AN INVESTIGATION INTO THE VALIDITY OF SOME OF THE PASTURE AND VELD NORMS USED IN BUDGET FEED PROGRAMMES IN THE UNDERBERG DISTRICT

BY

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I hereby declare that the research work in this thesis is my original work, but assistance was received for routine field and laboratory work and for statistical analyses of the data.

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C O N T E N T S

CHAPTER 1

I N T R O D U C T I O N

1.1 Hypothesis

Pasture research in South Africa has developed into a respected scientific discipline since its formal commencement in 1934. The monitoring by research workers of the practical situation is difficult, due to the many variables that are encountered, and hence the tendency over the years has been for pasture investigations to become more orientated towards clipped experimental plots, than towards grazed farm paddocks. The reasons for this situation are generally valid, but extrapolation of research results to the extension situation has been difficult due to a deficiency of studies aimed at testing the validity of the norms used under the practical situation, and the errors which may be made, when an objective attempt is made by extension workers to design factual programmes based on the available research data.

Booysen (1972) suggests that pasture research should be orientated towards the limiting factors within the area concerned. Further, the evaluation and results should be expressed in units depicting the limiting factors concerned with the pasture research trial. Most pasture plot experiments are expressed in kilograms dry matter per hectare, which suggests that grass yields and land available are limiting factors. Perhaps farm management, dissimilar soil types and conditions and non-uniform climatic conditions could be termed limiting factors, and as such more cognisance should be taken of them, when evaluating pasture research trials.

Generally the pasture adviser needs quantitative data on the yield, quality, palatability and season of production of pasture species adapted to his area. For many years, farmers and advisers in the Underberg area have progressively increased pasture yields and have now reached the stage where a community team research project could be launched. Such a multi-facetted project must answer practical production problems if it is to serve its purpose. It must also be planned and executed within the existing on-going pattern of production in the district throughout which its co-operators are distributed. This given situation precludes the use of some facets of the experimental method normally associated with pasture research and introduces an unorthodox methodology to planning, sampling and interpretation of the investigation. This study represents one of the first investigations of its type in Natal. As an integrated operation by farmers, extension workers and analytical scientists it may serve as a case study for those concerned with the production orientation of pasture research.

Unlike most experimental research, this study, rather than deciding on and imposing predetermined treatments, applies the alternate methodology of sampling and monitoring an existing economic production system based on pastures which are managed by experienced and well informed producers for monetary gain.

1.2 Problems encountered in extension with the application of research results in the Underberg area

Very rarely are the maximum quantitive and qualitative research results obtained in actual practice on the farm. Possible reasons for the validity of the previous statement could be found in the following:

(1) research provides trials and experiments under certain topographical, soil, climatic and other miscellaneous limitations.

On completion, trials and experiments provide a certain set of scientific results. These results are for the use of the extension worker and the farmer. However, a certain amount of extrapolation must be done, as very rarely is the farm situation similar to that of the research trial. It is possible that farm advisers could therefore be incorrect;

(2) research experiments are designed to have a layout to suit statistic analysis. The layout of the experimental project may be entirely different from the practical farm situation;

(3) scientific plot results can be misleading when applied to the whole situation. Grass yield plot trials are kept very free of weeds, start growing immediately after cutting, are subject to very accurate fertilizer application and are the centre of attention from a research scientist. The plot trial results should be tested under farm conditions where the whole farm situation precludes the farmer from giving necessary attention to one facet of his farming enterprise, and so he may have weeds, he may not have a uniform soil type, he may not graze or cut the grass at the correct time and he will not apply the correct fertilizer to the "nth" degree. Because the farmer has numerous facets of farming to attend to he will not be 100% efficient in each of his farming lines;

(4) research computer programmes are an excellent

guide to research worker, and farmer alike, but certain norms used are not necessarily completely accurate. An example of a norm that needs perfection is the 25% wastage figure used in the feeding of animals computer programme. As yet no better figure has been calculated, but this work points to the fact that a much higher grass wastage figure should be used.

This work, which in general deals with the Underberg budget feed situation, investigates the variations of the actual norms used.

1.3 The Underberg budget feed situation

Through extension work in the Department of Agricultural Extension services it was found that the highest farm cost items in the Underberg district of the Province of Natal were:-

(i) the amount of cow feed purchased,

(ii) fertilizer costs,

(iii) tractor and machinery repairs and spares and

(iv) labour.

Generally speaking labour is treated as a fixed cost, while tractor and machinery costs are directly related to the management and the labour of the farm. Purchased feed and fertilizer costs are indirect related, for should the purchase of fertilizer be minimised, there is an increase in the purchased feeds on the farms.

The extension worker is required to help the farmer by cutting his farming costs and also improving his present farming methods. As costs of home grown feed were of a high order, extension workers decided to recommend reducing the purchased feed to a minimum, improving the quality and quantity of home grown feed and using the correct fertilization rate for the home grown fodder crops. At this stage it is worthy of note that through the Department of Agricultural Economics and Markets book keeping system (1970 to 1975), it was found in Underberg that annual fodder cropping alone, which consisted of oats for grazing with a gross margin of R30 per hectare, was more costly than a farming system which included perennial pastures, which had a gross margin of R72,1 per hectare. In fact, the Underberg Economic Study Group figures of 1973 showed tha the highest gross margin for a dairy cow unit (R107,2) was obtained from a hundred percent pasture system and that the highest gross margin from beef (R50,2) was obtained from a thirty three and a third percent pasture system.

The trend today is different, in that should the pasture not already be established, the high cost of pasture establishment has a negative effect on the dairy and beef gross margin.

Good management requires that all farmers plan a fodder flow scheme for their farm, and to this end a scheme known as budget feeding was set up by the extension workers in the Underberg area. Under this scheme, the farmer plans for the fodder requirements of all his animals for every day of the year. The farmer determines how many, and what type of animals he will be carrying on his farm every day of the year. The determination of the animal units' feed requirements is based on the protein and total digestible nutrients (T D N) required for satisfactory production, for example 0,5 to 1,0 kg liveweight gain a day in beef animals or

10 to 15 litres milk/day in dairy cows. The farmer's animal performance goals for the year are set, and the type, quantity and quality of feed necessary for the desired animal performance is specified. Based on feed quality figures from Morrison's (1951) and Bredon & Hathorn (1974) rations, which include the required amounts of dry matter, crude protein and total digestible nutrients are calculated for every group of animals on the farm.

Together the farmer and extension worker calculate a variety of rations using alternative grasses or crops known to be adapted to the area. Fodder crops that are not grown easily or economically on the farm are discarded in any ration calculation. Finally the quantity of the various feeds required to feed each herd is calculated. Underberg Study Group (1974) figures have established the mass of fodder that can be grown under both optimum and average fertilizer, climatic, soil and management conditions. It is, therefore, possible to calculate the number of hectares of the crop to be grown under ideal and average conditions, based on the actual yields of the crops in the district. Extension workers preferred to calculate yields under average conditions of management as efficiency of farm management is generally an unknown quantity.

Normally a group of farmers within a certain area are classified into a top twenty percent group, followed by the next forty percent group, and then the last forty percent group of laggards.

Underberg district is more fortunate in that the distribution could and possibly does follow a pattern of a 20:60:20

distribution of farmers. Extension is simplified in an area where there is a small laggard group of farmers.

Soil samples of the lands which are to be used for pasture or crop growing are taken in the prescribed manner by the Department of Agricultural Technical Services (1974) (Appendix I) and analysed by the soil science laboratory of the Natal Region of the Department of Agricultural Technical Services at Cedara. The recommended fertilizer is applied and a costing of the required fertilizer is calculated and recorded.

Once the pastures or crops have been grown a sample of the grown feed is taken from five random quadrats of one metre square ($1m^2$) cut at a 2 cm height, weighed and analysed for dry matter, crude protein and fibre by the feed analysis laboratory of the Natal Region of the Department of Agricultural Technical Services at Cedara. The feed quality figures obtained are compared with the figures used in the original feed and quality calculations and should the quantity of the feed vary significantly from the figures used in the original calculations, new calculations are made using supplementary urea as additional protein, and supplementary molasses meal or maize meal as additional total digestible nutrient. Should there be a shortage of quantity of feed, then a suggestion that fewer animals should be kept over the winter or summer period is made by the extension worker to the farmer. At all costs the farmer should not run out of bulk feed over the winter period.

This budget feeding scheme in the Underberg area went ahead for three years (1971 to 1973) but a number of problems arose from the scheme. Most important of these was that farmers found that, even when they carried out the scheme as planned and calculated at the end of the winter, that is the April to September period, they were generally short of feed.

The extension workers had the following suggestions to make to explain this discrepancy:-

(i) farm fodder mass per hectare norms for Underberg were incorrect;

(ii) the actual feed sampling or analysis were not reliable;

(iii) incorrect crop, crude protein and fibre content norms were used;

(iv) the weighed masses of the crops grown were incorrect;

(v) the quality of the feed deteriorated over the winter period and thus varied from the feed analysis Animals fed in September did not necessarily get the required amount and quality that had been calculated as available in the early winter; and

(vi) poor management by the farmer, leading to spoilage or non-efficient utilisation of the pastures.

Each of the above possible reasons for the discrepancy were examined. The conclusions drawn are discussed below.

(i) <u>Fodder mass norms</u>

The actual farm yields of hay and silage were checked. On checking the yields of <u>Eragrostis curvula</u> and <u>Eragrostis tef</u> hay, and of the oats, millet and maize silage, it was found that they were very similar to the norms used for those fodders in the budget feed exercise.

However, on checking the grazeable pasture grass yields it was found that they varied significantly from the norms used for the Underberg area.

(ii) Feed analysis

More than one sample of the same crop cut at the same time was sent for analysis and there was little variation in the results, indicating satisfactory sampling and analytical accuracy.

(iii) Crude protein and fibre content norms

There was a variation in the crude protein and fibre norms used for budget feeding compared with the actual crude protein and fibre obtained in some of the different pasture species.

(iv) Calculated fodder mass required

Stacks of hay were weighed, the number of bales from a given area counted and the actual bales weighed. No inaccuracies in estimation and calculations were found.

Weighing and calculations of silage mass also showed no significant variation from the figures used for the calculations.

The weight of the quadrat samples cut on the farms was checked, and a variation of 20,1% between farmers' weighings of quadrats cut and the quadrats cut by the extension workers was found. This variation was due to the farmer cutting his pasture at ground level and not at two centimetres height.

(v) <u>Deterioration of the feed</u>

The May recordings of the mass, dry matter and crude protein of a pasture varied from the August recordings of the same pasture which had not been grazed but saved in the interim period. This variation indicated that it was not advisable to budget for August pasture feed based on quantitive and qualitative analysis done in May of the same year.

(vi) <u>Management</u>

The managerial ability of different farmers varies, thus the pasture management by different farmers also varies. Some farmers wasted only approximately 10% of the pasture yield, whereas other farmers wasted approximately 50% as a result of less effective grazing management.

As a result of establishing where errors, or variations from the norm could have arisen in the budget feed exercise, this study sets out to:-

(i) determine the yields of different pasture grasses under topland irrigated, topland non-irrigated and lowland non-irrigated conditions in the Underberg district;

(ii) establish the accuracy of previously used crop, crude protein and fibre estimates and thus total digestible nutrient norms for the Underberg district;

(iii) measure the amount of the deterioration, if any, of feed quality and quantity of a pasture, should the grass be spared over the winter period and only utilized in late winter;

(iv) examine how management influences efficiency of feed usage of calculated budget feed which incorporates the required hectarage of pastures and crops grown;

(v) determine whether different cultivars of a grass produce significantly different dry matter yields over a six month growing season;

(vi) determine whether the seasonal dry matter yields of grass as measured on a plot trial are realistic when compared to farm scale paddock systems under similar soil and climatic conditions; and

(vii) determine the yields of dry matter of veld in the Underberg area, with a view to establishing a reliable norm for veld yields and carrying capacity.

CHAPTER 2

DESCRIPTION OF THE ENVIRONMENT OF THE UNDERBERG STUDY AREA

2.1 Location

Underberg lies at the foothills of the Drakensberg, 1 690 metres in altitude and 29°71 south latitude and 29°80 east longitude. As shown in Appendix II, the Loteni river forms the northern boundary and the Indawana river the southern boundary of the Underberg district. The eastern boundary is 30° east longitude and borders on the township of Bulwer. The locality of the Underberg area is particularly suited to animal production systems which utilise pastures on an intensive basis.

2.2 Topography

Appendix III shows the topography of the Underberg area. Along the western border runs the Drakensberg mountain range which varies in altitude from 1 800 metres to 2 700 metres. The average altitude of a vast section of the Underberg area is 1 500 metres. In this area lie the towns of Underberg and Himeville. The remaining area is approximately 1 200 metres above sea level.

According to Fair (1952) the Underberg area represents the unconsumed remnants of a retreating escarpment. Clarke (1966) states that "depending on the stage of the erosion cycle, the topography in the Underberg zone is undulating to broken. The veld is sour and considerable areas of land are suitable for cultivation."

2.3 Soils

The soils of Underberg are typical Highland Sourveld in nature, and according to Jackson (1963), Hutton form, with predominant Hutton series, make up 85% of all the soils present in the area. Ten percent of the soils are Katspruit and the remaining five percent are made up of other soil forms. Katspruit series are poorly drained, black, bottomland soils, high in clay content, which occur alongside the river courses. Hutton series are usually a deep, somewhat excessively drained, highly leached, red, loamy soil. With fairly intensive conservation practice the Hutton series has a high potential for arable use where slopes are favourable. The main limitations of this soil are the very low nutrient status and their susceptibility to wind erosion. The Hutton series are suitable for irrigation and are most suitable for pasture establishment or for cash crops in the form of maize and potatoes. In general 2 ton of lime and one of basic phosphate per hectare are recommended for these soils prior to cash cropping or pasture establishment.

In comparison with the Hutton series, the Katspruit series have a higher natural fertility. As the aluminium level in Katspruit series is very low, liming is not necessary. The pH of the Hutton and Katspruit series is low (in the region of 4,5% in KCℓ).

2.4 Climate

Underberg is a summer rainfall area, the majority of the rain falling during the period October to April. Appendix IV shows the monthly distribution of rain. A mean daily temperature chart is shown (Appendix V) and it can be seen that there is a vast variation in daily mean temperature over the year. Summer droughts of about three weeks duration are periodically experienced. Th months of April, May, August and September are dry months and with the increase in daily temperature into the spring the implementation of irrigation practices, preferably gravity schemes, has a beneficial economic effect on the farms. Winds of high velocity, 50 kilometres per hour and more, are experienced during the months of July and August. Rare winter snowfalls are experienced in the Underberg area. However, heavy snowfalls are experienced on the Drakensberg mountains during the winter months and occasional hailstorms occur in the Underberg area. Frost is experienced on an average of 124 days of the year (see Table 1). The number of rainy days for the period 1972 to 1975 is indicated in Table 2.

Table I Number of frost days in Underberg during the year for the period 1972 to 1975

	1972/73	1973/74	1974/75	Average
Total frost days	129	107	137	124
1st frost day of the season	23/4/73	20/5/74	16/4/75	
Last frost day of the season	26/9/73	15/9/74	19/9/75	

Table 2 Number of rainy days over a year in Underberg for the period 1972 to 1975

	1972/73	1973/74	1974/75	Average
Rainy days	79	106	89	91

2.5 Veld

The natural vegetation (veld) is highland sourveld comprising mainly of Themeda triandra (red grass) and Elyonurus argenteus (wiregrass). Along the mountain area there is more wiregrass than red grass but the composition changes to more red grass the further away one travels from the Drakensberg mountain range.

2.6 Farming practices

Over eighty percent of the farms in the Underberg area are sheep and beef farms. The majority of the beef and sheep farms are farmed on an extensive or semi-intensive basis. Twelve months of the year veld grazing, with the supplementation of hay, root crops or licks during some of the winter months, constitutes the requirements for an extensive animal grazing system.

The semi-intensive beef and sheep farms make use of the veld for six to eight months, and during the winter months the beef and sheep are fed on hay, silage, conserved pasture and root crops. Ten percent of the Underberg farms are dairy orientated, and thus are intensively farmed, with pastures and silage supplying the feed for the major portion of the year.

The owners of three farms derive most of their income from a potato cash crop.

Unfortunately the economic gross margin for beef during the 1977/78 year is a minimal amount of R5 per animal unit, when farmed on the semi-intensive system, whereas the gross margin is in the region of R50 per A U on the extensive beef system. The gross margin for sheep per A U, i.e. 6 sheep, is R50, while the gross margin for a dairy A U is in the region of R250. For the 1977/78 season the gross margin on a hectare of seed potatoes is R1 500.

