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AN ECONOMIC COMPARISON OF ROTATIONAL AND PERMANENT GRASSLAND BY A MODEL

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ABSTRACT

The pattern of yield over time and the persistence of resown grassland depends very much on the ecological and management conditions. The costs of establishment, the productivity and the persistence of the sward and the utilisation of the forage are the main economic factors. Rotational grassland is only economically viable if the total costs of reseeding are at least compensated by higher yields. Variation of the parameters in a model shows the conditions under which rotational grassland is more economic than permanent grassland.

INTRODUCTION

The reseeding of permanent grassland with cultivars of high productivity has been widely advocated in recent years. Often the replacement of permanent by rotational grassland is undertaken without consideration of the enormous variation in ecological conditions and the complex interactions between economics, productivity, persistence and utilisation of the forage.

MATERIAL AND METHODS

As a measure of economic benefit from replacing rotational by permanent grassland the average discounted gross margin ($\overline{DG}$) was chosen. To obtain $\overline{DG}$, formula (1) is used (Koehne, 1966).

$$\overline{DG} = q^N \frac{(q - 1)}{(q^N - 1)} \sum_{i=1}^{N} (GM_i/q - A) \qquad (1)$$

$\overline{DG}$ = average, discounted gross margin (N years)

GM_i = gross margin in the i-th year

i = 1, 2, 3, ..., N

A = investment costs for reseeding

$1/q^i$ = factor of discountation, where

$q = 1 + \frac{P}{100}$ and P = interest in %

The optimal length of rotation is indicated by the maximum value of the $\overline{DG}$. In Figure 1 two cases of yield development and the corresponding $\overline{DG}$s are demonstrated under given economic conditions. The factors influencing the economic superiority of rotational versus permanent grassland are shown by transformation of formula (1) when we get:

$$ANB = PCD\ q^{N} \frac{(q - 1)}{(q^{N} - 1)} \sum_{i=1}^{N} (YD_i q^{-1} - A/PCD) \tag{2}$$

ANB = average discounted net benefit of replacing permanent by rotational grassland.

YD_i = yield difference in the i-th year.

PCD = price-cost difference per kilo of starch equivalent in the field (KSTE).

The rotation is economic only when ANB > 0. As formula (2) shows, the economics of the rotation depend on: I interest (P); II costs of investment for reseeding (A); III price-costs difference (PCD), per KSTE in the field; IV yield development (YD).

While items I and II are considered to be fixed in this investigation, the consequences resulting from changing items III and IV are illustrated.

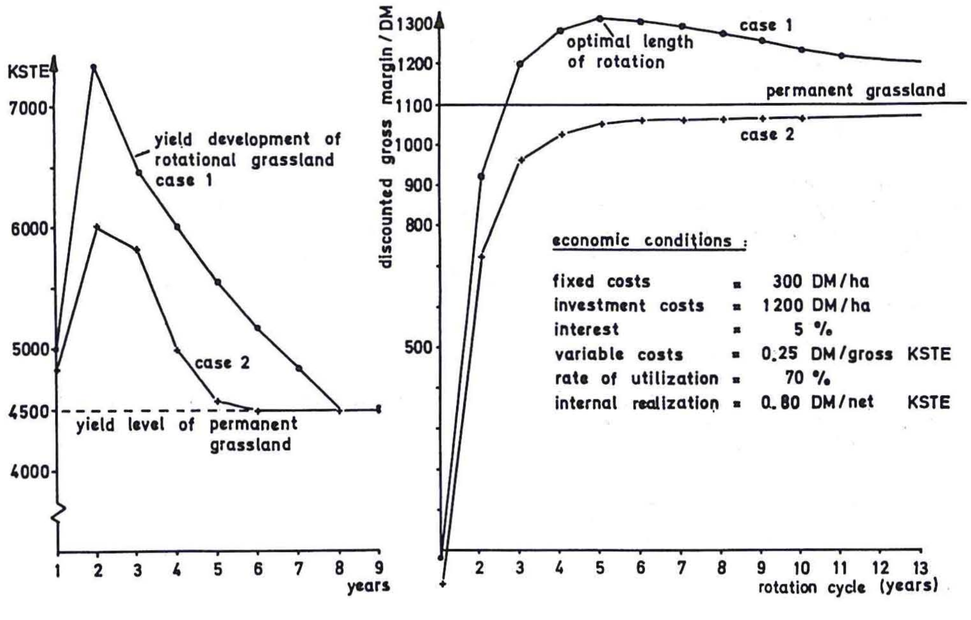


Fig. 1. Two cases of yield development (left) and corresponding discounted gross margins (right).

