Insights for Sward Management using LINGRA-N-Plus as an Interactive Learning Tool

Introduction and Aim

Grass yield simulation models can provide useful insights to improve pasture management. The aim of this poster is to describe the development and use of a version of the LINGRA-N model as a learning tool.

Methodology

We developed a modified version of the LINGRA-N grass model (Wolf 2012) for use on Microsoft Excel, called LINGRA-N-Plus. The model and a teaching guide **is available online** (Burgess et al. 2020). We asked agricultural students, researchers, and consultants to evaluate the model in a series of grassland management workshops in England, Scotland and Wales in 2019 and 2020 (Fig 1). Participants used the model to understand the effect of the grass-cutting interval on **green-leaf** and **total dry matter** yields (Fig 2, Fig 3). This and other activities demonstrated the potential of the model as a learning tool. The workshops prompted discussion, questions and the end of each session the participants were asked to identify the strengths and weaknesses of the tool.

Fig 1 We used the model in grass management workshops

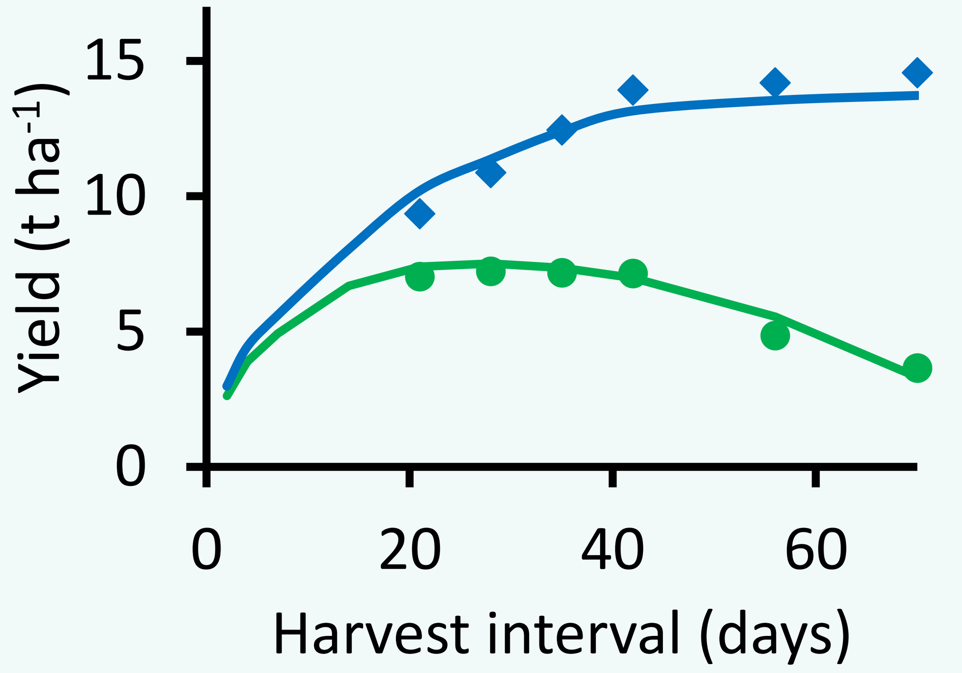

Fig 2 Effect of harvest interval (Mar-Oct) on the green leaf (●) and total dry biomass (◆) yields at Aberystwyth as reported by Wilman et al. (1976) at 262 kg N ha^{-1} and predicted by LINGRA-N-Plus (solid lines)

Results and Discussion

Three useful insights on sward management were derived from workshops.

1) Unlike some grass models, the LINGRA-N-Plus model reports both green-leaf and dry matter yields (Fig 2).
2) To improve nitrogen responses, we included the effect of temperature and water on nitrogen mineralisation (Addiscott and Whitmore 1987) and validated the model using the Morrison et al. (1980) dataset.
3) At two sessions, there was particular interest in whether the model correctly calculated the residual biomass left in the field after harvest. To obtain sensible results, it was necessary to estimate the proportion of the green leaf, stem, and dead leaf in the remaining biomass, for which we used data from Amaral et al. (2012).