CHAPTER 3

PASTURE PRODUCTIVITY STUDIES

3.1 A comparison of the productivity of eight existing pastures

3.1.1 Aims. To measure and compare the yields of dry matter, percentage protein and fibre of nine pastures under animal grazing conditions for the period August 1974 to July 1975 in the Underberg area. The pastures compared were:-

: *Festuca arundinaceae*. (Fescue)

: *Festuca arundinaceae* and *Trifolium repens* mixture (Fescue and clover mixture).

: *Dactylis glomerata*, cultivar (Danish cocksfoot).

: *Dactylis glomerata* and *Trifolium repens*, mixture (Cocksfoot and clover mixture).

: *Lolium multiflorum* (Ryegrass).

: *Lolium multiflorum* and *Trifolium repens* mixture (Ryegrass and clover mixture).

: *Trifolium repens* (Clover).

: *Pennisetum clandestinum* (Kikuyu).

3.1.2 Literature review on the productivity and the factors affecting the dry matter yields and thus the quantitative and qualitative norms used for the above eight species. There is no published literature on the productivity of the above pastures in the Underberg area. However, Table 3 shows some world-wide workers quantitative and qualitative figures for the pasture grasses that are under trial. All data refer to non-irrigated pasture, unless otherwise specified.

Table [illegible] Pasture analysis compiled from world literature

Research Workers	Country where trial done	Grass type	C P %	C F %	Yield of dry matter (t/ha)
Stahlin, Bogdan, Daniel & Rath (1971)	Germany	Cocksfoot mixture	13,8		
Stahlin, Bogdan, Daniel & Rath (1971)	Germany	Cocksfoot clover			23,7
Fagan (1929)	Wales	Cocksfoot	16,8 to 21,4	19,2 to 24,0	
Paulnäkaki & Luostarinen (1971)	Finland	Italian ryegrass	20,4 to 21,3		5,6
Rhind (1973)	S. Africa	Midmar ryegrass			11,3
Bredon (1969)	S. Africa	Italian ryegrass	9,3	30,7	
Denuldt & Lambert (1970)	France	Perennial ryegrass			10,9
Grunow & Klopper (1974)	S. Africa	Ariki ryegrass			12,7
Grunow & Klopper (1974)	S. Africa	Ariki ryegrass			9,2
Lynch (1966)	New Zealand	Ariki ryegrass and clover			13,1
Lynch (1966)	New Zealand	Ruanui ryegrass and clover			12,6
Frame & Hunt (1971)	Scotland	Grass and red clover			9,3
Lambert, Vartha & Harris (1969)	New Zealand	White clover			10,5
Bredon (1969)	S. Africa	Clover	24,7	15,1	
Rhind (1975)	S. Africa	Fescue			8,9
Paulnäkaki & Luostarinen (1971)	Finland	Fescue and clover			8,2 to 9,0
Wetherall (1970)	Australia	Kikuyu			1,6
Bredon (1969)	S. Africa	Kikuyu	20,3	17,6	
Voisen (1959)	France	Grasses in general			5,7

A Rhodesian trial by Rodel & Boultwood (1971) on the yields of thirty different species of grass, showed a range of 1,7 to 17,9 ton D M/ha.

In a Natal trial, Jones & Bartholomew (1973) found that *Eragrostis curvula* yields varied from 2,7 ton to 17,6 ton D M/ha.

Grunow & Kloppers (1974), in a Pretoria trial, found that Ariki ryegrass under irrigation yielded 9,2 to 12,7 ton D M/hectare.

O'Toole (1970) at Glenaway, found that ten ton of D M/ha can be obtained by applying various levels of nitrogen to ryegrass pastures.

Work by Wolton, Brockman & Shaw (1970) in Devon, very similar to that of Hunt (1971) in Ayr, showed that high nitrogen applications could increase grass yields by up to 20%. An increase of 20% in yield of pasture is significant, and so nitrogen could have a significant effect on the norms used in the Underberg area.

Charles, England & Thompson (1976) showed from their Welsh and Scottish trials that the out-of-season growth of perennial ryegrass could be affected by autumn management, nitrogen application, cultivar and location. The same workers also found that allowing undefoliated herbage to accumulate in autumn could increase the subsequent spring yields.

Tainton (1974) at Palmerston North showed that different grazing treatments, when applied to pastures in which perennial ryegrass was dominant, had little influence on D M production during the main reproductive growth period in late spring and early summer.

Roberts (1976) suggested that a norm could be affected by cutting all pastures down to the same height. He further suggested that cutting height of quadrats for different pasture species should in fact vary, due to the pasture species physiological defoliation height requirement.

Smetham (1973) found that a D M norm could be affected by a certain type of grazing or stocking density. Quoting Campbell (1966), Smetham (1973) writes that on ryegrass clover pasture, under controlled grazing with a low stocking density of 40 cows grazing for half a day, the D M yield was 13,15 ton D M/ha. The yield dropped to 12,33 ton D M/ha under a controlled high stocking system of 40 cows grazing for a whole day.

It was found by Binnie, Harrington & Murdock (1974) that by increasing the level of nitrogen applied, there was a change in the chemical composition of the herbage.

Smetham (1973), citing Fagan (1929), writes that cocksfoot crude protein figures varied during late spring and summer from 16,78% to 21,39%. To establish a norm the average could be taken as 19,09%, but as the range is quite great, the norm could be inaccurate, depending on the time of the season.

Greenhalgh (1974) found that late season herbage is lower in net energy value than the earlier growth.

Jagusch (1973) makes a statement which could have a bearing on possible pasture norm variations. He states that "The season of the year and stage of growth within a season affect the protein and fibre content of pasture". Jagusch (1973) showed that protein in grass clover pasture varied between 10 to 20% and the fibre varied between 14 to 30%. The results presented in paragraph 3.1.4 showed similar variations. Thus, the seasonal norm could be influenced considerably by the peak period of herbage production and the growth stage at which the material was harvested. This influence could vary between different trials.

Jagusch (1973) also showed that pasture norms could be affected if there was inconsistency in the number of cuts at different grass growth stages. A pasture norm could vary just by the inclusion of more protein figure analyses from grass cuttings at a short leafy stage, rather than figures of grass cuttings at the pre-flowering stage. Protein in grass clover mixtures cut at a short leafy stage was 27%, whereas when cut just prior to flowering, the material analysed gave a 16% protein figure. Hence pasture norms determined from data which include figures determined from a variety of cutting stages could have a high variation.

3.1.3 Procedure. During the 1974/75 season, it was not possible to compare all the grass species on one farm in the Underberg area, for no farmer had all the species represented on his farm and hence to get production data from all grass species, grass quality and quantity trials had to be performed on a number of different farms in the Underberg area. Co-operative farmers of similar managerial ability with farms on similar soil series, similar rainfall and similar altitude were carefully selected, so as to compare different pasture species on their farms with other species on other farms, but all within the Underberg area.

The farmers selected to co-operate with the trial not only came from different parts of the district but were involved in different types of farming. Farmer A, a pure Friesland dairy farmer had made use of pastures for feeding purposes for over thirty years. He had worked his average milk yield per cow to over 20 litres. Farmer B, also a dairy farmer, but for only fifteen years, also ran a pedigree sheep flock. Both the dairy and sheep belonged to a feeding system which was eighty percent pasture orientated. An important point about Farm B was the network of dams which gravity fed the pastures with irrigation water. Farmer C, a relative newcomer to the Underberg district, runs a semi-intensive beef herd and an intensive sheep flock. The sheep are on various types of pasture for 365 days in the year, while the beef run on the local indigenous veld for eight months of the year and on pastures for the other four months. Farmer C and a fourth farmer D run sheep and beef on pastures for the duration of the year.

Farmer E runs dairy and sheep on pastures for the whole year, while the last farmer F runs sheep only on pasture throughout the year.

In selecting the co-operative farmers, it was necessary to take cognisance of the fact that it was also necessary to compare the pasture yields on lowlands of the Katspruit series, with the toplands pasture yields on the Hutton, Griffin, Clovelly, Farningham or Balmoral series. Pasture performance under irrigation was measured only under topland conditions.

The similarity of the soils under different pastures was checked by Scotney (1974) of the Natal Region of the Department of Agricultural Technical Sèrvices. The initial soil analysis of the different pasture lands is presented in Appendix VI . The corrective fertilizers were applied to the pastures as per soil sample analysis. For the Underberg area a phosphate level of 60 kilograms per hectare is desirable. The desirable figures for potash and aluminium are 250 and 0 kilograms per hectare.

In all, seven farms were chosen (see Appendix VII) for the collection of the data. All sites were to be grazed by dairy or beef stock. The size of the pasture lands measured and recorded are seen in Appendix VIII. Different sizes and shapes of pasture lands were selected and used to obtain the experimental data. The actual mass of pasture feed requirements were calculated for the grazing of the dairy or beef animals in question. In comparing the mass yields, dry matter, protein and fibre content of different pastures under top or lowland, non-irrigated or irrigated conditions, material from five random quadrats ($1m^2$) in the pasture lands was weighed. Heavy dung spots were avoided in placement of quadrats. Quadrat sizes and number of quadrats cut to determine the grass yield was investigated by Waddington & Cooke (1971) in Saskatchewan. Over a 3 year period they found that grass production estimates were 8% less when using 2,51m^2 cages, than when using 0,84m^2 cages. The same workers found that larger cages increased precision slightly when used on Russian wild rye. They did, however, suggest that the increase may have been due to the forage being planted in rows 0,91m apart, since the quadrats cut were 0,91m^2. Further, Waddington & Cooke (1971) stated that the number of caged sites needed in each plot to estimate, with a 95% confidence, was 14 for four replicates and over 30 for fewer replicates. The studies in this thesis used no replications, and only five quadrats to give an average reading. It should be stressed that before the studies began, a trial on the number of quadrats to be cut was undertaken. It was established that the average yield from cutting five separate quadrats varied very little from the average yield from twenty five separate quadrats. Hence it was decided to use average figures from the cuttings from five quadrats. In this work the grass was cut to 2 cm height, collected and weighed separately and the data converted to kilograms per square metre (kg/m^2). A sub-sample from the five quadrats was then taken, weighed and air dried ready for chemical analysis. All dry matter yield were air dried and recorded as such and not as oven dried. It was then necessary to take samples of air dried pasture and oven dry them so as to record the difference (see Appendix IX). Crude protein and crude fibre results are presented on an oven dried basis. The dried samples were sent to the feed analysis laboratory of the Natal Region of the Department of Agricultural Technical Service at Cedara where the samples were dried and analysed for protein by the block digestion method, reading extract as ammonia autoanalyser, and fibre, by the digestion method using sodium hydroxide and sulphuric acid. The number of animals grazed on the pasture was recorded and in the case of beef, where an animal was between 100 and 200 kilograms, the animals were recorded as one third of an animal unit. In the case of dairy cows, all were treated as animal units with a pasture feed requirement necessary to supply 10 litres of milk. The quadrat records were taken each time the pasture was ready for grazing, which was regarded as being as near to 12 cm in height as was possible. In the case of the irrigated lands 2,5 cm of water was applied over a two hour period in the form of sprinkle irrigation, when it did not rain for ten days. The soils being sandy loam in nature, retain much of the water applied over a two hour period. The penetration of the water to the pasture root area seems to be best when applied at 2,5 cm water per hour. This irrigation procedure was practised from August to May. No irrigation supplement was supplied during the months of June and July as the temperature was too low to obtain any growth.

As temperatures on the non-irrigated lowland area can be of the order of -5°C for periods of ten days or more, kikuyu pasture growing in this area has not been considered by the Underberg farmer.

The seeding rate per hectare for the pastures was 12 kilograms of grass seed, and when clover was added to the mixture, it was added at the rate of 1,5 kilograms per hectare. In the case of kikuyu the establishment was done by planting sods at one metre intervals.

3.1.4 Results.

3.1.4.1 Pasture yield and composition of topland irrigated pastures

The quantitative and qualitative results obtained from the eight pastures under topland irrigation conditions are shown in Table 4.

Table 4 Pasture yield and composition of topland irrigated pastures for 1974/75

Pasture type	D M %	C P %	C F %	Yield A D M (t/ha)
Ryegrass	20,9	23,2	26,7	14,70
Ryegrass and clover	17,6	22,8	24,1	15,06
Fescue	19,5	17,2	28,4	10,99
Fescue and clover	19,2	22,0	22,3	12,19
Clover	16,1	25,1	16,3	14,94
Cocksfoot	24,5	19,4	26,5	10,04
Cocksfoot and clover	18,1	20,9	25,2	12,31
Kikuyu	16,8	22,0	22,2	11,51
Average	19,1	21,6	24,0	12,72

Under topland irrigated conditions the ryegrass and clover mixture gave the highest air dry matter yield (15,06 t/ha). Cocksfoot yielded the lowest air dry matter under irrigated conditions (that of 10,04 t/ha).

The highest crude protein percentage of 25,1 was found in clover. The lowest crude protein percentage was found in fescue (17,2%). The lowest crude fibre percentage was found in clover (16,3%).

Clover, under irrigation, yielded very well and at the same time had a high percentage of crude protein, coupled with a desirable low percentage of crude fibre. Ryegrass and clover, although outyielding pure clover, nevertheless had a lower percentage of crude protein and higher crude fibre, when compared with the clover under irrigation conditions. Because of the high yield, high percentage of protein and low percentage of fibre in the clover and ryegrass mixture and in the pure clover, these two types of pastures should be strongly recommended for the Underberg area.

The addition of clover to the grass species increased the yield, as is seen in Table 5.

Table 5 The increase in air dry matter per hectare (A D M/ha) yield by the addition of clover to the grass species (under topland irrigation conditions) for 1974/1975

	Air Dry Matter t/ha
Ryegrass and clover	15,06
Ryegrass	14,70
Increase due to clover	0,36
Fescue and clover	12,19
Fescue	10,99
Increase due to clover	1,20
Cocksfoot and clover	12,31
Cocksfoot	10,04
Increase due to clover	2,27
Average increase due to clover	1,28

By the addition of 1,5 kilograms of clover seed per hectare to the pasture seed mixture a very significant average increase of air dry matter of 1,28 t/ha is achieved. Based on 1978 fertilizer, seed and land preparation costs, economists of the Department of Agricultural Economics & Markets at Cedara calculate that 1 kilogram of dry matter pasture would cost in the region of three cents. Thus 1,28 ton air dry matter or a calculated 1,16 ton oven dry matter gives an increased return of R34,64 per hectare/annum by the addition of clover to the sward.

3.1.4.2 Pasture yield and composition of topland non-irrigated pastures

The qualitative and quantitative results obtained from the eight pastures under topland non-irrigated conditions are shown in Table 6.

Table 6 Pasture yield and composition of topland, non-irrigated pastures for the 1974/75 season

Pasture type	D M %	C P %	C F %	Yield A D M (t/ha)
Ryegrass	21,8	22,3	25,0	9,66
Ryegrass and clover	19,3	23,6	25,3	9,90
Fescue	20,8	15,9	27,1	9,21
Fescue and clover	19,0	20,7	25,3	9,56
Clover	16,9	26,5	17,0	10,14
Cocksfoot	24,1	21,8	25,0	8,71
Cocksfoot and clover	20,9	21,9	27,1	8,91
Kikuyu	16,1	23,2	22,3	13,15
Average	19,9	22,0	24,3	9,91

Under topland non-irrigated conditions kikuyu produced the highest air dry yields (13,15 ton). The cocksfoot gave the lowest air dry matter yield per hectare (8,71 ton). Clover had the highest crude protein percentage (26,5%) and fescue once again the lowest crude protein percentage (15,9%). The lowest crude fibre percentage came from clover (17,0%) and the highest came from fescue (27,1%), and cocksfoot and clover (27,1%).

It is interesting to note that under non-irrigated topland conditions there was only an average increase of 0,26 ton air dry matter/hectare by the addition of clover to the three types of pastures shown in Table 7.

Table 7 The increase in A D M/ha yield by the addition of clover to the grass species under topland non-irrigated conditions for 1974/1975

	A D M t/ha
Ryegrass and clover	9,90
Ryegrass	9,66
Increase due to clover	0,24
Fescue and clover	9,56
Fescue	9,21
Increase due to clover	0,35
Cocksfoot and clover	8,91
Cocksfoot	8,71
Increase due to clover	0,20
Average increase due to clover	0,26

3.1.4.3 Pasture yield and composition of lowland non-irrigated pastures

The quantitative and qualitative results obtained from the seven pastures under lowland non-irrigated conditions are shown in Table 8.

Table 8 Pasture yield and composition of lowland, non-irrigated pastures for the 1974/75 season

Pasture type	D M %	C P %	C F %	Yield A D M (t/ha)
Ryegrass	22,2	18,9	25,3	9,78
Ryegrass and clover	19,2	20,5	23,6	10,06
Fescue	20,5	16,4	27,8	9,80
Fescue and clover	18,3	19,9	23,8	9,92
Clover	17,9	24,3	17,7	9,14
Cocksfoot	25,8	16,6	27,1	8,80
Cocksfoot and clover	22,6	18,6	26,5	9,43
Average	20,9	19,3	24,5	9,56

Under lowland non-irrigated conditions ryegrass and clover produced the most A D M/ha (10,06 ton). Once again cocksfoot produced the least A D M/ha (8,80 ton). The highest crude protein percentage was again found in clover (24,3) and the lowest in fescue (16,4). Clover had the lowest crude fibre percentage (17,7) whereas the highest crude fibre percentage was found in the fescue (27,8).

