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LIVESTOCK PRODUCTION SYSTEMS IN A HIGH RAINFALL, DIVERSIFIED FARMING AREA: THE NORTHERN DRAKENSBERG GRAZING REGION[1]

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Abstract

Overwintering of livestock has been regarded as a major problem in the Drakensberg grazing regions, which are characterized by high rainfall, cold winters and uneven topography. The latter limits arable land and this leads to mixed farming. The natural vegetation is predominantly sour veld; natural grazing becomes unpalatable and indigestible in winter. Farmers have for long handled this livestock overwintering problem by moving animals to grazing outside the region. The practice has been dying out. Linear programming was used to determine optimal livestock and cropping systems. The most profitable farming enterprise was shown to be dairying. Grazing and arable land should supply the dairy herd with its roughage needs and after these needs are satisfied, the remainder of arable land should be used for cash crops (maize and dry beans), leaving no room for either beef cattle or woolled sheep. If the farmer does not want to keep dairy cattle, his second best choice - with much lower profitability - is a combination of cash crops and woolled sheep. Sheep numbers have to be adjusted to the ability of natural grazing and crop residues to sustain their nutritional needs. It does not pay to use arable land to produce feed or pastures for sheep. Beef cattle cannot compete economically with either dairy cattle, sheep or cash crops. Thus, the main problem in this region is not overwintering, but rather selection of optimal farming systems.

Samevatting

Die oorwintering van vee word beskou as 'n belangrike probleem in die Drakensbergweistreke wat gekenmerk word deur hoë reënval, koue winters en ongelyke topografie. Laasgenoemde beperk bewerkbaarheid van grond en dit lei tot gemende boerderysisteme. Die natuurlike plantegroei is oorwegend suurveld; natuurlike weiding word onsmaaklik en onverteerbaar in die winter. Boere het lank hierdie vee-oorwinteringsprobleem gehanteer deur met hul vee na weidings buite die gebied te trek. Hierdie praktyk is besig om uit te sterf. Lineêre programmering is gebruik om optimale vee- en gewasproduksiesisteme te bepaal. Dis aangetoon dat suiwelboerdery die mees winsgewende boerderyvertakking is. Weiveld en bewerkbare grond moet die suiwelkudde voorsien van ruvoerbehoeftes en nadat aan hierdie behoeftes voldoen is moet die res van die bewerkbare grond gebruik word vir kontantgewasse (mielies en droëbone). Dit los geen ruimte oor vir vleisbeeste of wolskape nie. As die boer nie suiwelbeeste wil aanhou nie is sy tweede beste keuse - wat heelwat minder winsgewend is - 'n kombinasie van kontantgewasse en wolskape. Skaapgetalle moet aangepas word by die vermoë van die natuurlike veld en oesreste om aan hul voedingsvereistes te voldoen. Dit betaal nie om bewerkbare grond te gebruik vir voerproduksie of aangeplante weidings vir skape nie. Vleisbeeste is nie in staat om ekonomies met suiwel, skape of kontantgewasse mee te ding nie. Die hoofprobleem in hierdie gebied is dus nie oorwintering nie, maar eerder die keuse van optimale boerderysisteme.

1. Introduction

Overwintering of livestock has for long been regarded as an important problem in high rainfall, sour veld areas. Much of the vegetation (predominantly grass) can provide lush grazing for livestock in summer, but loses palatability, digestibility and nutritional value in winter. Farmers have to find ways to provide alternative sources of winter feed.

In the Drakensberg regions many farmers have traditionally handled this problem by acquiring land in parts less affected by seasonal changes in the use value of natural grazing. They retained their farms in the high rainfall, sour veld region as their main base of operations, and moved their livestock to the winter grazing farms for approximately three to four months per year.

As agriculture became more commercialised and land prices higher, this practice became more expensive, and its importance waned. By 1985, approximately 27 per cent of farmers in the Drakensberg grazing regions still trekked with livestock, mainly with sheep (Minnaar, 1990).

Livestock can utilize the following feed resources in addition to, or instead of natural grazing: purchased feeds, self produced feeds, crop residues and planted pastures. This implies cash outlays and/or competition with cash cropping. Different types of livestock with different feed requirement compete for available resources. This implies that the real problem is more complicated than a mere partial problem of how to provide winter feeding to a specified quantity of livestock in the most economical way.

The real problem is to find the most economical way to use available resources to achieve an output of marketable products; it is one of selecting an optimal combination of livestock types, cash crops and feed crops on a farm, given resource constraints.

