Nitrogen and phosphorus losses in runoff on beef production systems

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Introduction In West Europe countries between 37 and 82% of the nitrogen (N) and between 27 and 38% of the phosphorus (P) reaching water sources come from agriculture and a strong correlation between the number of animals per area unit and N and P contribution to waters has been shown (Issermann, 1990). There are few data about the environmental impact of beef production systems in Southern Chile. The objective of this experiment was to quantify N and P losses in runoff (surface and subsurface) with two different stocking rates in Southern Chile.

Materials and methods The experiment was carried out in winter 2004. Two stocking rates were tested (3.5 and 5 steers/ha) in closed systems (2 ha each). Grazing was carried out with Holstein-Friesian steers (200 kg initial live weight) under rotational grazing, in a permanent pasture on an Andisol (40º35'S, 73º12'W). In each system, three surface lisymeters (5x5m) were established (Scholefield & Stone, 1995), and runoff collected periodically (ground level and at 50 cm depth). Water samples were kept at 4ºC until analysis for N ($N\text{-}NO_3^-$ and $N\text{-}NH_4^+$) and reactive P. Total N and P losses were calculated as the product of drainage and nutrients concentration in the runoff samples.

Results Total drainage during the experimental period was 978 and 1002 mm for the 3.5 and 5 steers/ha treatments, respectively. Most of water moved down the soil profile (>60 cm depth). Subsurface runoff represented only a small proportion of the water flows, confirming that in this soil type surface runoff and leaching are the most important pathways for nutrients transfer and losses. Results showed that during the experimental period no differences were found between the two stocking rates tested for N leaching losses (on average 16 and 17 kg N/ha for the 3.5 and 5 steers/ha treatments, respectively; data not shown). Total losses in runoff varied between treatments.

Table 1 Drainage (% of the total drainage), average nutrient concentrations in surface runoff samples (mg/L) and N and P losses (g/ha) in paddocks grazed by 3.5 and 5 steers/ha, in Southern Chile

Stocking rate	3.5 steers/ha	5 steers/ha
Drainage		
Surface runoff	34%	37%
Subsurf. runoff (0-50 cm)	3%	2%
Leaching (60 cm)	63%	61%
Average surface runoff concentrations (Range)		
NH_4^+	52 ± 19.9	34 ± 11.4
	(1 – 116)	(1 – 82)
NO_3^-	37 ± 10.7	17 ± 5.0
	(1 – 64)	(1 – 33)
Reactive P	1 ± 0.3	2 ± 0.5
	(0 –3)	(0 – 7)
Total losses in runoff (surface plus subsurface)		
Nitrogen	36 ± 0.9	15 ± 0.5
P	3.5 ± 0.29	1.4 ± 0.111

Total N and P losses in runoff were 2.4 and 2.5 times greater in the treatment with the lower stocking rate. This could be explained by differences in animal behaviour of both treatments. Where the higher stocking rate was used, there was lower grass availability, so that animals spent more time walking in the paddock looking for feed and there was a greater distribution of the faeces and a reduction in the nutrients concentration in a specific area. Because of the small amount of water measured as subsurface runoff, total nutrient losses in this pathway was small (on average they represented only 5% of the total losses in runoff). Ammonium losses from surface runoff were on average 200% greater than those measured for $N\text{-}NO_3^-$, probably due to the direct effect of urine patches. The soil bulk density did not vary between treatments (0.49 g cm^{-3}).

Conclusions The stocking rates studied differed in the magnitude of nutrient losses in runoff. In these grazing systems, on average 95% of the N and P lost in runoff was lost in the surface pathway. Most of available N lost in runoff was lost as ammonium. Further studies need to be carried out to fully understand the mechanisms controlling N and P losses in Southern Chile.

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References

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