MANAGEMENT PROBLEMS AFFECTING THE UTILIZATION OF HIGH-PRODUCING PASTURES AND FODDER CROPS

(Met opsomming in Afrikaans)

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Abstract

In this article certain aspects of proper pasture utilization for optimal animal performance are reviewed. How best to utilize pasture entails the choice of the right type of animal consuming the right pasture at its most useful nutritional stage in order to yield the highest profit per unit of land. Pasture yield alone is a poor indication of usefulness for the animal if digestibility is not considered. It is suggested that in the case of cattle, the milk cow is physiologically best suited for highest pasture utilization followed by the growing beef and fattening beef animal in that order. It is also suggested that artificial pastures for optimal production should be considered primarily as a source of energy rather than of high quality protein. Grazing systems for optimum pasture yield and animal performance are by no means adequately researched.

Introduction

With the increased food requirements of a growing population and the physical as well as biological reduction of natural grazing in the Republic, the development of intensive pastures seems to be an economic necessity for the not too distant future. This intensification of necessity must take place in the eastern parts of the country, particularly in the high rainfall areas of Natal and Eastern Cape. Already research is underway to investigate the agronomy of artificial pastures. So far, however, very little work has been done to determine the best utilization of pastures and fodder crops by the animal. This paucity of information on the animal/pasture biosis is perhaps understandable if one considers the complexities involved. On the other hand it is difficult to see any difference of kind between veld utilization and intensive pasture utilization — the differences are rather in degree — and one should therefore be able to extrapolate from veld utilization to pasture utilization. The continuing controversy on veld utilization, alas, leaves little hope even along these lines.

In view of this lack of information one can but consider the principles involved and view management in the broad sense. It is true that good management is concerned with physical waste and hence with techniques aimed at minimizing physical loss. However management at the decision level is also very much involved in proper biological utilization and with the minimizing of the biological waste of the pasture. For this purpose is required not so much mechanical knowledge as biological knowledge of the pasture and various types of animals. This, of course is a comprehensive subject so that only certain aspects can be considered.

The pasture

Generally speaking the temporary pasture presents fewer problems than a permanent pasture since it can be planted, used and replanted. One would therefore consider largely the needs of the animal and simply harvest (by grazing or cutting) the pasture with the least physical waste. The permanent pasture must however be harvested in a manner that will also ensure continued or even improved pasture yields over years. It is generally accepted that this requires periods of rest followed by a short period of high pressure grazing. Within limits, the longer the period of rest the higher the yield of dry matter per unit area per unit time.

During the growing period the chemical composition of the dry matter however changes as does the digestibility. To illustrate these changes the findings of Sherrod & Ishizake (1967) are presented for two types of grasses in Table 1.

TABLE 1 Effect of stage of regrowth on composition and digestibility of fertilized Kikuyu and Pongola grass pasture

Regrowth period (weeks)	3		9		18	
Grass type	Kikuyu	Pongola	Kikuyu	Pongola	Kikuyu	Pongola
Dry matter percentage	11,5	15,6	17,3	21,2	18,6	18,1
DM producion (kg/ha)	2 137	1 564	5 416	4 655	9 026	9 760
Chemical analysis (DM) %						
Protein	20,8	18,9	8,9	11,6	5,7	7,5
Ether extract	3,1	2,6	1,7	2,3	1,0	1,9
Crude fibre	25,6	29,8	33,1	31,8	35,9	33,0
N free extract	40,9	38,7	49,4	45,1	52,7	50,4
Ash	9,6	10,0	6,9	9,2	4,7	7,2
Digestible nutrients (DM) %						
Protein	14,8	14,7	4,5	7,9	2,2	4,3
Ether extract	1,6	1,0	1,4	0,8	0,3	0,8
Fibre	14,6	22,0	17,2	24,0	16,5	23,3
N free extract	23,7	24,7	28,7	30,9	25,8	35,8
TDN (%)	56,6	63,7	52,4	64,7	45,0	65,2
Production (kg/ha)						
Digestible protein	316	229	241	368	196	6 364
TDN	1 210	996	2 838	3 011	4 062	420

A striking feature of Table 1 is the rapid decline in the crude protein content of both grasses. Furthermore it is significant that whereas the chemical analysis of Kikuyu and Pongola grass is similar at different stages of regrowth, significant differences were found in digestible nutrients. When one compares dry matter yield with digestible nutrient yield it is also clear that yield alone is a poor criterion of usefulness.

