrated urea is likely to then enter the supply line to the trough. Problems can be associated with water quality. Water containing high concentrations of calcium or magnesium salts can cause precipitation of calcium or magnesium phosphates in the supply tank and/or the water supply line, effectively removing the P from the water and blocking the supply lines. Where the water supply is alkaline, urea supplement can be hydrolysed and the ammonia lost by volatilisation, effectively removing most of the N supplement from the water. Algal growth in the supply tank can also cause problems. Application of water medication is also limited by the needs for controlled and centralised water supplies, and for skilled maintenance of the system.

Nutritional problems with water medication are the high cost of P sources such sodium monophosphate suitable for water medication and, the possibility of urea toxicity. Also little information is available on whether urea N ingested in the water is used with similar efficiency to urea N ingested in supplements (McLennan *et al.* 1991).

Liveweight and reproduction responses

Responses by sheep and cattle to supplements of NPN/S alone, with other minerals, or with small amounts of grain or molasses for cereal straws and other low quality roughages have been examined in numerous experiments.

Many pen experiments with both sheep and cattle have shown large increases in intake of roughage and of ME, and alleviation of LW loss, in response to NPN/S supplements for cereal straws or low quality roughages. These responses have often been related to a dietary deficiency of rumen degradable nitrogen, and rumen ammonia concentrations which we would expect to be too low to support maximum microbial digestion of low quality roughage.

A number of researchers with sheep and cattle grazing cereal stubbles or senesced pastures in southern Australia have reported small responses, or sometimes no response, to NPN/S/molasses/grain supplements, and benefits were lost during subsequent compensatory growth (Table 6 and 7). Based on this type of information many workers have concluded that NPN-based supplements are of little value (Messenger *et al.* 1971; Mulholland & Coombe 1979; Coombe & Mulholland 1989). However, in the experiments summarised in Table 7, on average LW loss of unsupplemented sheep was 1.4kg/month. The reduction in LW loss due to the NPN supplements was on average 1.2kg/month, and ranged from 0.5 to 2.1kg/month. Therefore we conclude that although the effect of NPN/S supplements is usually small, they do have an important role in alleviating the rate of LW loss and allowing longer utilisation of stubbles and senesced pastures.

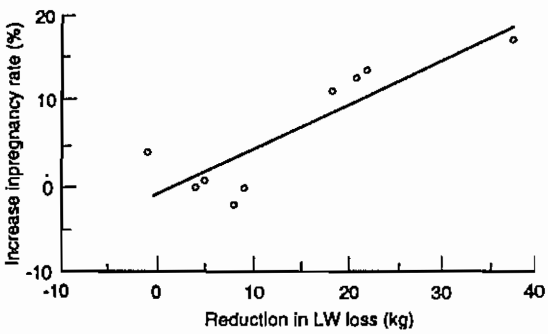
Comprehensive studies with young Bos indicus cross cattle grazing speargrass pastures during the dry season in northern Australia have clearly shown the benefits of NPN/S supplements in this environment (Table 8). Over 12 experiments the reduction in LW loss averaged 18kg, and ranged from no effect in benign dry seasons up to 36kg during harsh dry seasons. The alleviation of LW loss due to NPN/S supplements can be even greater in breeder cows, and is sufficient to drastically reduce breeder mortality; industry surveys suggest reductions from 12 – 15% to 3 – 6% per annum. There is also clear evidence of increases in reproductive rates of cattle (Figure 1) and sheep (Stephenson *et al.* 1981). Use of dry lick supplements high in NPN/S/P for breeders and weaners has become routine for much of the northern cattle industry during the last decade. Supplements based on molasses, grain or protein meals give much larger responses, but are too expensive to be used routinely for breeders.

Table 8 Liveweight change responses of young Bos indicus cross cattle grazing dry season speargrass pastures to supplements providing principally urea N and inorganic S.

Year	Months of supplement	LW change (kg)			Expt
		No supplement	Plus supplement	Change due to supplement	
Molasses-urea roller drums supplement					
1970	3	-4	+21	+25	A
1970	6	-26	+10	+36	B
1971	6	-4	+16	+20	B
1972	7	-51	-16	+35	B
1971	7	+4	+26	+22	C
1972	7	-14	+2	+16	C
1973	6	+13	+31	+18	C
1974	5	+43	+54	+11	C
Urea-salt dry lick supplement					
1975	5	-4	-3	+1	D
1976	6	-13	0	+13	D
1977	8	+45	+56	+11	D
1978	6	-2	+9	+11	D

Experiments: A, Winks *et al.* 1972; B and C, Winks *et al* .1979; D, McLennan et al 1981.

Figure 1 The relationship between the reduction in LW loss of breeders during the dry season due to NPN based dry lick supplements, and the increase in pregnancy rate from mating during the subsequent wet season. Source of data: Holroyd *et al.* 1983; 1988; R.M. Dixon, M.J. D'Occhino and G. Fordyce unpublished results.



Reasons for Variable Responses to NPN/S Supplements

Selection by animals under grazing conditions

The abilities of both sheep and cattle to select spilt grain, green herbage and the higher digestibility components of stubble have been discussed above. With such selection the diet ingested may be quite high in quality and not be deficient in N and S for rumen fementation. There will usually be no opportunity for breeders in the northern Australia environment to select green material during the later dry season, and senesced native pastures in the semi–arid tropics are of very low quality.

Interactions between straw characteristics and supplements

Two experiments have shown the importance of the quality and morphological components of straw ingested on responses to supplements of NPN/S, protein meal or cereal grain. Doyle and Panday (1990) examined the responses to urea supplement in sheep consuming two wheat straws which differed widely in leaf content, IVOMD and intake when fed alone. Intake of the high leaf, high intake straw was increased by 26% by supplementary urea, but that of the low leaf, low intake straw was not changed. In another experiment (Rafiq *et al.* 1995) sheep were fed diets consisting predominantly of separated barley straw leaf or stem and various supplements. Supplements of NPN/S resulted in a 27% increase in DM intake, a 41% increase in ME intake, and alleviation of LW loss with the high leaf diets, but had no effect on the stem diet. Similarly, a fishmeal supplement increased intake of leaf roughage, but not of stem roughage. These two experiments suggest that when animals can select a diet consisting mainly of leaf, large responses are likely to occur to NPN/S supplements, but that when animals have to select a diet consisting mainly of stem responses to NPN/S are unlikely. The latter experiment also suggests that with diets based on cereal straw leaf, the constraints to intake and growth will be associated with supply and balance of nutrients for both the rumen and for the animal. However with diets containing a large proportion of stem material, particle breakdown and passage is likely to be the first limiting factor to intake.

Supplement delivery systems

Many of the poor responses by grazing animals to NPN/S supplements are probably associated with high variability in supplement intake among individual animals in the mob. Measurements of variation among individual animals in intake of dry licks or blocks indicate large variation (CoV usually exceeding 50%,) and there may be a considerable proportion of animals which do not consume supplements at all during the early weeks and months of exposure to the supplements. This is also the period when NPN/S supplements are likely to be most effective. Furthermore the proportion of non-eaters and the variation in supplement intake is likely to be much greater for low palatability dry licks or blocks than for more palatable concentrates (Wheeler *et al.* 1980; Table 9). However, even following adaptation of animals to a delivery system providing palatable supplements, the variation of supplement intake is likely to be substantial (*e.g.* CoV of at least 20%). Unequal intakes by individual animals will be much more important for NPN/S supplements than for concentrate supplements because the responses to the NPN/S only occur up to a threshold level meeting rumen microbial requirements, with no response thereafter. The management strategies to alleviate this problem are likely to be by training of animals when they are young to accept supplements, and by choosing supplements associated with low variability.

An additional reason for poor responses to NPN/S supplements containing urea as the NPN source is poor synchrony of supply of the N substrate with slow digestion of fibrous components. This may explain better responses observed in some experiments with high–urea lick blocks available at all times, compared with molasses/urea liquid supplements which were only available to the animals for about 2 days of each 4 day feeding cycle. Synchrony of supply may be improved by providing the NPN/S with fermentable substrate to allow rapid microbial growth, which is followed by slow release of N with turnover of microorganisms.

The Value of NPN/S Supplements

Much of the difference in perception of the value of NPN/S supplements (*e.g.* between Southern and Northern Australia) follows from differences between environments and planned levels of production. For example in the semi-arid tropics under-nutrition during the prolonged (5 – 10 month) dry season results in average breeder mortality of about 10% per annum and branding rate of 60%. The principal value of NPN/S supplements in the northern cattle industry is to delay the need for high-cost options or, where these cannot

Table 9 Variation in intake of supplements among individual animals with the mob, and number of non-eaters of supplement in the mob. Bos indicus cross heifers (18 months of age) were fed restricted amounts of cottonseed meal twice weekly, or had ad libitum access to molasses containing 8% urea (M8U), dry lick based on salt and urea, or molasses based lick blocks (R.M. Dixon and J.C. Petherick, unpublished results).

Supplement	Coefficient of variation within mob (%)	Fraction of non–eaters of supplement
Cottonseed meal	27	0/40
Molasses/urea (M8U)	31	0/40
Dry lick	69	1/40
Blocks	82	5/40

be implemented, to reduce mortality of susceptible animals (breeders and weaners). This is demonstrated in Figure 2.

By late in the dry season breeder cows are often approaching the critical LW and body condition for survival. A reduction in LW loss of 20 – 30kg during the dry season (*e.g.* to November), means that crisis feeding (or other costly management strategies such as sale of cattle in poor body condition) is not required for an additional 4 – 8 weeks. Hence the value of the NPN/S supplements for a specific property is influenced principally by the costs of crisis feeding, the probabilities of the seasonal break occurring in various months, and the changes in mortality and the level of production due to the NPN/S supplements. However, the efficacy of a dry season supplementation strategy has to be balanced against other management strategies such as calving times, weaning, stocking rate and wet season supplementation to increase body reserves before the dry season commences.

In southern Australia target production levels are much higher, drought periods are usually much shorter, and greater flexibility with alternative management strategies (such as sale, agistment, production supplementation or complete hand feeding), means that NPN/S supplements (to alleviate LW loss) are less important in drought management. Nevertheless we suggest that NPN/S supplements do have an important role in many southern situations where sheep and cattle are fed crop residues to reduce rate of LW loss, relieve grazing pressure on other pasture areas, and delay the necessity to implement alternative nutritional or management strategies.

Conclusions

There is wide variation in voluntary intake, ingestion of nutrients and performance of stock depending primarily on crop residues or senesced pasture. Although we probably have a fairly good understanding of causes of this variation, we currently have a poor ability to predict intake of ME and other nutrients in practical situations. Producers will have to still depend to a large extent on monitoring of stock performance coupled with ongoing adjustment of management and supplements to achieve desired goals of productivity.

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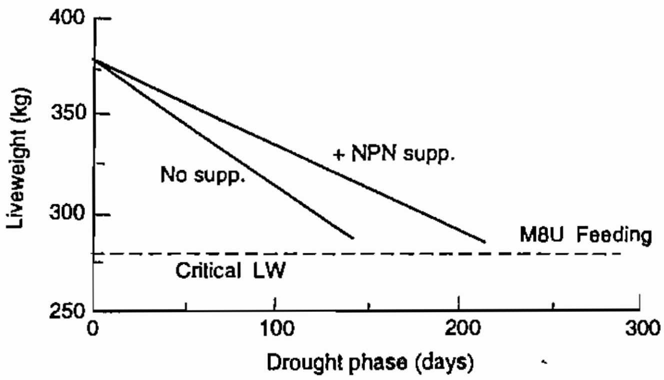
Figure 2 A diagrammatic representation of the consequences of NPN supplements fed during the dry season drought on liveweight loss by breeders. The NPN supplements delay the time when breeders approach the critical liveweight for survival, and when crisis feeding with M8U is needed to avoid high mortality rates.



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14.2 Appendix 3.

Milestone Report 3. Collation of recent information on productivity and use of supplements for breeders in the marginal and harsh regions of northern Australia - 1995.

PROJECT DAQ.098

Collation of recent information on productivity and use of supplements for breeders in the marginal and harsh regions of northern Australia

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Contents

Section

1. Introduction

This document has been prepared during project DAQ.098 in order to collate recent information on performance and management of the northern breeder herd. This has been done to assist focus within the project on issues of highest priority in relation to supplementation of the northern breeder herd. In preparing this document I have tried to avoid reiterating information presented in recent readily available reviews, annual reports and project final reports which most readers will already have on their bookshelf, but rather to summarise less easily available or dispersed reports.

I would like readers to treat this document as a Working Paper, and to contact me if there are aspects with which they disagree, if they think I have drawn the wrong conclusions from the data, or if they have additional relevant information and/or results.

There have been a number of recent reviews which discuss interactions between the nutrition and reproduction of the northern breeder:

Anderson, V.J. (1990). Factors affecting conception rates of beef cows in the Speargrass region of north Australia. M. Sc. Thesis, JCU.

Entwistle, K.W. and McCool, C.J. (1991). Nutritional influences on reproduction in tropical cattle and buffalo. In Recent Advances in the Nutrition of Herbivores. Malaysian Society of Animal Production.

O'Rourke, P.K., Winks, L. and Kelly, A.M. (1992). North Australia Beef Producer Survey 1990. QDPI and MRC.

Fordyce, G. (1992). Opportunities to increase productivity of North Australian breeder herds. In NW Australia Pastoral Conference, Katherine.

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2. Breeder herd productivity - mortality

Accurate and objective information on breeder mortality in the commercial production systems is difficult to obtain. Most producers clearly have the perception that mortality tends to be low, and mortality rates in the range of 3 to about 7% will often be cited.

The range of mortalities recorded on a number of sites where actual measurements have been made are reviewed by O'Rourke (1994). Comprehensive analysis of long-term records at Swan's Lagoon in the northern speargrass zone reported an average mortality rate of 1.2% (range 0.5-2.6%) in F2 and subsequent generations of a Bos indicus crossbred herd (O'Rourke et al 1995 a). Mortality of F1 animals tended to be slightly higher (average 1.7%, range 0-4.2%). These data demonstrate that low mortality rates can be achieved under good management conditions possible on a research station or on a well managed commercial property. In contrast, data over 11 years from a breeder herd at Kidman Springs in a harsh environment found an average mortality rate of 11.5%, ranging between years from 5.7% to 24.8%

Obvious difficulties in estimating mortality rates on extensive commercial properties usually include: (a) absence of accurate records of breeder numbers; (b) musters are seldom clean (and may often miss a substantial proportion of the mob), (c) large numbers of breeders can be lost in episodic events (drought, botulism, BTEC), and (d) in practice breeder herd numbers are often not stable.

Figure 2.1. Relationship between female sales (no. of females sold as a % of total cattle sold) and female mortality (%) assuming stable herd structure and number (Wicksteed 1992)

Probably the most accurate estimate of mortality of breeders across the northern industry as a whole can be derived from the proportion of females in total sales (Wicksteed 1992). The relationship between mortality of female cattle (of all ages) and proportion of sale cattle consisting of females has been calculated making assumptions that mortality rate and branding rate will tend to be inversely related (Figure 2.1). If we know the proportion of total sales consisting of female cattle, we can estimate (for either an individual property or for a region) the female mortality. This calculation does depend on several assumptions:

(a) That the breeder herd is neither increasing nor decreasing in numbers. Some error must be introduced by the year-to-year variation as breeders are sold to reduce herd numbers in drought, and retained following drought to build up the herd.

Also in some areas breeder herds will still be being built up after reductions during the BTEC program. If recent drought years combined with the BTEC program mean that the breeder herd is being built up, the rate of female sales will over-estimate mortality.

(b) Sale of store cattle to southern Queensland and boat cattle to Asia cause some error if the number of males and females is not equal. However, of the 360 000 cattle passing through clearing dips in NW Qld in 1993 and 1994 the ratio of males to females was about 60/40. Hence the sale of cattle out of the region should not seriously affect the estimate of female mortality from female sales.

Despite these difficulties of using the female turnoff ratio to estimate female mortality, it is still one of the best tools available for a commercial property situation. Female sales ratios for N. Qld have been estimated at 30-35%, suggesting an average female mortality across the industry of 10-12% per annum (see Wicksteed 1992, Millungra Field Day Report 1993).

Estimates of mortality rates made initially by Local Consensus Data (LCD) groups in the Lower Gulf region of N. Qld suggest that with current supplementation systems mortality rates of breeders will be in the range 2-8%. However, when these LCD groups have applied herd modelling techniques with estimates of branding rates, turnoff, etc., these mortality rates often had to be increased appreciably to get the models to balance.