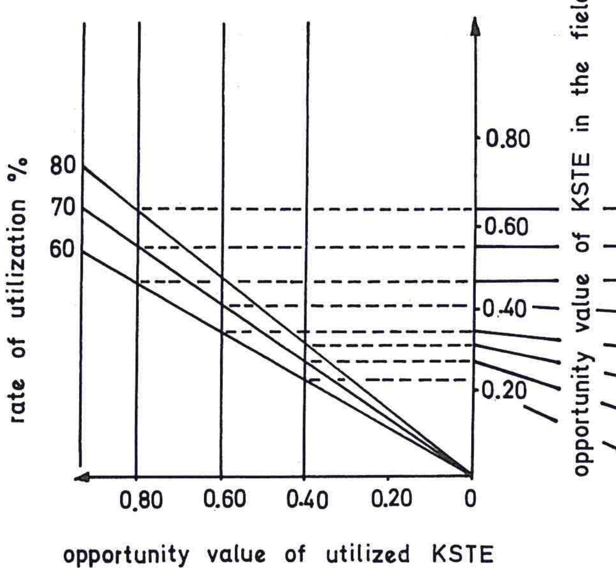
RESULTS

Consequences of the price-cost difference

The relationships between costs of production and opportunity value of the utilised yield are shown in Tables 1 and 2 for permanent grassland and for cases 1 and 2 of rotation grassland. The opportunity value for utilised KSTE depends on the animal production system applied on the farm. The relationship between the opportunity value for utilised grass and grass in the field depends on the rate of utilisation of the standing grass. The gain from replacing permanent by rotational grassland increases as the price-cost difference increases. The larger the price-cost difference becomes the sooner a rotation becomes superior.

TABLE 1

THE INFLUENCE OF THE OPPORTUNITY VALUE, THE RATE OF UTILISATION AND THE VARIABLE COSTS ON THE PRICE-COST DIFFERENCE (DM/KSTE)



variable costs (DM/KSTE in the field)			
0.25	0.20	0.15	0.10
price-cost difference (DM/KSTE in the field)			
0.39	0.44	0.49	0.54
0.31	0.36	0.41	0.46
0.23	0.28	0.33	0.38
0.17	0.22	0.27	0.32
0.11	0.16	0.21	0.26
0.07	0.12	0.17	0.22
0.03	0.08	0.13	0.18
-0.01	0.04	0.09	0.14

further economic conditions	
fixed costs	300 DM/ha
investment	1200 DM/ha
rate of interest	5 %
length of period	15 years

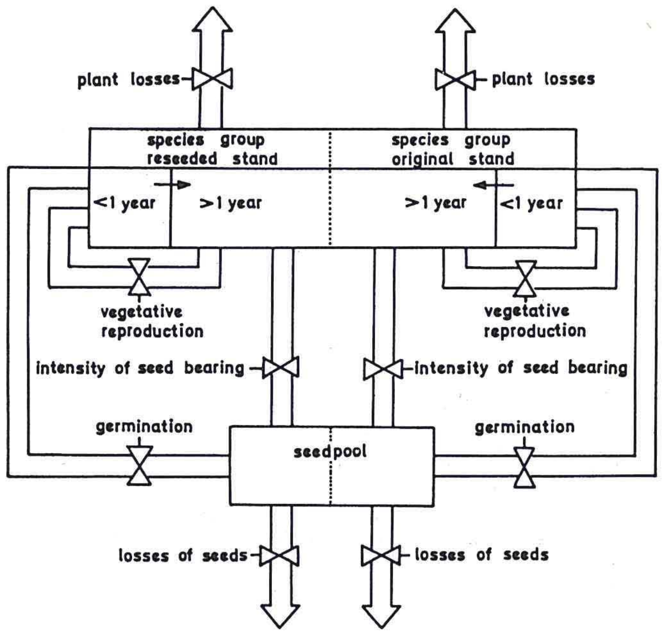


Fig. 2. Flow diagram of grassland development.