The composition of pasture dry matter is also influenced by rate of nitrogen application and by method preservation. It has been shown that as the percentage protein is increased with progressively higher rates of nitrogen applications the TDN increases but that this increase is due largely to increase in protein whereas soluble carbohydrates in fact decrease. The significance of this is in the end products of rumen fermentation. With a lower percentage soluble carbohydrates the acetic:propionic acid ratio may increase resulting in less efficient fat synthesis. Furthermore the apparent high protein percentage of heavily N-fertilized pasture is due in some measure to a higher percentage NPN compounds such as nitrates and nitrites.

As far as the protein fraction is concerned it has also been suggested that the process of drying decreases the solubility of the protein and hence leads to its better utilization by the ruminant.

The animal

Nutrient requirements of animals are experimentally determined under situations where the food is brought to the animal. Under such conditions it is known that the high-producing animal (fattening young beef animals and even dairy cows producing milk) requires a ration which on a dry matter basis must contain 11-13 per cent crude protein and 70-75 per cent TDN. If the daily intake of such a ration is in the region of 2,5 kg DM per 100 kg live-mass one can expect optimum performance.

Ration dry matter intake is influenced by the digestibility of the DM (which in turn is affected by the protein content), the palatability of the feed (which is not well understood) and by the moisture content of the feed. Intake of pasture DM is however also influenced by the physical ability of the animal to harvest the feed itself.

Water

The water requirements of animals are closely linked with DM intake and with environmental temperature. Animals have a known maximum capacity of DM consumption of about 2,5 kg per 100 kg live-mass so that it may be assumed that their maximum capacity for water consumption is related to maximum capacity of DM consumption and environmental temperature.

Using the figures of Winchester & Morris (1956) and assuming water consumption to be the limiting factor the DM intake of a 363 kg beef animal grazing pastures of different DM contents under different environmental temperatures is shown in Table 2.

TABLE 2 Dry matter intake of a 363 kg beef animal according to environmental temperature and pasture DM percentage

Environmental temp (°C)	10,0	15,6	21,1	26,7
Water intake (kg)	36,3	40,8	49,9	56,7
Estimated DM intake at pasture DM percentage of				
10	3,6	4,1	5,0	5,9
15	5,4	6,3	7,7	8,6
20	7,3	8,2	10,0	11,3
25	9,1	10,4	12,2	14,1
30	10,9	12,24	15,0	17,2

If the assumptions are correct, Table 2 shows that up to a temperature of 15,6°C, pasture with a DM content of less than 25 per cent will not allow maximum DM intake of about 9,1 kg for a 363 kg animal. At temperatures of 21,0°C and 26,7°C the minimum pasture DM content for maximum DM intake is about 20 per cent. When pastures however reach 20-25 per cent DM, the protein content often is below the 11-13 per cent required for optimum production (Table 1) and the digestible energy value of some grasses also falls rapidly at that stage.

Table 1 however shows that in the case of Pongola grass the drop in protein content was not accompanied by a reduction in TDN. One can however expect that intake of pasture lower in protein will be less than of one higher in protein. In order then to secure the maximum yield of DM and TDN per hectare it would appear that allowing certain grasses to mature to about 25 per cent and supplementing protein on such pasture would also yield best performance per animal and hence highest profit. The fact that supplementing immature pasture (high in moisture) with maize has consistently given disappointing results supports this approach. One is furthermore tempted to doubt the value of Kikuyu since it would appear that at the moisture content where animals will consume enough DM, the protein content as well as the digestible energy content have decreased to a level where high productivity can no longer be sustained.

Again using the figures of Winchester & Morris one can also calculate the intake of DM for dairy cows producing different quantities of milk and come to a similar conclusion; advanced pasture supplemented with protein only can support milk production of up to 13,6 litres per day.

Apart from the limitation imposed on DM intake by the moisture content of pasture, Voisin (1959) emphasised the physical ability of an animal to harvest enough grass with a 60 mm mower (mouth) weighing half a tonne to provide the requirements for high production.