D. Petty (unpublished data) has made similar comparisons between producer perceptions and female turnoff for the Alice Springs region. Modelling of the 40% of female turnoff for the area suggests that either (a) female mortality is 7% and branding 70-75%, or (b) female mortality is 5% and branding 60-65%. These values contrast sharply with the belief of producers in that area that branding is about 80% and female mortality is of the order of 3%.

Jayawardhana et al (1992) have discussed similar discrepancies in the Victoria River District region of the NT between graziers' perceptions of mortality rates and those that have been measured in trial sites.

3. Breeder fertility. Nutrition x fertility interactions

3.1 Static liveweight x fertility effects

The effects of liveweight on the fertility of breeders is well known, and has been examined in a large number of studies (eg. Lamond 1970; Holroyd 1985). As an example, the relationships developed for Lansdown Droughtmaster cows by Goddard et al (1980) are shown in Figure 3.1. In this study the relationship, particularly for mature cows, was curvilinear. Effects of liveweight on fertility were more important with lighter rather than heavier cows. However in some other studies (eg. some data sets derived from Swan's Lagoon and Fletcherview herds summarised by Anderson, 1990) the relationship between liveweight and fertility tended to be linear.

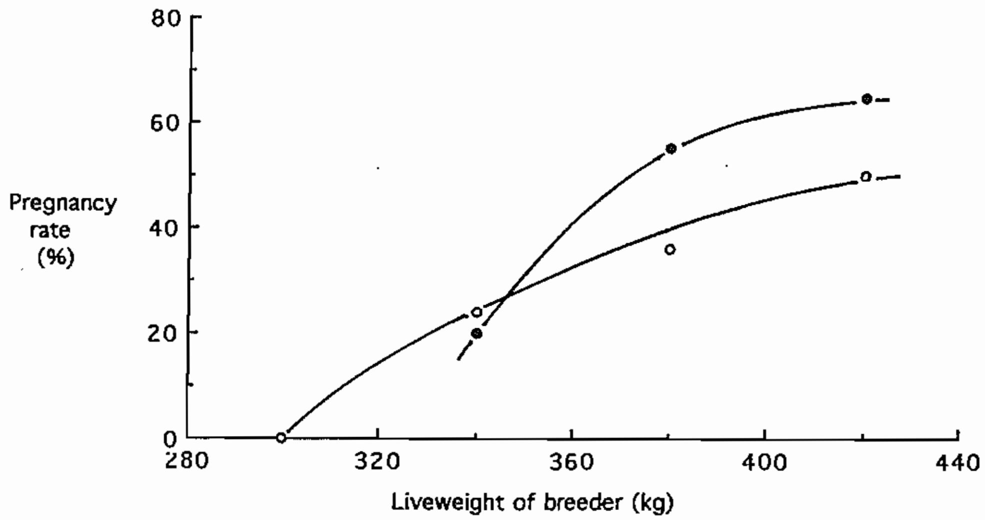


Figure 3.1 Relationship between start of mating liveweight of lactating first-calf cows (o) or mature breeders (●) and subsequent pregnancy rate. Date derived from Lansdown Droughtmaster cows (Goddard et al 1980).

Table 3.1 summarises all data sets of which I am aware from Bos indicus cross cattle in the marginal and harsh zones of northern Australia, and also includes two data sets from southern Africa. Data sets derived from herds run in the endowed zone of northern Australia have not been included. In the endowed zone fertility is usually satisfactory, and where it is not satisfactory is much less likely to be due to under-nutrition. Breeder liveweight seldom declines to the extent that fertility is severely affected.

In order to simplify the presentation of the data in Table 3.1, where the liveweight-fertility response was curvilinear the response has been expressed as two approximate linear relationships for a lower and for a higher liveweight range.

Table 3.1 Approximate increases in pregnancy or calving rates (%) of lactating Bos indicus crossbred cows due to increase in liveweight. Where the liveweight-fertility response was curvilinear the response has been expressed as two approximate linear relationships for a lower and a higher liveweight range. Liveweights are for start of mating except where otherwise indicated.

Source of data and age of cows	Type of response	Liveweight range (kg)	Increase in pregnancy rate per 10 kg increase in LW (%)
Goddard et al (1980)			
First calf cows	Curvilinear	300-340	6
		340-380	3
Mature cows	Curvilinear	340-380	9
		380-460	3
Anderson (1990)			
Swan's Lagoon (Data set 1)			
First calf cows	Linear	290-350	4
Mature cows	Linear	390-450	4
Swan's Lagoon (Data set 2)			
First calf cows	Linear	260-390	3
Mature cows	Curvilinear	310-350	5
		350-450	0
Fletcherview			
First calf cows	Linear	290-360	8
Mature cows	Linear	340-410	3
O'Rourke et al (1991) (Mt Bundy)			
Mature cows*	Curvilinear	260-360	3
		360-430	0
O'Rourke et al (1991) (Kidman Springs)			
All ages	Curvilinear	240-290	4
		290-390	0
Meaker (1975) (South Africa)			
Mature	Linear	310-440	7
Buck et al (1976) (Botswana)			
All ages (mostly mature cows)	Curvilinear	290-330	7
		330-430	1

* Liveweight in the mid-dry season.

The following trends are evident from these experiments:

(a) For both first-calf cows and mature cows when the response was curvilinear, the inflexion point was usually in the range 330-350 kg LW, e.g. the data of Goddard et al, Anderson (Data set 2 cows), Buck et al. (1976).

(b) Where responses were curvilinear, for low LW cows the pregnancy rate response to increased LW was in the range 4-9% units increase in pregnancy per 10 kg of additional LW e.g. data of Goddard et al. (1980) Buck et al. (1976) and Anderson (1990) (Swan's Lagoon Data set 2).

(c) Where responses were curvilinear, for high LW cows the pregnancy rate response to increased LW was in the range 0-3% units increase in pregnancy per 10 kg of additional LW.

(d) Where responses were linear over the range of LW in the study, the responses were between 3% units and 8% units increase in pregnancy per 10 kg additional LW in the studies of Anderson (1990) (Swan's Lagoon, Data set 1, Fletcherview).

(e) In the harsh environments of Mt Bundy and Kidman Springs the response was 3-4% unit increase in pregnancy per 10 kg additional LW for low LW cows, and <1% for high LW cows. Even when LW was >400 kg, pregnancy rate was only 65%. A constraint associated with this data is that LW was measured in the mid-dry season rather than the start of mating. Variable LW losses between the mid-dry season and the commencement of the following wet season (which presumably will also be representative of start-of-mating) as well as the harsh nutritional environment may explain the differences between these experiments and the others shown in the Table.

It appears from these data that for cows less than 340 kg LW at mating we might reasonably expect a 5% increase in pregnancy rate for each additional 10 kg LW achieved by improved nutrition leading up to the time of mating. For cows greater than 340 kg LW at mating the response is more likely to be a 3% increase.

The improvement of a herd to improved nutrition will depend a great deal on the profile of liveweights of individual animals in the herd. Substantial increases in pregnancy rate are only likely to occur where a large proportion of the herd is in the lower liveweight ranges.

The fertility responses to increased liveweight appeared to be similar for first-calf cows and for mature cows where it was possible to compare over similar liveweight ranges eg. in the experiments of Goddard et al. (1980) and Anderson (1990) Data set 2. This was unexpected since it is usually considered that the fertility of the first-calf cow is more susceptible that the mature cow to adverse seasonal conditions, and from the industry perspective is the "problem animal". However, direct comparison between the two age groups of animals for the same liveweight range ignores the more mature animal will have a larger frame size then the first-calf cows, and therefore at the same liveweight will be in lower body condition. The absence of large differences between the two age groups of animals suggests that the low fertility often observed in first-calf cows may be because this type of animal is usually in lower body condition while lactating, rather than differences in the liveweight-fertility relationship for the two groups of animals

3.2 Fertility responses by breeders to low-level supplementation through the dry season

Two groups in the 1970s (at Swan's Lagoon and Lansdown) examined the effects of supplements such as dry licks fed through the dry season on fertility of breeders. Supplements of this type reduce LW loss during the dry season, and a positive fertility response can be expected due to higher LW at the following mating. Furthermore, in commercial property situations where breeder numbers are often not known accurately, reduced mortality of breeders due to dry lick supplementation will lead to a increased number of calves branded from a specific paddock. In many commercial property situations the number of breeders in a paddock would not be adjusted according to mortality rate, and many station records will report number of calves branded from an area without accurate records of the number of breeders present at various times.

Holroyd et al (1977; 1983; 1988) reported a series of experiments at Swan's Lagoon each year from 1970 to 1980 in which breeders were fed various supplements including low-level urea-based supplements during the dry season. The reduction in dry season LW loss due to supplements and changes in pregnancy rate in these experiments are shown in Table 3.2.1. In the experiment of Holroyd et al. (1977) reporting results for 1970/71, 1971/72 and 1972/73, half the breeders were Shorthorn and half were Bos indicus cross. Also, and probably even more importantly, calving was during June-November and therefore out-of-season. These factors would have exacabated stress on the breeder during the dry season, and explain the large responses (20%, 16% and 23% increases in pregnancy rate due to dry lick supplement) during this experiment. However, even if we consider only the results reported by Holroyd et al. (1983; 1988) where Bos indicus cross cows were calving early in the growing season, there was a significant correlation between the reduction in LW loss due to feeding supplements during the dry season, and the increase in pregnancy rate the following year. This is despite the minor effect of supplement in a number of the years due to moderate dry season conditions. During two of the years (1977/78 and 1979/80) LW loss was reduced by 18 and 21 kg, and pregnancy rate was increased by 10 and 13% units. The magnitude of this increase is consistent with the suggestion from Section 3.1 that each 10 kg increase in LW of cows <340 kg LW at start of mating will result in an increase in pregnancy rate of about 5% units.

Table 3.2.1. Results from breeder experiments at Swan's Lagoon.

Expt	year	Dry season LW change of unsupplemented breeders (kg)	Reduction in dry season LW loss due to supplements (kg)	Pregnancy rate of unsupplemented breeders (%)	Increase in pregnancy rate of breeders due to supplements (%)
A	1970/71	-	+20	65	20
A	1971/72	-	+20	78	16
A	1972/73	-	+20	21	23
B	1973/74	+41	-1	71	4
B	1974/75	+27	+4	97	0
B	1975/76	-14	+8	87	-2
B	1976/77	-28	+9	91	0
C	1977/78	-15	+21	56	13
C	1978/79	+15	+5	78	1
C	1979/80	-19	+18	29	11

Expt A, Holroyd et al (1977). LW not given and assumed from differences in condition scores; Expt B, Holroyd et al 1983; Expt C, Holroyd et al 1988.

Siebert et al (1975) examined responses of first-calf cows to inorganic supplements (N,S,P,Na) over five years, and also to a low level of cottonseed meal (CSM) supplement in one year. In three of the five years rain during the dry season led to LW gain by the cows during the dry season, and pregnancy rates in the following year greater than 70%. The results for the other two years are shown in Table 3.2.2, and indicate that in one year when approximately 20 kg CSM/head was fed during the dry season, pregnancy rate was increased from 25% in the unsupplemented controls to 46% due to Urea N, S and P, and to 84% with the CSM. This occurred despite the absence of effects of the supplements on LW loss by the heifers during the dry season.

Table 3.2.2. Liveweight change during the dry season, live weight at mating and the proportion of heifers which became pregnant following nutrient supplementation (Siebert et al 1976)

Supplement		Liveweight change July-Oct (kg)	Live weight at mating Jan/Feb (kg) (following year)	Percentage pregnant in May (following year)
1972	Nil	-41	288	15
	P	-31	238	7
	N,S,Na	-35	288	18
	N,S,Na,P	-25	285	11
1974	Nil	-10	333	25
	N,S,Na	- 3	340	46
	CSM meal	-14	359	84
	Maize	- 8	355	38

3.3 'Spike-feeding' effects in late pregnancy.

In addition to the LW of the breeder at mating, the nutritional history of the animal in the months leading up to mating can have substantial effects. It has been clearly shown that increasing the plane of nutrition for a short period during late pregnancy above that on dry season pasture alone ('spike-feeding') can have substantial effects on reconception. The experimental evidence for this is extensively discussed by Fordyce et al (1994). The hypothesis proposed to explain this phenomenum is that during extended periods of under-nutrition the ovaries become inactive, and require a period of higher nutrition before 'normal' function can be resumed. If this hypothesis is correct then maintaining a higher level of nutrition during the dry season (eg. by an appropriate level of supplements) may have the same effect as 'spike-feeding' by ensuring continuing ovarian activity.

3.4 Responses to weaning

The major effects of weaning have been reported and discussed over several decades by many authors (Burns 1964; Arthur and Mayer 1975; Moore 1984; Murphy 1992; Petty et al. 1992; Trial reports in Section 4 of this document). The benefits of weaning for the breeder are two-fold; first from the removal of the suckling effect and second from reduced LW loss associated with the absence of lactation.

The removal of the suckling effect is clearly much more important than the reduction in LW loss in terms of reconception by the breeder. There is only limited information (see Fordyce et al 1994) on the relationships between body condition score and plane of nutrition of the breeder after weaning on reconception. The information does suggest that if the body condition score of the breeder is at least "store" then reconception should occur quickly.

4. Summaries of observations at specific sites

This section summarises results from PDS sites, research stations and some commercial properties where breeder herd productivity has been recorded over a number of years under defined conditions, or where treatments such as weaning and/or supplementation have been examined.

List of data sets summarised.

4.1 Swan's Lagoon Research Station, Millaroo. (Contact: Geoff Fordyce). In: Swan's Lagoon Annual Reports.

From 1986 to 1994 a Brahman cross herd of about 450 head was maintained primarily to provide animals for fertility studies. Separate lines of 1/2 Br and 3/4 Br were maintained up until 1993, and a 5/8 Br line formed then by mating 1/2 Br bulls with 3/4 Br cows or vica versa.

The management practices used include:
(i) Three month controlled mating period commencing in mid-January.
(ii) Weaning 6-8 weeks after the end of mating when calves are 5-7 months of age.
(iii) Moderate stocking rate on native pastures, and no supplements except to prevent excessive mortalities when there has been a delayed break to the wet season.
(iv) Pregnancy diagnosis about 7 weeks after the end of mating.

The pregnancy rates for various age groups of animals for each of the genotypes is given in Table 4.1.1. Overall pregnancy rate for the herd was approximately 81%, and ranged from 69% in 1991 to 94% in 1990.

Table 4.1.1 Summary of pregnancy rates, weaning rates and losses from pregnancy to weaning.

Mating year	Pregnancy rate (%)	Weaning rate (%)	Pregnancy to weaning losses (%)
1986	75	63	12
1987	86	74	12
1988	81	72	9
1989	88	81	7
1990	94	87	7
1991	69	62	7
1992	79	65	14
1993	78	69	9
Mean	81	72	9

4.2 Swan's Lagoon Research Station, Millaroo. (Contact: Geoff Fordyce). In: Swan's Lagoon Annual Reports.

From 1985 to 1994 a Brahman cross herd (average 5/8 Bos indicus and 3/8 Shorthorn origin) of 800-1000 breeders has been maintained in three approximately equal paddock groups. Paddocks size is 2500-3000 ha. The primary purposes are to study management practices on herd productivity and to supply animals for experimental studies.

The management practices include:

(i) Moderate stocking rate (average 1 AE per 6 ha).

(ii) Weaning musters twice each year in April/May and August/September normally of calves greater then 100 kg LW at each muster time. Calves have been weaned to a lower liveweight in some very dry years or to provide small weaners for other experiments.

(iii) Continuous mating with 4% bulls.

(iv) Replacement heifers selected for post-weaning performance and normally mated as 2 year olds.

(v) Vaccination (botulism all in cattle, leptospirosis in females, 5 in 1 and tick fever in calves, vibrio and BEF in bulls).

(vi) Supplementary feeding with M8U only as required to avoid excessive mortalities in drought years and when there was a delayed break in the season.

(vii) Cows usually culled at 8 years of age.

At each of the two annual musters cows are weighed, body condition scored, pregnancy tested and assessed for lactation status. Calves are tagged and weighed.

Table 4.2.1 Branding rate and timing of conceptions estimated from pregnancy diagnosis

Year of branding	Branding %	Peak conceptions
1985	89	Dec 84 to Mar
1986	72	Jan to Mar
1987	87	Jan to Mar
1988	77	Jan to May
1989	92	Jan to Mar
1990	87	Jan to Mar
1991	85	Feb to Mar
1992	77	Feb to Jun
1993	84	Feb to Mar; Jun
1994	85	Feb to Mar; Jun
Mean	84	

Table 4.2.2 The reproductive status of the herd, averaged over 8 years (1987-1994) for first-round musters and 3 years (1992-1994) for second round musters. Mean and range in parenthesis.

