

A PROPOSED METHOD OF VELD CONDITION ASSESSMENT FOR THE WINTER RAINFALL REGION

MB Bayer

Introduction

The Department of Agriculture and Water Supply (1985), in an action programme based on a Whitepaper on Agricultural Policy (1984), stressed the need for grazing capacity norms by which stock and game numbers could be limited according to the capacity of the environment to carry them. Such norms, based largely on the judgement and experience of officials of the Department in liaison with farmer groups, are available for the Winter Rainfall Region. These norms are to a degree based on available knowledge of climate, soils and vegetation of the area as well as on practical experience. Nevertheless, there has been no objective quantified method for verifying or modifying these norms. The problem always remains that while the norms recognise the overall potentials of the respective areas, there is no mechanism whereby veld condition in particular camps or on particular farms can be related to the relevant norms. The principal need for assessing veld condition is thus for determining the potential for animal production for both long and short term decision-making purposes. Its accurate measurement is essential for assessing stocking rate and management options to ensure long-term and sustained production.

Tainton (1988) reviewed the various methods for assessing veld condition and trend in South Africa, and pointed out that no technique was then available for the winter rainfall region. Two areas are recognised by the Department of Agriculture Development which need to be considered in relation to a mediterranean climate, one is the Karoo Agricultural Region and the other is the Winter Rainfall Region. Possibly the Eastern Cape Region at its south-western point could also be regarded as a winter rainfall zone. This subdivision may thus not be entirely appropriate phytogeographically. Bayer (1984) saw good reason to suggest that the concept of the Cape Flora (a winter rainfall flora) was confounded with and limited to Fynbos. It was more correct to view the Karoo, for historical reasons, also as a winter rainfall flora. There is therefore no good reason to consider the extensive rangeland areas of the socio-political Winter Rainfall Region as greatly different from that of the Karoo Region. This view was supported by Gibbs-Russell (1987), Hilton-Taylor (1987) and implicitly in the biomes recognised by Rutherford and Westfall (1986). This suggests therefore that the Ecological Index Method (EIM) of Vorster (1982) should be equally applicable to the karoid veld of the Winter Rainfall Region as it is to the greater Karoo (the Karoo Region).

The object of this paper is thus to discuss the methodology of Vorster and other veld assessment systems, their relation to veld utilization, and their applicability to the Winter Rainfall Region.

Veld condition assessment and grazing capacity

Ideally grazing capacity and stocking rate are synonymous (Booyesen, 1967), where grazing capacity is essentially the theoretical consideration and stocking rate the practical implementation. Both are for convenience, and also for obvious and real

practical reasons, either expressed in terms of hectares/stock-unit/year or per grazing season. Danckerts (1982) cautioned that for mathematical considerations, grazing capacity should be expressed in stock-units/hectare because there is a linear relationship between the number of animals and the area of land occupied. Grazing capacity was defined by Booysen (1967) as describing the productivity of an area of vegetation in terms of the area of land required to maintain a specific number of animals over an extended period without deterioration to vegetation or soil, under a particular system of management. He added that for comparative purposes it is desirable that the area be expressed in terms of the customary unit of land area measurement for the country, that the specific number of animals be a single animal unit and that the time be stated as the length of the period that grazing is useable in each year. Booysen's definition does not imply, but is clearly aimed at, definition of a situation which can be maintained over "an extended period". Danckwerts (1982a) suggested a revised definition on the rather tenuous grounds that grazing capacity may change due to "fluctuations in rainfall or changes in veld condition". His revised definition thus added nothing new other than to limit grazing capacity to grazing season and make provision for change outside of one season. This seems to confound and defeat the object of the original definition and in any case Booysen does make provision for grazing season too. Probably both definitions have limitations in that they attempt to serve two goals, the long-term and the short-term. For practical reasons a definition is needed which relates grazing capacity to a fixed time-schedule and preferably a calendar year. For this discussion the following definition is thus used: "Grazing capacity is the number of hectares required in the long term to sustain a stock-unit at maximum production under normal fluctuating climatic conditions, without any deterioration of the resource. It is expressed in ha/su/year." While grazing capacity may well be a theoretical abstraction (Tidmarsh, 1971), the overall stocking rate (and manipulation thereof) which achieves the goals of sustained maximum production in any production system is the correct grazing capacity within that system.

