

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

**A STUDY OF PATCHINESS IN MID-SEASON DAIRY PASTURES:  
CONSEQUENCES AND CONTROL**

**A Thesis Presented in Partial Fulfilment of the Requirements  
for the Degree of Masterate in Applied Science at Massey  
University**

**Mauricio Javier Padilla Pérez Peña**

**1997**

## ABSTRACT

There is interest among some dairy farmers in increasing herbage intake of cows during spring by increasing pasture cover but without compromising pasture quality into the summer. "Late control" is a grazing management strategy developed in Massey University that meets those requirements (Matthews et al., 1996). In addition, it has been demonstrated in previous trials that Late control increases pasture production in the summer-autumn period by increasing ryegrass tillering vigour. Late control requires a period of lax grazing during spring to allow some reproductive growth development on ryegrass pastures, which is then controlled by hard grazing in late spring before anthesis. However, patchiness may develop in Late control during the lax grazing period when the herbage allowance is high.

The objectives for the present experiment were to compare the pasture characteristics under Late control and conventional "Early control" spring management strategies in December-January, with particular reference to the consequences of vegetation heterogeneity to pasture production and utilisation over this period, and to discuss the implications to spring grazing management. The experiment involved detailed studies on three paddocks chosen from each of two farmlets of 22 paddocks used for a system trial comparing Early and Late control spring management on herds of 120 cows. Herbage mass distributions were estimated by taking 200 capacitance meter readings at random on each paddock. Relationships between herbage mass and utilisation and accumulation were estimated by using two 30 m permanent transects in each paddock. To determine botanical composition and tiller population variability within a sward, five tall patches and five short patches were sampled in each paddock.

Paddocks in Late control before the control phase in December had more herbage mass than paddocks in Early control (3600 vs. 5000 kg DM/ha), but the variability of herbage mass was similar (1000 vs. 1000, standard deviation in kg DM/ha). The skewness of the herbage mass distribution was positive but greater in Early control than in Late control (0.57 vs. 0.32). Botanical composition was similar between treatments and within paddocks. Pasture morphology showed tiller size-density compensation in both treatments. Pasture characteristics in late control were not an impediment for efficient pasture removal in late control and more herbage was harvested than in Early control (1900 vs. 1000 kg DM/ha), although herbage allowance was greater in Early control. Short patches in both treatments were defoliated in less proportion than tall patches, but in Late control the proportion of short patches was less than in Early control. Therefore, low herbage mass and greater proportion of short patches in Early control had a negative effect on total herbage utilisation.

Harvesting efficiency was controlled on Late control paddocks to avoid limitations to herbage intake, and the skewness of the distribution of herbage mass after grazing increased compared to Early control, as well as the proportion of tall poorly utilised patches. Topping of pastures after grazing was effective in removing poorly utilised material and in decreasing patchiness in January. In January, Late control paddocks had more herbage mass, but less patchiness than Early control paddocks (6300 vs. 4700 kg DM/ha). Sward characteristics were affected by treatment, and in general Late control increased ryegrass content and its leafiness during January

compared to Early control. In January, herbage utilisation was greater in Late control than in Early control (3000 vs. 1700 kg DM/ha).

It was concluded that because Late control had greater responses in tall patches, the objective should be to modify management to a longer rotation length before controlling reproductive growth in late spring, to allow a greater proportion of the sward to achieve high herbage mass. The combination of grazing and topping of pastures gave high herbage intakes and effective pasture control. More pasture was produced in Late control than in Early control and the rotation length can also be increased during the summer in Late control, which may benefit further ryegrass tillering.

## ACKNOWLEDGEMENTS

I would like to thank my supervisors Professor John Hodgson and Mr. Parry Matthews for their guidance. I also thank Dr. Cory Matthew, Dr. Ian Valentine and Mr. Greg Bishop-Hurley for the advice given during the experimental period.

I thank the help from the field and laboratory technicians, Mr. Terry Lynch and Mr. Mark Osborne, Drew, Carl, Roger and Shaun. I thank the No. 4 Dairy staff, Shaun Wilson, Bernard, Mike and Alex.

Many fellow graduate students gave me comments and advice about this work. I thank Arturo Luque, Luis G. Barioni, Penny Back, Aurelio Guevara, Alberto Torres, José García-Muñiz, David Pacheco, Louise Gosling, Fabio Montossi, Cesar Poli, Dr. Alfonso Hernández-Garay, Mark Hyslop, Wendy Hollingsworth, Sylvia Weill, Meng Fu, Dr. Fuyuan Liu, and João M. Da Silva.