Muster Breeder class	Number of animals	Wet		Dry	
		Preg	Empty	Preg	Empty
First round muster					
2.5 y.o.	196 (156-253)	1 (0-5)	3 (0-7)	65 (8-91)	32 (4-85)
3.5 y.o.	170 (134-219)	32 (6-65)	44 (5-71)	20 (0-74)	3 (1-15)
4.5 y.o.	159 (138-217)	33 (2-59)	42 (17-61)	23 (7-52)	3 (1-4)
>4.5 y.o.	490 (332-600)	48 (27-70)	32 (12-54)	18 (13-30)	2 (1-3)
All Animals	979 (870-1118)	35 (18-56)	32 (19-56)	26 (13-46)	7 (3-16)
Second round muster					
2.5 y.o.	189 (145-224)	1 (0-1)	1 (1-3)	89 (83-96)	9 (2-17)
3.5 y.o.	186 (147-219)	4 (1-10)	10 (6-13)	80 (75-88)	6 (3-10)
4.5 y.o.	178 (135-212)	13 (6-20)	24 (21-27)	60 (47-68)	4 (2-6)
>4.5 y.o.	274 (116-394)	17 (9-27)	19 (17-22)	58 (43-70)	6 (4-8)
All Animals	827 (744-873)	10 (5-17)	14 (11-17)	70 (64-77)	6 (3-8)

First-round musters were in April/May except for one year (1989) when it was in July. Second-round musters were in August/September.

HENCE, on average:

	Mature	First-calf cow
Proportion of cows lactating		
April	80%	76%
July/Aug	36%	42%
Proportion of cows reconceiving while lactating leading up to:		
April	60%	14%
July/Aug	47%	29%

4.3. Millungera, Julia Creek. (Contact: Evan Acton or Mick Sullivan). "Millungra breeder herd management demonstration", In: Millungera Field Day Progress Report 1993. PDS Site (1988-1993).

Objectives:

The goal of this PDS site was to demonstrate a management package to maximise the performance of the breeding herd. This management package included:

(i) Breeder management (culling for low reproductive performance and at 9 years of age).

(ii) Heifer management (heifers joined as 2 year old at target liveweight of 280 kg. Heifers that do not wean a calf as a 3 year old are culled).

(iii) Bull management (cull for abnormalities, join as 2 year olds, cull for age at 7 year old).

(iv) Weaning management (two weanings per year in April/May and August/September down to 100 kg LW. Early weaners (100-150 kg) and normal weaners (>150 kg) are segregated, and fed sufficient levels of supplements to maintain growth).

(v) Steer management (half sent off-station at 6-12 months of age, and the other half at 18-24 months of age).

Conventional management in the region results in a branding rate of 50-70%, mortality rates of 3-15% and female sales ranging from 20-40% of total sales. On Millungra before the trial this conventional management and some dry lick supplementation resulted in 60% weaning and 5% breeder mortality.

Results:

The modified management package has been tested in a paddock of approximately 600 breeders over the 5 year period. Weaning rates from 1989-93 averaged 77% (range 71-81%). The three year average mortality has been 2%, although it has been somewhat higher (4%) in first-calf cows. Dry season dry lick supplements are fed routinely (standard mix 30% urea, 20% Biofos, 20% CSM, 25% salt, 3% lime, 2% sulphur and 1.5% trace mineral mix), and the cost averages out at approximately $10 per head per year.

Table 4.3.1. The reproductive status of the herd, averaged over the 5 years for mature breeders and 4 years for first calf cows. Mean and range.

Group & muster	Wet		Dry	
	Pregnant	Empty	Pregnant	Empty
Mature breeders				
(April/May)	32 (18-41)	40 (37-41)	25 (20-38)	3 (2-3)
(Aug/Sept)	15 (7-25)	27 (22-36)	55 (46-60)	3 (3-4)
First calf cows				
(April/May)	29 (22-44)	56 (37-72)	13 (6-19)	2 (0-5)
(Aug/Sept)	4 (0-11)	16 (9-25)	70 (59-77)	11 (3-18)

HENCE, on average:

	Mature	First calf
Proportion of cows lactating:		
April/May	72%	85%
Aug/Sept	42%	20%
Proportion of cows reconceiving while lactating leading up to:		
April/May	44%	34%
Aug/Sept	36%	20%

Approximate numbers (averaged over 5 years) of calves weaned at each muster, and the proportion of early-weaner calves is shown in Table 4.3.2.

Table 4.3.2.

Muster	No. calves weaned	No. early weaners	Proportion of calves consisting of early weaners (%)
April/May	300	91	30% of that weaning
Aug/Sept	145	98	67% of that weaning
Total for year	445	189	43% of all calves

(Average 578 breeders in paddock.)

This site has demonstrated that large improvements can be made in branding rate and mortality rates in a harsh environment by applying a package of management strategies to the breeder herd.

4.4 Lucky Downs, Greenvale. (Contact: Henry Atkinson or Felicity Hill). "Lucky Downs Early Weaning Producer Demonstration Site". In: Notes for 1992 Field Day at Lucky Downs and 1993 PDS reports to the MRC. Duration 1988-1992.

Objectives:
This PDS site was intended to examine the value of early weaning, weaner management and cattle responses to stylo. Specific objectives included:
(i) The cumulative effects of weaning calves to a younger age on lifetime breeder performance.
(ii) The management and husbandry of young weaners.
(iii) The comparative growth rates of young (3-6 months) weaners and older (>6 months) weaners, until sale age at four years.
(iv) The value of stylo pastures for cattle production.

Methodology:
The site was located near Greenvale on red duplex semi open ironbark/speargrass woodland experiencing a dry sub coastal climate with annual rainfall of 650 mm. One hundred and sixty hectares of Verano and Seca stylo was sown in the weaner paddock during the demonstration.

The breeder herd consisted of approximately 300 females and 12 bulls. Twice a year calves were weaned and lactation status, cow condition and liveweight recorded. Pregnancy status of breeder was recorded each year at the second mustering round. Early weaned calves were fed 500 g of cotton seed meal (CSM) hd/day twice a week plus lucerne hay for 8 weeks following weaning before being turned into the weaner paddock.

Results:
(i) Breeders.

Table 4.4.1

Muster & weaning	Liveweight		Condition score	
	Wet	Dry	Wet	Dry
March 1988	-	-	5	6
Sept 1988	300	350	4	6
April 1989	404	520	4.5	5.3
July 1989	391	440	5.6	7.2
April 1990	402	462	5.1	7.0
Aug 1990	405	455	5.8	7.2
April 1991	400	418	4.3	5.8
Sept 1991	306	342	3.2	5.0
April 1992	323	496	4.4	6.5

Condition scores used
1 = weak 2 = very poor 3 = poor 4 = backward store
5 = store 6 = forward store 7 = prime 8 = fat.

The variation in condition scores and liveweights of breeders was largely a reflection of the stress of lactation and was more obvious in poor seasons and at the second mustering round each year.

Table 4.4.2 Proportions of breeders wet or dry at each muster round.

Year	WD	WW	DW	DD
1989	81	34	11	73
1990	87	64	10	80
1991	91	18	5	61
Mean	86	39	9	71

WD Cows wet at the first muster dry at the second muster, ie. calf >3 months old weaned in April.
WW Cows wet at both muster, ie. calf <3 months old in April.
DW Cows dry at first muster and wet at the second muster, ie. cows calving April-September.
DD Cows dry at both musters, ie. cows dry, possibly pregnant.

In each year the majority or conceptions occurred in the group which were wet at the first muster, had a calf weaned at that first muster and were therefore dry at the second muster. Except for 1990 the majority of conceptions occurred in the eight weeks following weaning. While the conception response appeared to be greater in poorer seasons, the response in good years highlighted the need to wean to a young age at the first round on a regular basis. Cows dry at both musters had the next highest conception rates and all empty cows in this group were culled. Cows wet at both musters had calves too small to wean at the first muster. In a good year 64% of this group conceived while lactating, but in a poor year only 18%. Cows dry at the first muster and wet at the second muster with a small calf had the lowest conception rate or all groups. Both weaning rate and the percentage of breeders wet and/or pregnant at the second muster improved each year. These results can be attributed to weaning to a younger age early in the year, culling non performing heifers and breeders and improved seasonal conditions in 1989.

Table 4.4.3 The percentage of the herd which was wet and/or pregnant at the second muster of each year, and estimated annual conception rates and weaning percentage.

Year	Breeders wet and/or pregnant (%)	Conception rate (%)	Weaning rate (%)
1989	88	85	70
1990	90	82	76
1991	97		81
Mean	97	84	76

(ii) Weaners.

The liveweight performance of all weaners was followed after each weaning round. The difference in liveweights was largely a function of age. With the exception of the March 1988 and the 1990 groups, the difference in total liveweight between young and older weaners appeared to decrease each wet season. All year groups of younger weaners gained more weight than their older counterparts.

Table 4.4.4 Difference in liveweight gain in April 1992 between groups of cattle which had been weaned early (3-6 months), or older (>6 months).

Month and year of weaning	"Early" weaners liveweight gain advantage to April 1992
March 88	+14
September 88	+62
April 89	+53
July 89	+38
April 90	+19
August 90	+ 1
December 90	+36
April 91	+12

Conclusions.

The branding percentage of the herd improved from approximately 60% to 80% during the demonstration. This improvement is attributed to both early weaning and culling of non-performing breeders, with good seasonal conditions in 1989 and 1990 also having some effect.

Cow condition improved and mortality was reduced. Early weaning led to higher conception rates in cows in both good and poor seasons. This highlighted the advantage of "early" weaning of calves on the first round even when cows were in good condition. The increased culling and sale of non-performing breeders was made possible by higher branding rates. Bullock weights were not affected by early weaning.

4.5. Clothes Peg, Hughenden. (Contact: Tony Murphy). "Clothes Peg sodium and sulphur supplementation demonstration report". In 1992 PDS reports to MRC. Duration 1989-1991.

Objectives

(1) To measure and demonstrate any liveweight response in breeders, their calves and steers to Na and S supplemention.
(2) To measure and demonstrate any branding rate response in deficient cows due to Na and S supplemention.
(3) Increase awareness and understanding of Na and S supplementation on deficient properties.
(4) Depending on outcomes facilitate the adoption of Na and S supplementation of deficient cattle.

Trial measurements

The paddocks used at "Clothes Peg" comprised a mixture of red earth and basalt soils expected to be low or marginal in sodium and sulphur. The demonstration was initiated with one hundred cows with calves aged from 4-12 weeks and forty No. 9 steers in December 1989. A further 40 No. 0 steers were included in the demonstration from December 1990. One half of each group was supplemented year round with salt and sulphur (88% stock salt and 12% elemental sulphur) while the others remained as unfed controls. The demonstration was conducted during the 1989/90 and 1990/91 seasons.

The following were measured:

(1) Liveweight: Experimental cattle were weighed 3 times per year.
(2) Fertility: Pregnancy and branding rates were recorded each year.
(3) Saliva samples: Saliva samples were collected from 20 head of breeders and 10 head of each age group of steers.
(4) Supplement intakes were recorded.

Results

Supplement intake	Dec 1989 - June 1990	89 g/d
	July 1990 - Dec 1990	37 g/d
	Dec 1990 - May 1991	49 g/d
	May 1991 - Sept 1991	48 g/d

Cost of supplements $11 per head over the whole demonstration Dec 1989 - Sept 1991.

The liveweight response to supplementation by lactating breeders in the 1989/90 growing season (36 kg LW) was large and was maintained throughout the year. Liveweight response of lactating breeders during the 1990/91 growing season (10 kg LW) was not as marked. Also supplement increased LW gain of dry cows during the wet season by 25 kg in 1990/91.

Supplement increased LW gain of steers during the wet season as follows:

of No 9 steers by 28 kg in 1989/90 (ie yearling steers).
of No 9 steers by 8 kg in 1990/91 (ie 2 year old steers).
of No 0 steers by 33 kg in 1990/91 (ie yearling steers).

Only small liveweight responses were measured in calves suckling supplemented cows. 12 kg and 11 kg respectively, in each of 2 growing seasons. However, late calves suckling supplemented cows gained 39 kg in the May to September period in 1991, whereas calves suckling unsupplemented cows gained only 20 kg.

There were large effects of the supplements on fertility as follows:

1990. Overall 98% pregnant. Supplements increased the proportion of wet cows pregnant before weaning in April from 58% to 75%.

1991. Supplements increased the proportion of wet cows pregnant before weaning in May from 30% to 73%, and the proportion of all cows pregnant by Sept from 58% to 83%.

Conclusion.

There was a major benefit of sodium and sulphur supplementation on fertility, particularly in timing of conceptions. This improvement was presumably due to the greater LW gain of supplemented animals during the wet season. There was also a major improvement in the wet season growth of yearling steers due to the supplementation.

4.6 Dagworth, Georgetown (Contact: Bill Tincknell)
Herd management Demonstration. In 1994 PDS Reports to the MRC.
Duration 1987-1994.

Objectives

To demonstrate the benefits of improved breeder management on herd productivity in the Georgetown district. Vaccination, early weaning and culling was used in each of two trial herds, and wet season P supplementation in one of the herds.

Rationale

Breeder herd profitability in the Etheridge shire is low, with branding rates averaging around 55% and death rates 10%. Improving breeder productivity has important implications for improving profitability.

Methodology

Two groups of breeders (about 800 head in total) were run in adjacent paddocks. Management practices for both groups included early weaning, botulism vaccination, 5 in 1 vaccination of calves and vibriosis vaccination of bulls. Infertile breeders were identified and culled using a tagging system. Dry season urea was fed only when necessary.

Both groups were mustered using spear trap mustering techniques. Phosphorus supplement was fed to one group only. Measurements included branding rates, supplement intakes and early weaner weight gains.

The demonstration commenced in 1989 with an emphasis on phosphorus supplementation. In 1991 the demonstration was altered to include a whole breeder management program.

Results and discussion

Branding rates for 1990 to 1994 are given in the table. In 1992 and 1993 there was a marked difference in branding between the phosphorus supplemented group and the controls. Branding rate was consistently higher (averaging 18% higher) in the phosphorus supplemented group (77%) than in the controls (59%). This would have largely been due to the supplemented group always being in better condition than the unfed group. One interesting result of this PDS trial site was that high productivity was achieved without using dry season urea licks, feeding of which has become standard industry practice in this district.

Table 4.6.1.

Branding rate	1990	1991	1992	1993	1994
Phosphorus supplement Control	81% 65%	*77% -	73% 59%	76% 53%	65% -

(The branding rate figures for 1991 were unable to be separated and were calculated on the total herd. Brandings are calculated including 3 year old heifers and older). In 1994 the control group were moved due to drought and branding numbers were unable to be recorded.

In 1993/94 cattle consumed considerably less Kynofos supplement than expected. Intakes were around 11 grams of Kynofos per head per day costing $1.45 per head for 6 months.

Conclusion

Spear trapping systems were successfull, and mustering time and efficiency improved significantly. The value of phosphorus supplementation, early weaning, improved weaner nutrition and management, culling practices and stylo pastures have been demonstrated as individual practices capable of improving breeder herd productivity at other sites in North Queensland.

These results have been extensively used in the Local Consensus Data (LCD) process as an example of the animal production figures possible for the district with improved management systems in place.

4.7. Maitland Downs, Mareeba. (Contact: G. Ahlers and John Boorman). "Cattle trapping and oversown Stylo plus phosphorus supplements". In 1994 PDS reports to MRC. Duration 1993-1997.

Objectives:

(i) To demonstrate the effectiveness of trapping using water, lick and a small area of sown pastures as lures to reduce the cost and increase the efficiency of mustering in extensive areas:

(ii) To demonstrate the effectiveness of the cow/calf separator.

(iii) To demonstrate the effectiveness of electric fencing and the potential for cost savings using electric fencing for trap enclosures.

(iv) To demonstrate the benefits to cattle productivity of an integrated system of stylo oversowing and supplement.
(v) To demonstrate the effect of early weaning on reproduction and breeder condition and hence survival.
(vi) To demonstrate that early weaned calves will grow as well as later weaned calves.