TABLE 2

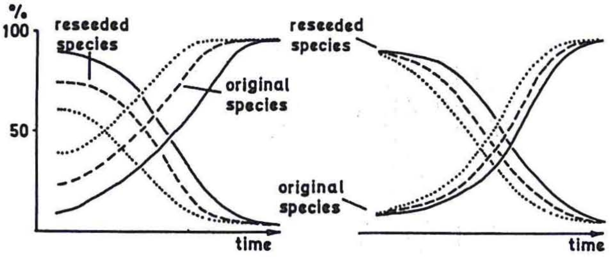
THE INFLUENCE OF THE PRICE-COST DIFFERENCE (DM/KSTE) ON THE GROSS MARGINS OF PERMANENT GRASSLAND VERSUS ROTATIONAL GRASSLAND

Variable costs DM/KSTE in the field	0.25	0.20	0.15	0.10
Net margins (DM/ha) of permanent	1455	1680	1905	2130
grassland yielding 4500 KSTE/ha	1095	1320	1545	1770
(values corresponding to values of	735	960	1185	1410
Table 1)	465	690	915	1140
	195	420	645	870
	15	240	465	690
	-165	60	285	510
	-345	-120	105	330
Discounted net benefit (DM/ha) of	(5)	(5)	(5)	(5)
rotational grassland, yield devel-	347	427	507	587
opment case 1, optimal length of	(5)	(5)	(5)	(5)
rotation in brackets	219	299	379	459
	(6)	(6)	(5)	(5)
	101	174	251	331
	(7)	(7)	(6)	(5)
	17	86	160	235
	(-)	(7)	(6)	(6)
	-35	4	72	145
	(-)	(-)	(7)	(6)
	-63	-27	17	86
	(-)	(-)	(-)	(7)
	-93	-57	-20	31
	(-)	(-)	(-)	(-)
	-123	-86	-50	-13
Discounted net benefit (DM/ha) of	(5)	(4)	(4)	(4)
rotational grassland, yield devel-	16	56	101	146
opment case 2	(-)	(-)	(5)	(4)
	-18	-3	31	74
	(-)	(-)	(-)	(5)
	-43	-28	-12	9
	(-)	(-)	(-)	(-)
	-63	-47	-31	-15
	(-)	(-)	(-)	(-)
	81	-65	-50	-34
	(-)	(-)	(-)	(-)
	-94	-78	-63	-47
	(-)	(-)	(-)	(-)
	-106	-90	-75	-59
	(-)	(-)	(-)	(-)
	-119	-103	-87	-72

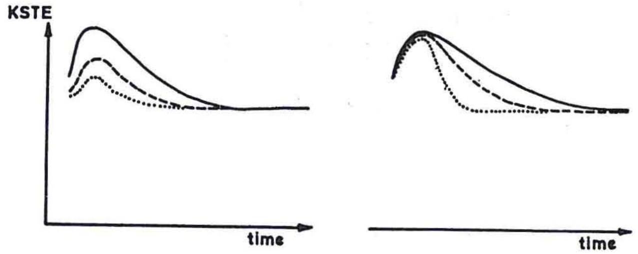
Consequences of the yield development

The factors influencing the yield development are based on plant population dynamics. The flow diagram (Figure 2) shows the basic relationships within the simulation model. Investigations of the behaviour of the model facing external variables reveal two salient characteristics as regards yield development. a) The yield development depends on the initial conditions at establishment. b) The yield development depends on the speed with which the botanical composition of the sown sward deteriorates (Figure 3).