One comes to the general conclusions that the choice of grasses for a pasture should be based also on the rate of decrease in energy digestibility with advanced maturity rather than on yield and protein content alone; that if the value of young well fertilized grass is to be exploited, the grazing animal is not the best method of harvesting and that for optimum pasture and animal production, pasture should be grazed at a fairly advanced stage (approx 25 per cent DM) and that the animal should then receive protein, rather than energy supplementation. The emphasis with nitrogen fertilization would then be more on additional energy production rather than on protein production. The need for local research to test these deductions is in any event very obvious.

System of grazing

The discussion of grazing systems by a non-pasture scientist can at best be speculating on a speculative subject. One could however venture one principle namely that, in terms of animal yield per hectare, the system of grazing is not as important as the intensity of grazing. This means that if the overall stocking rate remains the same, higher grazing intensity will require fewer herds, each of a larger size. This principle is not compatible with good herd management which rather requires division of the entire herd into more groups according to sex, age, feed requirements, etc.

It seems as if a compromise is called for but the problem will be lessened as production becomes more specialized. In the case of the beef-breeding unit for instance the industry is fast developing towards earlier mating of heifers and earlier marketing of cattle which will reduce the number of groups substantially.

It is however not always true that higher stocking intensity leads to higher production per hectare as found by Raymond & Spedding (1966) whose figures are summarized in Table 3.

TABLE 3 Production per steer and per hectare at two levels of N application and three levels of stocking intensity

Mass gain	N-level (kg N/ha)	Stocking intensity		
		Low	Med	High
Per steer (kg/day)	335	1,08	0,90	0,66
	670	0,89	0,68	0,42
Per hectare (kg)	335	1 926	2 148	2 055
	670	2 125	2 114	1 632

Table 3 shows that moderate stocking density produced more beef per hectare than low intensity but only at the lower rate of N-fertilization. At the high level of N-application production per hectare declined as stocking intensity increased to less than the production with lower N-application. This must be ascribed to more trampling and soiling of a dense pasture. It should however also be noted that even the rate of low N-application presented in Table 3 must be considered as high.

Pasture soiling and trampling

Neumann & Snapp (1969) reported on the utilization of lucerne by beef steers when the lucerne was grazed, fed as hay or fed as green feed (soilage). Some of the results are presented in Table 4.

TABLE 4 Utilization of lucerne by beef steers

	Pasture lots		Dry lots	
	Rotational grazing	Strip grazing	Hay	Soilage
Average daily gain (kg/day)	0,81	0,74	0,66	0,78
Beef production/ hectare	772	828	959	1210
Percentage of soilage	29,0	30,8	35,8	45,4
Percentage of rotational grazing	45,4	48,5	56,2	71,2

According to Table 4 the highest production per hectare was obtained from taking green-chopped lucerne to animals in dry lot. This in fact resulted in 57 per cent more beef produced per unit area than when steers grazed the pasture rotationally. (The actual difference was nearly 448 kg live-mass per hectare). Obviously the economics of soilage will depend on labour and machinery costs but at present local beef prices Snapp's figures represent a difference of about R96 per hectare. Superficially, it appears unlikely that the soilage costs can be as high as R96 per hectare in the case of a unit of optimum size for such a procedure.

The reasons for lower producion with grazing are trampling, incomplete harvesting by the animal and manure soiling.

Cattle in adjacent camps are inclined to congregate along fences and at gates damaging areas which are then wasted. If at all possible different herds should have an intervening empty camp.

Dung patches represent another waste factor as cattle will not eat grass around such areas. Depending on weather conditions and consistency of dung, such patches may be grazed at the next rotation or only during the next season. This is especially a problem if cattle soil ungrazed pasture which can be overcome with break grazing using an electric fence. Chain harrowing will solve the problem but with certain pastures results in lower DM production.

Pasture soiling can however be greatly reduced through good stockmanship. Cattle usually develop a definite pattern of time spent grazing, ruminating and resting, depending on season. By observing this cycle herds can be kept in rest paddocks during their times of resting and ruminating and put on to the pasture only during peak grazing cycles.

Disease and metabolic disorders

Any system of intensification can also be expected to intensify incidence of disease. At the same time however intensification also results in better control and supervision. Since disease control has consistently enjoyed preference in research and practice, intensification is unlikely to create many unknown or uncontrollable disease conditions.