Methodology:
The trapping demonstration consists of a trapping square around an existing dam and an adjacent holding paddock. A lick station was erected in the trapping square and 25 ha of stylo and Wynn Cassia with small areas of grasses were planted in the holding paddock. Hirst spears allow entrance to and exit from the squares. The square and paddock are fenced with plain electrified wire. Lick supplement contained 80% kynophos, 19% urea and 1% sulphur. Cattle using the site include cows and calves, growing cattle and bullocks. Groups which use two other waters also use this site.

The stylo production area was fenced and watered and the seed and establishment fertiliser applied from the air. Verano and Seca were planted. To date weaners, steers, sprayed cows, bulls and horses have been run on the area.

Results.
The stylo, after establishing in discrete and well-spaced strips through the native pasture, spread well so that the original strips are no longer visible. Weaners and other cattle have grazed the 90 ha since 1987. Until 1990, weaners grazed at 1/3 ha to 1/1 ha between July and March, with spelling in April-June. Since 1990, grazing has been continuous, with numbers fluctuating between 10 and 35 head. The area in its natural state might have carried 6-8 head and the cooperator is convinced the value of the pasture is in its carrying capacity. Performance of weaners has been very variable but in a season when P supplementation was most successful (in M.A.P. days), weaners gained 135 kg liveweight between August and March.

The pasture can now serve the industry most effectively by becoming part of the trapping-early weaning demonstration.

Training of the cattle at the trapping site was slower than anticipated and some cattle had difficulty finding the exit spears which were some 200 m from the entrance. However, contrary to popular belief, bullocks did not seem to be any more difficult to coax into using the trap than other classes of cattle. The 'OUT' spear was relocated closer to the 'IN' spear in 1993, and this appeared to work well.

The phosphorus lick in the trapping square benefited the cattle using it to the extent that they were in better condition than cattle on other parts of the station at the end of the wet each year. This advantage was noticed by passing producers and commented on.

Conclusion
As a demonstration of low-input stylo pasture development and its use in conjunction with phosphorus supplement, the (STYLO + P SUPPLEMENT) demonstration fulfilled its objectives.

4.8. Drumduff, Lower Palmer River. (Contact: C. Hughes and John Boorman). Producer Demonstration Site. "Self-mustering and phosphorus supplementation". In 1994 PDS reports to the MRC. Duration 1991-1996.

Objectives:

(i) To demonstrate increases in mustering efficiency using trapping.

(ii) To demonstrate improved branding rate and breeder body condition due to phosphorus supplementation.

Methodology:

A trapping square and paddock was erected around Boomerang dam, which is adjacent to the Palmer River. Kynofos was fed throughout the year in two lick sheds in the square. Verano, Seca, Wynn cassia and small quantities of grasses were planted in the holding paddock.

Two lick sheds were erected at Onion waterhole and Kynofos is fed there also. These feeding sites were established as the cattle at Onion are normally flooded out during the wet season and congregate on the levy of the Palmer River around Boomerang. The lick is fed at Onion to attract the cattle home after the wet season and reduce the stocking rate around Boomerang.

Results

Verano and Seca have established well in the trapping paddock adjacent to the trapping square. However Wynn Cassia has disappeared altogether. Of the grasses planted Urachloa and Indian couch have established, but have not spread as yet.

Cattle at Boomerang use the spears all year round. However during the wet they are set in the training position to allow cattle coming onto the levee the opportunity to get to the lick.

Acceptance of the supplement during the first year of the trial was below expectation. However following a change in the lick mixture to include salt as an attractant, supplement intakes increased. The mixture finally used was 61% kynophos, 24% salt, 15% urea and 1% sulphur. Addition of molasses to the supplement was not very effective to increase intake. An unusual observation was that although cattle were eating appreciable amounts of supplement, bone fragments were being dropped in and around troughs.

Breeders being fed supplement are in much better body condition than breeders in other areas of the paddock, but no production measures are available.

4.9. Laura, Cape York Peninsula. (Contact: John Boorman).
(PASAP, 1986, <u>16:</u> 155-158. Turn-off from cattle properties in Cape York Peninsula: Improvement possibilities.

In a Brahman cross breeder herd, management was modified to early wean calves down to an estimated 3 months of age in June/July and November.

Branding rate was increased from 47% (six year average before early weaning was introduced) to 59% (two-year average after early weaning was introduced. Calves were not supplemented, but growth rates were still comparable with older calves weaned at the same time.

4.10. Blackbraes, Hughenden. (Contact: Stewart Ross and Peter Smith). Early weaning demonstration.

<u>Objective</u>
The aim was to demonstrate the effect of weaning to a younger age earlier in the year on both the cow and the calf. It was thought that preserving condition on cows by weaning to a younger age earlier in the year would improve conception rates and reduce the need for survival feeding of cows later in the year. The performance of the calves was a major concern. For the practise to be successful, calves weaned at a younger age, 3-4 months, had to continue to grow at an acceptable rate.

<u>Methods</u>
One hundred cows and their calves were identified and weighed on the 1 April 1987. The average age of the calves was estimated to be 15 weeks. Fifty calves were weaned on this date and all cows and the remaining 50 calves were returned to a paddock. The weaned calves settled down in yards for a few days and were turned out into a paddock. These weaners were fed a supplement of molasses, urea and meat meal until the rest of the calves were weaned in July. On the 21st July the rest of the calves were weaned when their estimated age was 31 weeks. Following settling down in yards the late-weaned group of calves were turned out with the early-weaned group. Both groups of weaners were run together until July 1988. The cows were pregnancy tested and weighed on the 21 July 1987 and the 22 February 1988. The weaners were weighed again on the 20 July 1988 to complete the demonstration.

<u>Results</u>
Cows weaned early lost 29 kg April to July }
Cows not weaned lost 55 kg April to July } Difference 26 kg.

Cows weaned April: July CS = 3.7. Feb 1988 CS = 6.4 }
Cows weaned July: July CS = 2.8. Feb 1988 CS = 5.3 }

Early weaned cows reconceived much earlier.

Table 4.10.1. Months during which cows reconceived

Months	April weaned	July weaned
Feb/Mar 87	18%	20%
Apr/May 87	54%	14%
Jun/July 87	22%	2%
Aug/Sept 87	6%	42%
Oct/Nov/Dec 87	0%	20%
Total	100%	98%

Discussion

Weaning earlier in the year had a marked effect on the time of conception, condition and liveweight changes of cows. All early-weaned cows conceived to have a calving peak in January/February the following year. Late-weaned cows conceived over a much longer period with a peak calving in June/July the following year.

Weaning calves to a younger age earlier in the year had no effect on the growth rate of calves when compared to calves the same age weaned 4 months later.

4.11 Kynuna Station, Diamantina River headwaters. NAPCO. (Contact: Steve Millard). In "Producers adapting to market needs. The NAPCO story". Beef 94 Seminar.

This paper discusses management, genotypes and nutrition on NAPCO properties. Breeder productivity is increased by rigorous culling of heifers, pregnancy testing of all dry cows, continuous mating, early weaning down to 60 kg and a high level of supplementation even in better seasonal conditions.

The following calving rates are stated for Kynuna during the three seasons 1991 through to 1993 where cattle numbers fluctuated between 3600 and 5900 head.

Year	Calving %	Supplementation cost per head
1991	96	$5.76
1992	93	$14.50
1993	95	$13.10

4.12. Lansdown, Townsville. (Contact: Tony Schlink).
(PASAP, 1988, 17: 326-329).
"Cow management strategies and reproductive performance in a northern Australian cattle herd".

First-calf Droughtmaster cows with calves at foot grazing native pasture were weaned conventionally in early May, or early weaned at the end of January (30 or 33 per group). Mating was from early January to mid-April.

Table 4.12.1.

Measurement	Conventional weaning	Early weaning
Cow LW early January (kg)	366	368
Cow LW late March (kg)	397	431
Cow LW early May (kg)	407	453
Pregnancy rate in early May (%)	61	90

The early weaning resulted in cows 45 kg heavier at first round muster. Reconception rate was increased from 61% to 90%, and foetal ages indicated that cows reconceived earlier with the early weaning treatment.

4.13. Lansdown, Townsville. (Contact: Tony Schlink).
(PASAP, 1994, 20: 339)
"Impact of long-term early weaning on the productivity of Bos indicus cross cows".

Droughtmaster breeders were seasonally mated (for 12 weeks commencing in early January) over three years. Calves were weaned conventionally (CW) in May, or by early weaning (EW) (> 55 kg) in January.

Table 4.13.1.

Measurements	1990		1991		1992	
	CW	EW	CW	EW	CW	EW
Liveweight (kg)						
January	503	492	452	478	414	438
May	500	527	505	554	452	518
LW change (kg)	-3	35	53	76	38	80
Pregnancy rate (%)	-	-	-	-	47	76

Continuous annual early weaning improved cow LW, and this increased LW was reflected in higher conception rates in 1992. Approximately 50% of the weight advantage from early weaning was carried through to the following year, leading to continuously early weaned cows being 79 kg heavier at the end of the 3-year period.

4.14. Lansdown, Townsville. (Contact: Tony Schlink).
(PASAP, 1988, 17: 326-329).
"Cow management strategies and reproductive performance in a northern Australian cattle herd.".

Mixed age Droughtmaster cows with calves at foot were seasonally mated, and calves from half the cows were creep-fed ad lib with supplement for 4 months. The supplement contained 79% maize, 12% formaldehyde-treated sunflower meal, 4% meatmeal and 5% molasses. Each treatment was given to one herd of 20-29 cows.

Table 4.14.1

Measurements	No creep fed		Creep feed	
	Improved grasses	Native grasses	Improved grasses	Native grasses
Creep feed intake (kg/d)	0	0	1.7	1.8
Cow initial LW (kg)	434	429	435	450
Cow LW change to weaning (kg)	66	27	56	-7
Pregnancy rate (%)	45	62	83	50
Calf LW gain (kg)	108	105	112	107
Plasma P (mM/L)	1.7	2.0	1.8	0.8

It appeared from the plasma P concentrations that the herd grazing native pasture and given creep feed were P deficient, and the authors suggest that the poor response of this group is due to this factor.

Consideration of the two groups grazing improved pasture indicates a large increase (45% to 83%) in pregnancy rate due to creep feeding, but no effect on the cow LW gain during lactation.

4.15. Mt. Bundy, N.T.. (Contact: Terry McCosker).
(Rangeland Journal, 1991, 13: 3-13).

Supplementation experiment with Braham crossbred breeders (900) in the monsoonal tall grass zone during 1980-1984. Measurements were made at musters in April/May and August/September. The herd was mated from mid-December to April/May. Calves >150 kg were weaned in April/May, and the remaining calves in August/September.

Four treatments were used:
(i) Nil wet. No supplements in wet; Uramol blocks in dry season.
(ii) Mineral. Supplement of P + other minerals in wet; Uramol blocks in dry season.

(iii) Protein. Supplement of NPN + P other minerals in wet; Uramol blocks in dry season.

(iv) Strategic. Supplements of salt in dry season in November/December, P + minerals in January/February, NPN + P + minerals in March/April; Uramol blocks in dry season.

In addition a separate herd (not part of the formal experiment) was run without any supplementation in the wet or dry seasons.

Table 4.15.1.
Results are means for 3 or 4 years.

Measurement	No supp*	Nil wet (+N dry)	P wet (+N dry)	N+P wet (+N dry)	Strategic wet (+N dry)
Mature cow mortality (%)	15	8	3		
Heifer mortality (%)	21	12	3	3	5
Pregnancy (%)				2	4
lactating FC cows	15	27	25		
lactating mature cows	20	49	47	67	23
				60	52
LW in April/May					
lactating mature cows	331	333	341		
lactating FC cows	269	295	303	359	343
				311	306
Branding (%)	44	51	52		
% of calves weaned Apr/May	-	60	54	62	56
Calf LW/breeder	59	78	80	70	59
				103	85

* Separate herd, and not an integral part of experiment.

Supplementation with Uramol blocks (May-Oct) had a major effect on mortality and branding rate. When dry season supplements were fed, P supplement reduced mortality but had little effect on reproduction. NPN + P fed during the wet substantially increased breeder LW in April/May, pregnancy rate, breeding rate, the proportion of calves which were normal weaner LW by April/May, and kg calf produced per breeder.

4.16. Kidman Springs. N.T. (Contact: Rohan Sullivan).
(Sullivan et al. AJEA, 1992, 32: 149-156).
"Effects of once-yearly weaning or some aspects of herd productivity in an extensive herd in the semi-arid tropics of northern Australia".

Two weaning treatments were measured over 4 years (1981-1985) in a 500 head crossbred breeder herd grazing native pastures. In June cows with calves >100 kg were either weaned or not weaned, while all cows with calves <100 kg were not weaned. Breeders were reallocated to treatments each year.

Table 4.16.1
Results are the means over the four years of the trial.

Measurement	Not weaned	Weaned	Young calf (not weaned)
Breeder LW change			
Year 1 (June-Nov)	-50	-26	-84
Year 1 (Nov-June)	87	104	72
Year 2 (June-Nov)	-48	-82	-41
Breeder mortality (%)			
Year 1 (June-June)	14	5	16
Year 2 (June-Apr)	9	8	11
Breeder conception rate in Year 1 (%)*	74	94	78
Breeders calving out-of-season in Year 2	4	27	4

* Of those breeders weaned or not weaned. 20% of these breeders failed to rear a calf to branding age.

Weaning in June reduced breeder LW loss during the remainder of the dry season, and resulted in heavier LW, lower mortality, higher conceptions during the following 12 months. However weaning resulted in a high proportion of out-of-season calves and high LW loss by breeders in Year 2, which in practical terms negated the benefits in Year 1 from weaning.

4.17. Kidman Springs. N.T. (Contact: Rohan Sullivan).
(In: Petty et al. 1992, NW Australian Pastoral Conference and also Sullivan and O'Rourke, Aust. J. Exp. Agric., In press).

Work at Kidman Springs from 1985-90 compared early weaning once and twice annually. This was done as a follow-up to the work reported by Sullivan et al (1992) where weaning in June each year resulted in 27% of weaned cows calving out of season the next year with consequent higher mortality and conception rates. It was considered a second weaning round late in the season could relieve a significant proportion of cows from lactation stress and hence improve calving and mortality rates.

Table 4.17.1. Mortality and weaning rates (%) of cows weaned once and twice annually (1985-1990)

	Once	Twice
Weaning (%)	52	52
Mortality (%)	14	13

The herd grazed native pastures, was continuously mated and was not supplemented. Cows were weaned either once-yearly in June (W1), or twice-yearly in June and October (W2) and remained in their allocated group for the duration of the experiment. Calves were weaned if > 100 kg liveweight at muster.

The proportions of branded calves weaned at the June muster for W1 and W2 were similar (73% and 76%), and 14% of W2 calves were weaned at the October muster. The low numbers of calves suitable for weaning in October for W2 indicates that the weaning times were too close together, and didn't allow enough late calves to reach the target weight for weaning. This may have reduced the benefit to the W2 herd from the second weaning.

There was no difference in liveweight change, mortality or branding rates between the treatments. Productivity was low with average branding and mortality rates of 52% and 12%. 47% of cows were pregnant at the June muster, but 23% of these cows failed to rear the calf to the following June. It is argued that poor nutrition of cows during both dry and wet season masked treatment effects and contributed to the low productivity of the herd as a whole.

The current breeder management system at Kidman Springs includes twice yearly weaning (April and September) down to 100 kg. Under this system around 75% of the calves were removed from the breeders in the first round for 1992. This is similar to the proportion removed from both treatment groups in the once vs twice weaning comparison. The branding rate at Kidman Springs in 1992 was 85%, so 20% of the breeders were suckling weaner sized calves in September. Hence the necessity of the two weaning rounds,particularly in a poor year such as this.

Another aspect of the twice weaning system is that calving peaks during the year correspond to the previous years' weaning rounds. These calving peaks make the two weaning rounds essential in a continuously mated herd as calves too young to wean at any particular muster will be ready at the next muster.

4.18. Kidman Springs. N.T. (Contact: Tom Stockwell).
(In: Proceedings NW Australia Pastoral Conference, Katherine, 1992).

Results for performance of the breeder herd at Kidman Springs Research Station during 9 years when supplements were not used, or for 2 years after a supplementation strategy was introduced are outlined in the figure below.

