SUMMER GRAZING

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SUMMARY

A model has been constructed to simulate the grazing of summer pasture by sheep. It records daily changes in the amount and digestibility of the food available and the diet eaten and the resulting changes in the weight of the sheep. The model has been used to predict the response of sheep weight to grazing subdivision, rainfall, growth rate of herbage, the amount of dry food available and the efficiency with which this is grazed.

INTRODUCTION

Rotational grazing of farm animals is a common practice: the herd or flock is not continuously run on a single area but is concentrated at any time on one of a number of paddocks into which the farm is divided. The animals are moved from one paddock to another, usually in strict sequence, depending on time, or according to some criterion judged by the farmer (e.g. amount of food, or animal weight). In southern Australia, field experiments which have compared animal production from rotational and continuous grazing systems during the growing season have so far revealed only minor differences. The costly long-term trials necessary to compare alternative systems in summer have not been attempted. It was to examine this question in theory that the present model was constructed. It keeps a daily tally of the amount and digestibility of food available on all paddocks in a one- or multi-paddock system and the amount and digestibility of food eaten with its resulting effect on animal weight.

THE MODEL

For simplicity food is considered to consist of two components, green and dry. Green is produced only in response to rain; as it ages its digestibility falls. Its quantity can be reduced through consumption by sheep or through conversion to dry material with age. Dry material can increase only through green material drying off, but in addition to being eaten it decreases because of trampling losses, weathering losses following rain, and a continuing time loss found even in the absence of both animals or rain, presumably owing to the action of insects, wind damage etc.

Basic features of the model appear in Fig. 1.

Simulation begins with the exogenous event START causing the endogenous events LOOK, DSTRY, and SAMPL to recur at regular daily intervals. LOOK examines each paddock for the presence or absence of sheep and restricts trampling and eating losses to the paddock with sheep.

The exogenous event RAIN calculates a finite period for weathering following rainfall, related to the amount of rain and evaporation rates. The reduction of dry material is determined by the four endogenous events WETHR (weathering effect), DSTRY (time loss), TRMPL (trampling losses) and EAT (consumption); each assumes that the more digestible material is reduced first--that it is either actively selected by the animals (in EAT) or is more prone to destruction by the other agents (in the other events). Consequently all draw on the one subroutine, DECR, which relates the losses in each event to a theoretical exponential function according to the actual digestibility of the material present.

In RAIN an assumed transpiration ratio is used to calculate the total production (A) of green material which is to follow rain. GRO uses a logistic growth function to relate growth rate per day to A and the amount of green material present on each paddock (increased by GRO and perhaps reduced by EAT). In each paddock the green material produced each day is followed separately, ranked in a set according to age, and the digestibility of each age class in each set is reduced daily in AGIN.

EAT recognizes that sheep select actively for green material and relates the proportion of green eaten to that on offer. It also assumes that within green material the amount eaten in any age class is dependent upon its digestibility and the amount in that class. This event calculates the mean digestibility of the diet selected (green + dry) and reduces the theoretical intake drawn from DECR to actual intake accordingly; it then causes the subroutine GROFAT to calculate the effect on bodyweight of the total digestible food units eaten.

At the end of each day all the relevant amounts remaining on each paddock are calculated in SAMPL. Should the amount of food fall below a predetermined level the endogenous event MOVE employs subroutine SELECT to choose the paddock with most green food (if much) or dry material and moves the animals onto it. Should bodyweights fall below 27 kg SAMPL causes DROUT to remove sheep from the field to be fed maintenance rations in yards. If a given level of green is subsequently reached through GRO the sheep are returned to the grazing system.

In conjunction with this model in SIMSCRIPT an autoplot program was used to plot pertinent changes with time.

RESULTS

In the absence of rain (Tables 1 & 2) subdivision had little effect on the final weight of sheep after 100 days grazing at 6 sheep per acre although the pattern of weight change differed (Fig. 2). The efficiency of food utilization (EFU) expressed as the ratio of the digestible units eaten to the digestible units originally available increased with decreasing availability (Table 1), reaching an upper limit of about 60%. This represented complete disappearance of dry food, the remainder having been lost through time and trampling.

The growth of green which resulted from rain increased liveweight more in a continuous grazing system than in a 9-paddock rotation because more of the green food was eaten when its digestibility was high (Fig 2), resulting in a higher value for EFU (Tables 1 and 2). This difference was directly related to the growth response of the pasture species and was also greater when the same quantity of rain was distributed over 10 occasions at 5-day intervals (Table 2).

The final weight of the sheep was sensitive to changes in the slope of the function relating the intake of food to the amount available (Table 3) but not to that relating the proportion of green in the diet selected to the proportion of green in the food available.

If the many assumptions which must be made in this type of simulation experiment are reasonable then the effects of initial food supply, stocking rate, number of subdivisions, criteria for movement to another paddock, amount of rain etc. could be examined for different types of production from different species of animals on various pastures and in different environments.