The increase in A D M yield by the addition of clover to the pasture species is shown below in Table 9.

Table 9 The increase in A D M/ha yield by the addition of clover to the grass species under non-irrigated lowland conditions for 1974/1975

	A D M t/ha
Ryegrass and clover	10,06
Ryegrass	9,78
Increase due to clover	0,28
Fescue and clover	9,92
Fescue	9,80
Increase due to clover	0,12
Cocksfoot and clover	9,43
Cocksfoot	8,80
Increase due to clover	0,63
Average increase due to clover	0,34

3.1.4.4 Comparison of A D M yields of the topland irrigated (T I) and topland non-irrigated (T N-I) pastures

The increase in A D M t/ha yield by the application of irrigation on the topland Underberg situation is shown in Table 10.

Table 10 Comparison of pasture A D M yields under topland irrigated and topland non-irrigated conditions for 1974/1975

		A D M (t/ha)
Ryegrass irrigated	I	14,70
Ryegrass non-irrigated	N-I	9,66
Increase due to irrigation		5,04
Ryegrass and clover	I	15,06
Ryegrass and clover	N-I	9,90
Increase due to irrigation		5,16
Fescue	I	10,99
Fescue	N-I	9,21
Increase due to irrigation		1,78
Fescue and clover	I	12,19
Fescue and clover	N-I	9,56
Increase due to irrigation		2,63
Clover	I	14,94
Clover	N-I	10,14
Increase due to irrigation		4,80
Cocksfoot	I	10,04
Cocksfoot	N-I	8,71
Increase due to irrigation		1,33
Cocksfoot and clover	I	12,31
Cocksfoot and clover	N-I	8,91
Increase due to irrigation		3,40
Kikuyu	I	11,51
Kikuyu	N-I	13,15
Decrease due to irrigation		1,64
Average increase due to irrigation		2,81

On an average over all types of pasture, irrigation was responsible for an increase of 2,81 t/A D M/ha which is considered to be enough food to feed 266 animal units for one day, or at 3 cents per kilogram of pasture dry matter an increase in the value of materia produced of R76 per hectare. It is worthy to note that kikuyu A D M did not increase with irrigation. Kikuyu is entirely a summer pasture in the Underberg area and obviously grows well without supplementary irrigation.

3.1.4.5 Comparison of the A D M yields under non-irrigated topland conditions and lowland conditions

The results obtained when comparing D M yields of non-irrigated topland and lowland pastures is shown in Table 11.

Table 11 Comparison of A D M yields under non-irrigated topland and lowland conditions

		A D M (t/ha)
Ryegrass (non-irrigated topland)	N-I T	9,66
Ryegrass (non-irrigated lowland)	N-I L	9,78
Decrease from lowland to topland		0,12
Ryegrass clover	N-I T	9,90
Ryegrass clover	N-I L	10,06
Decrease from lowland to topland		0,16
Fescue	N-I T	9,21
Fescue	N-I L	9,80
Decrease from lowland to topland		0,59
Fescue and clover	N-I T	9,56
Fescue and clover	N-I L	9,92
Decrease from lowland to topland		0,36
Clover	N-I T	10,14
Clover	N-I L	9,14
Increase from lowland to topland		1,00
Cocksfoot	N-I T	8,71
Cocksfoot	N-I L	8,80
Decrease from lowland to topland		0,09
Cocksfoot and clover	N-I T	8,90
Cocksfoot and clover	N-I L	9,43
Decrease from lowland to topland		0,53

There was an average decrease in A D M yield throughout of 0,12 ton when comparing yields from non-irrigated lowland with non-irrigated topland. However, as far as clover was concerned the non-irrigated topland outyielded the non-irrigated lowland by 1 ton of A D M/ha.

Possibly the low temperatures of around -5°C at the lowland sites had an adverse affect on A D M yields per hectare.

One of the most marked findings was the high yield of kikuyu under dryland conditions (Table 6). This finding is significant for situations where no irrigation can be developed, or where irrigation finance is not available.

3.1.4.6 Comparison with norms used in budget feeding

Certain norms of mass yield, dry matter percentages, protein and fibre percentages were used for the budget feeding exercise in the extension area of Underberg. These pasture quality figures were obtained from Morrison (1951) and Bredon (1969) and are presented in Table 12.

Table 12 Norms accepted for pasture yield and quality in Underberg (all data based on oven dried material)

	D M %	C P %	C F %	Dry matter t/ha
Perennial and annual ryegrass	26,6	11,4	25,5	13,3
Ryegrass and clover	26,6	11,4	25,5	13,3
Fescue	30,5	9,9	31,3	15,2
Fescue and clover	30,5	9,9	31,3	15,2
Cocksfoot	29,0	16,7	23,9	11,1
Cocksfoot and clover	29,0	16,7	23,9	11,1
Kikuyu	17,0	20,3	17,7	8,0
Eragrostis hay	90,0	8,0	36,2	12,1

The norms for quality figures used for the pastures of grass mixed with clover were the same as those for pure grass pastures for budget feeding purposes.

Over a period of three years the mass yield norms were derived from rough plot trials in the Underberg area.

The methodology used in determining the norms was similar to the methodology used in the pasture production trials, with the exception that the figure from only one randomised square metre quadrat was used and not the figure from the average of five square metre quadrats as in 3.1.3.

Table 13 shows the comparison of pasture yields actually obtained in this work, with the norms used in the budget feeding exercise.

Table 13 Comparison of budget feeding yields adopted in Underberg and actual yields measured

	Assumed D M yield (ton/ha)	Actual yields (ton A D M/ha)		
		N-I L	N-I T	I T
Ryegrass	13,3	9,78	9,66	14,70
Ryegrass and clover	13,3	10,06	9,69	15,06
Fescue	15,2	9,80	9,21	10,99
Fescue and clover	15,2	9,92	9,56	12,19
Clover	16,2	9,14	10,14	14,94
Cocksfoot	11,1	8,80	7,77	10,04
Cocksfoot and clover	11,1	9,43	8,91	12,31
Kikuyu	8,0	-	13,15	11,51

The norm figures used in budget feeding for fescue vary greatly from the actual figures obtained. The fescue norm figure of 15,2 t/ha exceeded the lowland non-irrigated fescue figure by 5,4 t/ha; the topland non-irrigated figure by 6,0 t/ha and the topland irrigated fescue figure by 4,2 t/ha. The budget feed fescue and clover norm was in excess of the fescue and clover yield found under all conditions in this trial.

The clover yields under irrigation were close to the norms used in budget feeding (16,2 and 14,94 t/ha) but dryland clover yielded well below the norm used (16,2 as against 9,14 and 10,14 t/ha), whereas in cocksfoot, both irrigated and non-irrigated yields were below the norm used (11,1, 10,04, 8,80 and 7,77 t/ha). However, the combination of cocksfoot and clover under irrigation showed a higher figure (12,31 A D M t/ha) than the norm used (11,10 t/ha). Under non-irrigated topland conditions a figure of 8,91 ton for cocksfoot and clover was obtained in comparison to the 11,10 D M t/ha norm used in budget feeding.

Where little was known about the yield of kikuyu, a figure of 8,0 ton D M/ha has generally been used. It was found, however, that kikuyu yielded 11,51 ton A D M/ha under irrigation and 13,15 ton A D M/ha under non-irrigated topland conditions. The higher yield of non-irrigated kikuyu compared with irrigated kikuyu is unexpected and an explanation for the phenomenon was required.

The yearly rainfall difference between the two kikuyu sites was 29 millimetres, the soil types were similar, both sites received the necessary corrective fertilizer and thus the difference in the kikuyu yields is difficult to understand. There appeared to be no stress factors, such as wind currents, heavy rain storms, hail storms or early frosts on the irrigated kikuyu area.

Originally it was assumed that the co-operating farmers had equal management ability, but the results with kikuyu point to the need to examine this assumption. Managerial studies (Chapter 4) have been undertaken to try and evaluate whether management could possibly have been the reason for the unexpected non-irrigated and irrigated kikuyu yields.

The ryegrass and mixed ryegrass and clover yields, under non-irrigated lowland and topland conditions (13,3 versus 9,78 and 9,66 and 13,3 versus 10,06 and 9,69) were below the yield norms used for these two pasture types in the budget feeding exercise. Hence it will be necessary to establish in each case whether the ryegrass and ryegrass and clover mixture is grown under non-irrigated conditions or under irrigation and to adjust the norms for them accordingly.

3.2 Comparison of the dry matter yields of topland irrigated pastures grown under farm conditions and under plot conditions

3.2.1 Introduction. Underberg budget feeding farm fodder mass per hectare norms were possibly incorrect and this could be a reason why farmers found themselves short of feed at the end of winter, even though they had done the budget feeding exercise. The pasture productivity studies in Chapter 3 have shown that some budget feeding norms were incorrect. The original norms were drawn up from trials done around Underberg and from yield masses received from local research stations. Possibly another reason for incorrect norms used for budget feeding is that plot yields possibly do not agree with similar pasture, farm and paddock yields.

3.2.2 Aims. To compare dry matter yields of *Lolium multiflorum* (Ariki ryegrass), *Dactylus glomerata* (Danish cocksfoot) and *Festuca arundinaceae* (Kentucky fescue) under practical farm conditions with the same pastures grown on an experimental plot scale. This comparison was to establish whether all pasture, small design plot yields, determined at research stations were in fact applicable to similar pasture types grown in large paddocks on farms. In this way it was possible to prove whether norms deduced from research station results were incorrectly applied to the Underberg budget feeding exercise.

3.2.3 Literature review on the factors affecting D M yields under farm and plot conditions

Frame and Hunt (1971) state, "grazing is an important method of grassland utilization, but because of the high requirements of land, labour, equipment and finance associated with animal output trials, agronomic cutting techniques are widely used to evaluate varieties, seed mixtures, fertilizers and other management factors; the results are then applied to the grazing situation. These techniques produce a large volume of information rapidly and cheaply, but are criticised because the grazing effects of treading, selection and excretion are ignored".

Brockman (1971) showed that where the nitrogen input was sufficient to produce 10 t/ha D M on the cut swards, the nitrogen recirculated by the grazing sheep increased yields to 12 t/ha D M, which is an increase of 20%.

Cambin & Stewart (1975) found a high correlation between the D M yields of ten cultivars of Italian ryegrass, when assessed under a cutting regime and a cattle grazing system.

3.2.4 Procedure. Pasture on three different Underberg farms (see Appendix VII) were weighed as described in Chapter 3, paragraph 3.1.3 and compared with plots 7m² in size, at the Underberg extension office during the 1974 to 1975 season. Most ryegrass trials at the Agricultural Research Institute at Cedara are carried out on plots which are in the region of 30m². The Agricultural Research Institute trials have three replications, whereas the Underberg extension office plot trial had no replications. The pastures selected for farm and plot comparison were:

Lolium multiflorum (Ariki ryegrass);
Festuce arundinaceae (Kentucky fescue); and
Dactylis glomerata (Danish cocksfoot)

One grass species only was grown on each of the three farms. The farm pastures and experimental plots, both situated in the 800 mm rainfall area, were on the Hutton soil series. The farm pastures and plots had similar irrigation practices and were irrigated only after rain had not fallen for ten days. The farm pastures and the plot pastures were soil sampled and corrective fertilizer applied.

The grass on both the farm and the plots were to be cut on reaching a height of 12 cm, and then cut back to a 2 cm height. Every second cutting or grazing was followed by an application of 180 units of nitrogen/hectare in the form of limestone ammonium nitrate (LAN) 26%. Over the whole 1973 to 1974 season, the farm that the Ariki ryegrass was grown on had 27 mm less rain than the Ariki ryegrass plot at the extension office. The farm where the Kentucky fescue pasture was being monitored had 21 mm less rain than the fescue plot at the extension office. In the case of the Danish cocksfoot, the farm had 33 mm less rain than the extension office plot. The Ariki ryegrass pasture was cut eight times under farm conditions and twelve times under the plot cutting regime. The Danish cocksfoot pasture was cut six times on the farm and nine times on the plot, and the Kentucky fescue pasture five times on the farm and eight times on the plot.

3.2.5 Results

The A D M/ha obtained from the farm and plot sites are recorded in Table 14.

Table 14 Yields of A D M/ha from three pasture grasses tested under farming conditions and in small plots at Underberg for 1974/1975

	Farm conditions (A D M t/ha)	Small plot conditions (A D M t/ha)
Ariki ryegrass	14,70	19,25
Kentucky fescue	10,99	13,81
Danish cocksfoot	10,04	14,43
Average	11,91	15,83

The plots outyielded the equivalent large scale pastures in the Underberg area by approximately 30% on average. There was 4,55 ton A D M/ha difference in the yield of Ariki ryegrass between plot and farm in favour of the plot. This is in fact a very significant amount when the air dry matter yield of Ariki ryegrass was only 14,70 ton/ha, showing thus a difference in excess of 30%.

The difference between the plot and farm yields must be sought in management and the fact that a plot has no animal wastage factor. The plot is also regrowing immediately after cutting, whereas a farm pasture is being defoliated more gradually over a period of about a week. Due to the variation in dry matter yields/ha of grasses grown under farm and plot conditions, it is a debatable point whether the results of grass plot yields should be used entirely for determining norms for Underberg budget feeding purposes. Such extrapolation may have caused serious misinterpretations of experimental station results when applied to the extension situation.

For the use on the farm practical situation, evidence or results from seven metre square plots may not be sufficiently accurate. A small area is subject to much more management attention than a large farm area, and as a result of such attention, may produce higher dry matter yields over a season.

As a result of this study it is suggested that pasture D M yields be determined on a field scale, so as to give realistic pasture D M yields on which the farmer can make his feed budget calculations.

3.3 Comparison of Lolium multiflorum cultivars

3.3.1 Introduction. For budget feeding purpose no specific cultivars were suggested by the Underberg extension workers and thus the farmer was in the position to select any cultivar he considered appropriate.

Different cultivars of a grass species could and do give different dry matter yields and such differences could cause problems when a farmer has grown the correct budgetted area of the grass for the budget feeding exercise but finds he or she is short of feed from the pasture before the end of winter due to the fact that he has grown the wrong cultivar of the grass. A trial was therefore undertaken to see whether, in fact, different cultivars of the same grass yielded different amounts of dry matter/hectare in the Underberg district.

All available cultivars could not, however, be tested and so, as the most popular or widely grown grass in the Underberg area was and is ryegrass, this project was restricted to trials on fourteen ryegrass cultivars.

3.3.2 Aims. To compare the dry matter yields of fourteen cultivars, or combinations of cultivars, of ryegrass, grown over the six winter months, comprising April to September.

3.3.3 Literature review on the yields of different *Lolium multiflorum* cultivars

Different cultivars of ryegrass have given different D M yields. Charles, England & Thompson (1976), Castle & Watson (1971) and Hunt (1971) all did research on the yield factors of different ryegrass cultivars under different conditions. Their different works showed that the leading cultivar was not necessarily the same throughout the different trials, emphasising the fact that different cultivars do better under different climatic, soil and management conditions.

Over the six winter months Rhind (1973) in his trials at the Agricultural Research Institute at Cedara, found that the Midmar cultivar of ryegrass did the best.

3.3.4 Procedure. Making use of a well drained, deep, non-eroded Hutton series with a pH of 4,15 in KCℓ, a randomised block design (Appendix X), for the performance of 13 ryegrass cultivars was examined in an experiment on the farm Wilanda Downs (Appendix VII) in the Underberg area. Rhind (1976) suggested that thirteen ryegrass cultivars, with one cultivar duplicated (see Table 15), be included in the trial.

A soil sample of the site was taken and analysed for nutrient content. The correct fertilizer was added for the maximum ryegrass production from the site. The trial was planted during March 1976. Diploid cultivars of ryegrass were planted at the rate of 20 to 25 kilograms seed per hectare, while tetroploid cultivars of ryegrass were planted at the rate of 30 to 35 kilograms seed per hectare. Approximately 25 mm of sprinkle irrigation was applied every ten days. The plots were cut to 2 cm when approximately 12 cm high. The plot yields were dried at the Natal Agricultural Research Institute. Yields were expressed in oven dry matter/hectare, and statistical differences expressed at the 1% significance level. After every cut the equivalent of 90 kg of nitrogen per hectare was applied.