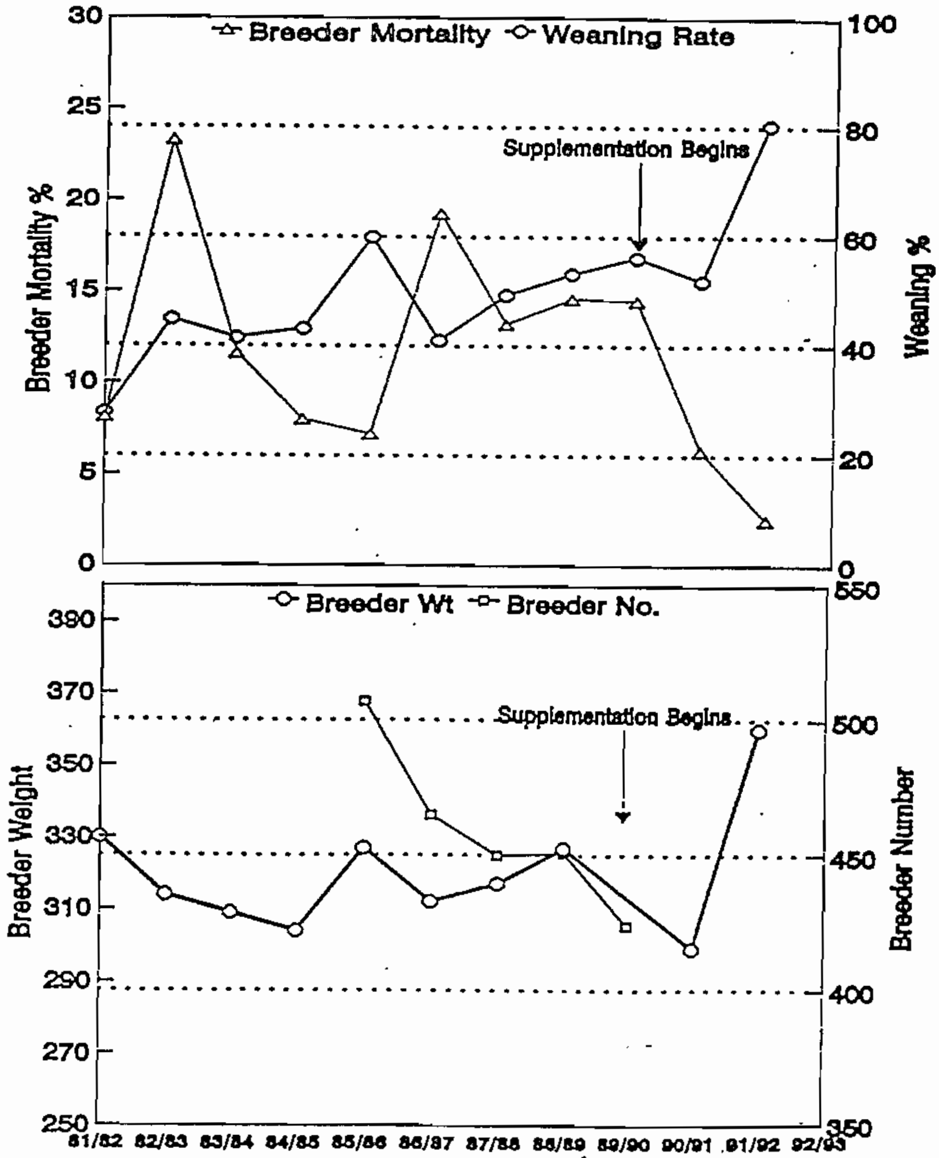


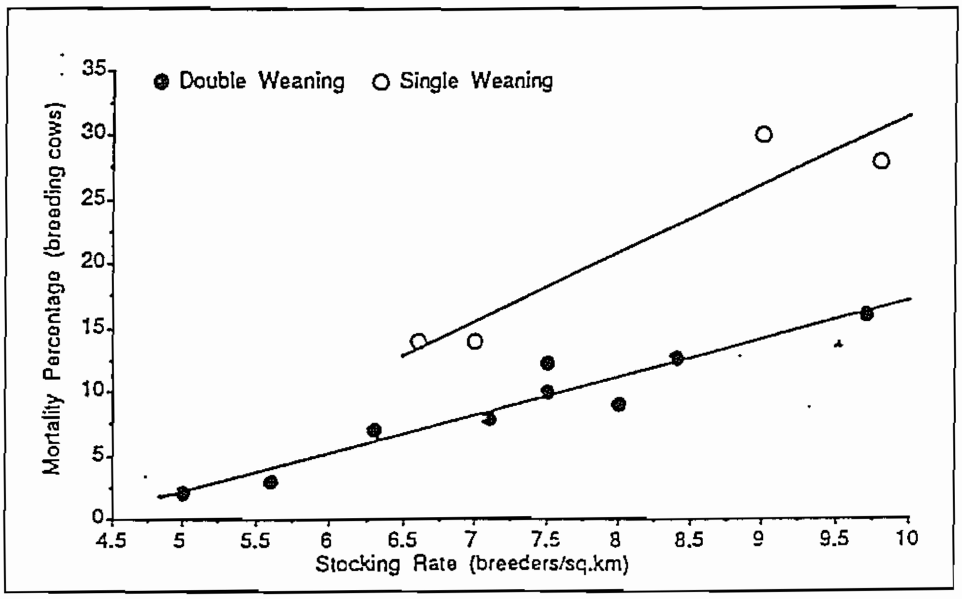
Figure 4.18.1. Changes in breeder mortality, reproductive rates, liveweight and umbers at Kidman Springs between 1981/2 and 1989/90 when no supplement was supplied (Sullivan et al 1992, Sullivan and O'Rourke unpub data) and between 1990/91 and 1991/92 when supplementation was introduced (Sullivan, Stockwell and MacDonald, unpub data).

4.19. Victoria River District, N.T. (Contact: Gehan Jayawardhana, Colin McCool). "The effect of stocking rate on breeder productivity in the Victoria River District". (In NW Australia Pastoral Conference, Katherine 1992).

Six herds on four commercial properties in the VRD were studied for two to four years between 1988 and 1992. Data was collected annually or biennially depending on the property's mustering program. As well the averages of data from two herds on Kidman Springs Research Station and another commercial property (McCool and Perkins unpub) were used. The paddocks were a mix of black and red soils and ranged from the monsoonal tall-grass areas of the northern VRD to Flinders/Mitchell grass plains and river country in the southern VRD. Mortalities were calculated as the number of tagged breeders missing over the yearly period. Weaning percentage was calculated as the number of weaners removed as a percentage of the number of cows in the paddock at the time of mustering.

Breeder mortality was strongly related to increasing stocking rate (Figure 4.19.1.).

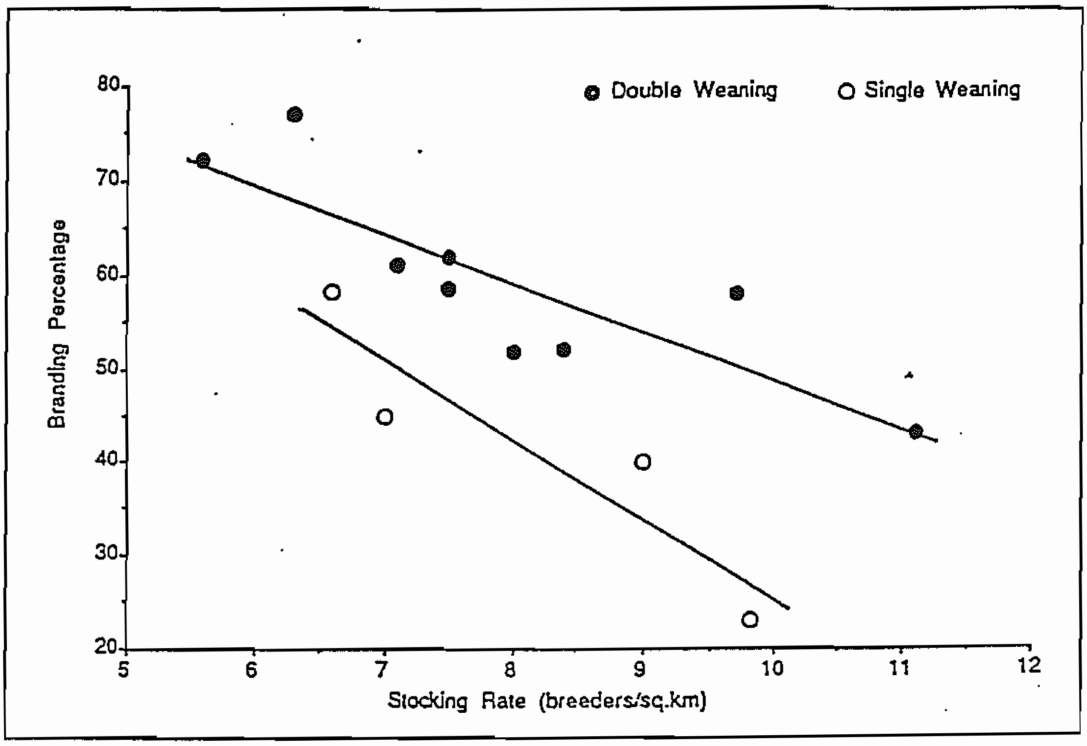
STOCKING RATE vs COW MORTALITY



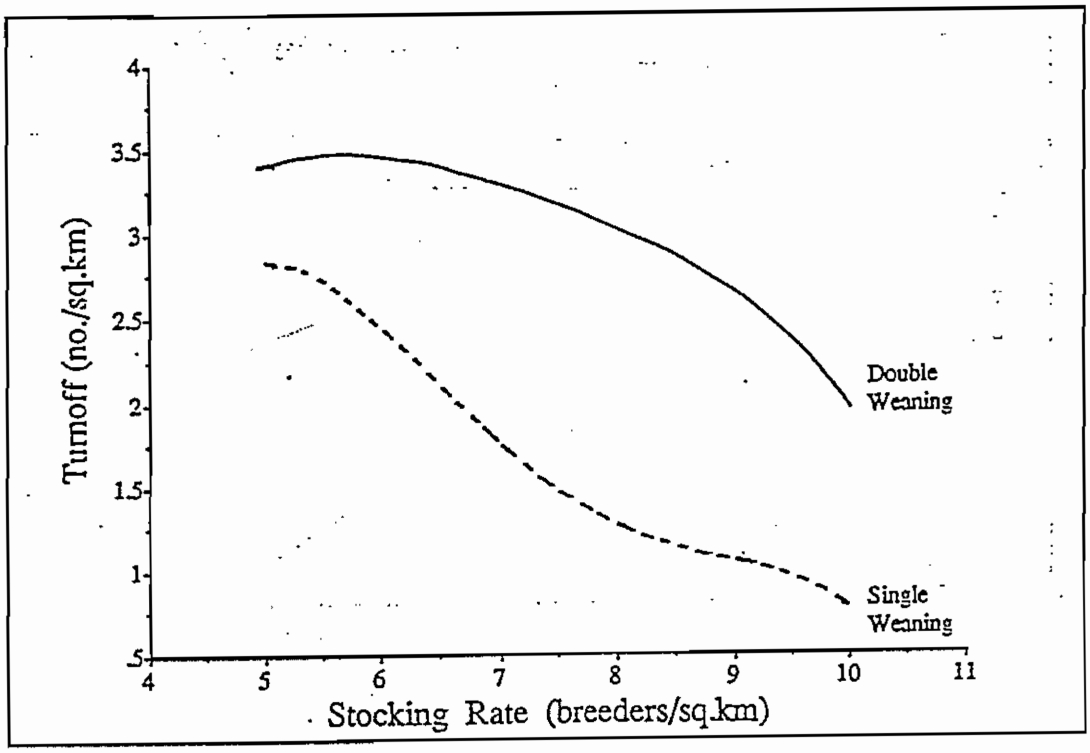
255.

There was an inverse relationship between branding percentage and stocking rate (Figure 4.19.2.). Branding was done at weaning in these groups so the two are synonymous.

STOCKING RATE vs BRANDING PERCENTAGE



The relationship between stocking rate and turnoff is shown in Figure 4.19.3. This was calculated from the regression lines for stocking rate versus weaning and mortality. For the comparison weaners were given a 3% annual mortality till turnoff two years later. Female numbers could not be maintained with the higher stocking rates under a single weaning system.



Traditionally, stocking rates in the VRD have been determined somewhat arbitrarily. This approach has sometimes led to situations where animals are stocked to the point where they cannot be economically supported. In this area pastoralist perceptions of breeder mortality have been far lower than the mortality figures that have been seen in field trials. Pastoralists surveyed by the GRM questionnaire estimated an average mortality of 7.1%. However McCool and Perkins (unpub), over two below average seasons in the northern VRD, recorded mean annual breeder mortalities of 22.9%, 35.4% and 51.4% in Brahmans, Crossbreds and Shorthorns respectively. Comparable results have been found in adjoining regions. A mortality of 47% was reported for lactating Shorthorn cows in the Kimberley (Armstrong et al 1968). Stockwell and Norton (1990) found 10-25% mortalities in crossbred breeders on the Sturt plateau.

The maintenance of realistic stocking rates by sale of some females (eg 65-75% of female weaners) should increase property viability and profitability while promoting sustainable agriculture.

4.20. Mt. Sanford. VRD, N.T. (Contact: Neil MacDonald).
Comparison of effects of a range of stocking rates and supplementation treatments.

Commencing in August 1994 six groups of cattle (each 54 breeders, 10 steers and two bulls) have been grazed in paddocks varying is size to allow stocking rates equivalent 5, 7.5, 10 and 15 breeder cows per km². One paddock of cattle at each of these stocking rates is supplemented with dry lick (+S), and in addition two paddock groups stocked at 5 and 7.5 breeders per km² are not supplemented (-S).

Cattle are mustered twice per year (May and September), and all calves heavier than 120 kg weaned at each muster. At one muster (usually May) all animals are vaccinated against botulism, cows are pregnancy tested, some cows culled for low fertility and obvious faults and if older then 10 years. Supplements consist of dry licks intended to provide 6-8 gP/day during the wet season, and urea from February (approximately 4 gN/d) to September (approximately 10 gN/d).

Table 4.20.1. Results from Mt. Sanford trial.

	Stocking rate (number/km²)					
	5 (+S)	7.5 (+S)	10 (+S)	15 (+S)	5 (-S)	7.5 (-S)
Breeder CS Oct 94	7.7	6.6	6.6	6.8	6.9	5.9
Breeder LW (kg)	415	411	406	388	398	388
Breeder LW change (kg) (May-Oct 94)	-6	-9	-25	-29	-14	-29
Breeder LW May 95	419	437	413	417	396	401
% wet cows pregnant	74	47	44	60	41	73
Weaning %	76	76	87	89	81	85
Weaning weight (kg)	209	213	192	193	196	208
Steer LW gain (kg) (May 94-May 95)	141	150	120	137	118	125

Extremely good seasonal conditions have led to cattle at all stocking rates being in excellent body condition, and little difference between the various stocking rates being examined.

4.21. McArthur River, W Gulf. (Contact: Tony Schlink).
Productivity of a Bos indicus cross cattle herd in the Western Gulf region of the Northern Territory. (PASAP, 1994, 20: 93-96).

The productivity of 570 breeders in two herds was measured from May 1985 to May 1990. Herds were mustered once per year (in May/June), in most years, and also at second round muster in two of the years. Herds were continuously mated, and calves heavier then 120 kg were weaned at each muster. Uramol blocks were fed during the dry season to both herds for the 6 years, and during the last 3 years one herd was also supplemented during the wet season with Phosrite blocks.

Table 4.21.1. Measurements in May/June (mean of 3 years) 1987/88-1989/90.

Group and muster	Wet		Dry	
	Preg	Empty	Preg	Empty
Cow LW				
Control	310	293	347	317
P supp	323	310	383	367
Cow CS				
Control	3.1	2.7	4.2	4.3
P supp	3.7	3.6	4.7	4.7
% in each group				
Control	8	49	36	5
P supp	15	41	37	7

(Condition score: 1 = poor, 5 = fat)
Mortality = 18% mean (range 11-28%)
Branding rate = 54%
Proportion of cows lactating (May/June): 57% control treatment
56% P supp treatment
Proportion of lactating cows reconceiving while lactating leading up to May/June muster:
14% control treatment
27% P supp treatment
In 1987, dry season LW loss of 8 kg for dry cows and 78 kg for lactating cows
P supp increased: LW at end of wet by: 15 kg in lactating cows
43 kg in dry cows
CS at end of wet by: 0.6 in lactating cows
0.5 in dry cows

Herd productivity was low and there was apparently a small response to the wet season P supplementation.