A Study was done to determine such optima in a part of the Drakensberg Grazing Region.

2. Area and farm system description

In the research, an attempt was made to determine an optimum organization for what may be regarded as a representative farm in the Northern Drakensberg grazing region, with Ermelo as the main centre.

In this region, mean annual rainfall varies between 600 and 1000mm, of which approximately 85 per cent occurs between October and March. The mean precipitation varies sharply over short distances (Weather Bureau, 1986; Afdeling Landbouproduksie-ekonomie, 1967). The precipitation has a high degree of reliability (approximately 80 per cent) (Transvaalstreek, 1985:5) and the region is also characterized by mist, cloudiness and high relative humidity (Transvaalstreek, 1985:7).

The region is regarded as temperate to cold, with a comparatively short growth period (Kotze, 1985). Frost occurs regularly in May, June, July and August (Transvaal Region, 1976), and snow often occurs during winter.

A variable topography and differences in soils limit arable areas (Transvaalstreek, 1983). The natural vegetation is sour grass, and acidification has occurred over the last 115 years. Grazing practices have contributed to deterioration of natural grazing (Acocks, 1975:5-7).

The present predominant farming system is a diversified one; livestock consists mainly of dairy cattle, woolled sheep and beef cattle. Arable land is used for feed crops and cash crops, particularly maize and dry beans. Approximately 27 per cent of farmers trek with livestock; there appears to be an inverse relationship between this practice and availability of crop residues (Minnaar, 1990).

3. Empirical model and data used

Linear programming was used to determine profit maximizing enterprise combinations, including intermediate production activities, for representative farms in the region. The model maximised sum of gross margins. It was a deterministic model and did not consider factors such as liquidity or solvency. Neither was risk included in the form of variability; the model was a pure static one.

Cropping activities included cash crops (maize and dry beans), maize silage, pastures (Eragrostis, kikuyu, rye, radishes and oats grazing) and hay (teff and eragrostis). Three types of livestock were considered: dairy and beef cattle and woolled sheep. Production of fodder (also from natural grazing) was determined on a monthly basis and expressed in terms of dry matter (DM) in kg per ha, metabolic energy (ME) in Mega Joules (MJ) per ha and digestible crude protein (DCP) in kg per ha. Estimates were made of quantities of unutilized nutritional value which could be transferred for use in subsequent months[2]. The nutritional needs of livestock were expressed in the same terms[3].

The constraints in the model firstly consisted of constraints regarding available arable land and natural grazing. These constraints were based on median values obtained in a mail questionnaire survey carried out by Minnaar (1990).

Transfer activities formed an important part of the constraint matrix. Livestock numbers were constrained by feed requirements which could be met by natural grazing, feed crops, pastures, crop residues and feed purchases.

Some constraints were arbitrary: The dairy enterprise was limited to 115 cows lactating at any time (thus 393 animal units) and feedlots were not considered. Other arbitrary constraints will be noted when results are presented.

Gross margins for livestock enterprises and cash crops and variable costs to fodder crops were based upon results of group discussions. The COMBUD routine of the Directorate of Agricultural Economics was used for the compilations. Gross margins as developed by Horn (1990) of the OTK were used as a benchmark of comparison, although these are strictly speaking not quite comparable, since some types of costs are handled differently.

Separate solutions were obtained for four types of farm organization: Dairy farmers, some who use the trek system for sheep and other who do not use the trek system and non-dairy farmers, also divided amongst those who employ the trek system and those who do not.

However, since the results obtained generally revealed the same phenomena, results of only one group will be presented.

The results have all been found to be feasible in terms of livestock numbers that could be sustained, given the yield and use coefficients.

4. Empirical results

Results are presented for a farm situation in which the total usable area of 1264,5 ha consists of 276 ha arable land and 988,5 ha natural grazing, of which 662 ha are sour veld and 326,5 ha mixed veld. Different enterprise constraints were introduced to cater for individual preferences, thus leading to different optimum solutions. These constraints were as follows:

(i) In the initial solution, arable land was divided between cash and feed crops in exactly the same proportion as represented by the median in the survey for farmers who do not move livestock to other farms for winter grazing. Livestock numbers were constrained both to feed availability and, as a maximum, the median numbers kept by farmers at the time of survey (Solution A).

(ii) A solution was also obtained for a situation where dairy cattle were constrained to a maximum of 393 animal units (AU). Winter licks were constrained to a maximum of 10 tons. Beef cattle and sheep were constrained by available feed, and the model had to optimize use of arable land (Solution B).