Table 15 The ryegrass cultivars planted in the Underberg trial during 1976

Billion		Tetraploid	Annual
Polycross 12		"	"
Tama		"	"
Tetila		"	"
Tetrone		"	"
Tewera		"	"
Common Oregon		Diploid	"
Local A	Hipkin's	"	"
Local B	Hulley's	"	"
Paroa		"	"
Rocket		"	"
Midmar		"	"
Ariki		"	Perennial
Ariki/Midmar		"	

3.3.5 Results.

The results are given in Table 16 in order of production.

Table 16 The dry matter yields of the different ryegrass cultivars in the Underberg trial during 1976

		D M t/ha over 6 months
Tetila	Tetraploid	9,7749
Tetrone	Tetraploid	9,3892
Midmar	Diploid	9,3326
Local Hipkin's	Diploid	9,2795
Local Hulley's	Diploid	9,1303
Ariki/Midmar	Diploid	8,2917
Paroa	Diploid	8,2475
Rocket	Diploid	7,8957
Common Oregon	Diploid	7,8030
Billion	Tetraploid	7,4076
Polycross 12	Tetraploid	7,3669
Tewera	Tetraploid	7,3350
Ariki	Diploid	7,3223
Tama	Tetraploid	6,6675

At the 1% level of significance, the following cultivars of ryegrass were not significantly different from one another:

Tetila

Tetrone

Midmar

Local Hipkin's

Local Hulley's

The purity of the two local cultivars is suspect, as, in fact, cross pollination of farmer local seeds leads to deterioration of the cultivar dry matter yields. Under the circumstances, only Tetila, Tetrone and Midmar could be confidently regarded as superior.

The seasonal distribution of yields is equally important to the Underberg farmer, who is often short of green feed during late June, July and early August. The yields for all cultivars during the July to August period are shown in Table 17.

Table 17 Dry matter yields (t/ha) during the July and August period of the different ryegrass cultivars during 1976

Cultivar	Yield D M t/ha/two months
Midmar	2,9308
Local Hipkin's	2,2969
Local Hulley's	2,2397
Rocket	2,1479
Paroa	2,1376
Common Oregon	2,1271
Tetila	2,0670
Ariki/Midmar	1,8797
Tewera	1,8088
Tetrone	1,7030
Tama	1,6908
Polycross 12	1,5148
Billion	1,4873
Ariki	0,9571

The first seven cultivars in Table 17 are not statistically different from one another at the 1% level. It appears that Midmar is the highest yielding cultivar at the critical green feed period in Underberg.

Note that the overall high yielders Tetila and Tetrone are low on the list of yielders during July and August. Midmar at this time of the year, i.e. July and August, is the highest yielder. It yields significantly (P = 0,01 level) more than Tetrone but is not significantly better than Tetila. On an overall basis it appears then that the two leading cultivars of annual ryegrass to grow in the Underberg district are Midmar and Tetila.

On analysing the above ryegrass cultivar D M yield results, Rhind & Goodenough (1976) of the Natal Agricultural Research Institute, showed that in Underberg the diploid cultivars in general outyielded the tetreploid cultivars during the critical green feed period of June to August. This superiority of the diploids during the June to August period was significant at the 1% level.

Ariki, a ryegrass perennial, which has been widely grown throughout the Underberg district in the past, did not fare too well during this one year trial. It therefore seems important to note that certain cultivars may outyield others and hence, a specific cultivar should always be stated when applying a norm for budget feeding exercises in this area.

3.4 Foggage value. Evaluation of foggage feed yields and quality of ryegrass

3.4.1 Introduction. In the past, for Underberg budget feed purposes, the D M yields and pasture quality measured in terms of crude protein and crude fibre percentages, have been evaluated during the month of April. Perhaps the April pasture quantitative and qualitative figures do not hold good for the months of May, June and July. It was therefore necessary to establish whether the April pasture analysis figures could be used as a norm for budget feed purposes.

3.4.2 Aims. To measure the change in dry matter yield per hectare and in crude protein and crude fibre percentage of a foggaged Underberg ryegrass pasture between April and September.

3.4.3 Literature on ryegrass foggage. Dent & Aldrich (1968) showed that the digestibility and composition of perennial ryegrass foggage varied during the April to November period. This variation is shown in Table 18.

Table 18 Digestibility and composition of perennial ryegrass foggage during the April to November period. (Dent & Aldrich, 1968)

	MONTH								
	Apr.	May	May	June	July	Aug.	Sept.	Oct.	Nov.
	10th	1st	21st	10th	1st	1st	1st	1st	1st
C P %	25,0	21,8	18,6	19,7	16,7	15,1	17,0	19,8	26,8
C F %	16,9	20,2	22,6	23,7	22,1	24,6	22,4	21,0	18,2

3.4.4 Procedure. At this stage the superiority of Midmar ryegrass cultivar was unknown, and so a local Hipkin cultivar of ryegrass was planted at the farm Wilanda Downs in the Underberg district on the 15th February, 1976, and grown out until the end of April. The fertilization of the pasture was based on the Natal Agricultural Research Institute soil analysis recommendation, 90 kg of Nitrogen/hectare being applied on the 18th March. As in the pasture productivity studies described in Chapter 3.1.3, five random quadrats of 1m^2 each were cut to a height of 2 cm, the green material air dried and then oven dried at the Natal Research Institute and analysed for crude protein and crude fibre.

This quadrat cutting procedure was practised on new sites at every cutting. The grass on the plot was left standing, and not all cleared off after each cutting.

3.4.5 Results. The May to September quantity and quality data on Italian ryegrass are presented in Table 19.

Table 19 The quantity and quality of Italian ryegrass over the May to September period for 1976

Date	Yield Wet Material kg/m^2	Yield Air Dry Material kg/m^2	Air Dry Matter %	Oven Dry* matter %	Crude Fibre[+] %	Crude Protein[+] %
1/5/76	2,38	0,67	28,2	93,0	24,5	21,4
15/5/76	2,71	0,53	19,6	92,8	22,2	18,3
1/6/76	1,81	0,42	23,4	93,3	17,2	17,6
15/6/76	1,50	0,47	31,2	88,2	18,6	13,1
1/7/76	0,59	0,20	33,3	87,5	17,6	13,9
15/7/76	0,57	0,28	49,1	86,8	17,8	16,2
31/7/76	0,55	0,28	51,0	87,8	22,3	16,7
15/8/76	0,62	0,29	47,4	87,3	22,1	12,5
31/8/76	0,74	0,40	54,4	89,5	25,8	11,2
15/9/76	1,33	0,27	20,3	89,5	33,7	11,9
Average	1,28	0,38	35,8	89,6	22,2	15,3

* These data reflect D M % determined after oven drying material which had previously been air dried.

\+ Based on oven dry matter.

The average quadrat yield dropped from 2,71 kg wet material/m in mid May to 0,55 kg wet material/m^2 at the end of July. This is a 79,7% drop in yield. It appears that heavy frosts dried the grass out and then strong winds blew the dried grass away. Wastage of conserved grass surely has a great impact on a budget feed system, for a feed nor that is worked out in May can then be approximately 80% out. This means that in budgeting, and extra four fifth of the total amount of feed required for August must be added to the budget, so as to cater for the actual drop in ryegrass pasture yield over the winter months.

The grass did, however, appear to grow in August. However, the air dry matter percentage only showed the impact of August pasture growth during the middle of September. For observation purposes, it should be noted that the Natal Agricultural Research Institute feed analysis department may dry ryegrass to anywhere between 93,3% and 86,8%, a difference of 6,5%. This variation may be important in practice.

The crude fibre percentage was at a low of 17,6% on 1/7/76 and thereafter, as the pasture got older, the crude fibre percentage increased up to a maximum of 33,7% on 15/9/76. The high crude fibre percentage on this date could be due to a relatively large proportion of dead material being included in the sample at that time of the year.

The crude protein figure shows a general drop from 21,4% on 1/5/76 to 11,9% on 15/9/76.

For budget feeding purposes the saving of pasture from May to September before grazing, has the effect of dropping the dry matter yield, increasing crude fibre content and decreasing the crude protein percentage and hence lowering the total digestible nutrient value of the forage.

3.5 Comparison of productivity of veld at two sites in the Underberg area

3.5.1 Introduction. Budget feeding in Underberg, for various animal feeding systems, involves supplying feed to farm animals, from both pasture and veld. The reasons for the Underberg farmer being short of feed, even though he had budgeted his feed exercise, have been researched from the point of view of the established pasture (Chapter 3.1 to 3.4). It is also necessary, however, to investigate whether the air dry matter norms used for veld in budget feeding were in fact realistic. Veld of the highland sourveld nature constitutes approximately eighty percent of the average Underberg farm area. The veld is grazed mainly during the period of mid October to mid April, after which it becomes unpalatable and stock are loathe to eat it. During the mid April to mid October period animals graze on winter pastures and possible supplementation of silage, hay and root crops.

Veld grazing systems in the Underberg area are at the present time based on four to five days utilisation, followed by a grass rest of up to sixty days.

Veld dry matter yield variations may be expected on different soil types or different aspects and even under different grazing or cutting frequencies. Despite these variables, one veld carrying capacity norm of 0,5 hectare/M L U, for Underberg had been used, regardless of whether the actual farm concerned was in the wet or dry zonal area of the Underberg district. The higher population of Elyonurus argenteus in the wet zone leads, unexpectedly perhaps, to a lower yearly overall veld yield. Hence, a veld yield trial in the wet zone of Underberg should assist in establishing whether the budget feeding veld yield and carrying capacity is realistic or not. The veld dry matter yield estimate should be safely conservative for the district as a whole.

3.5.2 Aims. To measure the dry matter and crude protein yield of the natural Underberg veld, with no supplementary fertilization, over the summer months. Plots will be cut at four, six and eight weekly intervals to see whether a carrying capacity norm of 0,5 Mature Livestock Unit/hectare (M L U/ha) per season is appropriate to this veld.

3.5.3 Literature on the carrying capacity of Underberg veld

There is no literature on the carrying capacity, dry matter yields and crude protein yields of the Underberg veld. Work has been done on Cedara, Ukulinga and Kokstad veld with the idea of determining the carrying capacity and dry matter yields, but as the veld grass components from those three areas differ from those of Underberg veld it would be misleading to apply the results of these investigations to Underberg veld.

3.5.4 Procedure. One north facing and one south facing site, each 0,1 hectare in area, were selected in the wet zone of the Underberg sourveld (see Appendix VII).

The sites selected average 1 250 mm of rainfall per annum. Berg winds are experienced during the months of August and September. The sites are subject to the rainfall distribution shown in Appendix IV and the mean daily temperature shown in Appendix VI.

According to Foran (1976), who used a modification of Dyksterhuis quantitative climax method (QCM) for assessing veld type components and condition, the Underberg veld chosen for carrying capacity evaluation was mainly made up of Elyonurus argenteus (32%) and Themeda triandra (19%). The other more predominant grasses, making up the remaining 49% of grass composition, were Harpechloa falx, Microchloa caffra, Alloteropsis semi-alata and Diheteropogon filifolius. Three fifths of the Underberg area could be included in this wet zone (Appendix VIII). Due to higher rainfall and change of grass dominants the wet zone is characterized by poor dry matter yields compared with the dry zone.

A cutting trial arranged in randomised block design, using plots 3m x 6m with three replications of three cutting frequencies was undertaken. The three cutting frequencies were constituted by cutting certain plots every four, six and eight weeks.

The grass was cut to a 5 cm level, collected, air dried and weighed, and then sent to the Natal Agricultural Research Institute for analysis on a dry matter basis. The first cut was on 13th October and the last cut was on the 28th April of the year.

3.5.5 Results.

The total oven dry matter yields for the summer of 1971/1972 are given for both aspects in Table 20.

Table 20 Average oven dry matter yields as influenced by cutting frequency (D M kg/ha) for 1971/1972

Aspect	Cutting interval (weeks)									Mean yields		
	4			6			8					
	D M yield kg/ha	C P yield kg/ha	C P %	D M yield kg/ha	C P yield kg/ha	C P %	D M yield kg/ha	C P yield kg/ha	C P %	D M yield kg/ha	C P yield kg/ha	C P %
South plot	1 527	142,72	9,4	1 584	147,02	9,3	1 935	165,22	8,5	1 682	151,65	9,0
North plot	1 297	123,76	9,5	1 576	141,58	9,0	1 622	136,92	8,4	1 498	134,09	9,0

D M = Dry matter

C P = Crude Protein

% = Percentage

Note: No statistical analysis is provided, as some of the data was mislaid in transit between Underberg and Pietermaritzburg.

In comparing the two sites it is noted that the south facing site yielded about 20% more dry matter than did the north facing slope when cut at the four weekly intervals; there was little difference in dry matter yields of the south and north facing plots when cut every six weeks; and when cut every eight weeks, there was 16% more dry matter on the south facing plot when compared with the north facing plot. The south facing slope site was ± 200 metres higher in altitude than the north facing slope site. This altitudinal difference is probably not large enough to result in significant temperature differences due to altitude. At Thaba 'Nchu, Roberts (1975) showed that over an altitude difference of 610 metres there was a change of 5°C in temperature. Thus the Underberg north and south facing slopes could have an approximate 1,6°C difference in temperature. The greater production on the southern aspect is most likely due to the lower temperature and therefore lower evapotranspiratio rates here than on the northern slopes. Hence moisture conditions would have been more favourable on the southern slopes. Edwards (1977) has established a similar relationship between temperature and yield of <u>Eragrostis curvula</u>.

At one mature livestock unit being equivalent to a 500 kg animal, Bredon (1974) recommended carrying capacities for the summer period based on the production data presented in Table 20. These are shown in Table 21.

Table 21 Carrying capacity of the veld for the summer six months (M L U/ha) based on the production data presented in Table 20 for 1971/1972

Aspect	Cutting interval (weeks) 4	6	8
South plot	0,62	0,61	0,78
North plot	0,53	0,64	0,66

No correction for wastage of grass at cutting time was included in any of the results presented in any veld evaluation tables, since wastage at cutting, or the collecting of the grass, was presumed to be equal for all plots. Incorporating a wastage figure would have meant more D M/ha and thus slightly higher stock carrying capacity figures than those shown in Table 21. It is evident that cutting the grass at an eight weekly interval allowed for higher stocking rates than more frequent cutting.

On equivalent trials in the Ixopo and Kokstad areas, similar trends in carrying capacity of veld have been found, in that eight weekly grass cutting intervals allowed for the highest stocking rate. A ten weekly cutting interval may have given an even higher carrying capacity. Lyle (1977) in Kokstad research station trials finds that the average carrying capacity for Highland Sourveld is around 0.75 M L U/ha, unless the year is exceptionally dry, when the figure will drop to 0,50 M L U/ha. The crude protein figures at the Kokstad research station vary between 5,0% and 7,7% which are considerably less than the average crude protein figure which was obtained from the three cutting frequencies in this trial.

It does appear that more research should be done to confirm the crude protein percentage found in the Underberg summer veld as the figures are higher than those measured at Kokstad.

In general the Kokstad area is warmer and has less rainfall than the Underberg area, and as a result the Kokstad veld is a sweeter form of sourveld. This is probably associated with the fact that the desirable <u>Themeda triandra</u> can constitute up to 30% of the grass species in this veld. Logically, the sweeter veld should have a higher crude protein percentage, but from the above figures it appears that the opposite applies. A minimum difference of 2,1% crude-protein between Underberg and Kokstad veld, appears to be too high, and thus too much confidence in the veld quality figures is not warranted. The prime significance of these results is that they confirm the accuracy of the carrying capacity norm of 0,5 M L U/ha used in veld budget feeding. The veld carrying capacity norms would not be affected by the discrepancy in the Kokstad and Underberg veld crude protein percentage figure.

Budget feeding has been based on pasture and veld feeding systems, with the emphasis on the pasture, with the pasture designed to supply the animal feed for the winter months in the case of beef and for the winter and summer months in the case of the milking dairy cows. The veld was planned for use, in the budget feeding scheme, as the feed supply for both the beef and dairy dry stock for the summer months. Such budget feeding allowed for the carrying of 0,5 mature livestock units per hectare on veld. In all three of the experimental cutting frequencies, estimated carrying capacity appears to be more than 0,5 mature livestock units/ha, and this capacity is increased by extending the cutting interval. As the 8 weekly cutting gave more dry matter per hectare, naturally the carrying capacity would be higher with a greater time interval of absence from grazing.

It is concluded from these results that the assumed carrying capacity of the veld as used in budget feeding has not been too high or too low, and thus any improvement to an Underberg farmer's forage flow system should not be sought in the veld.

3.6 Discussion

An investigation into the pasture quality and quantity norms has showed a variation from the budget feeding norms used. The degree of variation was quite high in some pasture species and thus more accurate norms can be used for the Underberg budget feeding exercise in the future.

The variation in yields of certain pastures, when evaluated under farm paddock systems and small experimental plot trials, seems to emphasise the point that there is an "X" or unknown factor which should be taken into account when employing norms for the evaluation of any farm scheme, or the projection of a farm scheme.