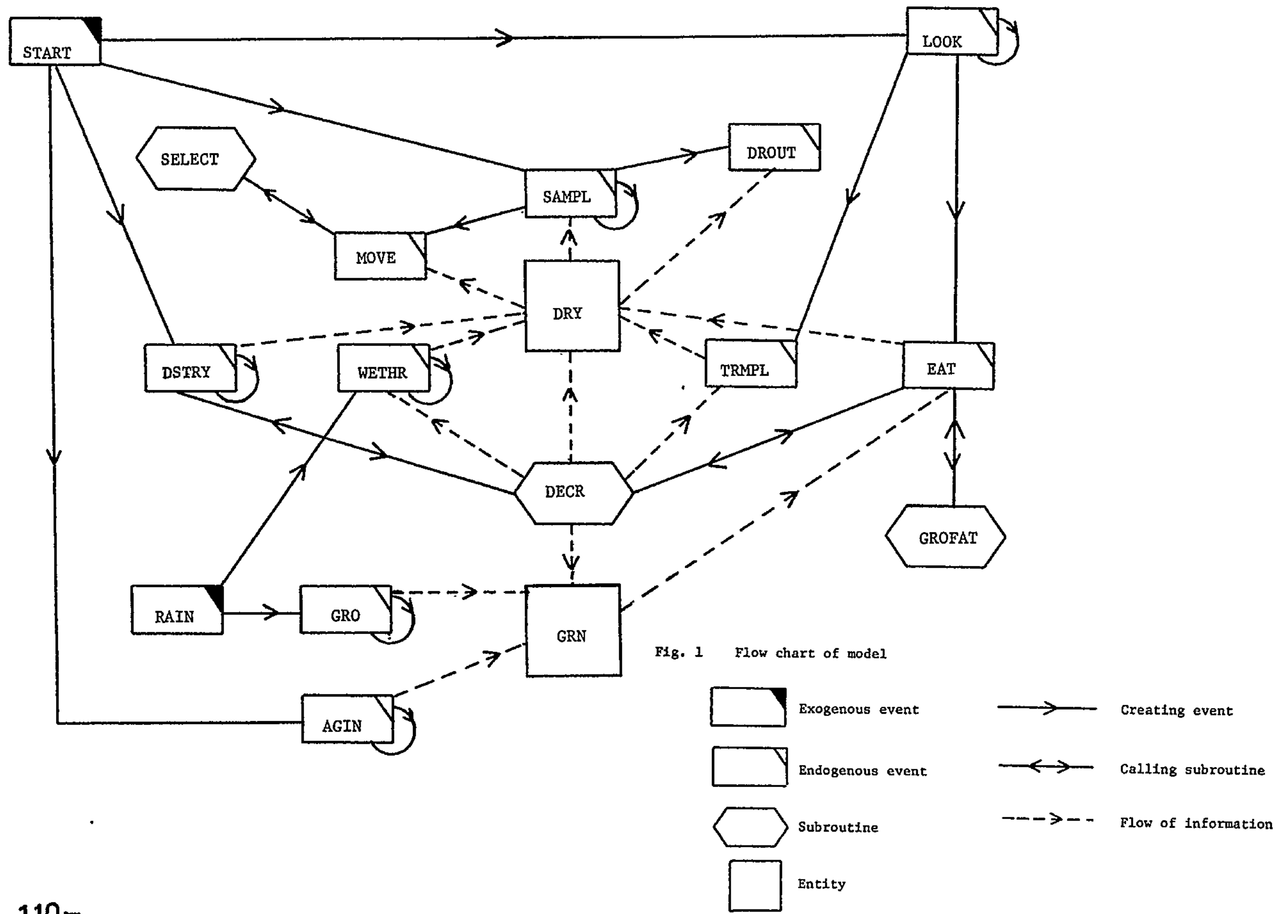

Fig. 1 Flow chart of model

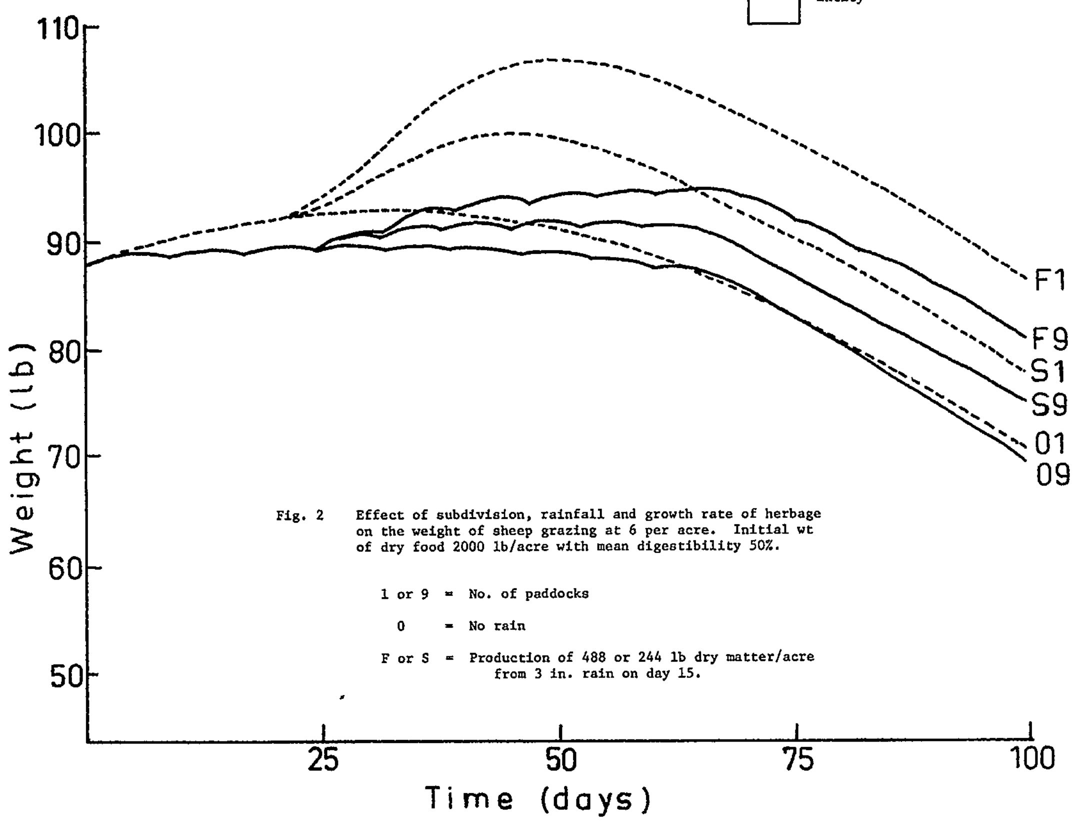

Fig. 2 Effect of subdivision, rainfall and growth rate of herbage on the weight of sheep grazing at 6 per acre. Initial wt of dry food 2000 lb/acre with mean digestibility 50%.

1 or 9 = No. of paddocks

0 = No rain

F or S = Production of 488 or 244 lb dry matter/acre from 3 in. rain on day 15.

Table 1. Effect of the initial weight of dry food available, the occurrence of rain and subdivision of the grazing area on the efficiency of utilization of dry, green and total digestible food and on the weight of the sheep after 100 days

Sheep:	Initial wt. 88 lb; 6 per acre
Dry food:	Mean initial digestibility 50%
Rain:	One fall of 3 in. on day 15
Green food:	488 lb per acre (dry wt)

Wt. dry food (lb/acre)	Rain (in.)	No. of paddocks	EFU[a] dry	EFU[a] green	EFU[a] total	Final wt. of sheep (lb)
3000	0	1	.46	-	.46	82.8
		9	.44	-	.44	82.6
3000	3	1	.38	.83	.47	94.8
		9	.41	.33	.39	88.7
1000	0	1	.63	-	.63	59.5[b]
		9	.60	-	.60	59.4[c]
1000	3	1	.54	.90	.70	74.5
		9	.64	.48	.57	69.7

[a] EFU = digestible units eaten/digestible units initially available (dry) or produced (green)

b & c Sheep removed after 92 and 91 days respectively because of low weights

Table 2. Effect of distribution of rainfall, growth rate of pasture and subdivision on the efficiency of utilization of digestible food (EFU) and on the weight of the sheep after 100 days