(iii) In another model, no livestock would be kept; the solution became one of optimal selection of cash crops (Solution C).

(iv) In another analysis, it was assumed that the farmer would not keep any dairy cattle. Beef cattle and sheep were constrained by feed availability (Solution D).

A few other constraints were also introduced, eg. zero beef cattle, zero sheep and zero feed purchases. These constraints were found not to be limiting, and results were in each case identical to one of the solutions to be presented. Results are summarized in Table 1.

The most striking point emerging from the results is the relative profitability of dairying in this region and its potential effect on profitability of the whole farm unit. In Solution B, where dairy cattle were subjected to only one real constraint (animal units fewer than or equal to 393) the optimal solution included the maximum allowable number of dairy cattle. Although the model permitted the purchases of roughage, the solution did not include any such purchases. The only feed purchases consisted of dairy rations and licks. The major part

of the arable area (205,2 ha out of 276) was devoted to production of hay and to pastures, with the remaining 70,8 ha used for the production of maize and dry beans as cash crops.

Table 1: Summary of results obtained by linear programming

Model	A	B	C	D
Constraints:				
Dairy cattle (AU)	S*	≤ 393	= 0	= 0
Beef cattle (AU)	S	≥ 0	= 0	≥ 0
Sheep (AU)	S**	≥ 0	= 0	≥ 0
Arable land use (ha)	V**	W***	W	W
Purchase of licks (t)	≥ 0	≤ 10	-	≤ 10
Land use:				
Sour veld (ha)	662,0	662,0	662,0	662,0
Mixed veld (ha)	326,5	326,5	326,5	326,5
Maize grain (ha)	151,3	56,6	220,8	215,8
Maize silage (ha)	-	-	-	-
Dry beans (ha)	31,7	14,2	55,2	53,9
Eragrostis past. (ha)	-	56,2	-	-
Eragrostis hay (ha)	36,0	19,3	-	3,5
Kikuyu pasture (ha)	-	-	-	-
Rye (ha)	-	-	-	-
Oats (green fodder) (ha)	-	91,7	-	-
Radishes (ha)	-	-	-	-
Teff (ha)	18,0	16,3	-	2,8
Crop sales:				
Maize (tons)	454,0	169,9	662,0	647,4
Dry beans (tons)	49,4	22,1	86,1	84,1
Eragrostis hay (ha equivalent)	13,6	-	-	-
Feed purchases:				
Teff hay (ha equiv.)	2,3	-	-	-
Dairy concentrate (t)	6,1	56,8	-	-
Winter licks (tons)	53,2	10,0	-	10,0
Total feed crop area (ha)	93,0	205,2	-	6,3
Livestock:				
Beef cattle (AU)	-	-	-	-
Dairy cattle (AU)	42,0	393,0	-	-
Sheep (AU)	21,9	-	-	18,5
Sum of Gross Margins	93265	279499	77989	78357

* S - Maximum number: those on farm during survey or feed availability
** V - Same proportion as during survey
*** W - Constrained by total area available

Crop residues were also utilized by the dairy herd, as was the natural grazing, leaving no room for either beef cattle or sheep. This system yielded a sum of gross margins of R279 499, which is a multiple of those obtained in other solutions.

Another important conclusion is the inability of beef cattle to compete with either dairying or woolled sheep. These results are particularly striking in the light thereof that in the research, calculated gross margins for beef cattle and sheep favoured these enterprises *vis-a-vis* dairying if relative gross margins are compared with those obtained from members of the OTK Cooperative. A comparison is shown in Table 2.

In Solution B, the dairy herd would use up all the available feed (produced, purchased, crop residues and natural grazing). When one turns one's attention to solution A, the comparison between the optimal solution and mean livestock numbers tends to underscore these findings. These numbers are shown in Table 3.

Table 2: Livestock gross margins (feed costs not included)

Livestock type	Gross margin Rand per AU
Beef cattle	
OTK, Average*	197,00
OTK, Upper third*	309,00
This study	245,34
Sheep:	
OTK, Average*	366,60
OTK, Upper third*	452,4
This study	473,45
Dairying:	
OTK, Average*	975,73
This study	898,81

* Source: Horn (1990a)

Table 3: Livestock numbers (Animal units)

Livestock type	Survey median	Solution A
Dairy cattle	42	42,0
Beef cattle	216	0
Sheep	244	121,9

Thus, when livestock numbers were constrained so as not to exceed the numbers during the survey and feed crops to use the same area of land, the solution dictated dairy cattle to be kept at the upper bound, sheep numbers to be halved, and beef to be eliminated from the system. Beef cattle showed a complete inability to compete with either sheep or dairy cattle.