Roux (1966) observed that fluctuations in the vegetation as brought about by the fluctuation in seasonal rainfall are regarded to be one of the main causes of the instability and dynamic nature of the vegetation of the eastern mixed Karoo. Barnes and McNeill (1978) explored the role of rainfall variability in relation to both plant and animal production and discussed the complexities involved in modelling this relationship. McNaughton (1979) postulated the herbivore optimization hypothesis in which it is stated that as grazing intensity increases, so does net primary production increase to some optimum level. This phenomenon is commonly recognised in the colloquial expressions "sonder beweiding raak veld stokkerig", and "veld moet mak gevreet word". Grossman (1982) discussed the practical and interpretive problems of measuring primary production in some detail without specifically considering the role of rainfall, while Szarek (1979) reported on ecophysiological studies aimed at determining such production in North American deserts. Sneva and Hyder (1960) presented a method of predicting herbage yield of rangeland in semi-arid regions from median precipitation. Shiflet and Dietz (1974) were also successful in relating production to rainfall in a higher rainfall area but reported that they could not arrive at a prediction early enough for it to influence management decisions adequately. Kruger (1983) utilised rainfall in his estimates of grazing capacity in the western Transvaal and recommended that the rainfall levels of the current season be used to calculate grazing capacity (stocking rate) for the following season. This is an important consideration echoed by Danckwerts in substituting total rainfall received in the 12-month period preceding

assessment of current grazing capacity. Van den Berg (1983) investigated the relationships between long-term average rainfall and grazing capacity of the arid areas of South Africa. He concluded that there was a positive correlation between the recommended grazing norms of the Department of Agriculture and mean annual rainfall. However, his suggestion that therefore grazing capacity could be derived from rainfall is a circular argument. What is more interesting is his observation that grazing norms (capacities) for the Karoo were higher than for the Orange Free State, and also higher than for similar rainfall levels in Australia and the USA Skinner (1985) stated that the productive capacity of the veld per unit moisture and the relation of this to stocking rate and permissible useage, had not received the attention it warranted.

The consideration of biomass production in determining grazing capacity is becoming increasingly evident in the more popular literature (Liversidge, 1980; Fourie, 1982; Bezuidenhout, 1983; van Wyk, 1988; Nel, 1990).

Where grazing trials have been conducted and there has been some quantification of herbage production and stocking rate, there is some basis for estimation of grazing capacity. However, the dryer and more extensive the area, the more difficult it becomes to conduct meaningful grazing trials, because of the larger areas required per stock unit, heterogeneity of the vegetative cover and lessening reliability of rainfall. However, the principles of some or other assessment method and the concept of Veld Condition Score (VCS) in particular, are intrinsic to many of the methods of estimating grazing capacity (Tainton, 1988). As soon as the assessment is linked to grazing capacity it must imply a connection between veld condition and utilisation.

Roberts (1967) listed three functions of utilisation: (i) the amount of herbage produced, (ii) the proportion consumed and (iii) the efficiency of conversion. Nevertheless there seems to be an element of confusion in the literature dealing with veld condition assessment. Roberts (1970) stated that his technique for measuring "state of health" did not provide a measure of herbage present and thus could not be used as a basis for estimating grazing capacity. Despite this, the pressing need for a suitable technique to measure grazing capacity, has forced authors to link ecological status of veld to measure of herbage and thus production (Tainton, 1988). Most systems are considered to be ecologically based despite the recognition by Mentis (1983) that the ecological groups were "phantasmal". It is only Snyman and Grossman (1990) who unequivocally state that the ecological classification systems are based on the reaction of the various plant species to grazing. It is not certain that this is in fact always the case as Foran et al (1978) also recognised fire as a major factor influencing plant succession. Vorster (1982) too, classified species according "to their reaction to injudicious veld management practices and other disturbances". There are "strong undertones of Clementsian succession theory in this approach" as pointed out by Hoffman and Cowling (1987). Westoby (1980) suggested that there was a tendency to look upon grazing pressure and the tendency of vegetation to change towards a (favourable) climax, as principal opposing forces. Snyman and Grossman (1990) showed that in semi-arid regions, species may show a greater response to rainfall than to grazing and Hoffman and Cowling (1987) pointed out that there was in fact a suite of factors which need to be considered rather than a generalised succession sequence. Noy-Meir et al (1989) suggested that there were many plant species which do not respond in a consistent way to grazing intensity, and these would confound assessment techniques.

The main problem is still how to arrive at a sound estimate of potential forage production, without seriously compromising the considerations put forward by Barnes and McNeill (1978), and by Grossman (1982). Whatever the difficulties are in accurately modelling plant and then animal production in a rangeland situation, it is clear that this is the logical route that has to be taken. Barnes et al (1984) did in fact take this step but failed on the critical issue of obtaining accurate base values for production. Tainton (1988) comments that the problem in Barnes' (1984) paper was that it required a measure of species palatability. This is truer still of Barnes (1990a) which admitted to this problem. Thus, if it is true that the assessment methods are as strongly linked to the affects of animal grazing as Snyman and Grossman (1990) suggest, then clearly palatability must be a powerful factor in determining veld condition and trend. Edwards (1974) suggested that herbage yield "allowed a fair estimate of carrying capacity provided stocking rates were at an optimal level". His introductory discussion also implied that the conversion of herbage output to animal production could not be expected to be the same under all circumstances, presumably due to palatability and nutritional variables. Hobson (1989a) also warns of confusing ecological and agronomic indices.