Sheep:	Initial wt. 88 lb; 6 per acre
Dry food:	Initial wt. 2000 lb/acre with mean digestibility 50%

Rain (in.)	Green produced (lb. dry matter/acre)	No. of paddocks	EFU dry	EFU green	EFU total	Final wt. of sheep (lb)
0	0	1	.54	-	.54	71.7
		9	.52	-	.52	70.8
1 x 3.0	488	1	.46	.87	.58	86.8
		9	.48	.52	.49	82.1
1 x 3.0	244	1	.50	.88	.56	78.6
		9	.49	.50	.50	75.6
10 x 0.3	488	1	.48	.91	.60	90.8
		9	.50	.50	.50	83.6
10 x 0.3	244	1	.51	.90	.58	81.5
		9	.51	.53	.51	77.4

Table 3. Effect of the efficiency with which the sheep maintain food intake and the proportion of green food in their diet with decreasing availability on the utilization of digestible food (EFU) and on the weight of the sheep after 100 days

Sheep:	Initial wt. 88 lb; 6 per acre
Dry food:	Initial wt. 2000 lb/acre with mean digestibility 50%
Rain:	One fall of 3 in. on day 15
Green food:	488 lb per acre (dry wt.)

Efficiency of maintaining total intake	Efficiency of selecting green	No. of paddocks	EFU dry	EFU green	EFU total	Final wt. of sheep (lb)
H	B	1	.46	.87	.58	86.8
H	B	9	.48	.52	.49	82.1
L	B	1	.34	.80	.47	78.6
L	B	9	.38	.37	.38	73.2
H	A	1	.46	.88	.58	86.9
H	C	1	.46	.85	.57	86.6

H & L represent values of 0.003 and 0.001 respectively for j in the equation: Efficiency = $1.0 - e^{-j(\text{amount available})}$

A, B & C represent values of 9.6, 8.0 and 6.3 respectively for k in the equation: Proportion of green in diet = $1.0 - e^{-1.2k\,(\text{prop. green available})}$