In Solution D no dairy cattle was allowed in the system. The results were comparable to those of Solution C in which no livestock would be kept. Only a small number of sheep would be kept, and arable land would be used almost exclusively for cash grain cropping. A small area (6,2 ha) would be devoted to the production of Eragrostis hay and teff. The overwintering problem would largely be handled by using crop residues and reducing sheep numbers to the level that could be sustained over winter by these feed sources. The production of feed crops for woolled sheep does not appear to be a viable proposition. The alternative of renting out surplus natural grazing during summer at a rental of R20 per hectare is more profitable than expanding sheep with the aid of feed or using the grazing for beef animals.

Table 3 also lends some support to the notion that natural veld is heavily overgrazed in this region. Overgrazing and injudicious grazing have been identified as a serious problem in practically all parts of South Africa in which wool farming is practiced (De Klerk *et al*, 1983:18). According to the Transvaal Region (1984:31) degradation of natural grazing in this area is not primarily the result of drought but rather of grazing mismanagement.

The results therefore indicate that dairy farming is the most profitable enterprise in this region. Production of roughage for a dairy herd is the most economic use of arable land, with cash cropping (mostly maize) being the second most lucrative - but much less so. The use of arable land to produce feed for woolled sheep does not appear to be economically justified; it

pays better to reduce sheep numbers to a level that can be almost completely sustained by natural grazing and crop residues.

5. Conclusion

The results obtained vindicate the opinion that the livestock problem in the high rainfall sour veld areas of the Drakensberg grazing regions is not primarily one of supplying sufficient winter feed for existing livestock. It is rather one of adjusting resource use and production systems to the natural and economic environment with the purpose of optimizing results.

The two most rational choices for farmers in this area, given the present economic environment, will be to concentrate either on dairying or on a combination of cash crops and woolled sheep.

Under present conditions dairying will by far be the most remunerative option. If this system is chosen, the arable land should mainly be used as pasture and for fodder production. After the requirements of the dairy herd have been meet, the remainder of the arable land should be used for cash cropping (maize and dry beans). The dairy herd will, in this process, also use all available roughage from crop residues and natural grazing. The farm should supply all roughage; only licks and dairy concentrates should be to purchased as feeds. The best use of the land resource appears to be supply a profitable dairy herd with its roughage needs and to use what remains for cash crops.

The second viable alternative appears to be the use of the arable land mainly for cash crops, and to keep sheep to utilize natural grazing and crop residues. A very limited amount of arable land should then be used to produce some hay and green fodder for sheep. Considerable plantings of pastures or feed crops for the purpose of sheep production do not appear to be viable. Neither does beef farming seem to be able to compete with either dairying, sheep or cash cropping for the use of land resources in these regions.

A third alternative which appears to yield almost as good results as the sheep - cash cropping alternative is to concentrate on cash cropping and rent out the unused grazing.

These results tend to indicate that land conversion which will change crop land over to fodder production and pastures will in these areas be viable only if the fodder and pastures are used for dairying. If, however, the whole region would get onto the bandwagon, the dairy market may become oversaturated.

The results also tend to support the notion that grazing in these parts have been heavily overstocked and mismanaged.

Notes

1. Based on an MSc (Agric) thesis by HA Minnaar at the University of Pretoria. The authors are indebted to Prof J van Zyl and Mr WF Lubbe for numerous suggestions. The research was funded by the Directorate of Agricultural Economics.

2. Sources for production of feedstuffs: Daines (1987), Kohlmeyer (1988), McDonald *et al* (1981), Van der Merwe (1977), Barnes (1988), Bekker (1987), Meissner (1986), Eden (1988), Esterhuizen (1988), Natal Region (1983a:82), Osterhoff *et al* (1979), Rethman (1988), Schoonraad (1985), Van Heerden (1986), Van Heerden (1988), Paulsmeier (1987).

3. Sources for nutritional needs by livestock: Meissner (1986), Natal Region (1983a:8), Natal Region (1985a:64-152), Natal Region (1985b), Natal Region (1983b:8).

4. These areas represent the median calculated from the mail questionnaire survey (Minnaar, 1990) for farmers who do not move their livestock to separate farms for winter grazing.

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