4.22. Central Mt. Wedge, Central Australia. (Contact: Jack Peart). (In: Proceedings NW Australia Pastoral Conference, Katherine, 1992, and Producer Demonstration Project reports to MRC.

This demonstration was intended to assess the effectiveness of supplementation by water medication.

Materials and Methods

Two bores were selected on Central Mount Wedge station, approximately 250 km north-west of Alice Springs. The vegetation types around each bore are similar, being predominately mulga and spinifex communities. At both bores, Poll Hereford breeders are run, with progeny being removed in the normal weaning process on the property. Approximately 200 mixed cattle were run on each bore.

A nutrient dispenser was installed at one of these bores (Xmas) and run for 2 months with no nutrient in the system. This was the first installation of the unit and the early proving period was necessary to ensure its efficiency. After the initial period, a nutrient mix (75% urea, 20% mono-ammonium phosphate and 5% sulphate of ammonia) supplied nitrogen, phosphorus and sulphur. The unit delivered this mix unchanged throughout the 2 year period of the trial described. The cattle at the other bore (Yundutch) received no supplement during the period although blocks were put out during a particularly dry period but intake was minimal.

Cattle were weighed, and breeders pregnancy tested and wet/dry recorded three times per year over the 2 year period.

Results

Rainfall over the 2 year period was well below average with a difference between the two bores favouring the control bore (Yundutch) (Table 4.22.1). The difference was approximately 100 mm over the period and the effect of this was aggravated by the fact that the falls at the treatment bore were scattered and light with very little response shown in the vegetation.

Table 4.22.1. Rainfall (mm) during the demonstration trial period. Summer period = October to March; Winter period = April to September.

Period	Xmas bore (Medicated water)	Yundutch bore (Control)
Summer 90-91	75	156
Winter 91	42	44
Summer 91-92	57	53
Winter 92	90	113
Summer 92-93	18	17
Total	282	383

Table 4.22.2. Average of liveweight and reproductive status for 6 musters over two years.

Measurement	Control	Supplemented
Liveweight of breeders (kg)	335	354
Reproductive status (%)		
Pregnant	42	44
Wet and empty	38	41
Dry and empty	21	15
Calves as % of breeders	39	48

The average intake of supplement during the 2 years of the demonstration was 14 g per head per day, or approximately half the intended dose.

Reproductive status of the two mobs did not differ greatly (Table 4.23.2). Treatment cows were consistently heavier then the control group, even though rainfall was lower in the area of the bore which was supplemented. Also, as a subjective comment, visiting pastoralists consistently commented that the cattle fed supplements were in better condition.

4.23. Ord River, E. Kimberley Region. (Contact: David Pratchett).
"Production characteristics of a free range cattle herd in the East Kimberly of Western Australia". (Australian Rangeland Journal. In Press).

Production characteristics were measured over 8 years in a herd managed in a manner typical of the Kimberly Region. From 1980 to 1983 the herd was Shorthorn, and Brahman bulls were used from 1984-1988. Cows were culled on the basis of age, and steers were turned off in May when LW exceeded 450 kg.

The herd was mustered once per year (May/June) in 1980-83, and twice per year (May/June and October/November) from 1984. Calves were not weaned.

Branding rate.	Mean 52%, range 29-71%.
Breeder mortality rate.	Mean 11%, range 7-21%.
Steer mortality rate.	Mean 8%, range 3-14%.
	Mean LW of cows >2 year old approximately 302 kg, and LW in the best year (1987) was only 320 kg.

4.24. Ord River, E. Kimberley Region. (Contact: David Pratchett).
"The benefits of weaning on cows in the Kimberley Region of Western Australia".
(W.A. Journal of Agriculture 1989, 30: 56-57 and unpublished results).

Three groups each of approximate 300 breeders (Shorthorn and Shorthorn/Braham cross) were run under these management systems from 1984 to 1988. All herds were mustered twice each year (May and November), the management systems (one herd per system) were as follows:

System A — No weaning, continuous mating. Old poor condition cows culled in May.

System B — Weaning at >140 kg LW in May + November. Continuous mating. Replacement heifers introduced at 18 months of age.

System C — Weaning at >140 kg LW in May + November. Seasonal mating November-May. Bulls checked. Replacement heifers introduced at 18 months of age.

Table 4.24.1 Mean (and range) production parameters for the 5 years were as follows.

Measurements	System A	System B	System C
Weaning (%)	47 (30-35)	80 (72-89)	70 (70-73)
Mortality (%)	18 (12-25)	9 (6-11)	9 (7-14)
Cow LW in May			
(wet)	310	345	341
(dry)	337	354	357
Cow CS in May			
(wet)	1.2	1.8	1.9
(dry)	1.5	2.5	2.6

(CS: 1 = backward store, 2 = store, 3 = excellent)

Productivity under System A, the traditional low input system for this region, was low. Both systems involving weaning greatly increased branding rate and reduced mortality. There was no advantage, and possibly a disadvantage, with seasonal mating used for System C.

4.25. Ord River and Flora Valley, E. Kimberly Region. (Contact: Steve Petty). "The impact of once a year weaning of calves to 60 kg on breeder fertility and mortality in the Kimberley - Prelimenary results". (PASAP 1994, 20: 340).

Two breeder herds (700 or 400 breeders) were either conventionally weaned (calves >150 kg) twice a year (May and October), or very early weaned (calves >60 kg) once a year (May). The Flora Valley breeders had not been regularly weaned before the trial commenced, whereas Ord River breeders had been regularly weaned twice per year.

Table 4.25.1. Mean results for three years 1991-93.

Measurement		Wean 2 x p.a. to 150 kg	Wean 1 x p.a. to 60 kg
Weaning (%)	Flora	69	84
	Ord	76	78
Mortality (%)	Flora	2	2
	Ord	2	3

Weaning once per year to 60 kg in May was as effective as conventional 2 X year to 150 kg to reduce breeder mortality and increase branding rate.

4.26 Jubilee Downs, Fitzroy Crossing. (Contact: Keith Anderson or Andrew McLaughlin). Producer Demonstration Site. Duration 1988-1994

The demonstration area consisted of two paddocks. The "Breeder" paddock covers about 7000 hectares of low carrying capacity (2.5 cattle units/sq km) pindan country characterised by red sandy soils and spinifex-wire grass pastures. The initial breeder herd consisted of 14 Brahman bulls over 200 mixed age Shorthorn cows. The paddock was serviced by two waters and trap yards, at either end. The "Weaner" paddock covered about 2500 hectares of highly productive (10 cattle units/sq km) black soil and frontage dominated by Mitchell grass and bluegrass. The paddock was serviced by two waters and was mustered by horseback.

Both paddocks were mustered twice yearly, in May and September. All animals were individually tagged and basic production parameters (weight and lactation status) were recorded. All animals were vaccinated for botulism. Weaners down to 100 kg were removed from the breeder herd and transferred to the weaner paddock at each muster. Cows were culled on age (9 years), reproductive performance (based on lactation status) or defects. Replacement heifers (>300 kg) were sourced from the weaner paddock and steers were grown out in an adjacent bullock paddock.

Breeders grazing the poorer quality "pindan" country were supplemented on a rather ad hoc basis at the discretion of the station manager. Normally a phosporus based lick block was put out close to watering points towards the end of the wet season (March-April). A urea based lick block was made available towards the later part of the dry season (August-September onwards). The weaner paddock was unsupplemented due to the high quality pastures found there and consequent inability to encourage animals grazing this country type to take supplements.

Rangeland management was an important component of the demonstration. All pasture types were monitored using photographic monitoring sites which were reviewed at each muster. Stocking rates were adjusted seasonally in response to changes observed and recorded at the sites. Areas of historically degraded river frontage in the weaner paddock were being regenerated through the use of strategic fencing, cultivation and the exclusion of stock.

Table 4.26.1

Year	Breeder mortality (%) (A)	Weaning rate (%)	Weaner growth (kg/year) (B)
1989	6	-	172
1990	13	51	118
1991	5	65	133
1992	16(C)	75	67
1993	7	75	96
1994	-	88	158
Mean	10	71	124

A. May include some animals which have escaped from the breeder paddock and not subsequently found.
B. Average for weaners in 100-200 kg LW classes
C. Includes approximately 4% due to urea toxicity problems

4.27 Glenroy, Central Kimberley (Contact: Jim Addison). Producer Demonstration Site. Duration 1990 -.

Aims

The aim is to demonstrate improved herd productivity levels through the adoption of a package of management strategies. The management package consists of appropriate stocking rates, Brahman infusion, twice a year weaning, culling breeders on age and fertility, botulism vaccination and feral animal control.

Methodology

The PDS consists of a breeder paddock (3120 ha). Stocking rates for 1993 were approximately 1 cattle unit per 22 ha and 1 cattle unit per 21 ha respectively. The predominant perennial pastures include *Sehima nervosum, Chrysopogon fallax* and *Dicanthium fecundum*. Soil P of 2-5ppm suggests that P deficiency occurs in this area. Musters have been by horse or horse/helicopter at first round, and by spear gate trapping at second round.

The strategies adopted at Glenroy to enhance branding rates are:

(1) Conservative stocking rates to improve breeder nutrition.
(2) Bull power at not less than 6%.
(3) Twice a year weaning (May and September). In early years to 150 kg, and in later years to 130 kg.
(4) Wild dog control - strategic aerial baiting with 1080 fresh meat baits in September.
(5) Culling breeders for lack of fertility. Any breeder found to be non-pregnant and dry for two consecutive musters is culled.

At each muster the breeders are weighed, body condition scored, wet and dried, given a tick burden score, and pregnancy tested. Each animal is individually identified and the data recorded. Breeders and bulls are vaccinated against botulism once per year.

Weaners are removed from the breeder herd at 140 kg at the first muster and down to 100 kg at the September muster - depending on the season and condition of the breeders. All are tagged, weighed and vaccinated. Brahman bulls are used at no less than 6% and are culled on age, physical defects and temperament. Weaner heifers are transferred from the weaner paddock to the breeder herd at 240 kg (or when obviously already in calf). Some steer weaners have been held in the weaner paddock to observe growth rates. All calves are dehorned at branding or weaning.

Results

The reproductive status of the herd is shown in Table 4.27.1. Results for each year have been shown because of the high variability between years.

Table 4.27.1 Proportion of breeders in each reproductive class.

Muster and year		Wet		Dry	
		Preg	Empty	Preg	Empty
May	1990	32	28	25	13
	1991	9	32	44	15
	1992	13	51	25	11
	1993	20	47	24	9
	Mean	19	40	30	12
Sept	1990	5	16	59	29
	1991	7	21	65	7
	1992	19	26	52	3
	1993	18	45	34	3
	Mean	12	27	53	11

The proportion of breeders in the empty + dry category decreased and the proportion in the empty + wet category increased during the demonstration.

HENCE, on average over the four years;

Proportion of cows lactating:	May	59%
	Sept	39%
Proportion of cows reconceiving while lactating leading up to:	May	32%
	Sept	31%

Table 4.27.2 Breeder mortality and branding rate, and weaner growth rate

Year	Breeder mortality (%)	Branding rate (%)	Weaner growth (kg p.a.)*
1991	7	42	79
1992	17	51	49
1993	14	64	129#
1994	15	67	-

* Growth of weaners in the 100-200 kg liveweight.
# Phosrite P blocks fed in this year. Intake 80 g block/head/day during wet season.

Mortality has been high at 15-17%. Branding rate has increased progressively. There was a large effect of providing Phosrite P supplement blocks during the 1993/94 wet season on weaner growth rate.

5. Supplementation systems

5.1 Strategies.

Strategies for choosing the most appropriate type and level of supplementation for the breeder herd fall into five categories. The first two of these have been discussed by Lindsay (1983), McLennan (1983) and Nicol et al. (1984), and are outlined in Fig 5.1.1.

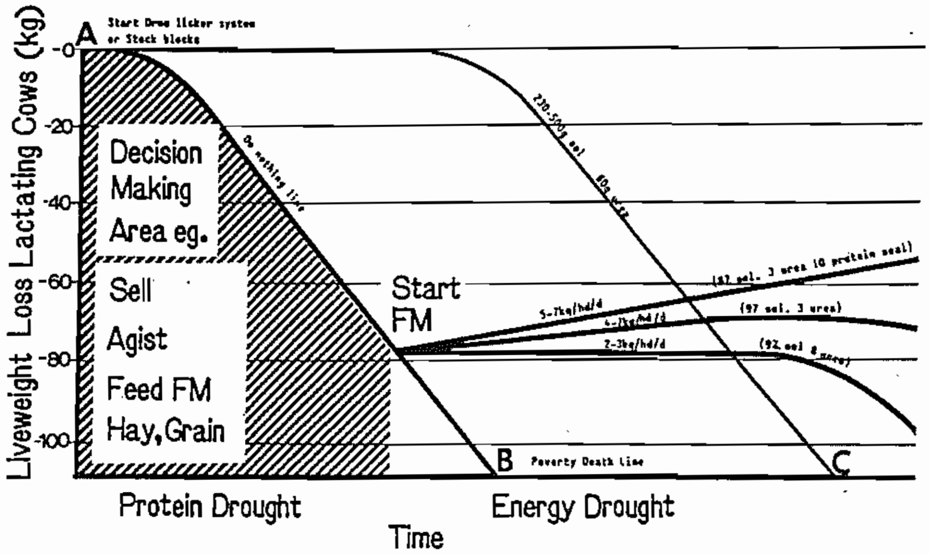


Figure 5.1.1 Drought management and feeding options in relation to LW change of lactating cows (Nicol et al 1984).
DL, drum licker system and would also apply to dry licks or blocks;
FM, molasses fortified with urea and possibly also protein meal.
DL feeding should start early at point A and level of supplementation will have to be increased at some point on the line AC. The 'do nothing' line from A to B denotes the strategy of graziers who do not feed until poverty deaths occur.

(a) Long-term low level supplements fed through the dry season to make better use of senesced pastures (ie. line A-C in Figure 5.1.1.) The principal objective becomes to provide non-protein nitrogen (urea N) and sulfur to reduce the rate of liveweight loss.

(b) Crisis supplements fed late in the dry season (ie. line A-B in Figure 5.1.1) The principle objective is to feed substantial amounts of an energy supplement (eg M8U) to avoid excessive mortalities. This is most commonly used when there is a delayed seasonal break, where managers have over-estimated the amount of dry feed available at the beginning of the dry season, or where managers have decided to take a risk and hope for rains and/or an early break to the dry season. Regular use of crisis supplements can have serious detrimental effects on pasture systems by maintaining high stocking pressure in the early stages of pasture growth.

(c) Long-term low level supplements fed through the growing season to make better use of pastures at this time of year. The most important will be P in deficient areas, but also applies to other minerals deficient for maximum growth such as sulphur, sodium and NPN during the later part of the growing season. The principal objectives are to provide the P or other nutrient at the time of the year when there is the greatest need and greatest animal response. This increases breeder liveweight before the dry season and increases fertility. Also there is evidence of increased fertility when NPN + S have been fed to lactating breeders during the growing season, presumably because pasture quality is sub-optimal at this time of the year for breeders in this physiological state.

(d) "Spike feeding" of breeders in late pregnancy and late in the dry season with substantial amounts of M8U or CSM. The principal objective is to increase reproductive rate and is discussed in detail by Fordyce et al. (1994) in MRC Final Report to project DAQ.062.

(e) Production feeding with high levels of supplements eg of molasses/urea/CSM to finish animals for lucrative markets and reduce age of turn-off. See for example Lindsay and Laing (1995).

The economic return from supplementation programs will usually be associated more with reductions in mortality than increases in breeding rates.

Decisions about which of the above strategies is optimal for a specific property will obviously depend on numerous factors including:

(a) Likelihood of P deficiency. In P deficient areas, P supplements are likely to be the highest priority.

(b) Likelihood of rain during winter and spring to alleviate or exacerbate the dry season conditions depending on type of country.

(c) Probabilities of when the seasonal break will occur.

(d) Amount of pasture available.

(e) Relative costs of long-term low level compared with crisis feeding strategies.

For example in coastal areas with highly variable severity and length of dry seasons, a crisis supplementation strategy may be more cost-effective when averaged over a number of years then a long-term low level strategy commenced early in each dry season. The "crisis feeding when required" strategy has been used for the Swan's Lagoon breeder herd over the last decade, and has produced low mortalities and high branding rate at an acceptable cost (see section 4.1). Alternatively in inland areas where the probability of rain in winter and spring is low and the cost of crisis feeding very high, the long-term low level strategy is more likely to be the best management option.

5.2 Controlling intake of supplement

The amount of supplement which cattle will eat under pasture conditions will depend on the following general factors:

(a) Palatability of the supplement.

