Nutrient Balances for Complimentary Forage Rotation and Pasture Systems

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The FutureDairy (Garcia *et al.* 2006) project is investigating a high input/ high yielding forage based on system a complementary forage rotation (CFR) comprising maize as the bulk crop, forage rape (*Brassica rapus*) as a "break" crop, in view of its biofumigatant properties, and Persian clover *(Trifolium resupinatum)*, to fix atmospheric nitrogen (N). This CFR has achieved over 40 t DM/ha/year of utilised forage for the past 3 years. However, the environmental sustainability (and nutrient use efficiency of N, phosphorus and potassium) of such a system needs to be assessed, compared to an intensively (PI) and extensively (PE) managed pasture as a control, and this was the objective of this study.

The study is being conducted on 2 replicate paddocks (0.7 ha/paddock) of the original 4 replicates of the CFR and PI. The PE is an additional treatment adjacent to the other plots and received only limited nutrient input (from water and dung) and was mainly rainfed. Devices were set up in each plot to collect runoff and, deep drainage water, in order to measure nutrient loss, and soil moisture was also monitored. Soil samples from the 0-30, 30-70 and 70-100 cm layers were collected, at the end of each season from the pasture treatments, while sampling in the CFR was undertaken at the end of each crop phase. Plant material and animal excreta (from grazing) were also periodically sampled and analysed for nutrient content.

The annual nutrient balances took into account the inputs of nutrients from animal excreta, N fixation from legumes and organic matter mineralisation in the soil. This input was higher in the PI treatments due to more frequent grazings, while grazing on the CFR was confined to the clover and forage rape components. Table 1 shows similar total nutrient input to the top soil (30 cm) for the CFR and PI.

Table 1. Average annual nutrients balance (N, P and K- kg /ha) and nutrient use efficiency (kg DM /kg nutrient) in top 30 cm of soil for CFR, PI and PE

	Treatments								
	CFR			PI			PE		
	N	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**
Inputs									
Change in soil content	-10.5	-164.3	-313.6	27.3	84.6	174.1	52.1	47.3	129.2
Fertilisers	555.3	184.6	375.2	543	60	164	0	0	0
Irrigation	19.2	2.2	160.2	18	1.5	146.5	10.4	0.6	41.6
Extra inputs	166.4	9.3	29.8	391	35.3	147.4	107.8	5.2	15.9
Total	**730.3**	**31.7**	**251.5**	**979.3**	**181.3**	**632.3**	**170.2**	**52.9**	**186.6**
Outputs									
Run off lost	39.6	6.4	42.8	9.2	2.1	20.2	0.1	0.4	3
Plant uptake	870	128.2	862.4	892.1	89.5	781.2	75.9	10.7	71.2
Total	**909.6**	**134.5**	**905.4**	**901.3**	**91.6**	761	**75.9**	**11.1**	**74.2**
Nutrient balance	**-179.3**	**-102.8**	**-653.9**	**77.9**	**89.7**	**-148.9**	**94.3**	**41.3**	**112.4**
Nutrient use efficiency	45	170	59	18	97	27.8	20.5	66	18.8

The nutrient use efficiency was greater for the CFR and the PE treatments. However, the sub-soil (below 30 cm) compensated for the nutrient deficit in the top-soil. The nutrient loss through the system was higher for the CFR (5.9 % of inputs) than for the PI (2%) and PE (<0.5%), and this was likely to be due to the existence of a more effective drainage system in the CFR treatment, that helped drain excessive water from heavy rain events.

The nutrient used efficiency was highest successively in CFR, PI and the PE in regards of the yield recorded in these three pasture systems (44.3 against 16.7 and 3.5 t DM/ha respectively CFR, PI and PE). Fertiliser contributed the greatest input of nutrients for the intensive forage systems, with 75% and 55% as inputs into CFR and PI. Nutrient movement beyond the root zone was limited in drought years.

Garcia S., Fulkerson B. and Brookes S. (2006). Increasing productivity on farm 1- Results of the forages module of FutureDairy, Proc. Dairy Research Foundation Symposium. pp. 54-64

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