As far as metabolic disorders are concerned it would appear as if some such conditions are caused by improper pasture utilization. Grass tetany (accompanied by hypomagnesemia) seems to be associated with excessive intake of young highly N-fertilized pasture containing a high percentage non-protein-nitrogen especially nitrates. This may upset the mineral, particularly magnesium, balance. Abnormally high nitrite levels may also produce vitamin E deficiency.

As it is in any event not advisable to graze very young pasture grass tetany should not be a problem in a well managed pasture system.

Conclusions

Pasture-animal management is a vast subject and one can at best touch on some aspects.

1 The type of animal best capable of utilizing expensive pastures is one of the primary managerial decisions.

Since beef cattle for fattening have a limited digestable capacity (relative to dairy cattle); since the end products of fibre digestion in the rumen are less suitable for fat synthesis and since supplementation of pasture with energy rich feeds tend to reduce the fibre digestibility, utilizing pasture for finishing beef animals does not appear to represent its most economic use. However using pasture to grow out young beef animals prior to feedlot finishing would appear to be a logical procedure provided the pasture is not grazed when very young (and high in moisture) and when such cattle are supplemented with a protein-rich feed.

Because the high water requirements for lactation would allow the cow in lactation to consume relatively larger quantities of dry matter this type of animal will utilize pastures well. This applies not only to the dairy cow but possibly also to the modern beef cow which is required to produce large quantities of milk for a heavy calf at weaning. Furthermore the end-products of rumen fibre digestion yields products which are effectively used as energy in the metabolism of milk production.

Bearing in mind the seasonal nature of pasture production, at least part of the pasture should in any event be utilized with beef stores which can be introduced during flush periods and removed to a feedlot during the season of low pasture production.

2 For highest pasture production and animal yield per hectare, green feed should ideally be harvested mechanically at a moisture content of approx 25 per cent and fed to animals in confinement. If this procedure is not feasible or economical a long rotational grazing cycle with high stocking density should be adopted and in any event the beef animal be supplemented with a protein-rich rather than energy-rich feed and waste minimized through good stockmanship. A corollary of high intensity grazing is a simplified herd management system which requires the minimum number of separate groups.

3 Metabolic disorders sometimes associated with highly fertilized pastures may rather be due to improper utilization of such pastures than to a weakness in pastures as such.

Opsomming

BESTUURSPROBLEME WAT DIE VERBRUIK VAN HOË-PRODUSERENDE WEIDINGS- EN VOERGEWASSE BE-INVLOED

Die waardebepaling van aangeplante weidings op die basis van opbrengs alleen, of selfs op basis van chemiese analiese, kan baie misleidend wees aangesien verskille in verteerbaarheid voorkom tussen tipes van grasse asook stadiums van groei. Chemiese samestelling soos beinvloed deur stikstofbemesting kan ook aanleiding gee tot verkeerde interpretasie in terme van bruikbaarheid vir die dier. Weidingsbenutting deur die dier word bepaal deur die fisiese en biologiese vermoë van die dier asook, onder andere, die voginhoud van die weiding. Dit is moontlik dat op daardie stadium waar die voggehalte laag genoeg is om optimale droëmateriaal inname te verseker die proteïeninhoud onder die optimum is. Optimum weidingsbenutting kan dus met vrug ondersoek word in terme van maksimum droëmateriaal inname terwyl proteïen aangevang moet word teenoor die konvensionele begrip van maksimum proteïn inname met aanvulling van energie.

Weidings-intensiteit vir maksimum benutting mag afhang van weidingsdigtheid. Met digte weidingsstand is dit moontlik dat hoë weidings-intensiteit aanleiding sal gee tot 'n groot mate van weidingsverlies deur vertrapping terwyl minder digter weidings beter benut sal word met maksimum intensiteit van beweiding.

Aansienlike losstaande kennis is beskikbaar insake weiding en die dier as sodanig. Inligting insake die weidings dier kompleks is egter gebrekkig en vind soms gestalte in siekte toestande en metaboliese afwykings. Dit is egter heelwaarskynlik dat wanneer die beste metode vir weidingsbenutting bepaal is, metaboliese steurnisse ipso facto sal verdwyn.