I thank the help in different ways of Associate Professor Colin Holmes, Mr Chris Daké, Dr. Peter Kemp, and Mrs. Kathy Hamilton, and Mr. Jorge Bermúdez in Mexico.

I thank the sponsorship of the Official Development Assistance programme, New Zealand Ministry of Trade and Foreign Affairs, and the Mexico Ministry of Foreign Affairs and the “Facultad de Estudios Superiores Cuautitlán, Universidad Nacional Autónoma de México” for nominating me for an scholarship.

I thank my parents for lots of support (who easily got rid of me once again).

## TABLE OF CONTENTS

<b>ABSTRACT.....</b>	<b>ii</b>
<b>ACKNOWLEDGEMENTS.....</b>	<b>iv</b>
<b>TABLE OF CONTENTS.....</b>	<b>v</b>
<b>LIST OF TABLES.....</b>	<b>vii</b>
<b>LIST OF FIGURES.....</b>	<b>ix</b>
<b>CHAPTER 1. GENERAL INTRODUCTION AND OBJECTIVES .....</b>	<b>1</b>
<b>CHAPTER 2. LITERATURE REVIEW.....</b>	<b>3</b>
<b>2.1.Grazing Management.....</b>	<b>3</b>
2.1.1.Late Control Spring Grazing Management .....	3
<b>2.2.Patchiness in Grazed Pastures. ....</b>	<b>4</b>
2.2.1.Definition of patch grazing. ....	4
2.2.2.Causes of Patchiness.....	5
2.2.3.Effects on Pasture Production and Utilisation.....	7
2.2.4.Effects on Pasture Composition .....	9
<b>2.3.Literature Review Conclusions .....</b>	<b>12</b>
<b>CHAPTER 3. METHODOLOGY .....</b>	<b>13</b>
<b>3.1.Site description .....</b>	<b>13</b>
<b>3.2.Experimental design .....</b>	<b>13</b>
<b>3.3.Sward Measurements .....</b>	<b>15</b>
3.3.1.Herbage Mass.....	15
3.3.2.Botanical Composition.....	17
3.3.3.Grass Tiller Population, Tiller Weight and White Clover Stolon Dry Weight.....	17
<b>3.4.Statistical Analysis.....</b>	<b>18</b>
<b>CHAPTER 4. RESULTS.....</b>	<b>19</b>
<b>4.1.Herbage mass predictive equations .....</b>	<b>19</b>
<b>4.2.Herbage Mass Distribution .....</b>	<b>19</b>
4.2.1.Mean Herbage Mass.....	19
4.2.2.Within Paddock Variation.....	20

<b>4.3. Tall and Short patches.....</b>	<b>28</b>
4.3.1. Herbage mass.....	28
4.3.2. Botanical composition .....	29
4.3.3. Tiller numbers .....	32
4.3.4. Tiller Dry Weight.....	35
<b>4.4. Herbage mass, Utilisation and Accumulation Variability within     paddocks. ....</b>	<b>36</b>
4.4.1. Spatial pattern of herbage mass.....	37
4.4.2. Relationships .....	37
4.4.3. Frequency analysis results.....	44
<b>CHAPTER 5. DISCUSSION .....</b>	<b>49</b>
<b>5.1. Experimental Techniques.....</b>	<b>49</b>
<b>5.2. Effectiveness of Management Strategies.....</b>	<b>50</b>
<b>5.3. Pasture Differences between Management Strategies.....</b>	<b>52</b>
5.3.1. Pasture Characteristics in December .....	52
5.3.2. Pasture Characteristics in January .....	56
<b>5.4. General Approach to Patchiness.....</b>	<b>59</b>
5.4.1. Management Implications.....	61
<b>CONCLUSION.....</b>	<b>64</b>
<b>BIBLIOGRAPHY.....</b>	<b>65</b>
<b>APPENDIX 1.....</b>	<b>73</b>