Interpretation of the EIM

Despite the difficulties noted above, Vorster's (1982) Ecological Index Method (EIM) of veld assessment was a most notable contribution to solution of measuring veld condition in the karoid areas. However, Tainton (1988) was not wholly correct in stating that Vorster (1982) used the Ecological Index Method (EIM) to derive an estimate of grazing capacity and particularly that this value was related to a benchmark in order to do so. Hobson (1989a) points this out in adapting the EIM method for application in the Eastern Cape. In the Free State Region, a veld condition assessment is related directly to a benchmark (Snyman pers. comm., 1991; Fourie & du Toit, 1983; Fourie & Fouche, 1985) and this is what Foran et al (1978) and other authors mean by Veld Condition Score. In 1982 Vorster only proposed that EIM could be a method to couple grazing capacity to veld condition classes. It is Vorster (1981), Corster et al (1984) and Vorster and du Toit (1984, 1985) who put forward a direct link between the EIM and grazing capacity. Vorster and du Toit (1984) state "many trial runs in the Karoo Region have shown that the following formula gives reliable estimates of the present grazing capacity:-

$$\text{ha/ssu} = 650/X,$$

(where X is the "veld condition index", or
"ecological index" of Hobson, 1989)

The authors also add, "The EIM tends to give an over-estimation of the present grazing capacity in certain plant communities" (and it is important to recall Van Den Berg's, 1983, comments in this regard).

If the formula $650/X$ gives an answer expressed in ha/ssu, one needs to examine numerator and denominator. As grazing capacity is a function of potential production of the rangeland vegetation, then the formula must in some way express this. The Veld Condition Index (VCI) is in fact the key to understanding the import of the formula. The four categories of plant species are classified into Decreasers, Increasers Ila,

Increasers IIb, Increasers IIc and Invaders and these are allocated index values of 10, 7, 4, 1 and 1 respectively. Thus if there was a 100% occurrence of Decreaser species, the VCI would be 1 000, and the grazing capacity 0,65 ha/ssu. It is known if Vorster and Du Toit actually realised that 650 is closely equivalent to the annual dry matter (DM) requirement of a 60kg Dorper based on a daily intake of 3% of body weight (actually 657kg DM/year). If this is acknowledged in the equation, then the VCI is ipso facto DM production/ha/year. Thus the EIM is assigning a full value of 1 000kg/ha/year useable forage to a Decreaser species, 700kg for an Increaser IIa, 400kg for an Increaser IIb and 100kg for Increaser IIc and Invader species. These figures are irrespective of rainfall. Edwards (1974) in his discussion of herbage output and animal production should have clearly made the point that grazing capacity is the expression of the requirements of the animal on the one hand and the capacity of the veld to meet this on the other. Kruger's (1983) complex formula in which vegetation cover, vigour, soil surface-erosion, insect and rodent damage were all combined, may have flaws. The most obvious is that the enumerator (animal requirement) is the figure 657 000. This, like Vorster's (1982) formula, can be interpreted as the annual dry matter requirement (in grams) of a small stock unit, while the formula expresses grazing capacity in large stock units. A particular problem in Kruger's method lies in the calculation of a Veld Condition Score which is derived from ratings for soil erosion, insect and rodent damage in addition to vegetation cover, composition and vigour. Soil condition already must influence canopy cover, composition and plant vigour, as would insect and rodent damage. The inclusion of the product of cover and composition as a factor in the equation must be a superfluity. This product is similar to the VCI of Corster (1982) which is enhanced by the recognition of different ecological (palatability?) classes. Thus canopy cover, composition and perhaps vigour are adequate for the purpose of formulating a Veld Condition Score. Field (undated) also presented a complex formula for calculation of grazing capacity which provided for monthly temperatures, slope, annual rainfall, vegetation cover and tree cover. This formula is similarly flawed in that the enumerator (animal requirement) is confounded by both temperature and slope factors which predominantly affect herbage production (divisor).

There are two main problems which arise and which could account for the statement (Vorster & Du Toit, 1984), "The EIM tends to give an over-estimation of the present grazing capacity in certain plant communities". It has been suggested (Kirsten pers comm, 1990) that the EIM tends to under-estimate grazing capacity in the eastern (wetter) areas and over-estimate them in dryer conditions. The reasons are obvious. Firstly is the fact that dry matter production has a set level irrespective of any condition, of which rainfall at least would be critical. The EIM is not able to accommodate variable rainfall. The second problem is that of the index values. The index values may be taken to suggest that all (this is not necessarily so) material produced by Decreaser species is available as forage. If not all is available, this would mean that the production level is higher than 1 000kg DM/ha/year. Increaser IIa species produce 7/10 of the forageable material of a Decreaser species, an Increaser IIb species produces 4/10 and an Increaser IIc 1/10. Thus while the EIM is supposed to be based on ecological succession, it is in fact used as a direct measure of acceptability and forageability of the plant species classes and all production of the most palatable species is considered as available to the animal. The tendency to overestimate grazing under dryer conditions is thus aggravated by the implication that very palatable and less palatable species are being assigned to utilisation levels beyond the safe

