Project number: 6120
Funding source: Teagasc and Dairy Research Ireland
Date: August 2016
Project dates: Jan. 2011 – Dec. 2014

Strategies to increase white clover use in intensive dairy production systems

Key external stakeholders:
Farmers
Advisors
Scientific
Grass seed industry

Practical implications for stakeholders:
Incorporating white clover into N fertilised grass swards in intensive grazing systems can increase herbage production and milk solids production.
Nitrogen fixation by clover decreases as N fertiliser application rate increases

Main results:

- Including clover into grass swards can increase herbage production by 2.9 t DM/ha
- Sward clover content decreased as N fertiliser application rate increased from 33.3% at 0 kg N/ha to 19.6% at 240 kg N/ha.
- N fixation on the grass-clover treatments decreased as N fertiliser application increased from 220 kg N/ha for the 0N treatment to 112 kg N/ha for the 240N treatment
- Sward clover content increased and N fixation increased following the cessation of N fertiliser application to grass-clover swards in late spring/early summer
- Incorporating clover into N fertilised grass swards can increase milk production from May onwards

Opportunity / Benefit:

- Potential to increase herbage production or reduce N fertiliser use by incorporating clover in grass swards
- Potential to increase milk solids production by incorporating clover into N fertilised grass swards

Collaborating Institutions:

AFBI Northern Ireland
Queens University Belfast
UCD

Contact Deirdre Hennessy Email: deirdre.hennessy@teagasc.ie.

Teagasc project team: Dr. Deirdre Hennessy (PI)
Dr. Eva Lewis
Dr. Michael O'Donovan
Dr. Daniel Enriquez-Hidalgo
Dr. Michael Egan
Ms. Norann Galvin
Ms. Christine Fleming
Mr. Steven Fitzgerald
Mr. Fergal Coughlan

External collaborators: Dr. Trevor Gilliland, AFBI
Dr. Bridget Lynch, UCD

1. Project background:

White clover (*Trifolium repens* L.) is the most important legume in grazed pastures in temperate regions. It grows very well in association with perennial ryegrass and is tolerant of grazing. It can fix athmospheric N and make it available for sward growth, and its herbage has a higher nutritional quality for livestock than grass. White clover use in grazed swards across Ireland is low due to the availability and generally low cost of fertiliser N. However, in recent times there has been renewed interest in the use of white clover for environmental reasons (e.g. limitations on N fertiliser use under the Nitrate Directive), as well as increased cost of fertiliser and other inputs at farm level combined with declining product price. Research at Teagasc Moorepark Solohead Farm has demonstrated the successful inclusion of white clover in grass based milk production systems at lower stocking rates (<2.2 LU/ha). There is increasing interest in the use of white clover in higher stocking rate dairy production systems, however there are concerns around its persistence in N fertilised intensively grazed swards.

2. Questions addressed by the project:

Can white clover contribute to herbage and animal production in frequently grazed N fertilised swards?
What effect does N fertilizer application rate to grass white clover swards have on seasonal and herbage distribution and nutritional quality, persistency of white clover, and N fixation?
How does including white clover in N fertilised grass swards influence daily feeding behaviour pattern, sward depletion rate and rumen characteristics during the grazing season?

3. The experimental studies:

Four experiments were undertaken:
Experiment 1: This experiment was a plot grazing experiment and evaluated the effect of N fertiliser application level to grass only and grass clover swards on seasonal and annual herbage production and clover persistency. The treatments were: two sward types – grass only and grass clover, and five N fertiliser application rates: 0, 60, 120, 196 and 240 kg N/ha. Swards were grazed 8 to 10 times per year by dairy cows and the experiment was undertaken for 4 years (2010 – 2013). Measurements included pre-grazing herbage mass, pre- and post-grazing sward height, sward clover content, stolon mass and tiller density.
Experiment 2: This experiment used the grazing plots in Experiment 1 and quantified the N yield, N fixation and N transfer to companion grasses in frequent and tight grazed grass clover swards. The treatments were: two sward types – grass only and grass clover, and five N fertiliser application rates: 0, 60, 120, 196 and 240 kg N/ha. Measurements included herbage production, herbage N content, N fixation and herbage N yield.
Experiment 3: This was a grazing experiment undertaken for two years (2011 and 2012). There were two treatments – a grass only sward receiving 250 kg N/ha/year and a grass clover sward receiving 250 kg N/ha/year. Swards were grazed by lactating dairy cows (15 per treatment in 2011 and 20 per treatment in 2012). Measurements included herbage production, sward clover content, milk production, milk solids production, herbage DM intake and methane production by dairy cows (in 2011).
Experiment 4: This experiment used the treatments in Experiment 3 and measured dairy cow feeding behaviour, rumen characteristics of cows grazing grass only and grass clover swards and sward depletion patterns.