	A	B	C	D	E	F	G
5	**SITE and GRASS factors**			**MANAGEMENT choices**			
6	**Meteorological**			**Harvest**			
7	Selected weather data (1-21)	4	UK-Aberystwyth 1973	Grass cut at specific weight (1); Grass cut at specific dates (2)	2		
8	Latitude	52.4	°N	Total dry weight of harvestable grass **(only applicable if E7=1)**	1,800	kg/ha	
9	Temperature change from default	0	°C	Selected harvest routine (1 = fixed interval as in E12; 2-14 = default)	1		
10	Mean temperature	9.8	°C				
11	Annual rainfall	1,055	mm	Start of season	26-Mar		
12	Assumed annual irrigation	0	mm	End of season	22-Oct	10	harvests
13	Annual solar radiation	3,164	MJ/m^2	Selected interval if based on interval (**only applicable if E9=1**)	21		
14							
15	**Carbon dioxide**			Leaf area index after cutting	0.5		
16	Increase in carbon dioxide from default	0	ppm	Derived residual herbage weight after cutting	1602	kg/ha	
17	Assumed carbon dioxide concentration	330	ppm	**Nitrogen**			
18				Nitrogen stress? (0 = no nitrogen effects; 1 = nitrogen effects included)	1	N effects included	
19	**Partitioning of dry matter**			Selected N routine (1 = fixed; 2-14 = specified) **applicable if E18=1**)	1	200	kg N/ha applied
20	Is partitioning fixed or varied (0 = fixed; 1 = automatic)	1	Calculated varied^a	N application in N routine **(only applicable if E19=1)**	200	kg/ha	
21	Fraction of total DM to roots	0.165	0.150	N mineralisation based on	4	Moisture & temp	
22	Fraction of above-gr. DM to leaves	1.000	0.778	Total mineral soil N available at start of growth period	75	kg/ha	
23	Fraction of above-gr. DM to stems	0.000	0.222				
24	Fraction of above-gr. DM to storage organs (seeds)	0.000	0.000				
25	^{a}: assuming no stress			**Irrigation**			
26	**Root depth**			Is drought stress included? (0 = no drought; 1 = drought effects include	1	Drought included	
27		1,000	mm	Selected irrigation routine (1-4) (**only applicable if E23=1**)	1	0	mm irrigation
28							
29	**OUTPUTS**						
30	**Yields**			**Nitrogen use and transpiration**			
31	Total weight of harvested green leaves	**7,145**	kg/ha	Amount of nitrogen taken up by crop	265	kg N/ha	
32	Total weight of harvested stems	2,589	kg/ha	Ratio of nitrogen taken up and yield biomass	0.027	kg N/(kg dry matter)	
33	Total weight of harvested storage organ (seeds)	0	kg/ha	Total transpiration	229	mm	
34	Total weight of harvested "dead leaf"	163	kg/ha				
35	Total weight of harvested green leaves, stems, seeds	**9,897**	kg/ha	Nitrogen use efficiency (Nitrogen uptake/application)	1.33		
36	Total produced biomass - above and below ground	12,999	kg/ha	Transpiration efficiency (Dry matter production/m^3 transpiration)	5.66	kg/m^3	
37	Mean leaf area index	1.07		Harvested leaves as a proportion of total harvest	0.72		
38							

Fig 3. Part of the Excel model showing the main "Site and Grass factors", "Management choices", and "Outputs" used or derived from the LINGRA-N-Plus model

Conclusion

We received positive feedback on the use of the LINGRA-N-Plus model as a learning tool; participants were able to gain insights into the effect of climate, nitrogen application, and harvest frequency on both green leaf and total dry matter yields. The model is available online.

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