Milk production and nitrogen partitioning in dairy cows grazing standard and high sugar perennial ryegrass with and without white clover, during spring and autumn

A thesis presented in partial fulfilment of requirements for the degree of

Master of Applied Science in Animal Production

At Massey University, Palmerston North
New Zealand

Maria Belen Lazzarini
2010

ABSTRACT

Two field grazing experiments were conducted in New Zealand (NZ) in spring (Experiment 1; November 2008) and autumn (Experiment 2; April 2009) to evaluate the effects of feeding a high sugar perennial ryegrass (HSG; cv. AberDart; derived in the United Kingdom; UK) versus a NZ- derived control grass (cv. Impact) on milk production and estimated nitrogen (N) partitioning within the cow. Areas of both ryegrasses were replicated and sown with or without white clover (cl) (HSG+cl, control+cl, HSG and control). A cross-over design with four 10-day periods was used in each experiment, using 15 Friesian cows per treatment per period in Experiment 1 and 5 cows per treatment per period in Experiment 2. Treatment effects upon pasture botanical and chemical composition, cows' milk yield and composition, and estimated N partitioning were studied. Nitrogen partitioning was calculated using indirect methods.

Herbage concentrations of water soluble carbohydrates (WSC) were lower in autumn than in spring whilst crude protein (CP) concentrations were higher in autumn. Organic matter digestibility (OMD) and metabolisable energy (ME) concentration was similar in both seasons. There were no differences in the concentration of CP, WSC and dry matter (DM) among treatments in Experiment 1. The HSG+cl treatment had the lowest concentrations of neutral detergent fibre (NDF, 417 g/kg DM) and the highest content of ME (12.6 MJ/kg DM) and tended to have the lowest sward dead matter content compared with the other three treatments. In Experiment 2 both HSG treatments showed higher concentrations of WSC (15 g/kg DM) compared with the control, both with and without clover; the concentrations of NDF and acid detergent fibre (ADF) were the lowest for both HSG treatments.

In Experiment 1, cows grazing treatments with white clover produced more milk (1.6 kg/day) and more milk solids (MS; 0.16 kg/day) than cows grazing pure ryegrass swards ($P< 0.01$), with highest milk yields being from cows grazing the HSG+cl treatment (ryegrass cultivar x white clover interaction $P<0.05$). No differences in milk production were found in Experiment 2. Estimated urinary N excretion (g/day) was similar for all treatments in both seasons, although N intake differed among treatments. The proportion of N intake excreted in urine or secreted in milk was similar for all treatments in both experiments. Nitrogen output (g/day) in milk was the highest for the HSG+cl treatment in Experiment 1 but no differences were found in Experiment 2.

Data were combined from both experiments to study the effects of the herbage CP:WSC ratio upon estimated N partitioning between milk and urine. Mean ratios were 0.72 for spring herbage and 2.27 for autumn herbage. As the amount of WSC increased in the diet relative to

the amount of CP (thus a lower CP:WSC ratio) there was a significant increase in the amount of milk N secreted per unit of N intake in spring but not in autumn. The breakpoint in the relationship between the herbage CP:WSC ratio and the nitrogen utilisation efficiency for milk production (NUEm) was 1.32, and the NUEm for that breakpoint was 14 g milk N per 100 g N intake. Ratios below this point were associated with improved efficiency of converting pasture N to milk N; ratios above this point were not correlated with changes in N conversion efficiency.

It is concluded that the CP:WSC ratio in perennial ryegrass may be important in the partition of absorbed N into milk or urine. A NZ-selected HSG with a lower CP:WSC ratio is likely to have major benefits for pastoral farming in NZ. In order to be effective, a NZ-derived HSG should substantially increase WSC concentration in autumn pasture (from approximately 100 to 200 g/kg DM) whilst reducing CP content simultaneously (from 240 to 190 g/kg DM). The lower structural fibre and higher milk production for the HSG+cl treatment in both experiments suggest that under NZ conditions, best productive responses to HSG may be obtained in management systems that include white clover.

ACKNOWLEDGEMENTS

I am extremely grateful to the New Zealand Ministry of Foreign Affairs, NZAID agency, for the financial support which made possible the completion of this thesis.

I have no words to express my gratitude to my chief supervisor Prof. Tom Barry but I would like to try, anyway. Tom, thanks for your unconditional support and your wise orientation; thanks for helping me so much with the writing up of this thesis; thanks for reading all my drafts, and for guiding me at all times, even from your hospital bed. To have had a supervisor who always had an open door to discuss my progress and share ideas, not to mention handy with a red pen, is more than I could have hoped for. Tom, you are awesome!

Big thanks to Gerald Cosgrove for allowing me to participate in his project and for making me work so hard. Thanks to David Pacheco for his valuable help and comments. Thanks to Nicolas Lopez-Villalobos for his statistical advice. Thanks also to my co-supervisor Jennifer Burke for her comments. Many thanks are given to all the people who helped with the collection of my data: Kim Fraser, Geoff Purchas, Kate Lowe, Lex Foote, Ronaldo Vibart, Natalia Martin and all Massey dairy farm N°4 staff.

MUCHAS GRACIAS to my 'family' in New Zealand: Flia. Canterna, Flia. Baudracco, Flia. Vibart, Natalia and Grant. Thank you guys for your support, for all those bbqs together, for sharing your lives with me; thanks for making Palmy much more enjoyable!. Special thanks go to Javier Baudracco for helping me so much in my early academic career. I also wish to thank my family and friends back home in Argentina, for their love and support. A todos…gracias totales!

Many thanks to the authorities of Facultad de Ciencias Agrarias from Esperanza, Santa Fe, Argentina, for supporting me all these years. Thanks to all IVABS staff for their help and thanks also to the International Student Support Office, especially to Olive Pimentel, Silvia Hooker and

Sue Flynn. Thanks to all my friends in IVABS and especially to my Zambian friend Bornwell Mupeyo.

Finally, a big thanks and lots of love go to my partner, Javier, for all his love, for supporting me so much, for working so hard and for making my life so wonderful. Te amo!

Thank God for these two amazing years. We are finally going home…

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

AA	Amino acid(s)
ADF	Acid detergent fibre
ATP	Adenosine triphosphate
BCS	Body condition score
CHO	carbohydrate(s)
CP	Crude protein
DM	Dry matter
DMD	Dry matter digestibility
DMI	Dry matter intake
FV	Feeding value
HSG	High sugar grass(es)
IBERS	Institute of Biological, Environmental and Rural Sciences
IGER	Institute of Grassland and Environmental Research
IRG	Italian ryegrass
LW	Liveweight
ME	Metabolisable energy
MJ	Mega joules
MP	Metabolisable protein
MPS	Microbial protein synthesis
MS	Milk solid(s)
MUN	Milk urea nitrogen
N	Nitrogen
NAN	Non- ammonia nitrogen
NDF	Neutral detergent fibre
NPN	Non protein nitrogen
NUEm	Nitrogen utilisation efficiency for milk production
NUEu	Nitrogen utilisation efficiency for urine excretion
NV	Nutritive value
NZ	New Zealand
OM	Organic matter
OMD	Organic matter digestibility
PKE	Palm kernel extract
RDP	Rumen degradable protein

TAA	Total amino acids
TMR	Total mixed ration
UDP	Undegradable protein
UK	United Kingdom
UN	Urinary nitrogen
VFA	Volatile fatty acid(s)
VFI	Voluntary feed intake
WSC	Water soluble carbohydrate(s)