60% of standard grazing recommendations (Siepker, 1987), or the more conservative 50% of Hobson (1984). Snyman (1985: & pers comm, 1991) states that in the Central Grassveld, to accommodate wastage, a small stock unit requires 1 000kg DM/ha/year – thus 65% of primary production is available to the animal. It is thus here where Van den Berg's (1983) observations regarding higher grazing capacities for Karoo than for Orange Free State, Australia and USA may be significant. This problem of overestimation of grazing capacity is also highlighted in comment by Vorster et al (1983) that an alternative to adjusting stock numbers to fluctuating grazing capacity, was to maintain stocking rate at approximately 50% of the long-term grazing capacity. This is another way of saying that grazing capacity is overestimated. Shearing (pers comm, 1990) commented that conservation-orientated farmers in the Beaufort West area, recognised that if they were to stock for drought contingency, they would have to stock at levels of 80% of the regional norms.

It is noteworthy that the EIM is reported to be useful at all in estimating grazing capacity, and it is also obvious that an improvement may lie in correcting the anomalies which are associated with the bruto production figure of 1 000kg DM/ha/year, connecting this to rainfall and then with the index values.

This is probably the very problem of "base value" that Barnes et al (1984) experienced and it seems obvious that this is where the link has to be sought between "ecological" and "agronomic" methods of veld assessment. It is not entirely clear how the ecological status of plant species was actually derived for purpose of the EIM but it seems that it is largely a subjective classification reflecting personal views on relative palatability. The one list available by Blom (undated) is mainly a structural classification wherein grasses are divided into successional groups and the karoo shrubs into palatability classes.

The relation of the concept of rain-use efficiency to VCI

Much of the difficulty at arriving at a "base level" of production is the difficulty in measuring primary production (Grossman, 1982). Le Houérou (1975), however, in stating that "we are at the present time on the eve of a breakthrough in range development" referred directly to the possibility of expressing average annual productivity as a function of average annual rainfall only. He in fact used two criteria to classify North African rangelands into bioclimatic areas to which he could relate yield. These criteria were mean annual rainfall, and mean of the daily minima in the coldest month. While he recognised the importance of potential evapotranspiration, he considered that as it was inversely correlated with interannual rainfall variability, mean annual rainfall only was sufficient for the purpose. Le Houérou (1984) took a further step in this direction in a review paper where he presents "rain use efficiency" (RUE) as the quotient of annual primary production by annual rainfall. He argues convincingly that RUE is a useful tool for assessing health and productivity of arid zone ecosystems. More important is his view that ground cover and aerial phytomass seem to override the effects of soil and climate in the determination of productivity per unit of available water. Le Houérou et al (1988) presents data on RUE derived from an analysis of 77 data sets from various arid zones of the world. A mean value of $4 \pm 0,34$ kg DM is obtained per hectare per year for each 1mm of rainfall. In his 1984 paper, Le Houérou puts forward the substantiated view that RUE does not vary significantly with climatic types, so that equivalent winter and summer rainfall sites would have

similar values. Snyman (pers comm, 1990) considered it probable that cool temperatures during the rainfall period in the Mediterranean region, would compensate for higher evapotranspiration in a summer rainfall zone. RUE will of course depend to a large extent on soil condition and on factors such as permeability, texture, depth, water relations and fertility status and these would have to be considered in applying the concept. Szarek (1979) arrived at a mean value of 4,2kg DM/ha/year/mm rainfall for four North American deserts. Figures derived from Gutman et al (1990) give a figure of 5,6kg for transitional Mediterranean steppe. However, for a "drier Mediterranean-site", Gutman et al quote figures of 22,5kg (9 000kg DM/ha with 400mm annual rainfall) for a deep rock-free situation with adequate plant nutrients, which is far above a next highest figure of 12,4kg of Le Houérou (1988). Le Houérou cites presumably the same source as Gutman et al (i.e. Benjamin) for his highest, but gives a figure of 18,1kg. Despite these discrepancies it seems reasonable to accept the mean value presented by Le Houérou of 4kg DM/ha/year/mm rain. Smith (Tainton pers comm, 1991) uses a system in Natal which was brought from Zimbabwe. This system rates veld in four categories of excellent to poor in the ratio 4:3:2:1, and it is assumed that the amount of forage declines on that scale from 4 to 1kg DM/ha/year/mm rain. In the Central Grasslands (Orange Free State) the production potential is in effect based on a RUE of 2kg DM/ha with the usage factor of only 65% noted above, but this is grassland as opposed to shrubland. (Snyman 1985; and pers comm, 1991: Fourie & Du Toit, 1983). It is interesting to compare RUE figures calculated from Kruger's grazing capacity tables with those from Snyman's (1985) and Danckwerts' (1982) regressions (all for grassveld). See Figure 1. It must be noted that Snyman allows for wastage and a correction should thus be added to figures calculated from Kruger's and Danckwerts' data. If the divisor in Kruger's formula is taken to be a production figure, a corresponding adjustment to the numerator must be made to correct for a large stock unit. The obvious adjustment would be to consider that Kruger's relation of LSU to SSU is a factor of 10. If the more general figure of 6 is taken, then the numerator would be 394 200 (i.e. 6 X 657 000). This correction pushes the highest RUE to 6kg DM/ha/year/mm rain.