4. Main results:

Experiment 1

- Including clover into grass swards increased herbage production by 2.9 t DM/ha, regardless of N application rate.
- Grass-clover swards receiving 0 kg N/ha had the same annual herbage production as grass-only

Contact Deirdre Hennessy Email: deirdre.hennessy@teagasc.ie.

swards receiving 240 kg N/ha.
- Sward clover content decreased as N fertiliser application rate increased from 33.3% at 0 kg N/ha to 19.6% at 240 kg N/ha.

Experiment 2
- The N yield was 162 kg N/ha greater on grass-clover swards compared to grass-only
- N fixation on the grass-clover treatments decreased as N fertiliser application increased from 220 kg N/ha for the 0N treatment to 112 kg N/ha for the 240N treatment
- Following the cessation of N fertiliser application in late spring/early summer on the 60N and 120 N grass-clover treatments, sward clover content increased and N fixation increased.

Experiment 3
- The average annual clover content of the grass-clover swards receiving 250 kg N/ha was 20% in 2010 and 24% in 2011
- Herbage production and quality was similar on grass-only and grass-clover swards except in the last three rotations when herbage quality was greater on the grass-clover swards compared to grass-only due to high sward clover content
- Milk production was similar on grass-only and grass-clover swards in 2010 and was greater in the second half of lactation in 2011 on the grass-clover compared to the grass-only swards.
- In autumn there was a tendency for cows to consume more DM and emitted less CH_4 per unit of feed intake when grazing grass-clover compared to grass-only swards.

Experiment 4
- Only small differences were observed in sward depletion rates between the grass-only and grass-clover swards
- Ruminating time in the summer and autumn when sward clover content was high was reduced on grass-clover compared to grass only swards
- No differences in total VFA were observed between treatments but cows that grazed grass-clover swards had a greater proportion of rumen VFA isoacids, D-LA and ammonia compared to grass-only
- Rumen pH was higher for the cows grazing grass-clover compared to grass-only, and this response was greatest in autumn
-

5. Opportunity/Benefit:

This project highlights the potential benefits of including white clover in N fertilised grass swards. Results show that incorporating white clover in fertilised perennial ryegrass swards can result in increased herbage production, can reduce the requirement for chemical N fertiliser and can improve milk solids yield.

6. Dissemination:

An overview of the project was given at the Moorepark Open Day in 2013. Visitors to Moorepark, both national and international, received presentations on the project and many interesting discussions took place. Poster and oral presentations were made at the Agricultural Research Forum, British Grassland Society Research Conference, EGF Conferences and International Society for Applied Ethology Conferences. Two papers have been published from this project, one is in press and two more are in preparation.

Main publications:

Enriquez-Hidalgo, D., Gilliland, T. and Hennessy, D. (2016) Nitrogen accumulation, fixation and transfer to companion grasses in frequent and tight grazed grass white clover swards given different annual nitrogen fertilizer applications. *Grass and Forage Science,* 71: 559-574.

Enriquez-Hidalgo, D., Hennessy, D., Gilliland, T., Egan, M., Mee, J.F. and Lewis, E. (2014) Effect of rotationally grazing perennial ryegrass white clover or perennial ryegrass only swards on dairy cow feeding behaviour, rumen characteristics and sward depletion patterns. *Livestock Science* 169: 48-62.

Enriquez-Hidalgo D., Gilliland T., O'Donovan, M., Deighton, M.H. and Hennessy, D. (2014) The effect of grass white clover swards on herbage production, herbage dry matter intake, enteric methane emissions and milk production of dairy cows. *Journal of Dairy Science* 97: 1400 – 1412.

Popular publications:

Lewis, E., Hennessy, D., McEvoy, M., Enriquez Hidalgo, D., Wims, C. and Coughlan, F. (2012) Rumen function in grazing dairy cows. TResearch, 7 (3): 38-39. (http://www.teagasc.ie/publications/view_publication.aspx?publicationID=1527)

Enriquez-Hidalgo, D., Gilliland, T.J., Elliot, C. and Hennessy, D. (2015) Nitrogen fixation in grazed grass-white clover plots: effects on N fertiliser application rate. In: Agricultural Research Forum 2015, 9th and 10th

Contact Deirdre Hennessy Email: deirdre.hennessy@teagasc.ie.

March, pp. 1.
Hennessy, D., Egan, M., and Enríquez-Hidalgo, D. 2013 Exploiting the potential of white clover. Moorepark '13 - Irish Dairying – Harvesting Potential, Moorepark Open Day, 3rd July, 2013, Fermoy, Ireland. Pg. 50 - 51. (http://www.teagasc.ie/publications/view_publication.aspx?PublicationID=2788)
Hennessy, D., Enriquez-Hidalgo, D. and Egan, M. (2013) Using white clover to increase herbage DM production and animal performance. Teagasc National Dairy Conference. 12th and 13th November 2013. Pp. 14-25. (http://www.teagasc.ie/publications/view_publication.aspx?PublicationID=2989)

7. Compiled by: Dr. Deirdre Hennessy

Contact Deirdre Hennessy Email: deirdre.hennessy@teagasc.ie.