Field and modelling studies of the effects of herbage allowance and maize grain feeding on animal performance in beef cattle finishing systems

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ABSTRACT

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The objetive of the work described in this thesis was to develop a mathematical model designed as a tool for research intended to improve the efficiency of finishing systems for 1-2 year old beef cattle under intensive grazing mangement on sown pastures in Argentina. The work involved a) three experiments in Argentina carried out to define the effects of herbage allowance and maize grain supplementation on herbage intake and animal performance, b) one experiment in Argentina following a preliminary study in New Zealand of seasonal variation in the composition and nutritive value of intensively managed beef pastures, and c) an exercise to develop a model of beef cattle production incorporating modules dealing with aspects of pasture production and utiisation, herbage intake and animal performance. The results from the series of short-term grazing studies showed consistency in the comparison of the effects of increasing herbage allowance and supplementation on herbage intake and animal LWG (Chapter 4). A method combining the use of n-alkane and 13C method proved to be accurate for quantitative estimates of herbage and maize grain intake, and allowed estimates of a substantial variation in individual maize grain intake (between 31 to 41 % CV) when animals are supplemented in groups. The substitution rate (SR) measured in these studies varied little across experiments or level of grain at a herbage DM allowance of 2.5 % LW d^{-1} (0.36 and 0.38 kg herbage DM per kg grain DM for Chapters 3 and 4 respectively). Increasing level of herbage DM allowance increased quadratically the SR from 0.38 to 0.83 and 0.87 kg herbage DM per kg grain DM. The n-alkane method was effective in providing estimates of diet digestibility. Different methods for estimating diet composition, such as micro-histological evaluation of faeces, differences in nutrient and component selection indexes and n-alkanes were used in the initial grazing trial (Chapter 2) but they were not considered to be reliable and they were too laborious for continued use under field conditions.

The outcome of the studies on seasonal variation in herbage quality initially was useful in establishing a database of the range of values observed, and in demonstrating their relative robustness, at least under conditions of good pasture management. In these studies, herbage nutritive value did not seem to be a limiting factor for growing beef cattle, at least in terms of the minimum observed content of metabolisable energy (10.8 MJ ME kg DM) or crude protein (17.3 % DM). Additionally, significant relationships were established between morphological and maturity estimates and herbage nutritional variables in a pasture under grazing conditions. These relationships showed promise for future use in the prediction of herbage nutritive value, but require further work.

The model developed ("BeefSim"), represents the main biological dynamic processes of the target system of this thesis, together with additional management decision and financial estimates. It was shown that the model presents adequate flexibility and can be interrogated in terms of its response to different management conditions, scenarios and timeframes. Pasture management and grain feeding were controlled in an interactive management module responding to deviations in pasture conditions and animal liveweight from pre-determined targets. Two key outcomes of the model, liveweight gain and herbage intake were accurately predicted when compared against experimental information under different levels of herbage allowance and maize feeding. System comparisons developed with the model showed agreement with the literature, and maize grain feeding associated with the monitoring procedure demonstrated an effective use of grain in the system. The model provides a good biological basis for a holistic appraisal of the effects of "process technologies" such as grain feeding in beef cattle finishing systems, and will be developed further.

Key-words: herbage allowance; maize grain feeding; beef cattle; rotational grazing; herbage quality; modelling

Dedicated to Maria (my wife), Jova and Manuel (my parents)

PREFACE

This thesis was developed as part of the research activities of the author at the Facultad de Ciencias Veterinarias, Universidad Nacional del Centro de la Provincia de Buenos Aires, FCV-UNCPBA-Argentina. The thesis was developed under a "sandwich system", where research preparation and the final reporting, i.e. the first and the last part of the PhD activities, was developed at Massey University, and most of research was carried out in the candidate's home country (Argentina). Extra arrangements such as funding assistantship, organization of family issues and maintainance of other work responsibilities, were overcome and the way that the research was structured made it possible to focus in an Argentinean pastoral research problem, with the formal supervision from New Zealand expertise in the area.

The topic was identified from author's interaction with a group of beef cattle farmers and agricultural consultants. An early prior study was developed on a commercial farm to investigate tactical alternatives of maize grain supplementation in beef cattle finishing systems during summer[1]. Beyond its stimulating results and cooperative experience, the most challenging and frustrating thing was the limitations for extending the results in terms of the whole system perspective. What would happen if supplements were used earlier in the production cycle, or in different summer conditions, with different stocking rates, or combining different animal types....? With some of these "what-if" questions in mind and with the support of New Zealand expertise, this thesis was planned to address to a limited extent of these identified issues. An understanding of changes in herbage intake and animal performance when maize grain was fed and herbage quality were identified early in the programme and incorporated into modelling as tool for information synthesis and additional insights.

The experimental part of this thesis was mostly developed on farms, and that shaped the selection of research techniques applied to the plant/animal interface. The author started as a novice in modelling, and further motivation for modelling training came from his teaching experience. The author firmly believes that the

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[1] Machado et al. (2001), translated and presented in Annex A for explanation, but not as a part of the thesis.

efforts in the simulator development such as presented in this thesis, with adequate adaptation and improvement, should contribute to "experiential learning" and "systems thinking" development for agricultural students and professionals.

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