Dairy wintering systems in Southern New Zealand

Quantification and modelling of nutrient transfers and losses from contrasting wintering systems

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A thesis

submitted in partial fulfilment

of the requirements for the degree of

Doctor of Philosophy

in

Soil Science

at Massey University, Palmerston North, New Zealand

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2017

Abstract

Traditional dairy wintering practice in the lower South Island of New Zealand has been to graze brassica crops *in situ*. This practice has been under increasing scrutiny from local Regional Councils due to the relatively high nitrogen (N) leaching losses from this component of the whole farm system. Alternative wintering options to reduce N leaching losses that are currently available to farmers (such as barns and permanent wintering pads) are high cost and involve a large capital investment. In this work a new wintering system (termed a 'portable pad') was developed for use on support blocks (which can be located many kilometres from the milking platform) as an interim measure for reducing N leaching losses that is low cost and low input. This system is designed as a mitigation strategy that is available for use immediately while research investigates more permanent solutions. This system is a hybrid of the traditional crop grazing system and an off-paddock system, where effluent is captured. It makes use of the advantages of each of the original systems utilising the low cost feed source of the brassica crops, grazed *in situ*, while also utilising the benefits of duration controlled grazing with its associated effluent capture and irrigation at low rates.

The aim of the research was to generate whole system N leaching loss values for each of the three farm systems investigated (crop wintering, deep-litter wintering barn, and portable pad). Field and laboratory research was conducted to fill identified knowledge gaps such that system N loss values could be estimated. *OVERSEER* Nutrient Budget software tool was used in conjunction with measured and modelled (APSIM) data to simulate whole farm N leaching loss values for the three farm systems investigated. Nitrogen leaching losses from the portable pad and barn systems were between 5 and 26 % and between 13 and 26 % lower, respectively, than the crop wintering system.

Dedication

For Gorg

08.06.1920 – 26.02.2016

Acknowledgements

This thesis represents the end of one journey and the beginning of another. If there is one thing that I have learnt it's that no matter how well you plan and prepare for a journey there are unexpected twists and turns that are thrown at you along the way. How you learn from, and deal with, these challenges is as much of a learning experience as the thesis topic itself. Robert Service says it perfectly in his poem "The Quitter" which has been on the wall above my computer for the duration of my PhD.

The Quitter

When you're lost in the Wild, and you're scared as a child,
And Death looks you bang in the eye,
And you're sore as a boil, it's according to Hoyle
To cock your revolver and . . . die.
But the Code of a Man says: "Fight all you can,"
And self-dissolution is barred.
In hunger and woe, oh, it's easy to blow . . .
It's the hell-served-for-breakfast that's hard.

"You're sick of the game!" Well, now, that's a shame.
You're young and you're brave and you're bright.
"You've had a raw deal!" I know -- but don't squeal,
Buck up, do your damnedest, and fight.
It's the plugging away that will win you the day,
So don't be a piker, old pard!
Just draw on your grit; it's so easy to quit: It's the keeping-your-chin-up that's hard.

It's easy to cry that you're beaten -- and die;
It's easy to crawfish and crawl;
But to fight and to fight when hope's out of sight --
Why, that's the best game of them all!
And though you come out of each gruelling bout,
All broken and beaten and scarred,
Just have one more try -- it's dead easy to die,
It's the keeping-on-living that's hard.

Firstly, I would like to acknowledge AgResearch for funding my PhD, and express my gratitude to my managers, Drs Richard Muirhead and Bram de Vos, who saw the value in supporting me and convincing the 'powers-that-be' that I was worth supporting both financially and professionally. Without this backing I wouldn't have been able to do this project.

Secondly, to my supervisors who have motivated, encouraged, inspired, and at times dragged and pushed me along on this journey. It has been an honour to work with such passionate, professional scientists.

Professor Mike Hedley, my chief supervisor, thank you so much for your support, guidance and enthusiasm. I always came away from our meetings not only inspired, enthused and aware of just how much I had to learn; but also of how much I had learnt already.

Associate Professor Dave Horne, for your reassurance on my ability to make it to the end of this journey, and indeed the next leg of the journey, whenever I rang you during an “I’ll never get there” moment. Thank you.

Dr Ross Monaghan (whose office was located next to mine for the duration of my PhD), I thank you for suffering the constant and daily questions, queries, and requests for confirmation that I was on the right track. Thank you for guiding me along on this journey with humour, encouragement, a good dose of “keeping-it-real”, and a lot of red pen. I may, just may, have figured out the correct use of the colon and semi-colon by the end of this; here’s hoping.

Thank you to my colleagues at Invermay, especially the Nutrient Losses to Water and Atmosphere group. Your enthusiasm for your research is infectious, and the camaraderie in our team is unique and something to be valued.

To the Technical Team: Stuart Lindsay, Tom Orchiston, Alison Rutherford, Chris Smith, Tash Styles, Sonya Walker and Wayne Worth. Thank you all for your assistance with field work, sample collection and sample analyses. Without your assistance this project would not have been possible.

To Mum and Dad, thank you for teaching me the importance and value of education and continuing that education throughout life. To Mum, Dad, Matt, Sarah, Gorg, Kate, Alasdair and the extended family, thank you for your support and encouragement even if you’re still unsure exactly what my PhD topic is!

Finally I’d like to thank my husband Gregor and our wee family, Louisa, Elise and Mackenzie. I couldn’t have done this without you. You’ve been there supporting and encouraging me the whole way. It hasn’t been easy with a young family (which is now one member bigger than when I set out, welcome Mackenzie!) but because of your support I made it to the end, we made it to the end. They say it takes a community to raise a child, the same can be said about completing a PhD.

I am excited to begin the next journey and to continue my work in agricultural research. I hope that for many years to come my children can continue to tell their teachers and friends that their Mum’s job is (in the words of my 9-year-old daughter), “doing something with cow poo”.

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ACTH	Adrenocorticotrophic hormone
Ad lib	Ad libitum
APSIM	Agricultural Production System SIMulator
AWHC	Available water holding capacity
BCS	Body condition score
BMP	Best management practice
C	Carbon
C:N	Carbon:Nitrogen ratio
Ca	Calcium
CEC	Cation exchange capacity
CON	Control herd
CRH	Corticotrophin releasing hormone
DCD	Dicyandiamide
DIP	Dissolved inorganic phosphorus
DM	Dry matter
DON	Dissolved organic nitrogen
DRP	Dissolved reactive phosphorus
E.coli	*Escherichia coli*
EB	Exchangeable bases
ET	Evapotranspiration
ES	Environment Southland
FDE	Farm dairy effluent
FMO	Faecal micro organism
HPA	Hypothalamic-pituitary-adrenal axis
in situ	In the original place
K	Potassium
KCl	Sodium chloride
K-line	™ a flexible hose line and sprinkler pod irrigation system
LRLD	Low rate, low death
LW	Liveweight
Mg	Magnesium
Mineral N	Ammonium-N + nitrate-N
MJME	Metabolisable energy
MPN	Most probable number
MS	Milksolids
N	Nitrogen
N_2O	Nitrous oxide
NH_4^+	Ammonium
NO_3^-	Nitrate
OM	Organic matter
OPT	Optimal herd
ORC	Otago Regional Council
P	Phosphorus

P21	Pastoral 21 research programme
PAW	Plant available water
QT	Quick test
RES	Restricted herd
RI	Refractive index
S	Sulphur
SR	Stocking rate
SS	Suspended sediments
SU	Stock unit
SWB	Soil water balance
TBS	Total base saturation
TKN	Total kjeldahl nitrogen
TSE	Total solids