The importance of the palatability of the supplement is obvious, and some general statements can be made:

e.g. Salt at lower levels (eg 0-20% of a dry lick) is usually an attractant, but at higher levels (eg 40-80% of a dry lick) limits intake. There is a common belief that intake of salt is fairly constant in a particular situation, and that supplement intake can be changed by changing the proportion of salt.

e.g. Urea and ammonium sulphate will tend to reduce intake, presumably because of their tastes (see Hough et al 1995).

e.g. Sweet flavours such as molasses or palabind are attractants.

e.g. CSM in dry licks tends to increase intake, perhaps partly because of the flavour, but also because it reduces "sweating" of the mix and maintains a more acceptable texture. However extensive water damage causing putrification of the CSM may make the mixture completely unacceptable.

However we have a very poor understanding of the relative importance of each of the above taste, aroma and texture factors, and how they interact. Also we know from indoor experiments that at least under some circumstances sheep, and therefore probably cattle, find tastes such as butyric acid, monosodium glutamate, aniseed oil and amyl acetate attractive (Goatcher and Church 1970; Arnold et al 1980; Hutson and van Mourik, 1981; Gherardi and Black 1986).

Acids, alkalis, magnesium oxide, propionic acid, amyl alcohol and bitter tasting solutions can apparently be unpleasant. Intake of a range of phosphorus supplements when mixed with molasses was found by Clarke (1974) to vary over a four-hold range. It is not clear the extent to which this variation was due to acceptability of the phosphorus source per se, or associated with differences in how well the phosphorus supplement mixed with the molasses component of the mixtures. In other similar work finely ground mono-ammonium phosphate (MAP) has been found to be less attractive than granular MAP. (A. Laing, unpublished observations). It may be possible to include these or other unpleasant flavours in supplements to reduce palatability.

There seems to be a belief among experienced industry people that the flavours of salt and then molasses have, for practical conditions of the northern industry, an over-riding effect, but other possibilities have seldom been tested.

(b) Availability and quality of pasture on offer.
The effects of the availability and quality of pasture are obvious to the extent that cattle fed dry season licks or molasses drastically reduce their intake or stop consuming supplement altogether after rain. Clearly, and as commented by many LCD group and individual graziers, a major problem of the industry is to be able to achieve target levels of supplement intake during the wet season (for P supplementation), while intake of dry season supplements is much easier to achieve.

The effects of pasture intake on "hunger" for low palatability supplements was demonstrated experimentally by early work in N. America (Riggs et al 1953). When cattle were fed low quality hay and were losing liveweight over an 8-month period, the proportion of salt needed in a salt/CSM mixture had to be increased progressively from 15% in the first month up to 50% in the eighth month to restrict CSM intake to a target intake of 0.9 kg/hd. Furthermore more salt had to be included when the hay was of poor quality.

(c) Training, age and previous experience of cattle to supplements.
There does not appear to be any formal experimentation on training and habituation of cattle to supplements. Experience of producers is that cattle have to become accustomed

to dry licks gradually, that more palatable licks should be used during the earlier stages, that sudden changes in lick mixture (therefore palatability) should be avoided, and that cattle should be accustomed to consuming dry licks before the wet season (therefore at a time of the year when they have a greater "hunger" for supplements).

Considerable experimental evidence has been obtained from the way in which sheep become accustomed to consuming supplements, and from ecological studies designed to understand why grazing animals select some plants rather than others. The work with sheep (Lobato and Pearce 1980; Lobato et al. 1980; Chapple and Lynch 1986) has clearly demonstrated that older sheep will much more readily consume supplements when they have previously been exposed to the same or similar supplements. Early exposure to both the container in which the supplement is fed and to the supplement are important. Adult sheep do not accept new foods as readily as weaner sheep, and there was a much larger proportion of non-eaters in the flock. The most important phase for lambs to "learn" to eat cereal grain or molasses-based block supplements was while they were young and before weaning. However sheep learn to eat new foods more rapidly by being mixed with other animals which have already learnt to eat the new foods. For older lambs, it appears not to be important whether the adult was their dam or any other adult. The "memory" of new foods was retained by sheep for at least three years.

The proportion of non-eaters of supplement appears to be related to the palatability of the supplement. In one experiment with sheep the inclusion of 4% molasses in a salt lick has reduced the proportion of non-eaters from 26% to nil (Wheeler et al. 1980).

In groups of sheep, the animals which are 'non-eaters' can be affected by drafting them off as a separate group. In a separated group of 'non-eaters' many sheep commenced to eat, suggesting that they were non-eaters due to social interactions and aggression by other animals rather than entirely due to there lack of recognition of the supplement grain as food. Similar observations have been made in group of radical weaner calves (J.A. Lindsay, personal communication). However within groups of sheep supplemented with cereal grain, neither "leadership" (defined as those sheep which most readily came at feeding time) nor aggressiveness in competing for the supplement appear to be related to actual intake of the supplement.

(d) Type of country and presence of pica may have large effects on the acceptability of supplements.

5.3 Amounts of Urea N and P required.

The general recommendation by QDPI for the amount of urea N required in dry season supplements is 30 g urea/day for weaner and yearling cattle, and 45-60 g urea /d for breeders. Optimal amounts of P supplement are outlined by McCosker and Winks (1994) and are also being examined in Project DAQ.093. However these supplements will only be useful when there is an excess of low quality dry pasture available.

The most comprehensive experimental results on the effects of various amounts of urea for Bos indicus cross cattle in the N. Qld dry season are those of Winks and colleagues. These are summarised in Fig 5.1.3. The recommendation of 30 g urea/d is based on the concept that in most years this gives the majority of the response possible with higher doses. However, the shapes of the response curves in the figure suggest that, in many years, much of the response would be obtained with a dose of urea lower than 30 g/d.

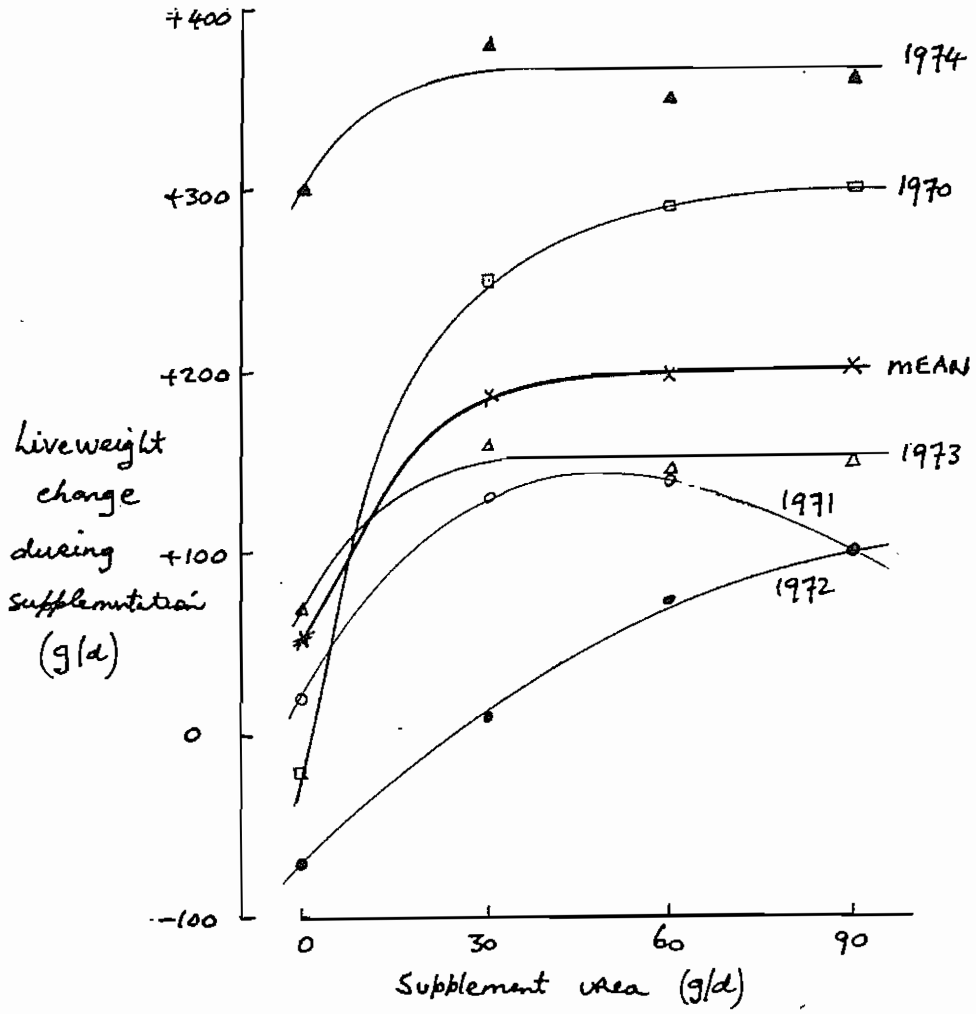


Figure 5.1.3 Summary of liveweight responses of young Bos indicus cross cattle (initially 18-24 months of age) to various levels of urea fed through molasses/urea roller drums during the dry season (Winks et al 1972; Winks et al 1979)

The optimal amount of supplementary urea to feed in a given situation will depend on many factors such as the degree of liveweight loss which the manager is attempting to alleviate, the condition of the cattle for the particular stage of the dry season and the level of risk which the manager is prepared to accept that alternative strategies (crisis feeding, sale, etc) will be necessary to avoid excessive mortalities.

The estimate of the amount of urea supplement required for a breeder cow is based less on direct experimentation with breeders, but rather on assumptions that because breeders consume more pasture than smaller growing animals, they require a proportionally larger amount of urea. The dry pregnant breeder (which is presumably the breeder of greatest interest) is likely to eat a similar proportion of liveweight as the growing animal. An amount of supplementary urea 1.5 times that used for the growing animal for the dry, pregnant breeder, and 2 times that for the growing animal for a lactating breeder appear reasonable practical recommendations.

Observations on intake of block supplements at Mt. Bundy (Eggington et al 1990) suggested that lactating breeders consumed more block than dry breeders. If this observation is generally applicable, then it provides an excellent mechanism where the animal that requires more supplement in fact eats more. However this may be because the lactating cow is hungrier and will continue to consume low palatability supplements (see section 5.1.2) rather than due to "nutritional wisdom" of the cow and the cow knowing what she needs to eat for her own benefit.

5.4 Distribution of supplements in the mob.

The economic cost associated with poor distribution of supplements within the mob is difficult to assess. Important factors will be:

(a) The shape of the animal response curve to increasing amounts of the supplement;

(b) The type of supplement (e.g. inorganic N or P compared to protein meals or molasses based supplements) will be central to this, since responses to the former will tend to occur up to a certain level, with very little further animal response to higher intakes of supplement.

(c) The opportunity for the manager to separate and manage differently sub-groups of animals which require a higher plane of nutrition (either because they are in a different physiological state or because they are not eating sufficient supplement) and animals which can tolerate a lower plane of nutrition (again either because of physiological state or because of luxury levels of supplement intake).

(d) The type of animal response required eg. to reach a threshold level of nutrition to survive and/or reconceive, compared to LW gain in finishing animals where higher than target supplement intake may be compensated by earlier turnoff.

5.5 Specific supplementation systems. Dry licks.

5.5.1 General.

Usual ingredients are salt, kynophos (or other source of calcium phosphate), urea, ammonium sulphate, sulfur, CSM (or other protein meals), and perhaps low levels of palabind, molasses and grain.

During the growing season the principal objective will usually be to provide P, and simple mixtures of kynophos and salt (or even kynophos alone) are often used. Target levels of P will depend on expected degree of P deficiency in the area and physiological status, and are discussed in detail by McCosker and Winks (1994).

During the dry season when the principal objective is to provide NPN and S, mixtures are likely to be based on salt and urea with some kynophos, S source and CSM.

An enormous variety of mixes are used in the industry as producers adjust recipes to achieve target intakes or from personal beliefs. Base recipes are outlined in the QDPI Drought Management Handbook (1993) and by McCosker and Winks (1994).

Intakes in the order 60-200 g per breeder per day of dry lick mix will be required to provide these target levels of P and for N. Cost per tonne of dry licks will usually be in the range $400-$600. For an intake of 100 g/d and a cost of $500 per tonne, the cost per head will be approx $1.50 per month.

5.5.2 Advantages.

(a) Cost.

(b) Well established technology.

(c) Flexibility to easily change mixes for the season and the specific situation, particularly when equipment is available to mix on property.

5.5.3 Disadvantages.

(a) It may be difficult to achieve target levels of intake. During the wet season it is often difficult to achieve sufficient intake. During the dry season intakes may be too low or excessive.

(b) There may be a large proportion of non-eaters of supplement and a high variability of intake in the mob (although there is very little information on this).

(c) "Sweating" of the mix due to absorption of water from the air can occur with some mixes. This reduces palatability.

(d) Urea toxicity problems can occur, particularly following rain.

(e) Rain spoilage of supplement may reduce or entirely stop intake, and spoiled supplement is often wasted.

5.5.4 Effect of pasture availability on supplement intake.

(a) Commonly intakes of dry lick supplements tend to increase as the dry season progresses, and control of excess supplement intake can become a problem.

(b) Recent results from Mt. Sanford trial site in the VRD, NT demonstrate both seasonal and pasture availability effects. (Table 5.5.4, results of Neil MacDonald).

Table 5.5.4. Intake of supplement at two times of the year at a range of stocking rates by groups of cattle consisting largely of breeders.

Stocking rate	Supplement intake (g/hd/day)	
	Late wet (Jan-Mar)	Late dry (Aug-Sept)
5/km^2	41	114
7.5/km^2	80	152
10/km^2	78	170
15/km^2	68	196

5.5.5 Means of controlling intake. (See also Section 5.2.).

(a) Previous experience and habituation to encourage intake.

(b) Control excess intake by stopping feeding for an interval. Often used in the industry. Problems may be in reduced efficiency of use of the supplement nutrients, and urea toxicity on refeeding (with dry season licks). The loss of efficiency is likely to be much greater with NPN than the P component of the licks.

(c) Most common control of intake is by changing the proportion of salt in the mix.

(d) Palatable components (molasses, palabind, CSM, grain) will tend to increase intake.

(e) Inclusion of proportionally higher amounts of urea and ammonium sulphate tend to reduce intake.

(f) Monensin and meatmeal are sometimes used to reduce intake by reducing palatability, but the effects tend to be transient. Limestone and magnesium salts have been suggested as an effective means to reduce intake. In observations at Swan's Lagoon limestone did not seem to have any effect.

(g) Addition of some CSM and use of refined salt (flossy fine) rather than coarse salt (containing Mg salts) to reduce "sweating" of dry lick mixtures.

(h) Some P sources are more acceptable then others, and this can be used to advantage (see Section 5.2).

(i) Another possibility to control excess intake which seems not to have been examined is to add simple fillers to dilute the attractive flavours. For example it may be possible to use clay.

(j) There seems to be a general observation that it is much easier to get satisfactory intakes of unpalatable supplements in P deficient regions then non-P deficient regions. This could be (i) a specific effect of pica, or (ii) could be because animals grazing P deficient pastures are more likely to have been exposed and habituated to supplements, or (iii) because they have a greater "hunger" for supplements (see section (5.2 (b)).

(k) In "salt hungry" areas (eg. basalt country) exclusion of salt from supplements will reduce intakes.

5.5.6 Intake distribution in mobs fed dry licks.

There is clear evidence from sheep that changing the dry lick composition and making it more palatable can change the proportion of non-eaters. Including 4% molasses in salt licks reduced the proportion of non-eaters from 26% to nil (see Section 5.2.c. above).

There appears to be only one study Tuen et. al (1982) where distribution of dry lick intake has been measured in cattle. In a mob grazing P deficient country and supplemented for 10 months with a dry lick of MAP, limestone, salt, urea and S, only 4% of the mob were non-eaters of supplement, but an additional 17% of the mob consumed less than half the mean intake of the mob. Another 13% consumed more than twice the mean intake of the mob. Hence supplement intakes of at least 1/3 of the mob were very different to the mean intake calculated from knowing how much supplement was consumed and the number of cattle in the paddock.

5.6 Specific supplementation systems. Blocks.

5.6.1 General.

Blocks are produced by a number of commercial companies. The high labour input to produce home-made blocks means that for most situations it will be a better option for producers to purchase blocks rather than to make them. Nevertheless the cost per unit of P or N will be much higher than for dry lick systems.

