Lower fertilizer N inputs for dairy production

J. Humphreys[1], A. Lawless[1], K. O'Connell[2] & P. Darmody[1]
[1]*Teagasc, Moorepark, Fermoy, Co. Cork.*
[2]*Teagasc, Johnstown Castle, Wexford.*

Introduction

There is pressure to lower fertilizer N input to dairy production in order to lower nitrate leaching losses and limit nitrous oxide emissions. This summary outlines the results of a three-year experiment (2000 to 2002) investigating systems of milk production based on lower fertilizer N inputs than currently practiced, without or with lower stocking rates.

Materials and Methods

There were four treatments in this experiment. The first was based on the Moorepark blueprint for spring-calving dairy herds (Dillon *et al*., 1995). It involved fertilizer N inputs of approximately 350 kg N ha^{-1} year^{-1} applied to grassland stocked at rates of 2.5 cows ha^{-1} year^{-1} (Intensive) and was the control treatment. The second treatment had the same stocking rate as Intensive but with fertilizer N input of approximately 250 kg N ha^{-1} year^{-1} (Moderate). The third treatment (Extensive) had a stocking rate of 2.1 cows ha^{-1} year^{-1} and fertilizer N inputs of 175 kg N ha^{-1} year^{-1}. The fourth treatment (Environmental) had a stocking rate of 1.75 cows ha^{-1} year^{-1} and fertilizer N inputs of 80 kg N ha^{-1} year^{-1} compatible with the requirements of the Rural Environment Protection Scheme. At lower stocking rates a greater proportion of fertilizer N was directed towards achieving optimum yields of herbage for silage per ha. There were 18 cows per treatment during each year. Each spring cows were divided into four main groups on the basis of lactation number (1, 2, 3 & ≥4) and then sub-divided into sub-groups of four on the basis of calving date. From within each sub-group one cow was randomly assigned to each herd. The same procedure was followed each year. Herds were randomly assigned to each treatment each year. Milk in the third week of lactation was used as covariate in analysis of variance. The aim in each treatment was to supply sufficient grass to (1) meet the cows feed requirements during the main grazing season (March to October) and (2) provide the winter feed requirements as silage. Quantities of silage produced were estimated as 750 g kg^{-1} of herbage dry matter (DM) harvested (Gordon, 1988). On this basis target quantities of silage were 1.4 t DM cow^{-1} year^{-1}. Swards were composed primarily of perennial ryegrass (>750 g kg^{-1}). The white clover content of swards varied between being undetectable to up to 50 g kg^{-1} in the sward DM in the spring 2000. Mean calving date was 23 February. Cows were turned out to grass during February and remained at grass until housing during November. Concentrate supplementation amounted to 595 kg cow^{-1} year^{-1}.

Results and Discussion

There were no significant differences in yields (kg cow^{-1} year^{-1}) of solids-corrected milk (6210; SEM = 97), fat (263; SEM = 4.4), protein (225; SEM = 3.3) or lactose (301; SEM = 5.2) between treatments combined over years. There was a significant ($P < 0.05$) difference in the quantities of grass silage produced (t DM cow^{-1} year^{-1}): 1.50 on Intensive, 1.22 on Moderate, 1.38 on Extensive and 1.80 on Environmental, SEM = 0.047.

Silage production on both Intensive and Extensive was more-or-less on target. Moderate was below target; input of fertilizer N was insufficient to meet the stock carrying capacity examined. Silage production (t DM cow^{-1}) on Environmental increased from 1.3 in 2000 to 1.9 in 2001 to 2.2 in 2002. This was due to the substantial increase in the white clover content (g kg^{-1} DM) of swards on this treatment from 133 during 2000 to 248 during 2001 and 232 during 2002. The white clover contents of swards in the other three treatments remained relatively low being less than 50 g kg^{-1} DM on average within each treatment.

There were no significant differences in the DM, crude protein and *in vitro* organic matter digestibility (*IV*OMD) of the silages produced from each of the four treatments.

On the grazing area, annual pasture production increased linearly with increasing N fertilizer input. Pasture yields increased from 5.77 t DM ha^{-1}, at 52 kg fertilizer N ha^{-1} on Environmental, to 9.63 t DM ha^{-1}, at 350 kg fertilizer N ha^{-1} on Intensive (SEM = 0.27, $P < 0.001$) along the line: y = 4.98 + 0.013 x kg N ha^{-1}; $R^2 = 0.82$, $P < 0.001$.

Mean crude protein concentration (g kg^{-1}) in pasture increased significantly ($P < 0.001$) with increasing fertilizer N inputs from 167 on Environmental to 214 on Intensive, SEM = 3.5. Likewise *IV*OMD concentrations (g kg^{-1}) in the pasture DM increased significantly ($P < 0.01$) from 804 on Environmental to 824 on Intensive, SEM = 3.3. Nevertheless, it was apparent that sward nutritive characteristics on all treatments did not impose a constraint on dairy production.

Conclusions

On Moderate 250 kg N ha^{-1} year^{-1} was insufficient to meet the requirements of 2.5 cows ha^{-1} year^{-1} imposed in this experiment. The results indicate that approximately 320 kg fertilizer N ha^{-1} year^{-1} is required to carry this stocking rate under the soil and climatic conditions at Solohead. Environmental did not impose a constraint on milk output/cow. Furthermore Environmental produced substantially more silage than required during 2001 and 2002, which was mainly attributed to the increasing contribution of white clover during the experiment. This surplus of herbage production indicates the potential for a higher stock carrying capacity from the combination of N inputs utilized on Environmental and this aspect requires further investigation.

References

Dillon, P., Crosse, S., Stakelum, G. & Flynn, F. (1995) *Grass and Forage Science*, **50**, 286-299.

Gordon, F.J. (1988) Harvesting systems for the production of grass silage for the dairy cow. *In:* Garnsworthy, P.C. (Ed.). Nutrition and Lactation in the Dairy Cow. pages 355-377.