It is certainly important to state the correct ryegrass cultivar necessary for a Underberg budget scheme, as it has shown that one cultivar can yield nearly twice as much dry matter over a season.

Dry matter, and quality, of a grass species appears to vary if saved through the autumn and winter period. A May grass norm may not necessarily be an accurate norm for an August budget feed exercise, and so more attention should be paid to monthly norms when drawing up a budget feed scheme.

The carrying capacity of Underberg veld does vary, but it appears that a 0,5 M L U/ha norm can be employed by the budget feed planner, as trials to date have shown that this norm is conservative and that most Underberg veld will carry a minimum of 0,5 M L U/ha.

CHAPTER 4

ASSESSMENT OF NON - UTILIZATION OF PASTURES

4.1 Assessment of non-utilization percentage of pastures by the grazing animals on seven Underberg farms

4.1.1 Introduction. Several farmers in the Underberg budget feeding scheme, although complying with the requirements and implementation of the scheme, found themselves short of animal feed near the end of the winter. A possibility for the feed shortfall could be the inefficient utilization of the pastures by the farmers' animals. It, therefore, seemed important to investigate the utilization or non-utilization of the pastures by the animals on the farm.

Secondly, a trial of this nature seemed advisable in order to establish whether there could be any link between the non-utilization of pastures and the fact that in the pasture productivity trials (Chapter 3.1.4) the non-irrigated kikuyu outyielded the irrigated kikuyu.

4.1.2 Aims. The trials were established to measure the following:

(i) the efficiency of management and utilization of seven of the pastures which were used in the pasture productivity studies (Chapter 3.1);

(ii) the green material yield of a given pasture, prior to grazing, on seven different farms;

(iii) from the green material yield, to determine the dry matter yield of the pasture;

(iv) from the total dry matter yield of the pasture, to calculate the number of animal units that the pasture could carry for a single grazing;

(v) to record the number of grazing days and number of animal units that the pasture did in fact carry in relation to the estimated number of days that the pasture should have carried a certain class of animal; and

(vi) from the expected and actual carrying capacity of the pasture for the one specific grazing, to try and establish whether the differences in the production of non-irrigated and irrigated kikuyu could be explained by differences in management.

4.1.3 Procedure. The data recorded in the pasture productivity studies (Chapter 3.1), where the dry matter yields of eight different types of farm pastures were being recorded, were used in this study. These pastures were subject to practical farm management, which included the grazing off of the pastures by farm animals. After the pastures had been quadrat sampled, weighed, and the dry matter yield calculated as in Chapter 3.1, the number of animal units, from dairy or beef breeds, that actually did graze the pastures was then recorded.

Using Morrison's (1951) and Bredon's (1969) feed requirement standards, it was calculated that an average animal unit of 320 kg would require an average of 8 kg of dry matter per day. The number of animals used for grazing purposes was not large as, in fact, it was difficult to find a group of animals that averaged 320 kg.

For this reason steers were used on some farms while heifers were used on other farms.

From quadrat yields the total D M production of each pasture was calculated. On the basis of an intake of 8,2 kg/M L U, the theoretical carrying capacity was calculated and compared with the actual recorded animal grazing days. This gave an estimate of the efficiency of pasture utilization by grazing animals in terms of potential grazing days not achieved.

Campbell (1966) has stated that 15% of pasture yield is wasted or non-utilized under grazing. Cedara college, in their computer programmes, use a 25% wastage or non-utilized grass figure.

4.1.4 Results. The comparative data used in calculating the percentage of waste in each of the seven pastures are presented in Table 22.

Table 22 Details of the comparative data used in calculating the percentage non-utilization of seven different pastures after a single grazing for 1975

Farmer	Pasture	(ha)	Animal type	Animal number	Total D M feed require-ments/day (kg)	Actual D M available to animal group (kg)	Calculated grazing days available	Actual grazing days obtained	%age of pasture not utilised by animal group
A	Irrigated ryegrass	0,7	Beef steers	71	582	6 111,0	10,5	7,5	28,6
B	Dryland ryegrass	2,7	Beef steers	122	1 000	48 955,6	48,9	38,0	22,3
C	Irrigated clover	0,6	Fries. heifers	21	172	8 276,0	48,0	46,0	4,0
D	Dryland cocksfoot	0,5	Beef steers	18	148	4 239,8	28,7	21,0	26,8
E	Irrigated kikuyu	9,1	Beef steers	30	246	1 777,5	7,2	3,5	51,4
F	Dryland kikuyu	0,2	Freis. heifers	22	180	734,0	4,1	3,0	26,8
G	Dryland fescue	2,9	Freis. heifers	28	230	5 621,9	24,5	18,0	26,5
								Average	26,6

From Table 22 a 51,4% non-utilization figure for the irrigated kikuyu was obtained, whereas the non-irrigated kikuyu showed a 26,8% non-utilization figure.

As all the variables for the determination of the pasture yields in Chapter 3 were constant, and yet the results showed that non-irrigated kikuyu outyielded the irrigated kikuyu, it could be suggested that the difference in utilization of the two pastures by the two farmers could possibly be the reason for the unexpected irrigated and non-irrigated kikuyu yield results. It appears that the "non-irrigated kikuyu" farmer managed his pastures better than the "irrigated kikuyu" farmer. It was assumed that the co-operating farmers in the pasture production studies (Chapter 3.1) had equal managerial ability. However, this work suggests that equal management assumption may not necessarily be correct.

The average non-utilization of 26,6% is very close to the figure used by the Natal Agricultural Research Institute. However, a disturbing factor is that four out of seven farmers had unacceptably high pasture non-utilization figures.

The non-controlled grazing of the paddocks by means of an electric fence, appeared to be a reason for the poor utilization of the pasture grass.

4.2 Assessment of non-utilization percentage of pastures by grazing animals on a further twelve Underberg farms

4.2.1 Introduction. As a result of the results described in paragraph 4.1.4 where there was a variation in pasture utilization ability, with an average non-utilization of pasture figure of 26,6%, it was considered advisable to undertake this further study to determine whether further information, on the reasons for non-utilization percentage of pasture by managers, could be gained. This will also help to explain the kikuyu results obtained in paragraph 4.1.4.

4.2.2 Aims. To measure the utilization of pasture as managed by 12 farmers using the total dry matter yield of pasture as a criterion for the number of days that the pasture should be grazed.

4.2.3 Literature on the non-utilization of pastures, and some of the possible factors influencing the utilization of pastures

Scarisbrick (1971) states that pasture yields and utilization efficiency are frequently reduced by treading and fouling with dung. Boswell (1971) supports Scarisbrick by stating that intakes from clean swards consistently exceeded those from contaminated swards by more than 30%.

Lane & Holmes (1971) looked into the actual area of a pasture that was grazed off at a single grazing by a beef herd. Their results showed a variation of from 34 to 86% of the pasture area being grazed off at a single grazing. Obviously there was a fairly high figure of non grazed area, possibly in the order of 14 to 66 percent.

The herbage wastage around contaminated areas of sward is unlikely to affect intakes at low stocking densities, but will probably affect the long-term productivity of the sward, unless the rejected herbage is regularly cut (Boswell, 1971). It is interesting to note that Garstang & Mudd (1971) found a mean percentage of pasture area rejection over the first year of pasture utilization to be 28%.

Greenhalgh (1975) suggests that pasture should theoretically produce 1 750 kg/ha of liveweight gain per year based on the D M/ha yield which he recorded. However, he goes on to state that for some reason or other, the estimated figure for liveweight gain was never approached, either experimentally or commercially.

Jones (1971) implies that to get accurate non-utilization of pasture figures, an assessment of the non-utilization of pastures should be made after every grazing during the season and not just after one grazing.

Brougham (1966) has calculated that since the New Zealand average butterfat yield per hectare is 143 kg and Hutton (1963) found that for a Jersey cow 10,9 kg D M at 70% digestibility was required for maintenance plus the production of 0,54 kg of butterfat, the utilized D M averages only 3 363 kg per hectare. This figure, in contrast to 13 000 to 16 000 kg D M produced from a pasture, shows a high non-utilization figure, of the order of 77,8% to 82%.

Theron (1977) suggests that a single grazing non-utilization figure of say 36% would decrease, under a grazing regime, if taken over a total year's grass production.

The methodology, as used in this study for determining the non-utilization of pastures, is not a standard scientific procedure or practice. The more usually practised methodology is to evaluate the amount of pasture D M that is available for grazing, then graze the pasture with a known number of stock, cut and weigh the grass that is not utilized and subtract this amount from the original amount of D M that was available to the animals. This method used by Brougham (1966) in New Zealand, thus allows for the estimation of the actual amount of dry matter utilized or conversely, non-utilized. Perhaps this method is more scientific than that used in this study, as there is a definite mass of grass that is left to weigh, whereas this study is based on the theoretical requirements of pasture D M necessary for weight gain or milk production. However, the theoretical requirements of pasture D M by certain classes of animals, so that they can perform, has been a method used for many years by scientists all over the world when determining any feed requirement regime for animals.

4.2.4 Procedure. The farmers concerned had no knowledge that this study was under way. This was done to ensure that normal management would not be modified to obtain desired results. The final recordings came from the farms of variable sizes with fairly similar climatic conditions, but with different pasture types, as shown in Appendix XI .

The management efficiency of the farmers varied, and thus variable pasture non-utilization figures could be expected from the farmers.

Five quadrats of grazeable pasture were cut prior to one grazing. The writer measured the area of the pasture, cut five quadrats of grazeable pasture, weighed the harvested material and later weighed the air dry matter from the subsample taken from the quadrats. The animals were grazed in paddocks of sizes varying from 1,2 hectares to 10,4 hectares. The system of grazing was set grazing.

Having the area and the data of mass yield from the five quadrats cut to approximately 2 cm height, and the calculated air dry matter from a subsample of cut grass, it was possible to calculate the total air dry matter yield of each pasture. The type of grazing animal was recorded, and in all except two cases they were made up of beef or dairy heifers. By calculation and using Morrison's (1959) and Bredon's (1969) feed requirement standards it was possible to work out the length of time that the number of animals concerned should have stayed in each pasture without reduction of intake to below their daily feed requirements. When the pasture was grazed the time of stay by the group was recorded. The actual time of stay was then equated with the theoretical calculated time of stay, and was expressed as a percentage of the time that the animals should have stayed in the pasture. The difference between the amount of grazing that should have been provided by the pasture and the actual grazing that was provided, was then calculated as an amount of non-utilized pasture.

4.2.5 Results.

The results of this study are presented in Table 23.

[illegible] comparative data used in calculating the percentage non-utilization of twelve different pastures after a single grazing for 1976

Farmer	Pasture	Animals	Month	No. of Animals	Area of pasture (ha)	Total feed require-ments/day (kg D M)	Actual dry matter available (kg)	Calculated grazing days available	Actual grazing days	Non utiliza-tion %age
1	Irrigated Ariki ryegrass & clover	Beef heifers	June	24	1,2	216	4 188,2	19,39	11,0	43
2	Non-irrigated Fescue	Beef cows	July	16	2,9	192	6 796,8	35,40	15,0	58
3	Non-irrigated oats and ryegrass	Dairy cows	May	102	9,3	1 224	21 910,0	17,90	9,0	50
4	Irrigated kikuyu	Beef steers	April	30	9,1	246	1 778,6	7,23	3,5	52
5	Irrigated Ariki ryegrass	Dairy cows	Sept.	126	10,4	1 512	24 645,6	16,30	10,0	39
6	Irrigated Fescue and clover	Dairy cows	May	63	3,8	756	9 298,8	12,30	9,0	27
7	Irrigated rye-grass and clover	Dairy cows	June	82	6,4	940	12 126,0	12,90	7,0	46
8	Non-irrigated kikuyu	Dairy cows	April	156	2,2	1 872	4 492,8	2,40	2,0	17
9	Non-irrigated ryegrass and clover	Beef cows	June	52	2,4	624	4 617,6	7,40	6,0	19
10	Non-irrigated Fescue	Dairy cows	June	81	2,8	972	7 387,2	7,60	5,0	34
11	Non-irrigated cocksfoot	Dairy cows	July	74	5,7	888	17 751,1	19,99	8,0	60
12	Irrigated ryegrass	Dairy cows	Sept.	120	9,4	1 440	22 320,0	15,50	11,0	29
								Average		39,5

The nature of this study created many problems. The farm manager was not to know that the trial was on, the pasture yield had to be measured before grazing, and so often pasture yields were recorded and then the pasture was not utilized at all by the farmer at that period, thus nullifying the mass recordings done beforehand. Opportune sampling times had to be sought and the study took six months to compile the 12 recordings. In all there were 31 recordings, 19 being fruitless. The type of pasture was selected only on a basis of what was available for recording without manager knowledge.

Measurement of pasture area was done by pacing, and regular checking of the writer's pace size. It was never known beforehand what type of animal the manager would place on the pasture. Thus all the calculations had to be done only once all the observations and recordings of animal type and pasture grazing period had been made. In the case of the beef and dairy heifer grazing groups, the manager informed the writer of the average mass weight of the group after the pasture had been grazed off by them.

Despite the theoretical need to retain a proportion of leaf area to ensure rapid regrowth after grazing, the approximate 40% wastage or non-utilization of pasture is a disturbing one. Jagusch (1973) in New Zealand accepted a 15% loss of available grazeable grass on milk production farms. It is even more disturbing when it is realised that the dairy cows will have received concentrate feeding in the shed when milked, while the feed requirement calculations are made from the pasture available only.

The addition of supplementary feed to the animal diet in fact means that the calculated grazing days available (Table 23, column 9) should have been even higher than those used in the calculations. It should also be recorded that most of the cows concerned yielded an average of only 10 litres/day.

Table 23 shows an average non-utilization of pasture percentage figure of 39,5. This average figure is higher than the non-utilization figure presented in paragraph 4.1.3 (Table 22).

The extreme figures in Table 23 of 60% and 17% surely indicate that there is a need for improvement in the utilization of pastures by some Underberg farmers. Further, the beef farmers in the sample appear to be the less efficient "pasture managers" than their counterparts, the dairy farmers, as shown by the figures of 43% versus 37,5%.

Pasture scientists may suggest that perhaps the high pasture non-utilized figure should not be taken as poor management, but possibly good management, in that the manager did not wish to graze the pasture right down to 2 cm height for he possibly wished to accumulate pasture for the winter period. This is possible, but on investigating the pasture utilization by the individual managers, and the feed needs of the cattle on the farms, there was no apparent reason for the non-utilization of the pastures in nine of the twelve cases.

Relating to Underberg budget feeding, where certain farmers maintain that feed shortages occur when they apply the budget feeding plan, this study indicated that a possible basic cause of shortage of feed is poor utilization of the feed. As shown in Table 23, an average of 39,5% of the feed is wasted. This wastage was not normally catered for in the application of research results to the planning of feed programmes.

This approximate 40% wastage or pasture non-utilization figure surely has economic repercussions. Extrapolating from Table 23, the average actual dry matter available was 9 799,5 kilograms. At three cents a kilogram of pasture dry matter, 9 799,5 kilograms is worth R294 and thus with 40% wastage, R118 of the R294 is wasted!

4.3 Discussion

The non-utilization of pastures by certain farm managers certainly has repercussions as far as the budget feed exercise is concerned. Feed, that the budget feed planner calculated would be used, in fact was not used. The non-use of the feed could inevitably lead to a shortage of animal feed, and hence the failure of a budget feed scheme.

It appears that a farmer educational scheme on the optimum use of pastures by the animals, should be envisaged by the Underberg extension workers. A non-utilization of pastures figure of approximately sixty percent appears to be far too high.

CHAPTER 5

GENERAL DISCUSSION, AND CONCLUSION

5.1 Estimating animal requirements

The lack of replications and the fact that the study had a duration of one year could be seen as weakness of this investigation. Budget feeding programmes are applied to farmers on their farms, and hence the norms for the real pasture yields can only be meaningfully established on farms over time. The original norms had been derived from plot trials. Naturally, from a practical angle, no single farm in the area was likely to have all the different types of pasture under study, thus it was necessary to find the different pasture types on different farms, that is, farms with similar rainfall, soil and management.

The complexity of the study, with all the work of cutting quadrats on different farms when the pastures were ready to be cut, made it impractical to continue the study for more than one year, and so the programme was restricted to only one season. Replications of the farm pasture cutting trials would also have aggravated the situation of monitoring and recording all the results in the time available to the writer.

Further, any variation in soil differences were minimised by corrective fertilization based on analyses, as would normally be recommended in the farm situation. This factor surely eliminated much of the fertility variations between sites.

A further point possibly affecting some of the results or some of the observations, was that all the farmers, where the different grass studies were being carried out, were not necessarily only beef or dairy farmers. Once again, from a practical point, the Underberg district does not have sufficient dairy or beef farmers to test the different pastures under one type of stock farming. It was thus necessary to find the different pasture types to test, regardless of whether the farmer was farming beef or dairy.