While Barnes (1990b) does not give rainfall figures, it is possible to calculate a RUE for each of his base values using figures from available weather data for his four grazing zones. By correcting his base values to a 12-month grazing period and using rainfall data for stations in his grazing zones, an average of 2,3kg DM/ha/year/mm rain is obtained. If a 65% correction is applied to allow for wastage, this RUE

	Mean annual rainfall in mm			
	400	500	600	700
Kruger's RUE factors				

VC = 20	0,3	0,5	0,5	0,6
VC = 50	0,9	1,2	1,4	1,4
VC = 80	1,4	2,0	2,2	2,3
Corrected to 65% utilization				
VC = 80	2,1	3,0	3,4	3,5
Snyman's RUE factors				
Pioneer veld	0,5	0,2	0,3	0,9
Sub-climax	0,9	0,7	0,9	1,8
Climax	1,0	1,6	2,6	2,9
Danckwerts' RUE factors				
VC = 30	0,4	0,8		
VC = 50	0,8	1,4		
VC = 80	2,0	2,3		
Corrected to 65% utilization				
VC = 80	3,1	3,5		

Fig 1. Rain-use efficiency figures calculated from Kruger (1983) on the basis of dry matter requirement for grazing capacities and from Snyman's (1985) and Danckwerts' (1982) regression equations, both for three veld condition classes – all for grassveld.

		Grazing capacity estimates		
		a	b	c
Benchmark	VCS = 100	3.5	3.1	3.1
Site 1	VCS = 97.8	3.6	3.1	3.1
Site 2	VCS = 50.1	7.0	5.6	6.0
Site 3	VCS = 25.2	13.8	9.3	11.9

Fig 2. Grazing capacity estimates from Danckwerts (1989a & b):
 a. Calculated from a benchmark with a GC of 3,5 ha/LSU
 b. Calculated according to regression equation (Danckwerts, 1989b)
 c. Calculated according to RUE of 3,5kg DM/ha/year/mm at rainfall of 523mm and VCI of 71,4, 69,8, 35,8 and 18,1 respectively Danckwerts (1989a)

is then 3,5. An analysis of Danckwerts (1982: 1989) estimates and calculations of grazings also suggests that RUE is a practical and useful concept. A comparison of grazing capacities derived by Danckwerts (1989) and by a RUE calculation are given in Figure 2. (Here the RUE of 3,5kg DM was based on the figure of 2,3 from Fig 1, adjusted for 65% usage).

The considerations by authors in Danckwerts and Teague (1989) are very thorough and considerable attention is paid to the problems of arriving at grazing capacity. Stuart-Hill (1989) particular warns against of using proportional species composition alone for prediction (of grazing capacity) in arid zones, but no one in the literature referred to here has in fact suggested this. Composition has always been related to canopy cover as well. Hobson (1989b) warns that a vegetation survey is affected by grazing and theoretically it could be argued that after grazing a survey should indicate a zero grazing capacity. The point is thus made that vegetation surveys should be conducted bearing in mind recent grazing history.

The application of the EIM to the Winter Rainfall Region

The concept of RUE may hold considerable promise for the practical modification and application of the EIM to the problem of assessing veld condition and then determining a production potential. Firstly, the EIM has to be seen as an agronomic assessment system in which the plant species are categorised in terms of their acceptability to animals. This is already available for the Winter Rainfall Region in two lists (Louw and Beukes for the Northwest Subregion, 1988; and an unpublished list by van Breda, Nel and Bayer for the Boland and Little Karoo Subregions, 1990). In these lists the species are grouped into four categories viz. (i) highly palatable, (ii) palatable, (iii) less palatable (iv) unpalatable. For the Winter Rainfall Region it is proposed that the RUE figure of 4kg DM, be used to arrive at a base value for the potential productivity of any area and that a VCI is then calculated to determine the degree to which that potential can be realised. Thus RUE is used to arrive at the level of biomass production for a site and VCI is used to assess how closely that potential is approached and how much of that biomass is usable forage.

