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**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  
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## 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 damndest, 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.

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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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## List of abbreviations

|                              |  |
|------------------------------|--|
| ACTH                         | Adrenocorticotrophic hormone   |
| <i>Ad lib</i>                | Ad libitum   |
| APSIM                        | <u>A</u> gricultural <u>P</u> roduction <u>S</u> ystem <u>S</u> IMulator |
| 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  |
| <i>E.coli</i>                | <i>Escherichia coli</i>  |
| EB                           | Exchangeable bases   |
| ET                           | Evapotranspiration   |
| ES                           | Environment Southland  |
| FDE                          | Farm dairy effluent  |
| FMO                          | Faecal micro organism  |
| HPA                          | Hypothalamic-pituitary-adrenal axis                                      |
| <i>in situ</i>               | 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 <sub>2</sub> O             | Nitrous oxide  |
| NH <sub>4</sub> <sup>+</sup> | Ammonium   |
| NO <sub>3</sub> <sup>-</sup> | 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                   |