Bredon & Meaker (1974) have drawn up a correlation between crude protein percentage, crude fibre percentage and total digestible nutrient (T D N) of a feed. Using their table it was possible to obtain T D N values for the grass types in Tables 4, 6 and 8 and the following T D N figures were calculated, and are tabled in Tables 24, 25 and 26.

Table 24 The calculated T D N figures of irrigated pastures listed in Table 4

Grass Type	T D N Value
Ryegrass	62,9
Ryegrass and clover	64,6
Fescue	61,4
Fescue and clover	66,7
Clover	71,5
Cocksfoot	62,5
Cocksfoot and clover	64,2
Kikuyu	66,7
Mean	65,1

Table 25 The calculated T D N figures of the topland non irrigated pastures listed in Table 6

Grass Type		T D N Value
Ryegrass		64,4
Ryegrass and clover		64,6
Fescue		62,0
Fescue and clover		64,2
Clover		71,0
Cocksfoot		64,4
Cocksfoot and clover		62,9
Kikuyu		66,8
	Mean	65,0

Table 26 The calculated T D N figures of the lowland non irrigated pastures listed in Table 8

Grass Type		T D N Value
Ryegrass		63,9
Ryegrass and clover		65,0
Fescue		61,3
Fescue and clover		64,9
Clover		69,9
Cocksfoot		62,2
Cocksfoot and clover		62,4
	Mean	64,2

An average of the T D N values for the different grass types grown under the three different conditions in the Underberg district are presented in Table 27.

Table 27 The average T D N figures for the different grass types, grown in Underberg

Grass Type	T D N Values
Ryegrass	63,7
Ryegrass and clover	64,7
Fescue	61,6
Fescue and clover	65,3
Clover	70,8
Cocksfoot	63,0
Cocksfoot and clover	63,2
Kikuyu	66,7
Mean	64,9

An arbitrary 275 kg beef type animal has been chosen as a basis for evaluating the application of the above T D N figures to budget feeding. A 275 kg animal consumes 7 kg dry material of feed per day. This animal, in order to gain 1 kg mass per day (A D G) must consume 5 kg T D N per day. Based on the average T D N values, the only grass type that could supply this 275 kg animal would be the clover pasture (in 100 kg D M of clover there is an average of 70,8 kg T D N, therefore, 7 kg D M of clover would supply 5 kg of T D N). The next highest T D N value comes from kikuyu, but this only supplies 4,7 kg of T D N which would be insufficient for 1 kg gain/day if kikuyu is fed to a 275 kg animal. However, kikuyu feed alone would allow a 275 kg animal to gain 0,85 kg/day. The other grass species would allow a 275 kg animal to gain less than 0,85 kg/day.

In the above example the economic importance of feeding pure clover versus other grass types is very significant. As shown above, theoretically a 275 kg animal would reach a required mass in 0,85 of the time if it were fed on clover rather than kikuyu. The comparison between clover feeding and the feeding of any other grass type, other than kikuyu, is naturally more significant in favour of clover feeding, as, in fact, the average T D N values of the other grass species is less than the 66,78% T D N in kikuyu. Perhaps the most significant comparison is the feeding of a 275 kg animal on pure clover with a 70,8 T D N versus pure fescue with a 61,6 T D N. The fescue would allow 0,75 kg gain per day. Therefore, it can be argued that pure fescue is 25% less efficient than pure clover when fed to 275 kg animals. It is suggested that the same pattern, as shown above, of mass gain from different types of pasture, would apply to all classes of animals.

Further, in reviewing the average T D N figures for the different pastures it is very noticeable that by the addition of clover to the grass types the T D N figures are increased. Examples verifying this statement are given in Table 28.

Table 28 The increase in T D N value by adding clover to the grass component

Grass Type	Average T D N percentage
Ryegrass	63,7
Ryegrass and clover	64.7
Increase in T D N percentage	1,0
Fescue	61,6
Fescue and clover	65,3
Increase in T D N percentage	3,7
Cocksfoot	63,0
Cocksfoot and clover	63,2
Increase in T D N percentage	0,2

Roberts (1959) showed that yields of D M/ha were increased by clover being added to the grass species, and these T D N figures support the recommendation that clover should always be added to grass for pasture purposes. Roberts (1959) showed that grass grown with clover, also had 2 to 3 percent more C P than the same grass grown alone.

Perhaps it is to be expected that the T D N yield figure should increase by the addition of clover to the grass species, as the highest T D N of 70,2% was obtained with pure clover.

From a consideration of the budget feeding programme, the production of pastures with higher T D N should be encouraged by the extension worker as higher animal mass gains and milk yields will be achieved in a shorter period of time. It therefore becomes important that the farm adviser stipulates the specific type of pastures to be grown when doing a budget feeding plan for the farmer.

T D N in the pasture types appears to be the limiting factor in animal performance while on pasture, for the protein figures of the pastures showed that all the pasture types had sufficient protein for 1 kg/day gain for the 275 kg animal cited as an example.
The straight fescue pasture has the lowest crude protein percentage figure of 16,5 (mean C P data from Tables 4, 6 and 8). The availability of this type of fescue pasture would enable a 275 kg animal to consume 0,89 kg digestible protein (D P). The protein requirements for a 1,0 kg/day gain by a 275 kg animal is 0,54 kg D P/day (Lesch *et al.*, 1974) so, in fact, fescue could supply an excess of 0,35 kg D P/day. These facts verify a previous statement that the pasture types concerned in this study, when fed to a 275 kg class of animal, had no protein limitation, but a T D N limitation on the performance,

should 1 kg/day gain be desired. 1 kg gain per day is a desirable gain for a 275 kg animal in the Underberg district.

When budget feeding was originally introduced by the extension worker, the norms for grasses were based mainly on expected yield and protein content. The above information, where the lack of T D N has been shown, was not considered in the original budget feed norms. Hence a budget feeding plan could have led to inadequate feeding, as the pasture feed limiting factor for certain animal performance could have been the lack of T D N in the pastures, due largely to the incorrect types of pasture species being grown by the farmer.

Reiteration of the fact that a 275 kg animal and its nutrient requirements for 1 kg/day gain was selected at random, is necessary. However, the above principals as discussed for the 275 kg animal should prevail throughout all classes of animals while grazing on pastures.

5.2 Seasonal growth curves

Unfortunately the derivation of seasonal growth curves from the figures in paragraph 3.1.4 was not possible. The actual quadrat yield figures for the irrigated topland pastures were scrutinised, but no pattern or curve could be obtained. This can be shown by the October grass yield figures where the highest D M yields came from the kikuyu and the clover pastures, whereas the lowest yielding grass was the cocksfoot and clover mixture. However the next set of cuttings which were done between 15th November and 24th December, 1974, showed that the cocksfoot clover mixture was the highest yielding.

It would be spurious to extrapolate comparative growth curves for the different types, as they were not all cut on the same day. It was a practical impossibility to cut all the grass pastures on the same day, as they were grown on different farms throughout the Underberg district.

5.3 The possible significance of a cocksfoot and a kikuyu pasture in Underberg

Although the work on pasture productivity (Chapter 3) was based on the optimum nitrogen, phosphate and potash (N.P.K.) levels being supplied for maximum growth, it should be mentioned that, where N.P.K. are shown to be insufficient in the soil, the cocksfoot pasture visually appeared to produce more herbage than ryegrass, fescue or kikuyu in the Underberg district. The extension worker, using a budget feeding technique, should take cognisance of the above favourable characteristic of cocksfoot, even if the results shown in Chapter 3 do not show cocksfoot up in a favourable light.

An observation worthy of note is that kikuyu in Underberg seems to resist weed infestation to a higher degree than the other pasture types. Weeds, especially *Eragrostis plana*, seem to creep into fescue, cocksfoot and ryegrass pastures should they be subjected to stress such as drought or overgrazing. This is not the case with kikuyu, provided fertility is reasonable. Nevertheless, kikuyu in Underberg has not been a favoured grass species amongst the farmers, as, under non-irrigated conditions, it does not grow vigorously in the early stages of the growing season. This statement is verified by the actual quadrat cutting figures for non-irrigated topland during October and November where kikuyu yielded 0,09 ton D M/hectare, whereas ryegrass yielded 0,11 ton and clover 0,12 ton.

5.4 Irrigation

Irrigation increased the D M yields of all the pastures by an average of 2,81 ton D M/ha. The economics of irrigating pastures in the Underberg district is always a debatable point as, in most years, seven months of the year have rain, while the months of June to August are too cold for active growth and thus the irrigation advantage would only be over the months of May and September. The longevity of a pasture is enhanced by the application of irrigation at strategic times, and hence the economic importance of irrigation at certain times of the year becomes very valid.

5.5 Choice of pastures

The difference of 1,26 ton D M/hectare between the highest and lowest yielding non-irrigated lowland pasture, ryegrass and clover (10,06 ton) and cocksfoot (8,80 ton), is not as great as the 5,02 ton D M/hectare difference between ryegrass and clover (15,06 ton) and cocksfoot (10,04 ton), in pasture yields under irrigated topland conditions. The difference figure of 4,44 D M ton between kikuyu and cocksfoot, under non-irrigated conditions, is surprisingly high and thus the importance of the higher yielding grass is very pertinent to the budget feed planner. Possibly, under non-irrigated lowland conditions, the selection of the correct pasture type is not as important to the budget feed planner, or farmer, as it is under the other two conditions of irrigated and non-irrigated topland.

5.6 The importance of using an accurate norm

Table 13, where the original budget feed norms used for pastures are shown to be different from figures obtained in the pasture productivity studies, should supply enough information to the budget feed planner to convince farmers in this area that they should endeavour to use a fairly accurate figure or norm, otherwise too large an error could creep into a budget feed plan.

To reiterate, as shown in Table 13, a budget feed plan which includes a **fescue** pasture, and using yields and chemical composition norms taken from Morrison (1959) and Bredon (1969), could have led to a 39,1% deficiency of budget feed, if the plan had envisaged no feed other than non-irrigated fescue pasture. Possibly it should be mentioned that the non-irrigated topland fescue variation from the norm used of 39,1%, was the greatest of the species tested and that a combination of different grass pastures on a farm would have led to less than 39,1% deficiency of feed being obtained, if a budget feeding plan had been carried out. It should be pointed out that the Underberg extension worker could have made an error of up to 39,1% in feed requirements in the original plans. This fact could have been one of the reasons why certain Underberg farmers were short of feed, even though they had carried out a budget feed plan.

5.7 Validity of results

5.7.1 Validity of results of the pasture productivity studies (Chapter 3).

As mentioned earlier, a criticism of the study recorded in Chapter 3 is the lack of replication and the fact that the study ran for only one year. However, in the year following the study, the yield for ryegrass and clover under irrigated topland conditions and the yield of cocksfoot under non-irrigated topland conditions were measured in a follow-up study. In this subsequent study the yield of ryegrass and clover was 14,88 ton D M/ha whereas the cocksfoot under non-irrigated topland conditions yielded 8,21 ton D M/hectare. It is therefore suggested that the criticism of the value of the figures obtained in the study should not be too harsh as, in fact, the difference between the two seasons' figures for the ryegrass and clover was only 0,18 ton D M/hectare (15,06 and 14,88). In the case of cocksfoot the difference in the two seasons' total D M/yield/hectare was 0,59 ton (8,80 and 8,21). In obtaining the D M yields in the subsequent study, the same study techniques and procedures, as was used in pasture productivity studies were followed and it is suggested that this replication in time adds weight to the validity of the pasture productivity study results.

5.7.2 Criticisms of the studies on the plot versus farm paddock grass yields (Chapter 3.2). The criticisms affecting the study results could be:-

(i) the study was only over one year;

(ii) there were no replications;

(iii) the plot grass would start growing immediately after it was cut, whereas the farm paddock could have animals grazing on it for many days, and thus the regrowth of the pasture would be delayed until the animals were removed; and

(iv) farmer management, in itself, was a variable.

However, the fact remains that the plots outyielded the equivalent pastures on the farm.

The extension worker usually uses a norm for budget feeding derived from plot cuttings or published experimental results. Perhaps a locally tested farm scale norm would be preferable. Should there be a difference between suggested norm figures derived from plot and farm scale trials, it possibly would be best for the Underberg budget feeder to use the farm scale norm, if thought to be reliable. It is interesting to note that, by taking the average yield of the pastures under farm and plot conditions, that is, 11,91 ton D M/hectare and 15,83 ton D M/hectare, the difference is 3,92 ton D M/hectare or a 24,76% difference in yield.

A possible variation in yield of up to 24,2%, linked with a possible variation of norm used in the pasture productivity study (Chapter 3) of up to 39,1% is very pertinent to the budget feed planner, as there is a real possibility of the above variations seriously affecting the outcome of a budget feed plan. Conscious of the criticism that the validity of the figures in Chapter 3.2.5 are questionable due to the trial only running for one year, the writer managed to test the yields of Ariki ryegrass for a further season, under farm and plot conditions. The yield in D M/ha was 14,20 compared with 14,70 found in the trial recorded in paragraph 3.2.5 and the yield on the plot was 18,88 compared with the yield of 19,25 shown in the results recorded in paragraph 3.2.5. The subsequent season figures are very similar to those reported in paragraph 3.2.5.

5.7.3 <u>Duration of the trial (Chapter 3.3) on the comparison of</u> Lolium multiflorum <u>varieties</u>. The study on ryegrass cultivar yields in the Underberg district was a biometrically sound study as there was more than one replication. However, once again, the study ran for one year. In a subsequent trial, the sequence of the top three and bottom two cultivars as shown in Table 16 did not change, but the actual D M yields were slightly lower than the results recorded in 3.3.5, as shown by Tetila yielding 9,7 ton D M/hectare tabulated in Table 16, as against 9,5 ton D M/hectare in the subsequent trial. Table 16 shows a difference of 3,11 ton D M/hectare between the highest and the lowest yielding ryegrass cultivars (Tetila 9,77 and Tama 6,67, a difference of 31,8 %). It is therefore not sufficient, when budget feeding, to tell the farmer to use any ryegrass cultivar, as, by using the wrong cultivar, the actual feed shortage over the season on the farm could be up to 31,8%, if the plan envisaged used ryegrass as the only feed.

To date, possible errors in budget feeding could be as follows:

pasture productivity study, up to 39,1%;
plot versus farm paddock
grass yield trial, up to 24,2%; and
ryegrass cultivar trial, up to 31,8%.

5.7.4 Errors associated with time of use of pasture. A further error could creep into budget feed, as shown in the study reported in paragraph 3.4 on foggage value. Previously, in paragraph 3.4.5, it was found that there could be a variation of up to 79,6% in D M yields, depending on the month of the year that the "saved" pasture or foggage was used. Budget feed planners should not use maximum D M foggage yield/hectare figures, as there is a good chance of the predicted yields diminishing as the winter progresses and thus in farmers being short of available feed for the animals.

5.7.5 Possible errors associated with animal feeding standards. Jagusch (1973) writes, "Like in all average figures, a great deal of common sense is needed when applying tabled feeding standard values to an individual enterprise. No-one should misunderstand and assume that average values are highly precise under all feeding conditions.

At best they are guides to feeding practice, and this applies to all feeding tables in spite of certain claims to the contrary".

The feeding tables, used in budget feeding, may not have been one hundred percent precise, and as such, error could have crept into the budget feeding programme.

5.7.6 Veld carrying capacity norms. The comparison of productivity of veld at two sites in the Underberg district was included in this work with the sole aim of checking that the 0,5 mature livestock units per hectare, as used in the original budget feeding plan, was in fact a reasonable norm. The veld carrying capacity norm trial did confirm the validity of 0,5 mature livestock units per hectare. The environmental components which would affect the performance of the veld, such as aspect, soil etc., were not a major issue in the trial which was undertaken to determine the carrying capacity of the veld. The veld in Underberg needs a separate study in situations where veld makes a major contribution to animal production.

In terms of error or variation for budget feeding purposes, the recommended veld carrying capacity norms used show little variation from the results of the veld study and thus budget feeding plans should not run short of veld feed.

5.7.7 Significance of low utilization of pasture. Chapter 4, where the non-utilization of pastures by farmers was investigated, showed that (Table 22) one farmer left 51,4% of his available pasture unused at a certain critical time. This non-utilization figure is pertinent to the farm adviser when working out a budget feed plan, for if it is known that the farmer will not utilize all the grass available at a grazing, then the plan should not include a 100% utilization figure.

The managerial study in Chapter 4.2 showed similar results to the study reported in Chapter 4.1, in that both supply a possible reason why Underberg farmers could have been short of feed, even though they had carried out a budget feed plan. The utilization of all the feed available during the cold dry winter months is important to ensure the success of a budget feed plan, as in fact the grass does not regrow very readily during the winter.