The potential for the site is obtained by multiplying the RUE figure of 4kg DM/ha/year/mm rain, by the mean annual rainfall. A vegetation survey is done using a descending point method with intervals of 1 meter and canopy spread is recorded. Each 1% of canopy represents 1% of potential production and hence by multiplying scores for each of the three categories of palatability by the appropriate index, an assessment is obtained of available usable forage. It is suggested that the index values are assigned to provide for 90% removal of highly palatable species, 50% of palatable species and 20% of the less palatable species. The figure for available forage is divided into 650kg DM/ssu/year to finally give grazing capacity in ha/ssu. The method incorporates the generally accepted principle that good veld condition is correlated with production and incidentally the Acocks' (1988) premise that at one time there van have been no part of the Republic which did not have a closed cover. Thus the EIM as it stands is not recommended because:-

- a) the biomass production estimate of 1 000kg DM/ha is inflexible. At a rainfall of 200mm p.a. would be equivalent to a RUE of 5kg DM/ha/year/mm rain which is too high.
- b) the index values are too high. At 10 (100%) for highly palatable species, it calls for total consumption and at 7 (70%) for palatable species, the level is above safe limits (Siepker, 1987; Hobson, 1984).

It is contended that this system as adapted here, will give a very practical way of objectively determining grazing capacities and developing management strategies ba-

sed on realistic estimates of production. It recognises that production is primarily determined by rainfall and that run-off or run-in, as well as soil factors, influence production on any unit of land. Provision can be made for this in determining carrying capacity of a production unit, but in general terms it is proposed that the average RUE of 4kg be used.

Further modification and adaptation which can be made is to plan stocking rates according to monthly rainfall and thereby calculate available grazing days. What may be particularly useful is managing flocks and camps in a production system, is the use of a monthly-calculated running annual mean rainfall. Weaknesses in the system are that the forage and intake values or the different species are not accurately known. This in any case may vary in the same species from site to site and also by season. Production on the basis of annual rainfall is itself highly problematical because clearly the quantity and quality of rainfall will affect plant growth. However, these are problems inherent in all veld condition assessment techniques which attempt to relate condition to production. In any case these same variables will also confound the ultimate test which will be grazing trials for the measurement of animal production and performance. As Snyman (1985) pointed out, in the arid areas little value can be attached to experimental work which extends only over short periods. A concerted effort will be required for proper verification of this assessment technique, both by grazing trials and by herbage production studies.

Example:

Step 1

A camp is surveyed and found to have the following composition and cover:-

--	--	--

Composition and cover		Index value	Product
Highly palatable species	5%	90%	4,5%
Palatable species	10%	50%	5%
Less palatable species	30%	20%	6%
Realisable production 15,5%			

Step 2

Under a mean annual rainfall of 200mm:-

$$\begin{aligned} \text{Potential production} &= 200\text{mm/year} \times 4\text{kg DM/ha} \\ &= 800 \text{ kg DM/ha/year} \end{aligned}$$

Step 3

$$\begin{aligned} \text{Actual Production} &= 15,5/100 \times 800 \\ &= 129,5\text{kg/ha} \end{aligned}$$

Step 4

$$\begin{aligned} \text{Grazing capacity} &= 650/129,5 \\ &= 5\text{ha/ssu/year} \end{aligned}$$

Step 5

$$\text{Number of grazing days} = \text{Camp size}/\text{grazing capacity} \times 365$$

References:-

Acocks, JPH, 1966. Non-selective grazing as a means of veld reclamation. Proc Grassl Soc sth Afr 1: 33-39