## LIST OF TABLES

Table 1. Sample paddocks and sampling dates under Early and Late control treatments, before and after grazing during December and January.....	14
Table 2. Herbage mass (Kg DM/ha) predictive equations used for the Pasture Probe capacitance metre readings (CMR).....	19
Table 3. Estimates of herbage mass (kg DM/ha) before and after grazing and amount removed during grazing, for early and late control treatments in December and January. Least square means ( $\pm$ SE).....	20
Table 4. Standard deviation of the estimated herbage mass distribution (kg DM/ha) before and after grazing, for early and late control treatments in December and January. Least square means ( $\pm$ SE).....	21
Table 5. Skewness of the estimated herbage mass distribution (kg DM/ha) before and after grazing, for early and late control treatments in December and January. Least square means ( $\pm$ SE).....	22
Table 6. Herbage mass before grazing (kg DM/ha) of sampled tall and short patches, for early and late control treatments in December and January.....	28
Table 7. Herbage mass after grazing (kg DM/ha) of sampled tall and short patches, for early and late control treatments in December and January.....	29
Table 8. Live proportion (%) on tall and short patches before grazing for early and late control treatments in December and January.....	30
Table 9. Legume proportion (% live fraction) on tall and short patches before grazing for early and late control treatments in December and January.....	30
Table 10. Ryegrass proportion of grasses (live fraction) on tall and short patches before grazing for early and late control treatments in December and January.....	31
Table 11. Ryegrass leaf proportion in the ryegrass component on tall and short patches before grazing for early and late control treatments in December and January.....	32
Table 12. Total tiller numbers ( $m^2$ ) on tall and short patches for early and late control treatments in December and January.....	32
Table 13. Ryegrass tiller numbers ( $m^2$ ) on tall and short patches for early and late control treatments in December and January.....	33
Table 14. Other grasses tiller numbers ( $m^2$ ) on tall and short patches for early and late control treatments in December and January.....	34



Table 15. Proportion of ryegrass tillers in the total grass tiller numbers (%) on tall and short patches for early and late control treatments in December and January. ....	34
Table 16. White clover stolon ( $\text{g}/\text{m}^2$ ) on tall and short patches for early and late control treatments in December and January. ....	35
Table 17. Ryegrass tiller dry weight (mg) on tall and short patches for early and late control treatments in December and January.....	36
Table 18. Other grasses tiller dry weight (mg) on tall and short patches for early and late control treatments in December and January.....	36
Table 19. Herbage mass before grazing quartile contribution to the total herbage mass on offer and its utilisation (kg DM/ha and percentage). ....	46

## LIST OF FIGURES

Figure 1. Herbage mass frequency and cumulative distribution in Early and Late control before grazing during December.....	23
Figure 2. Herbage mass frequency and cumulative distribution in Early and Late control after grazing during December.....	24
Figure 3. Herbage mass frequency and cumulative distribution in Late control after topping during December.....	25
Figure 4. Herbage mass frequency and cumulative distribution in Early and Late control before grazing during January.....	26
Figure 5. Herbage mass frequency and cumulative distribution in Early and Late control after grazing during January.....	27
Figure 6. Relationship between herbage mass before grazing (PREDM, kg DM/ha) and herbage mass utilisation (UTIL, kg DM/ha) for the combined data of all paddocks on both Early control and Late control, during December and January.....	38
Figure 7. Relationship between herbage mass before grazing (PREDM, kg DM/ha) and proportion of herbage mass utilised (PROPUTIL, %) for the combined data of all paddocks on both Early control and Late control, during December and January.....	38
Figure 8. Herbage utilisation in relation to the level of herbage mass in Early control and Late control paddocks during December.....	39
Figure 9. Herbage utilisation in relation to the level of herbage mass in Early control and Late control paddocks during January.....	40
Figure 10. Relationship between herbage mass after grazing (POSTDM, kg DM/ha) and total herbage mass accumulation between grazing periods (GROWTH, kg DM/ha) for the combined data of all paddocks on both Early control and Late control, from December to January.....	41
Figure 11. Relationship between the total herbage mass accumulation (GROWTH, kg DM/ha) in response to the proportion of herbage mass utilised (PROPUTIL, %) and for the combined data of all paddocks on both Early control and Late control, from December to January.....	42
Figure 12. Total herbage accumulation relation with residual herbage mass in Late and Early control from December to January.....	43
Figure 13. Probabilities of level of utilisation (kg DM/ha) in relation to herbage mass before grazing (kg DM/ha).....	44
Figure 14. Probabilities of the level of utilisation (proportion) in relation to herbage mass before grazing (kg DM/ha).....	45

Figure 15. Stability of patches during one grazing period, from before grazing to after grazing. ....	47
Figure 16. Stability of patches after one regrowth period from after grazing in December to before grazing in January. ....	47
Figure 17. Stability of patches from December before grazing to January before grazing. ....	48