The economic relevance of the initial conditions is clear and it is the task of the farmer to see that they are as favourable as possible. The



Change in species groups



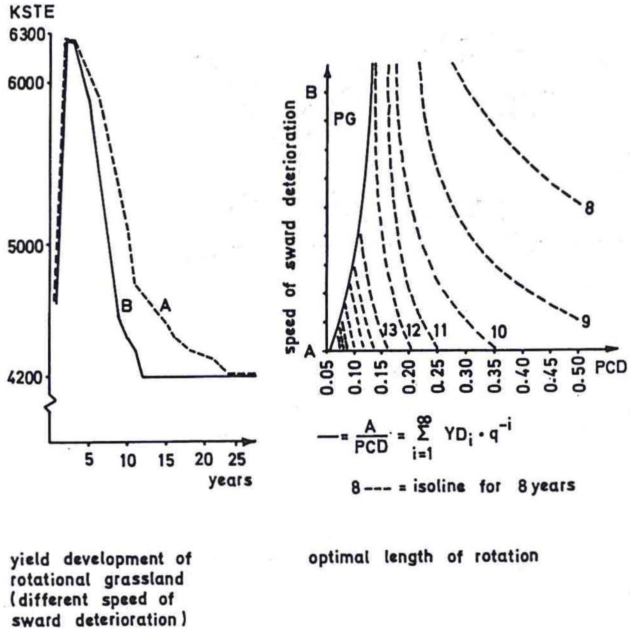
Development of total yield

Fig. 3. Modification of species groups and yield development by initial conditions (left part) and by changes in the botanical composition of the sward (right part).

influence of the speed of sward deterioration will be further investigated from an economic point of view. For the possible yield development indicated in Figure 4, isoclines for the optimal length of rotation and the discounted net benefit of rotational versus permanent grassland are reached at quite different levels of the price-cost difference for yield developments A and B respectively. The lower the speed of sward deterioration in the highly productive reseeded grassland, the more profitable rotational grassland becomes. The rate of mortality and reproduction of both the sown and the original species groups is the key to the speed of sward deterioration. A better adaptation to the ecological conditions causes a lower rate of mortality and a higher rate of reproduction. Permanent grassland is usually best adapted to the ecological conditions at the site. The sown cultivars usually have a higher productive potential but are not as well adapted to the ecological conditions. There seems to be a relation between high productive potential and poor ecological adaptation. Again it is the task of the farmer to use all practicable possibilities of management to sustain the conditions which are most favourable to sown cultivars.

CONCLUSION

A clear decision on whether permanent grassland or rotational grassland is the more economic is not possible. The superiority of either depends on many economic and biological conditions and their interactions. The rate of utilisation of the standing grass, the opportunity value of the forage and the costs of production and investment are the most important economic factors. The initial conditions after reseeding, productivity and the development of the yield are the most important biological factors. The improvement of ecological and management conditions in accordance with the needs of highly productive sown cultivars will improve their persistence and economics. There is no reason to believe that a re-seeding of poor permanent grassland necessarily involves switching from permanent to rotational



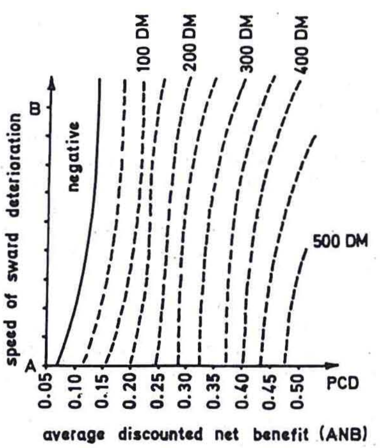


Fig. 4. Optimal length of rotation and discounted net benefit, as a function of yield development and price-cost difference.

grassland. It should be possible by improving the environment after sowing improved cultivars, to establish new permanent grassland of high productivity.

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Koehne, M., 1966. Theorie der Investition in der Landwirtschaft. Berichte über Landwirtschaft 182, Hamburg und Berlin.