It is interesting to note that if the farmer who had a 60% non-utilization figure (Table 23) of non-irrigated cocksfoot, used similar management throughout the year, he stood a chance of being short of at least half his budget feed requirements. However, the average non-utilization figure in Table 23 was 39,5%, a far better figure than the 60% noted above.

It is appreciated that the 39,5% average non-utilization of pasture by Underberg farmers could vary throughout the year, from farm to farm and from month to month, but the pertinent point arising from this study is that an average 60% utilization of budget feed should be reckoned on when planning feed requirements for a farm over the winter months.

It should be reiterated that section 4.2.4 attempts to substantiate the fact that non-utilization of pasture was leading to the downfall of the budget feed scheme. Feed was not being utilized, nor was it kept for later grazing by other animals. As shown, certain of the twelve farmers had no intention of regrazing the non-utilized portions of their pastures over the critical winter period.

5.8 Application of results

This work sets out to investigate possible weak links in the budget feed scheme and in particular to examine why the farmers were short of feed, even though they had grown the feed required of them by their budget feed scheme. Variation in accepted norms and principals used in budget feeding have been shown up. In summary, variations of the following magnitude have come to the fore:-

pasture productivity studies,	up to 39,1% variation from norm used;
plot versus farm pasture yield,	up to 24,2%;
ryegrass cultivar trial,	up to 31,8%;
non-utilization of pasture trial,	up to 26,7%; and
non-utilization of pasture trial II.	up to 39,5%.

What then should be done to remove variations from the norm, error or discrepancy from the "facts" used in a budget feed plan?

The above percentage figures averaged out at 32,3%. There was a chance of about one third inadequacy in a feed plan. In practice this figure could be less, because not all the discrepancies shown in Chapters 3 and 4 would apply to a maximum degree on any one farm. Nevertheless, the above figures appeared to be similar in magnitude, hence the conclusion that a 32% safety factor be added to the feed budget, to try and make sure that the farmer was never short of feed, once having carried out a budget feed plan.

It is interesting to note that Jagusch (1973), in making a feed requirement table for sheep, beef cattle and dairy cows, took the A.R.C. feeding standards and increased them by 30% so as to allow for the extra energy needed, for grazing under New Zealand farming conditions.

A 32% extra feed requirement factor, for budget feeding, was therefore built into eleven Underberg farm budget feed plans in the year ensuing the completion of the trials recorded in Chapters 3 and 4.

Five of the eleven new farm budget plans were performed and executed on the pasture productivity (Chapter 3) co-operators farms. The other six farm budget plans were performed on farms, where the original budget feed plans, that is before this study had taken place,had not been a total success.

On completion of the new budget feed plan that included the 32 percent extra feed factor, all eleven farmers had sufficient feed, three farmers even had a surplus of feed, but the main factor was that there was no complaint about being short of feed. Thus one could deduce that this study had led to a tangible practical success in helping Underberg budget feed farmers to achieve their goal.

S U M M A R Y

1. Underberg lies immediately to the east of and below the Drakensberg, which is a mountain range in the province of Natal of the Republic of South Africa.

The agriculture extension area is comprised of 200 farms, which on an average are 800 hectares in extent.

As a result of an active study group, which for the years 1963 to 1970 kept accurate economic figures, the main cost items on the farm were found to be fertilizer, bought feed, repairs, labour and fuel cost. The extension workers decided to help the farmers by trying to cut the bought feed costs. To this end the idea of budget feeding was introduced and put into practice by the extension workers. Budget feeding was the name given to the plan, which assisted the farmer in calculating the necessary feed required to feed his animals for the 365 days of the year. Knowing the amount of feed required, norms of quantity and quality were applied to the budget feed exercise, leading to the number of hectares of each crop that should be grown.

Over a five year period budget feeding was carried out in the Underberg district. The plan was moderately successful. However, there were a number of farmers that were disappointed with the plan, in that they apparently carried out the budget feed plan, but still ran short of feed towards the end of winter.

A check was made on the factors that could lead to a budget feed shortcoming. An evaluation on the check points showed that there were some limiting factors, which possibly

could hamper the success of an Underberg budget feed plan.

2. It was decided to investigate the limiting factors in more detail, and to this effect the following trials were undertaken.

A comparison of the productivity of eight existing farm pastures was undertaken under topland irrigated, topland non-irrigated and lowland non-irrigated conditions.

The dry matter yields of the eight types of pasture varied enormously from the dry matter yield norms used in the budget feed exercise. The actual yield of fescue was approximately thirty percent less than the fescue norm used for budget feeding.

The trial established that straight clover was a high yielder of crude protein and a low yielder of fibre. A ryegrass and clover mixture, from a feed quantity and quality point of view, performed well.

Cocksfoot in general supplied the lowest yield of dry matter per hectare and the fescue was found to be the highest container of fibre and thus the lowest T D N supplier.

Kikuyu, although having a shorter growing season for the area, gave the highest overall dry matter yield. The non-irrigated kikuyu outyielded the irrigated kikuyu, a phenomenon which needed investigation.

The addition of clover to the grass in the sward was definitely advantageous.

Irrigation on average increased the air dry matter yield by 2,81 ton per hectare. Due to irrigation, this extra dry matter yield at 3 cents per kilogram dry matter meant an extra gross amount of R76 per hectare.

Non-irrigated lowland pastures, with the exception of straight clover, outyielded their counterparts under non-irrigated topland conditions, the reason apparently being that the lowland conditions have much cooler temperatures over the year.

On the average, non-irrigated topland pastures yielded 0,12 ton of air dry matter per hectare more than the non-irrigated lowland pastures. Clover pastures under non-irrigated topland conditions outyielded the clover under non-irrigated lowland conditions by 1 ton of air dry matter (A D M) /ha.

3. A comparison of the dry matter yields of topland irrigated Ariki ryegrass, Danish cocksfoot and Kentucky fescue pastures grown under farm conditions and under plot conditions showed that plot yields on the average yielded 30 percent more than the equivalent pastures on the farm (15,83 air dry matter/ha versus 11,91 A D M/ha).

4. A comparison of *Lolium multiflorum* cultivars in the Underberg area showed that over the six month winter period, Tetila, Tetrone, Midmar, Local Hipkin and Local Hulleys were significantly superior to the other cultivars under test. Tetila, cultivar, a tetraploid type, gave the highest D M yield of 9,77 ton per hectare. During the critical July and August winter feeding period the cultivar Midmar outyielded all the other cultivars by providing 2,93 ton of dry matter per hectare.

Further, it was found that the diploid cultivars outyielded the tetraploid cultivars during the mid winter period. It is important to note that certain cultivars outyielded others, and hence, a specific cultivar should always be stated when applying a norm for budget feeding exercises in the Underberg area.

5. A variation in the quantity and quality of the material on annual ryegrass pastures over the May to mid September period was very apparent. The average quadrat yield dropped from 2,71 kg wet material/m^2 in mid May to 0,55 kg wet material/m^2 at the end of July. It is thought that heavy frosts dried the foggage out and then heavy berg winds blew much of the conserved foggage away. Over the test period the crude fibre of the ryegrass foggage varied between 17,8% and 33,7%, while crude protein varied between 21,4% and 11,9%. For budget feeding purposes no specific norm of yield and quality of ryegrass foggage can be used over the winter period. It appears to be impractical to apply an accurate ryegrass foggage quantity and quality norm to an Underberg budget feed exercise.

6. An evaluation of a trial on the productivity of Underberg veld with the aim of determining whether the budget feed norm of 0,5 M L U/ha/season carrying capacity was correct was undertaken. All the results showed that 0,5 M L U/ha/season was not too high and thus should the Underberg budget feed farmer be short of feed, the fault would not lie in the fact that an incorrect veld carrying capacity norm had been applied to his budget feed plan.

7. The assessment of the non-utilization of pastures by the grazing animals on seven Underberg farms showed that on average 26,6% of the pasture was not utilized after one grazing. One farmer utilized only 48,6% of the pasture available to him. It appears that the non-utilization of pastures by the farmer was one of the reasons why some Underberg farmers were short of feed after attempting to carry out their budget feed plan.

8. Due to the high non-utilization figure of pasture by grazing animals shown up in Chapter 4.1, a further similar investigation on another twelve farms was undertaken. This trial verified the Chapter 4.1 results by producing an average non-utilization of pasture figure of 39,5%. One farmer in this trial utilized only 40% of the available pasture at one grazing. On nine of the twelve farms there was no apparent advantage to be gained by such poor utilization since the pastures were not subsequently regrazed.

9. By calculation from the protein and fibre figures the highest T D N figure was obtained from the pure clover trial in the pasture productivity study (Chapter 3). The clover fed to an arbitrary 275 kg beef animal would provide the best pasture for obtaining a 1 kg/day gain. Should bloat be a problem the next best pasture, from the point of view of average daily gain, would be kikuyu, which would supply enough nutrients to allow a 275 kg animal to gain 0,85 kg/day.

The addition of clover to the grass sward improved the quality of the pasture and appeared to have an economic effect on both pasture and animal production.

It is apparent that the correct pasture type should be grown by the Underberg budget feed farmer, as is shown by the difference of 4,4 ton of D M in yield per hectare in favour of kikuyu over cocksfoot when grown under non-irrigated topland conditions.

10. It is important to use an accurate norm in a budget feed plan. The current inaccuracy of as much as 39,1% in the budget feed plan is unsatisfactory.

The validity of pasture productivity studies are discussed in paragraph 5.7.1. Certain of the results were verified by trials in an ensuing year.

The weaker links in the budget feed scheme formed the main focus of this work. Certain variations in accepted norms and principals in budget feeding are shown up, as summarized below:-

pasture productivity studies,	up to 39,1% variation from norm used;
plot versus farm pasture yield,	up to 24,2%;
ryegrass cultivar trial,	up to 31,8%;
non-utilization of pasture trial,	up to 26,7%; and
non-utilization of pasture trial II,	up to 39,2%.

The above percentage figures averaged out at 32,3%.

A safety factor of 32% extra feed necessary for feeding animals was built into eleven new Underberg budget feed schemes, and the result was that no farmer who carried out his budget feed plan complained of being short of feed.

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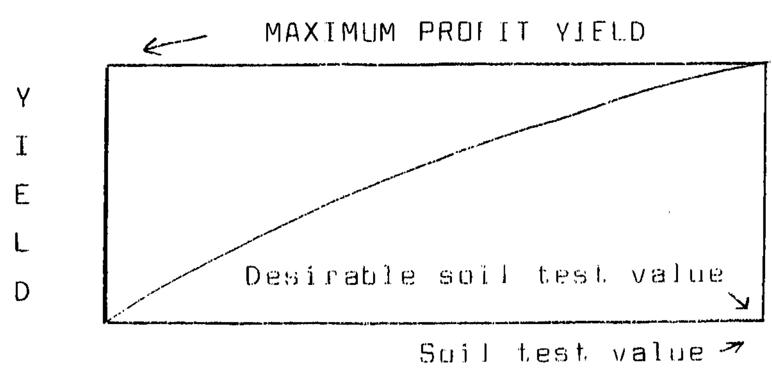
A P P E N D I X I

Note on soil testing.

In the Natal Farming Guide of 1974, the following advice is given on soil testing:-

"Soil testing has long been an established basis for the fertilization of agricultural crops in America, Europe and other countries where numerous laboratories analyse many thousands of samples annually. In Natal soil testing is in its infancy, partly through ignorance of its value and partly through inadequate adaption of foreign experience to local conditions. The popularity of soil testing is, however, rapidly increasing. The number of soil samples submitted to the Cedara soil testing laboratory by Natal farmers has doubled every year since 1968.

A soil test is a laboratory estimate of the amount of plant food contained in a sample of soil and enables the amount of fertilizer required to obtain optimum fertility in a particular field to be predicted. The prediction is made by calibrating the soil test used against actual crop growth, as shown in the following figure:-



The above curve is a characteristic relationship between soil test value and yield. This relationship is affected by soil type, climate, crop variety, type of fertilizer (in the case of phosphates) and soil test method. The soil test value must therefore be interpreted differently as these conditions change.

A soil test can be no better than the sample submitted for analysis. About a teaspoonful is eventually analysed and represents perhaps a whole field.

The following procedure will ensure that samples are correctly taken and analysed without delay:-

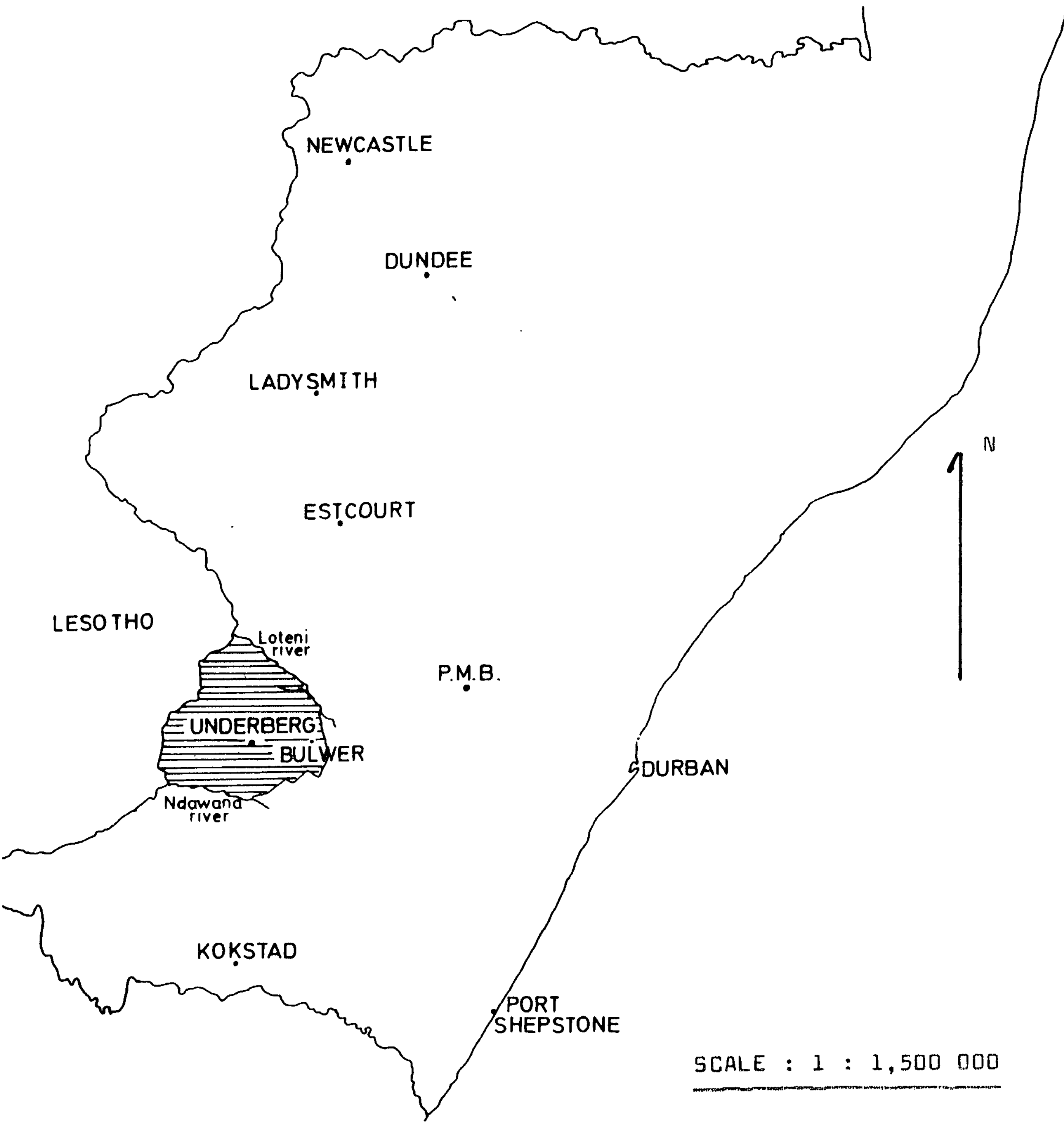
(i) a single sample should not represent too large an area. The land should be divided into blocks of about 5 to 10 ha according to the colour, depth and texture of the soil;

(ii) about 15 to 20 randomly scattered cores about 15 cm deep should be taken from each block, but obviously non-representative areas such as the previous year's fertilizer bands should be avoided; and

(iii) the cores from each block are placed in a clean container away from any source of contamination, by say fertilizer duct, and allowed to dry out in the atmosphere i.e. not in an oven. The clods are then crushed and the soil thoroughly mixed before filling the sample carton supplied by the Extension Officer".