- Acocks, JPH, 1988. Veld types of South Africa. *Memoirs of the Botanical Survey of South Africa*, No 57. Dept Agric and Water Supply (Botanical Research Institute). 3rd Ed pp 146
- Anon., 1984. Whitepaper on Agricultural Policy. Govt Printer, Pretoria
- Anon., 1985. Nationale Weidingstrategie. Dept Agric & Water Supply (Winter Rainfall Region). pp 21
- Barnes, DL, 1990a. A survey of grazed and ungrazed grassland in the south-eastern Transvaal Highveld. 1. Palatability, composition and grazing capacity. *J Grassl Soc South Afr* 7: 217 – 222
- Barnes, DL, 1990b. Guide to the estimation of the grazing capacity of veld in the south-eastern Transvaal. Unpublished. Dept Agric Dev (Transvaal Region). pp 8
- Barnes, DL & McNeill, L, 1978. *Proc Grassl Soc sth Afr* 13: 59 – 63
- Barnes, DI, Rethman, NFG, Beukes, BH & Kotze, GD 1984. Veld composition in relation to grazing capacity. *J Grassl Soc South Afr* 1: 16 – 19
- Bayer, MB, 1984. The Cape flora and the Karoo – a winter rainfall biome versus a fynbos biome. *Veld & Flora* 70: 17 – 19
- Bezuidenhout, J, 1983. Veld evaluation. *Farmer's Weekly* Sept 2,: 18 – 21
- Blom, CD, Undated. Group classification of Karoo plants. Unpublished Dept Agric & Water Supply (Karoo Region). pp 18
- Booyesen, P De V, 1967. Grazing and grazing management terminology in southern Africa. *Proc Grassl Soc sth Afr* 2: 45 – 57
- Danckwerts, JE, 1982a. Grazing capacity of sweetveld. 1. A technique to record grazing capacity. *Proc Grassl Soc sth Afr* 17: 90 – 93
- Danckwerts, JE, 1982b. Grazing capacity of sweetveld. 2. A model to estimate grazing capacity in the thornveld of the Eastern Cape. *Proc Grassl Soc sth Afr* 17: 94 – 98
- Danckwerts, JE, 1989a. Animal performance: stocking rate and grazing/carrying capacity of veld. In: *Veld Management in the Eastern Cape*. Dept Agric & Water Supply (Eastern Cape Region): 53 – 60
- Danckwerts, JE, 1989b. Monitoring vegetation and assessment of veld condition in grassveld. In: *Veld Management in the Eastern Cape* Dept Agric & Water Supply (Eastern Cape Region): 96 – 99
- Danckwerts, JE, 1989c. Sweet grassveld. In: *Veld Management in the Eastern Cape*. Dept Agric & Water Supply (Eastern Cape Region): 140 – 149
- Danckwerts, JE & Teague, WR, ed 1989. *Veld Management in the Eastern Cape* Dept Agric & Water Supply (Eastern Cape Region). pp 196
- Edwards, PJ, 1974. Estimates of carrying capacity and production from herbage yields and grazing days. *Proc Grassl Soc sth Afr* 9: 139 – 143
- Field, DI, undated. Potential carrying capacity of rangeland in Botswana. Unpublished. Botswana Dept Agric Field Services (Land Utilization Division). pp 16
- Foran, BD, Tainton, NM & Booyesen, P de V, 1978. The development of a method for assessing veld condition in three grassveld types in Natal. *Proc Grassl Soc sth Afr* 13: 27 – 33
- Fourie, C, 1982. Forecast your grazing potential. *Farmer's Weekly* April 9, : 32 – 35
- Fourie, JH & du Toit, PF, 1983. Weidingstudies in die Vrystaatstreek: Die bepaling van veldtoestand. *Glen Agric* 12: 5 – 9
- Fourie, JH & Fouche, HJ, 1985. Die bepaling van weidingskapasiteit vanaf veldtoestand. *Glen Agric* 14: 12 – 13

- Gibbs-Russell, GE, 1987. Preliminary floristic analysis of the major biomes in southern Africa. *Bothalia* 17: 213 – 227
- Grossman, D, 1982. Primary production of rangeland: Practical and interpretive problems. *Proc Grassl Soc sth Afr* 17: 76 – 78
- Hilton-Taylor, C, 1987. Phytogeography and origins of the Karoo flora, in *The Karoo Biome: a preliminary synthesis Part 2 – vegetation and history*. S Afr Nat Scientific Prog Rep No 142: 70 – 95
- Hobson, FO, 1984. Understanding defoliation – essential for sound veld management. Dept Agric & Water Supply (Karoo Region), Regional Newsletter, Spring: 19 – 20
- Hobson, FO, 1989a. Veld condition assessment of false karoo. In: *Veld Management in the Eastern Cape*. (Eds JE Dankwertz & WR Teague) Dept Agric & Water Supply (Eastern Cape Region): 108 – 113
- Hobson, FO, 1989b. False Karoo. In: *Veld Management in the Eastern Cape*. (Eds JE Dankwertz & WR Teague) Dept Agric & Water Supply (Eastern Cape Region): 174 – 185
- Hoffman, MT & Cowling, RM, 1987. Plant physiognomy, phenology and demography, in *The Karoo biome: a preliminary synthesis Part 2 – vegetation and history*. S Afr Nat Scientific Prog Rep No 142: 1 – 34
- Kirsten, GJC, 1989. Personal communication. Assistant-Director (Extension). Dept Agric Dev (Karoo Region)
- Kruger, JA, 1983. Bepaal self u plaas se weidingskapasiteit. *Sentraalwes-Bulletin*, Dec: 19 – 21
- Le Houérou, HN, 1975. The rangeland of North Africa: Typology, yield, productivity and development. Evaluation and mapping of tropical African rangelands – Proceedings of the seminar, Bamako, Mali, Addis Ababa: International Livestock Centre for Africa.
- Le Houérou, HN, 1984. Rain-use efficiency: a unifying concept in arid-land ecology. *Journ Arid Env* 7: 213 – 247
- Le Houérou, HN, Bingham, RL & Skerbek, W, 1988. Relationship between the variability of primary production and the variability of annual precipitation in world arid lands. *Journ Arid Env* 15: 1 – 18
- Liversidge, R, 1980. Management objectives. *Farmer's Weekly* June 18,: 10 – 12
- Louw, G & Beukes, T, 1988. Ken ons veldplante. Dept Agric Dev Northwest Subregion Newsletter,: 6 – 12
- McNaughton, SJ, 1979. Grazing as an optimization process: Grass-ungulate relationships in the Serengeti. *Amer Natur* 113: 691 – 703
- Mentis, MT, 1983. Towards objective veld condition assessment. *Proc Grassl Soc sth Afr* 18: 77 – 80
- Nel, C, 1990. Estimating veld grazing capacity. *Farmer's Weekly* Nov 2,: 15 – 18
- Roberts, BR, 1967. Pasture quality and its relation to utilization. *Proc Grassl Soc sth Afr* 2: 157 – 162
- Roberts, BR, 1970. Assessment of veld condition and trend. *Proc Grassl Soc sth Afr* 5: 137 – 140
- Roux, PW, 1966. Die uitwerking van seisoensreënval en beweiding op gemengde Karooveld. *Proc Grassl Soc sth Afr* 1: 103 – 110
- Rutherford, MC & Westfall, RG, 1986. The biomes of southern Africa – an objective categorization. *Memoirs of the Botanical Survey of South Africa* No 54
- Shearing, D, 1990. Personal communication. Chairman, Beaufort West Soil Conservation Committee.