## APPENDIX 1

Figure A1. Transects herbage mass profiles in paddock 6 (Early control), before and after grazing in December and January, regrowth from after grazing in December to before grazing in January, and comparison of herbage mass before grazing between December and January to visualize stability of patches.....	74
Figure A2. Transects herbage mass profiles in paddock 29 (Early control), before and after grazing in December and January, regrowth from after grazing in December to before grazing in January, and comparison of herbage mass before grazing between December and January to visualize stability of patches.....	75
Figure A3. Transects herbage mass profiles in paddock 62 (Early control), before and after grazing in December and January, regrowth from after grazing in December to before grazing in January, and comparison of herbage mass before grazing between December and January to visualize stability of patches.....	76
Figure A4. Transects herbage mass profiles in paddock 8 (Late control), before and after grazing in December and January, regrowth from after grazing in December to before grazing in January, and comparison of herbage mass before grazing between December and January to visualize stability of patches.....	77
Figure A5. Transects herbage mass profiles, before and after grazing in January in Paddocks 28 and 18 (Late control), and December in paddock 15.....	78
Figure A6. Plots of variance and block size before and after grazing during December and January, obtained from the pattern analysis for paddocks 6,29 and 62 under Early control.....	79
Figure A7. Plots of variance and block size before and after grazing during December and January obtained from the pattern analysis for paddocks 8 and 28 under Late control.....	80
Figure A8. Plots of variance and block size before grazing during December in paddock 15 and after grazing during January in paddock 18 (Late control), obtained from the pattern analysis.....	81

## Chapter 1. General Introduction and Objectives

In New Zealand the feeding of dairy cows is based on pastures, and efficient utilisation of herbage is important for the economic performance on a dairy farm, even though pasture production is seasonal with year to year variation. Seasonal calving of cows is one strategy used in Dairy farms to match animal requirements to pasture production, by making their peak lactation and high intake requirements coincide with high pasture production during spring (Holmes and Wilson, 1987). However, during late spring pasture becomes reproductive, and this reproductive growth must be controlled to maintain pasture quality. Different management strategies have been recommended to control reproductive growth in pastures. The most used strategy has involved hard grazing throughout the spring accompanied by conservation as required, which has been shown to maintain pasture quality and tiller density into the summer-autumn period (L'Huillier, 1987, 1988; Hoogendoorn et al., 1992). Despite these advantages, it is considered that hard grazing throughout spring limits herbage intake of dairy cows, which often results in loss of body condition that in turn will result in shorter lactation length. There has been an increasing interest over recent years in improving the nutrition of dairy cows during spring to achieve greater milk production and longer lactation. However, to reduce the intensity of grazing has been considered undesirable because pasture quality declines, and on the other hand, the use of large amounts of supplements to better feed dairy cows is not considered economically feasible.

An alternative grazing management strategy for the spring period was developed in Massey University based on tiller dynamics studies. It was found that allowing some development of reproductive growth in ryegrass pastures but controlling it before anthesis ("Late control") increased the ryegrass tiller population, tiller weight, leafiness and growth vigour during the summer-autumn period (Matthew et al., 1989; Xia et al., 1990; Da Silva et al., 1993; Da Silva, 1994; Da Silva et al., 1994; Hernandez, 1995). In practice, Late control requires a period of lax grazing during the spring to allow some reproductive growth development on ryegrass pastures, and then control by hard grazing in late spring before anthesis. Late control has been tested experimentally with dairy cows in the past to evaluate if the extra pasture growth could be converted into extra milk production, with positive results (Da Silva, 1994). There is also interest in Late control among farmers interested in increasing the herbage intake of cows during spring without sacrificing pasture quality into the summer (Matthews et al., 1996).

It has been observed that during the lax grazing period under Late control patchiness develops on the sward, with some areas being grazed more intensively than others. As a consequence, the development stage of reproductive growth may be greater in some patches than others. Then at the time of control during late spring, different patches would be at different development stages of reproductive growth, and this may complicate management.

Patchiness develops in Late control during the lax grazing period when the herbage allowance is high and it is not likely that there is a restriction on intake during this period. But it is not known if patchiness will affect the cows intake and production during the control phase. In a system based assessment of Late control, it has been observed that to obtain an efficient pasture control it is necessary to force the cows to

graze too low for too long so that intake and milk production decline during the control period, and this imposes a critical conflict for Late control management. However, the intensity of grazing between different patches during the control period may be different, and it is not known if this has any effect on ryegrass tillering and its regrowth vigour, or changes in botanical composition. It is necessary to describe the effects of patchiness during the control phase and the consequences in the next grazing period on herbage utilisation. Until the effects of patchiness under Late control are evaluated it is not possible to determine if controlling patchiness will bring extra benefits to the system.

The objectives for the present experiment were to compare the pasture characteristics of swards under Early and Late control spring management strategies in December-January, with particular reference to the consequences of vegetation heterogeneity to pasture production and utilisation over this period, and to discuss the implications to spring grazing management.