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Discussion

Prof Stielau

If we accept that the main objective is to produce a high bulk of palatable material for our animal and that we achieve this by suitable fertilizer practices, then I think this summarises the objective we have in mind. If at the same time fertilizer practice changes the chemical composition, we should be aware of the situation that this can be a mixed blessing in the sense that there is a certain desirable optimum of quality of nitrogen in the feed presented to an animal. If an animal consumes seven kg of feed for example which contains sufficient nitrogen for that animal's needs there is no great benefit in doubling the level of nitrogen in that particular feed. If an animal consumes more than it needs this is a waste. I make this comment particularly because of the reference Mr. Lombard made that it might be desirable to graze pastures which are not at optimum nutrient content but rather at that level at which utilization is optimal. This might be when the protein level is declining somewhat.

Another thought concerning management is that the carbohydrate content of the pasture varies during the day. Plants contain the least quantity of carbohydrates early in the morning, so from this point of view it would be better to utilize them later in the afternoon — apart from the fact that late in the afternoon the grasses might be wilted and contain the greater dry matter content and in this way promote a greater intake.

Dr Möhr

In the case of fertilizer research on a crop like maize we establish the reaction of certain fertilizer combinations in terms of soil and climate as obtained by yields which is very simple and straightforward. In the case of fertilizer research on pastures however the results are indirectly interpreted through the animal. This interpretation therefore and the management of the experiment is of the utmost importance. My question might be unfair. In this research shouldn't more attention be given to the management factor? In other words is it possible that certain data from pasture experiments might have been interpreted differently if more attention had been given to the management factor?

Mr Lombard

We must certainly give more attention to management and to the criteria we use in analysing results. We are inclined to accept these measurements or standards as being, say the performance of the animal or the dry matter and so on. Unless these criteria are closely allied with economic factors then they could be wrong. A case in point is the comparison of different breeds of animals on growth-rate for example. Type A might perform much better than type B, but if the cost of the growth increase is taken into account, B might outperform A.

Major H Heard

There is this pull between the man growing the pasture and the beast that is eating it. The objectives of the two are not one and the same at the time the beast uses the pasture. The cost of the dry matter of the pasture depends on maximum production, especially if it is an irrigated pasture. A production of say eighteen tonnes of dry matter per hectare from a pasture might give a cost of 1,3 cents to the kilogram of dry matter. But if you only get nine tonnes of dry matter the cost is 2,6 cents to the kg of dry material. This will make a difference between a profit and a loss. If nitrogen is not used to the maximum, maximum production from the pasture is not possible. It is not possible to produce eighteen tonnes dry matter from a pasture unless the protein is very high and the growth is very rapid. The possibility of using the pasture in a later stage when the protein has fallen and the dry matter has risen will reduce the yield of the pasture considerably. The farmer cannot afford to apply large amounts of fertilizer to pasture and then also buy protein to supplement the animal's requirements. There is a time in the growth of a pasture when the balance between protein content and carbohydrate is reasonably favourable. I think this is the grazing stage at which the farmer should aim at in utilization. In grasses like ryegrass this would be termed the 'booting out' stage. It may be difficult to recognise this stage in a grass like Kikuyu for example but there is an equivalent stage in the growth of Kikuyu. If this can't be done the alternative is to ration the amount of pasture which the animal is getting to the amount of protein that it needs. The animal shouldn't be allowed to eat fully from a high protein pasture. The means of supplementation should take the form of high energy — high digestible hay to make up its fibre requirements and a good deal of its energy requirements, in which case supplementation with maize meal would probably come down to a very reasonable amount. This I feel is the way we ought to tackle this question of trying to make a profit from beef on pastures. There are many problems attached to this and I feel that allowing the pasture to become mature and the protein content to fall is defeating the object of what we are trying to do in the intensification of pasture work.

Mr Lombard

Major Heard has made the point that in order to get cheap protein, animals should be allowed only so much protein in a high protein pasture and then taken out and given their energy elsewhere — possibly in an adjacent lot. This is a very practical way of going about things but the problem of protein quality still remains. This is coming more and more to the fore in the high-producing beef animal. We used to think that as far as ruminants were concerned the quality of protein was not important, but this is changing.