- Shiflet, TN & Dietz, HE, 1974. Relationship between precipitation and annual rangeland herbage production in southeastern Kansas. *J Range Manage* 27: 272 – 277
- Siepkers, AJ, 1987. The optimal use of natural grazing in the Karoo Region. Dept Agric & Water Supply, Wool Production CI52: 1 – 3
- Skinner, T, 1985. Drought in perspective. *Golden Fleece* 15: 4 – 6
- Sneva, FA & Hyder, DN, 1960. Estimating herbage production on semi-arid ranges in the intermountain region. Oregon Agric Expt Station, Technical Paper No 1473: 88 – 93
- Snyman, HA, 1985. Toestand van weiveld bepaal weidingskapasiteit. *Golden Fleece* 15: 4 – 5
- Snyman, HA, 1991. Personal communication. Univ OFS, Bloemfontein, Dept Pasture Science
- Snyman, DD & Grossman, D, 1990. Shortcomings of the nearest plant methods and Dyksterhuis-related classification systems for assessing veld condition in the semi-arid regions. *J Grassl Soc sth Afr* 7: 273 – 275
- Stuart-Hill, GC, 1989. Assessing the condition/ecological status of Valley Bushveld. In: *Veld Management in the Eastern Cape*. (Eds JE Dankwertz & WR Teague) Dept Agric & Water Supply (Eastern Cape Region): 103 – 108
- Szarek, SR, 1979. Primary production in four North American deserts: Indices of efficiency. *Journ Arid Env* 2: 187 – 209
- Tainton, NM, 1988. A consideration of veld condition assessment techniques for commercial livestock production in South Africa. *J Grassl Soc South Afr* 5: 76 – 79
- Tidmarsh, CEM, 1951. Veld management studies at the Grootfontein College. 1934 – 1950. Pature Research in South Africa. Prog Rep No III, Part 1, Dept Agric Pretoria
- van Breda, PAB, Nel, EJJ & Bayer, MB, 1990. Palatability of common Karoo plant species. Unpublished. Dept Agric Dev (Winter Rainfall Region). pp 15
- van Wyk, JAP, 1988. Biomassa as basis vir bestokking. *Agricola* No 6: 12 – 16
- Vorster, M, 1981. 'n Benadering om weidingskapasiteit vanaf veldtoestand te bepaal. *Karoo Agric* 2: 17 – 19
- Vorster, M, 1982. The development of the ecological index method for assessing veld condition in the Karoo. *Proc Grassl Soc sth Afr* 17: 84 – 89
- Vorster, M, Botha, P & Hobson, FO, 1983. The utilization of Karoo Veld livestock. *Proc Grassl Soc sth Afr* 18: 35 – 39
- Vorster, M, Blom, CD, du Toit, G van N & Immelman, WI, 1984. Handleiding vir die praktiese toepassing van die ekologiese indeksmetode (EIM) vir die evaluasie van veld in die Karoogebiede. Unpublished. Dept Agric & Water Supply (Karoo Region): 1 – 18
- Vorster, M & du Toit, G van N, 1984. The ecological index method for assessing veld condition in the Karoo and sweet grassveld areas. Unpublished. Dept Agric & Water Supply (Karoo Region). pp 13
- Vorster, M & du Toit, G van N, 1985. 'n Maklike metode vir weiveld evaluasie. *Golden Fleece* 15: 43 – 45
- Vorster, M, 1987. The assessment of veld condition and trend by means of the ecological index method in the Karoo areas. Unpublished. Div Agric Resources Dev, Dept Agric & Water Supply (Karoo Region). pp 14
- Westoby, M, 1980. Elements of a theory of vegetation dynamics in arid rangelands. *Israel J Botany* 28: 169 – 194

MB Bayer 90-04-08

650kg DM = Equivalent of the requirements of 1 X 60kg Dorper sheep per 1 year