Blocks can be considered in three classes:

(a) Uramol type (approx 30% urea, salt, some molasses, some P) designed for dry season supplementation.

(b) Wet season P blocks. These contain up to 8% P and are lower in P than many dry lick mixtures containing a high proportion of DCP or kynophos. They usually also contain some N.

(c) Production blocks for promoting higher productivity and containing more molasses, and protein meals or lupins.

Recipes for making on property blocks containing molasses, and the composition of common commercial blocks are given by McCosker and Winks (1994) (p30). Recipes are also described by John Boorman and Rob Webber (Northern Muster No. 30, March 1991). Also the following block mix without molasses has been used by Lux Lethbridge: 25 kg salt + 15 kg kynophos + 10 kg Granam (sulphate of ammonia) + approx. 2.5 kg cement first mixed dry and then water added.

5.6.2 Advantages.

(a) Well established technology.
(b) Variety of commercial blocks available.
(c) Convenience.
(d) Low labour for feeding out.
(e) Wet season feeding. Avoid the need for shelters and little loss by rain spoilage.

5.6.3 Disadvantages.

(a) Cost per unit of nutrient.
(b) Little opportunity to change mix to control intake.
(c) Limited ability to purchase blocks optimal for specific areas and situations.
(d) High variability of intake in the mob and at times a high proportion of non-eaters within the mob. Also in some circumstances mobs of cattle will not eat blocks at all.

5.6.4 Means of controlling intake.

(a) Training, experience and habituation.
(b) Distance from water. Some managers state that variation in siting of blocks from water (eg. 50 m to 1 km) gives good control of intake. It is also claimed that siting blocks up to 5 km from water results in better use of pasture distant from water.
(c) Hardness of blocks.

(d) The ratio of blocks to cattle appears important to obtain intakes by all animals. A ratio of 1 block to 10 animal appears desirable, and 1 block to 5 animals may further improve block intake. These ratios will seldom be used in practice.

5.6.5 Intake distribution in mobs.

Of all the supplementation systems most information is available on variation within mobs of intake of blocks.

The most extensive information is that from Mt. Bundy (Eggington et al 1990). Distribution of intake in this experiment is shown in Fig 5.6.5. Between 20% (lactating cows) and 40% (dry cows and heifers) of the mob did not consume any of the block supplement. The coefficient of variation of supplement intake within classes of animals usually ranged from 80-115%. Similar measurements in N. Qld with cattle by Gallagher et al (1977) and Murray et al (1988), and in Victoria by Lobato and Pearce (1980 a) with sheep have also found a high variability of block intake (CoV 70-85%).

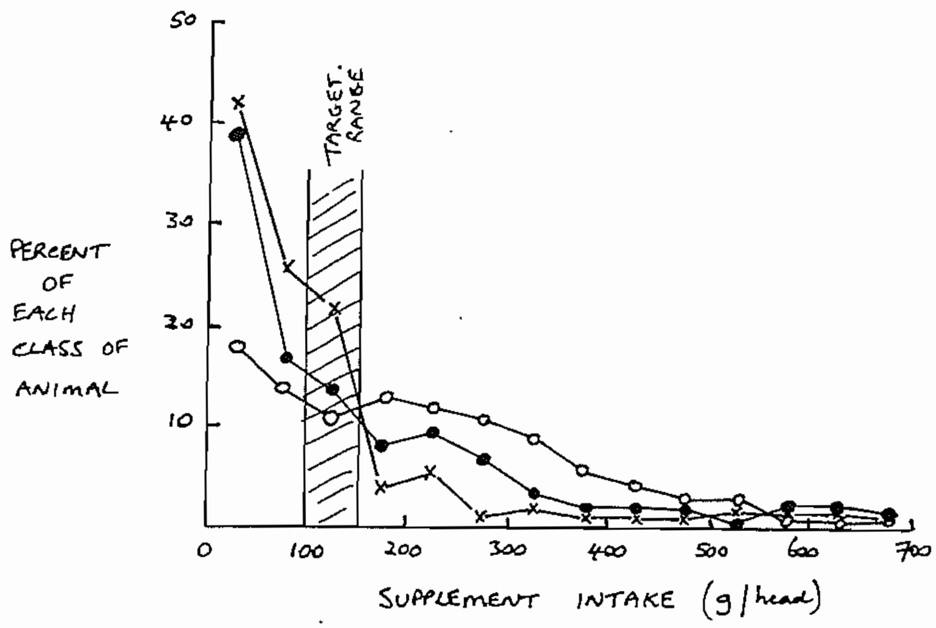


Figure 5.6.5. Distribution of block supplement intake by individual animals at Mt Bundy. Lactating cows (o), dry cows (●) and lactating first-calf cows (x) (Eggington et al 1990).

The proportion of animals in the mob classed as non-eaters of supplement may tend to be over-estimated by the marker methodology used in the above experiments. This is because the 'non-eaters' animals tend to be episodic in their 'non-eating' behaviour. For example there is some evidence in experiments of Lobato that although only approximately 65% of the flock consumed block on any one day, about 95% of sheep in the flock consumed block occasionally.

Observations that steers grazing high quality pasture can be trained to consume substantial amounts of anti-bloat blocks demonstrates that satisfactory block intakes are possible even with high quality pasture. In two experiments only one out of 11 and one out of 19 respectively, of cows, were non-eaters of block (Graham 1977).

5.7 Specific supplementation systems. Molasses-based supplements.

5.7.1 General.

The technology of using molasses is well established in the North Queensland cattle industry. There are two principal methods of feeding molasses diets:

(a) Fed in open troughs as various ratios of molasses and urea (eg. M3U, M8U), sometimes with addition of protein meal (for higher intake and productivity) or rumensin (for feed efficiency and/or/ intake control). These are usually used as crisis supplements or for high-level production feeding. Intake is limited mainly by the palatability of the mix.

(b) Molasses/urea roller drums, where the target is to provide only a minimal amount of molasses (eg. 200-300 g/d) as a carrier for urea. This technology was very successful but seems to largely have gone out of use in the industry due to:
- difficulty in controlling intake,
- high capital and maintenance of machinery,
- high labour,
- practical problems of storing, mixing and delivering large volumes of the mix on extensive properties,
- development of M8U technology for crisis feeding.

In theory intake is controlled by tongue-fatigue of the animal, and some control is obtained by changing the molasses/water and urea/molasses ratios of the mixture.

5.7.2 Cost.

Cost of bulk molasses at the sugar mill ranges from $45-$70 per tonne, but freight usually limits extensive use to the coastal areas close to sugar mills.

Thus the feed cost of an M8U mixture is typically 10-14 cents per kg, and ad lib intake will typically be 1.0 - 2.5 kg/day for crisis feeding in the late dry season.

Molasses/urea/protein mixtures are relatively expensive eg. 14-20 cents per kg, and if fed ad lib intakes will be up to perhaps 8 kg/d. Hence this is prohibitively expensive except for short critical periods to meet a specific need or for production feeding to meet specific markets.

Molasses/urea fed through roller-drum systems is much lower in feed cost at approximately $0.05 per head per day.

5.7.3 Advantages.

(a) Simple and robust technology that works well;
(b) Few problems of acceptance of the supplement;
(c) Appears to be fairly good supplement distribution;
(d) No need for adaption/build-up when starting supplement program;
(e) Low risks of urea toxicity problems providing mixing is adequate (eg. with mechanical mixers).

5.7.4 Disadvantages.

(a) Capital cost of machinery to store, mix, feed out;
(b) High labour cost;
(c) Costs increase rapidly with distance from sugar-producing areas.
(d) Logistics required to store, transport and mix the volume of supplement required.

It is difficult to get satisfactory suspensions of DCP or kynophos in molasses mixtures, and therefore the system is less suitable for wet season P feeding. Phosphoric acid was used at one stage but discontinued because of cadmium present in the commercial sources of black phosphoric acid then available. White phosphoric acid free of contaminants is available but the cost per unit of P is about 1.5 times that for DCP.

5.7.5 Means of controlling intake.

(a) Intermittent feeding. Not recommended by QDPI Extension Officers for M8U mixes because of risk of over-consumption and urea-toxicity when new feed is given. Used by some producers.
(b) Increasing urea concentration. Mixtures of up to M12U used, but not popular because of high cost of urea.
(c) Including rumensin (monensin) at high concentration (Gulbransen et al 1990). The increase in efficiency of feed conversion is sufficient to cover most of the cost of the rumensin. Limitation that reduction in intake is transient.
(d) Including meatmeal. Expensive, and effect is transient. Anecdotal evidence that a group of non-eaters may develop in the mob.
(e) Grids and screens floating on molasses mixture to reduce access sometimes works.
(f) In roller-drum systems changing molasses/urea ratio in the mix. Effective but tends to be transitory.

5.7.6 Intake distribution in mobs.

(a) There are no measures with north Qld cattle systems using marker technology to measure intakes of supplement by individual animals. However the observation that we do not usually see a "tail" of poor doers in commercial systems suggests a very low proportion of non-eaters and fairly good distribution of supplement.
(b) Measurements by Nolan et al (1974) with Hereford cattle in New England supplemented with roller-drums suggested a substanted proportion (8/48 or 17%) of non-eaters in the mob, and wide distribution among individuals in the mob comparable with that observed with dry licks and blocks (above). However the cattle were exposed to the supplement for only 3-4 weeks before measurements were made, and presumably the cattle used had no previous experience with molasses supplements. Appreciable variation (CoV 40%) in intake of molasses-urea fed through roller drums was also observed by Langlands and Bowles (1976) with cattle grazing temperate pastures . However these situations may not be typical of the north Qld cattle industry.
(c) Observational work at Swan's Lagoon in the early 1970's suggested that there very few non-eaters of molasses/urea supplements fed through roller-drums (Ernst 1973; McLennan 1973/74).

5.7.7 Opportunity for further developments.

The following areas seem to be where the technology could be improved:

(a) Improved control of intake, particularly for late dry season conditions when actual intakes are often considerably greater than target intakes of M8U needed for survival.

(b) Although the 8-12% urea provides sufficient bitter taste to restrict intake of the mixture, intake of urea will often be higher than is needed for the nutrition of the animal. Lower cost means to reduce the palatability of molasses-urea mixtures would be useful.

(c) We know very little about the efficiency of M8U supplement systems on pasture intake and provision of useful energy and protein to the animal. Understanding of these efficiencies is essential to improve recommendations for optimal mixtures, amounts and timing of supplementation.

(d) No open-trough simple system has been developed to provide, as does the molasses/urea roller-drums technology, a supplement consisting essentially of NPN and sulphur.

Early work in the 1950's (Beams 1960) showed that at least under small-paddock conditions molasses mixtures containing up to 50% urea could be fed successfully. Intake of these high-urea mixtures decreased progressively as urea concentration was increased, such that intake of urea tended to remain constant. There may be a role for molasses-based supplements containing perhaps 15-40% urea and other additives to control intake. Obvious advantages would be in cost of supplement, better use of capital invested in molasses and molasses handling equipment, and the potential to make a transition from long-term low level supplement to crisis supplementation with a series of modifications to molasses-based supplement.

5.8 Specific supplementation system. Water medication.

5.8.1 General.

Water medication by adding soluble supplements into the water supply has been attempted for several decades, but despite the many theoretical advantages has found little adoption in the industry.

There are two common options for medicating water supplements.

(a) Automatic dispenser machines which add supplements to the water supply line to troughs.

A number of versions of dispenser machines were developed and marketed 10-20 years ago, and a appreciable number purchased by producers. However few if any of these machines are still in use due to mechanical problems of getting them to work reliably.

Two machines the "Dositron" and the "Norprim", seem to be reliable enough to be useful in the industry. The Norprim may not be suitable for some climates due to detrimental effects of high humidity on the electronic control system. Also the Dositron machine requires a specific range of water pressure to work satisfactorly.

An important issue is that both of these systems dispense concentrated solutions (rather than solid supplement) of supplement into the water supply.

(b) "Bombing" of supply tanks and turkey nests by mechanically mixing supplements into the water on a periodic basis.

5.8.2 Cost.

Cost of providing urea or S (as ammonium sulphate) by this method is very attractive since no additional cost of carriers (salt, molasses etc) is needed. Cost of soluble P supplements such as sodium monophosphate is, per kg P, higher than for calcium phosphates. The higher cost per kg P must be balanced by other advantages for P supplementation by water medication to be more cost-effective than by dry licks. Phosphoric acid is not suitable because water intake may be reduced. Reduced water intake will reduce pasture intake and therefore productivity of the animal.

5.8.3 Advantages.

(a) In some situations, cost.

(b) Certainty that if the only water supply is medicated all animals must consume supplement.

(c) Some commercial companies (eg. Growforce) market pre-mixed soluble supplements suitable for use in water medication dispensers.

5.8.4 Disadvantages.

(a) Applicable only when stock water is from controlled points serviced by troughs. Hence not usually useful for wet season supplementation.

(b) Capital cost. If a large number of paddocks and troughs are watered from a single supply this will be low. However the capital cost (per head) of a dispenser unit for one trough is very high.

(c) Risk of urea toxicity associated with malfunction of dispensers, inadequate mixing, and concentration of urea in a trough by evaporation of water but not urea. This can also occur when tanks are "bombed" by settling out into the bottom of the tank a cold, high density layer of water containing a high concentration of urea. The outlet pipe from the tank will usually be within this bottom layer. This problem can occur even when considerable efforts (eg. with an outboard motor) are made to mix the urea with the water in the supply tank. Addition of solid urea rather than solutions of urea to the supply tank will exacabate this problem.

(d) Algael growth may occur in the supply tank when both urea and soluble P supplements are added. The algae tends to block water lines and trough float valves, and toxic blue-green algae can develop. The problem can be avoided by using covered supply tanks since the algael growth requires sunlight.

(e) Water supply containing high levels of calcium or magnesium salts can cause precipitation of calcium or magnesium phosphates in the supply tank and/or the water supply line, effectively removing the P from the water and possibly blocking water supply lines.

(f) Where the water supply is alkaline, urea supplement can be hydrolised and the ammonia lost by volatilisation, effectively removing some or most of the N supplement from the water.

(g) Skilled labour may be needed for maintenance of water medication systems.

5.8.5 Measurement of intake distribution in the mob.

(a) There do not appear to be any measurements of variation among animals in water intake of cattle grazing under extensive conditions.

(b) Generally water intake increases with dry matter intake. This is of advantage for water medication since the animal eating more pasture will require more supplement N and/or P.

(c) Estimates from animals in small paddocks indicates that water intake will be about 10% of LW per day, and has a CoV of approximately 10%.

5.8.6 Need for further development.

(a) For situations with controlled water supply and suitable water quality, water medication has advantages which suggest that it has wide application in the industry.

(b) Information is needed on water intakes, and variability of intakes, for cattle under extensive grazing conditions in the tropics.

(c) Easy diagnostic tests to check concentration of urea and P in the water at the point of delivery (ie. the trough) would be very useful for managers to monitor and adjust the system. Urea test strips sold for medical purposes may provide a partial answer.

(d) Improved dispensers. All presently available machines have some problems.

5.9 Specific supplementation systems. Protein meals, grains, concentrates.

Generally these are too expensive to use as supplements for breeders, but have a role for (a) feeding weaner calves, and (b) for production feeding systems targeting specific markets, and (c) "Spike-feeding" in late pregnancy.

There seem to be at least three areas requiring further R, D & E.

(a) The principal protein meal available for the northern industry is cottonseed meal (CSM). Changes in processing methods mean that modern CSM contains a much lower proportion of bypass protein (ie insoluble, escape or rumen undergradable protein) and fat than the CSM used in previous decades when much of this technology was developed. Information is needed on the importance of such changes in the nutritional characteristics of CSM and the consequences of replacing CSM with other protein feedstuffs or with specialty protein feedstuffs modified to contain high proportions of bypass protein. Also information on dose response of various types of animals to protein meal, variability of intake, etc is limited.

(b) CSM is often in short supply, but little information is available on the nutritive value, for northern industry circumstances, of alternatives such as lupins, whole cottonseed, copra meal and palm kernel meal.

(c) In areas away from the coast sorghum grain and whole white cottonseed from the Central Highlands are likely to be attractive alternatives to molasses as an energy feed. Fortification of barley grain with virginiamycin and/or urea and ammonium sulphate to avoid acidosis and control intake when grain supplements are fed ad libitium has been successful in Southern Australia. Similar benefits may be obtained by fortification of sorghum grain, but more information is needed.

6. Reviews and documents used to prepare this report.

(In addition to those listed in Section 1.1).

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