APPENDIX II

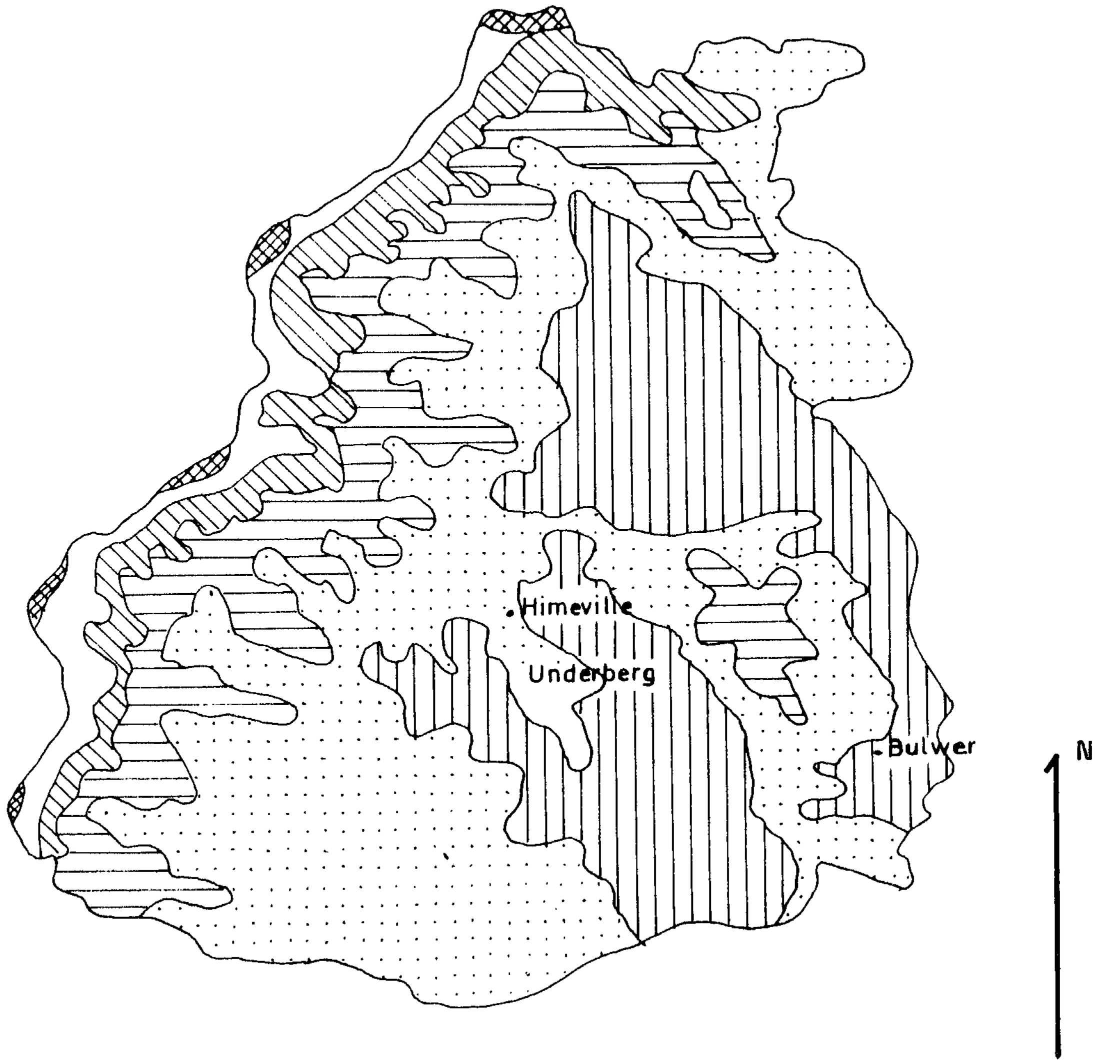
THE SITUATION OF THE UNDERBERG DISTRICT



SCALE : 1 : 1,500 000

APPENDIX III

TOPOGRAPHY OF THE UNDERBERG AREA



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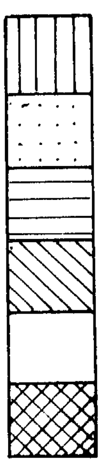


1219 - 1524 Metres

1524 - 1829 Metres

1829 - 2134 Metres

2134 - 2438 Metres

2438 - 2743 Metres

Above 2743 Metres

APPENDIX IV

Average rainfall for Underberg for seasons 1972/73 to 1974/75

Month	Rainfall in mm			Average
	SEASONS			
	1972/73	1973/74	1974/75	
July	000,00	10,00	23,75	11,25
August	28,75	60,00	32,00	40,25
September	43,75	38,00	000,00	27,25
October	17,50	71,76	5,00	19,00
November	98,00	124,50	86,75	103,00
December	37,50	122,75	195,50	118,50
January	75,00	311,50	192,25	193,00
February	147,50	461,25	180,00	262,75
March	98,75	132,00	171,50	134,00
April	167,50	137,50	33,00	112,50
May	000,00	000,00	000,00	000,00
June	000,00	18,00	000,00	6,00
Total	714,25	1 487,26	919,75	1 027,50

APPENDIX V

Mean daily temperatures from August 1974 to July 1975 at Underberg.

					Mean daily temperature in centigrade							
Day	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	Apr.	May	June	July
1	1,9	8,8	16,2	11,4	15,5	20,0	12,5	13,4	18,6	9,4	8,5	6,5
2	4,4	12,0	18,5	13,1	19,4	17,8	19,8	17,2	15,4	13,6	15,0	9,8
3	3,7	6,2	15,6	18,0	14,3	15,4	18,3	16,5	12,9	10,7	17,9	7,8
4	5,7	0,6	15,9	17,7	16,5	12,0	19,0	18,3	7,8	13,9	9,6	6,7
5	8,7	3,7	17,8	19,5	19,0	15,0	20,0	14,8	8,0	11,3	6,8	8,5
6	17,5	6,1	19,4	11,7	17,9	19,1	16,0	18,1	10,9	11,8	9,0	9,8
7	8,2	11,0	8,2	10,9	20,2	17,2	17,0	18,6	12,3	16,2	6,2	7,3
8	10,5	7,8	7,5	9,9	20,5	18,7	16,4	17,4	13,5	12,7	8,2	13,5
9	17,3	0,3	14,3	17,5	13,3	21,1	17,2	16,0	14,6	11,2	5,7	5,6
10	13,5	8,5	14,4	15,1	20,8	19,3	18,4	18,0	14,5	14,0	6,7	5,5
11	9,9	10,2	15,9	18,0	16,1	21,1	18,9	21,1	13,1	10,8	5,4	3,5
12	4,0	13,1	14,9	17,0	14,9	17,2	16,2	13,8	15,7	10,0	4,9	5,3
13	4,0	14,7	16,2	15,0	15,1	13,0	16,2	12,4	14,9	8,2	6,4	7,3
14	1,6	13,8	19,4	17,9	15,4	17,9	16,1	16,2	12,6	7,3	7,4	11,5
15	8,4	11,9	18,8	15,5	18,1	22,5	16,1	15,2	13,1	6,5	6,7	8,0
16	10,9	19,2	17,9	19,9	18,6	18,9	17,1	14,0	13,8	6,6	7,2	10,6
17	12,1	15,8	15,9	21,0	14,9	16,4	16,7	15,2	13,7	8,3	7,4	11,3
18	10,5	17,6	17,2	20,3	18,8	15,0	16,3	9,1	12,1	8,8	6,7	4,1
19	13,3	8,9	6,1	15,2	17,9	16,1	18,2	10,2	11,0	9,9	7,0	8,8
20	8,4	14,3	12,1	10,5	13,6	16,8	18,3	10,4	12,3	12,8	6,9	10,7
21	8,2	14,0	7,9	12,8	14,0	19,9	19,1	10,4	15,8	11,4	8,1	7,6
22	10,1	15,2	7,5	15,7	14,5	17,6	16,1	13,9	12,5	8,4	6,3	9,9
23	7,6	16,4	10,4	18,9	20,0	17,0	15,6	14,9	10,5	9,5	8,3	4,8
24	6,2	15,1	18,4	20,2	13,2	19,1	17,4	15,8	12,1	12,8	11,5	2,2
25	6,3	18,1	21,7	15,6	11,1	18,8	16,1	16,3	11,6	14,2	5,9	0,8
26	7,6	18,1	17,0	16,2	14,0	18,2	19,2	14,8	13,9	11,7	6,9	11,6
27	11,0	18,5	15,3	13,9	16,8	15,7	18,8	16,9	15,0	8,7	7,4	12,1
28	10,9	17,7	8,8	14,2	20,5	14,0	17,3	14,7	13,9	14,8	9,0	3,5
29	7,8	18,5	17,8	17,3	16,6	20,6		15,6	15,3	9,7	6,6	4,2
30	16,2	20,7	20,3	15,7	12,1	15,6		16,6	14,3	10,6	6,4	10,8
31	2,2		15,9		17,2	9,8		16,6		4,6		10,1
Average	8,7	12,6	14,9	15,9	16,5	17,3	17,3	15,2	13,2	10,7	7,9	7,7

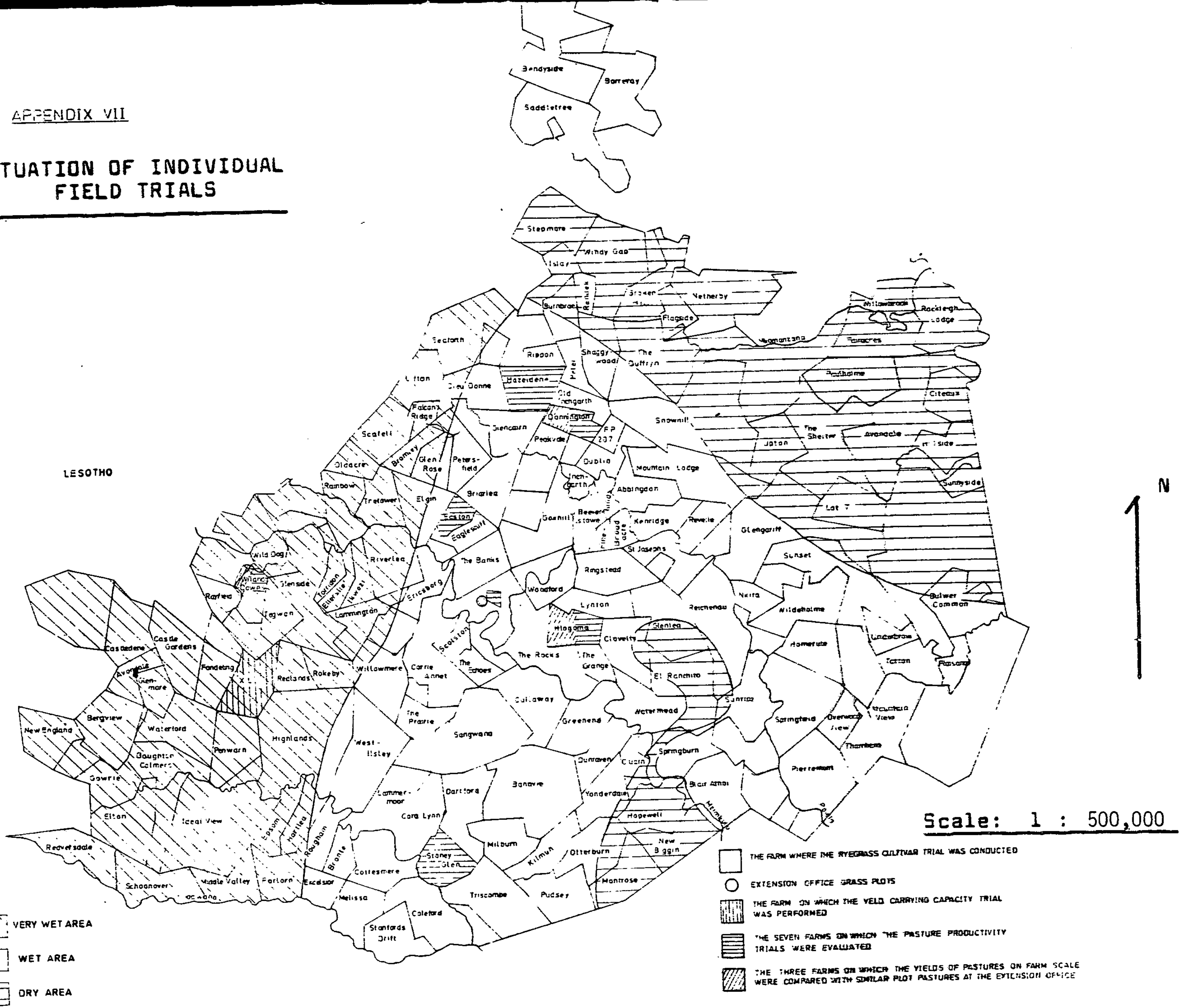
APPENDIX VI

Soil analyses of pasture before trial began. Expressed in kg/ha present in the soil.

Irrigated topland	pH in KCℓ	P	K	Aℓ	Ca	Mg
Ryegrass	4,8	49	176	27	2 032	310
Ryegrass and clover	4,7	33	520	36	1 680	341
Fescue	4,4	21	200	153	956	118
Fescue and clover	4,9	19	120	0	3 156	221
Clover	4,9	50	120	0	3 200	319
Cocksfoot	4,4	36	112	180	1 456	278
Cocksfoot and clover	4,3	54	88	279	800	108
Kikuyu	4,5	82	134	79	848	358
Non-irrigated topland						
Ryegrass	4,5	39	88	79	2 684	151
Ryegrass and clover	4,5	95	288	72	1 072	499
Fescue	4,7	27	120	27	1 456	180
Fescue and clover	4,4	40	104	162	1 220	175
Clover	4,4	50	180	152	1 320	165
Cocksfoot	4,5	56	672	140	1 562	218
Cocksfoot and clover	4,4	62	696	135	1 672	223
Kikuyu	5,1	31	7 800	0	3 420	602
Non-irrigated lowland						
Ryegrass	4,9	21	210	0	3 240	201
Ryegrass and clover	4,9	40	216	0	3 348	650
Fescue	5,0	18	168	0	>4 000	1 154
Fescue and clover	4,9	93	136	0	3 416	910
Clover	4,6	18	584	54	3 804	931
Cocksfoot	4,7	21	752	0	>4 000	1 805
Cocksfoot and clover	4,9	22	280	0	>4 000	1 094

APPENDIX VII

SITUATION OF INDIVIDUAL FIELD TRIALS



APPENDIX VIII

Actual areas of the pasture paddocks on which the quadrats were cut.

Irrigated topland	Hectares
Ryegrass	0,6
Ryegrass and clover	2,7
Fescue	2,6
Fescue and clover	3,8
Clover	0,6
Cocksfoot	1,8
Cocksfoot and clover	1,5
Kikuyu	9,1
Non-irrigated topland	
Ryegrass	2,7
Ryegrass and clover	2,7
Fescue	2,9
Fescue and clover	2,7
Clover	4,8
Cocksfoot	0,5
Cocksfoot and clover	3,6
Kikuyu	0,2
Non-irrigated lowland	
Ryegrass	8,4
Ryegrass and clover	7,7
Fescue	1,8
Fescue and clover	2,9
Clover	5,7
Cocksfoot	5,4
Cocksfoot and clover	4,8

A P P E N D I X IX

Relationship between air dry matter and oven dry matter.

Example:

2,62 kg	Wet grass i.e. a sub sample of wet ryegrass
0,51 kg	Air dry i.e. when dried at Underberg
0,45 kg	Oven dry i.e. when dried at Cedara prior to C P and C F testing.

Therefore, oven dry material is 8,4% drier than is air dry material for this particular example.

On an average the oven dried material was 9,1% drier than the air dried material i.e. taking every grass type under test and four sub samples of each grass type, in all, 32 tests. The variation was from 8,1% to 10,9%.

APPENDIX X

Layout of Lolium multiflorum yield trial No. 14 (1976)

Location: Underberg Planted: 25/2/76

Ariki	Rocket	Local B Hulleys	Common Oregon	Midmar	Tewera	P/C 12
Ariki/ Midmar	Billion	Tetrone	Tama	Paroa	Local A Hipkins	Tetila
Ariki	Tama	Local A Hipkins	Tetrone	Billion	Tewera	Midmar
Ariki/ Midmar	Common Oregon	Paroa	Rocket	Tetila	P/C 12	Local B Hulleys
Ariki	Midmar	Billion	Local A Hipkins	Tewera	Paroa	Rocket
Ariki/ Midmar	Local B Hulleys	Common Oregon	Tama	P/C 12	Tetrone	Tetila

Plot size: 4,0m x 7,7m

Sowing rates: Diploids 20 to 25 kg/ha

Tetraploids 30 to 35 kg/ha

APPENDIX XI

SITUATION OF TRIALS DESIGNED TO MEASURE THE PERCENTAGE NON-UTILIZATION OF PASTURE DRY MATTER

Scale : 1 : 500,000

THE FARMS ON WHICH THE NONUTILIZATION OF PASTURES BY THE GRAZING ANIMALS WERE INVESTIGATED