GRASSLAND FERTILIZATION AND ANIMAL PRODUCTION PROJECTS: THEIR DEVELOPMENT

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Introduction

The Fertilizer Society of South Africa has initiated a series of long-term field projects with the overall objective of assisting in the increase of red meat production in South Africa. The development of suitable production systems for different environments, based on increased production from pastures — both natural and sown — is the immediate aim. It has been found that improved soil fertility results in an increased nutritional status of the herbage and, in some cases, in an extended grazing season.

Work is being done in three main fields of activity. These are, veld in the higher rainfall areas, *Eragrostis curvula* in the Eastern Highveld regions and *Cenchrus ciliaris* in areas of higher temperature and lower rainfall.

Projects have been planned for a duration of five seasons and fall into two main categories:

Member Companies are responsible for certain of the projects while the FSSA is directly responsible for others. Co-ordination of the projects is the responsibility of the Society.

The Veld Projects

These projects are situated in the higher rainfall areas of South Africa: seven in Natal, one in East Griqualand, three in Eastern Cape and two in the Orange Free State. The procedures which have been followed have been based on the results of experiments, carried out over many years, by research workers from both the Department of Agriculture Technical Services and the private sector. As a background to the present field projects discussed in this paper some research results follow:

*Experiments on fertilization of veld were started as long ago as 1907 at Cedara College of Agriculture. Hall, in 1929, embarked on a programme of work which covered many different ecological regions. Some of this work was reviewed by Hyam (1968).

*Hall, Meredith & Altona (1950) conducted an experiment at Frankenwald Research Station to determine the value of fertilized veld for beef production. The annual average live-mass gain of beef per hectare, over an eight year period, was 65 kilogrammes from unfertilized veld. Veld fertilized with 212 kg of superphosphate and 276 kg of ammonium sulphate yielded a mean of 226 kg of beef per annum.

*In an experiment at Frankenwald, Hall & Altona (1952) found that an application of 64 kg of N and 17 kg of P increased dry matter yield from 1 071 kg to 1 957 kg per hectare.

*The results of a factorial experiment in which various combinations of phosphorus and nitrogen were applied to two veld types at the Agricultural Research Institute, Glen, were reported by Vorster & Mostert (1968). These showed that the climax retrogressed as a result of fertilization. Veld which was in a more pioneer stage responded more markedly to the application of fertilizers.

*Grunow, Pienaar & Breytenbach (1970) found from the examination of results of long-term experiments on veld fertilization that, in general, climax grasses were replaced by species of a more pioneer type. These workers state that "in Natal, weed encroachment on one of the experiments reported has posed a problem by reducing the value of the herbage produced. Possibly it could be circumvented by oversowing with an 'increaser' grass species like *Eragrostis curvula* to maintain a closed community, and by spraying with a selective hormone weedicide to knock-out broadleaved herbs".

*Working on veld in Natal, Edwards (1966) found that light soil disturbance accompanied by overseeding proved a successful operation in Highland Sourveld. Reduction in the degrees of competition from veld grasses is necessary before oversowing can succeed.

*At Nooitgedacht Research Station, situated in the North-Eastern sandy Highveld of the Transvaal, Rethman & Beukes (1973) fertilized veld with various levels of phosphorus and nitrogen. The sward was oversown with *Eragrostis curvula*. The importance of both phosphorus and nitrogen was reflected in yield responses to combinations of these elements. In the 1969/70 season, 342 kg N/ha yielded 3,5 tonnes but the treatment which received 22,5 kg P/ha, in addition to 342 kg/N, yielded 9,1 t per hectare.

*Another means of introducing desirable plant species into the veld sward is by use of a sod-seeder. Working with this implement, and by improving soil fertility, Graven, Birch & Muzzell (1968) successfully introduced red clover, white clover and lucerne into Döhne Sourveld.

*Work on the development and use of a sod-seeder in the field was undertaken at Cedara College of Agriculture for several years. Krog, Theron & Andrews (1969) reported that an experimental sod-seeder had been successfully used under practical farming conditions in Natal and East Griqualand.

*I'ons (1973) conducted an experiment at the De Hoek Research Station to determine the response of reinforced veld to application of fertilizers. Veld, which had been reinforced with star grass *(Cynodon nlemfuensis)* and fertilized with 50 kg P, 200 kg K and 500 kg N per hectare, yielded 10 222 kg of DM/ (dry matter) hectare compared with 918 kg from the unfertilized reinforced treatment.

*Theron & Mappledoram (1974) compared the production from unfertilized veld, fertilized veld, fertilized reinforced veld and fortified established pastures. It was concluded that any improvement of the veld by radical means resulted in an immediate increase in the stocking rate and the carrying capacity The increase was concomitant with an increase in the intensity of RVI (radical veld improvement) applied.

Procedure

It was considered important that the size of the area chosen for each project should be such that it is representative of the region and should yield the maximum amount of information. Of particular significance was the consideration that it be large enough to high-light practical management problems and at the same time small enough to enable a close watch to be kept on changes in vegetation and soil fertility.

The objective was to develop a sward that would produce a greater quantity of improved herbage which would be readily taken by stock. The herd had to be of manageable size. Animal performance had to be monitored regularly and, among other data, mass determinations had to be made on a planned basis. Too small a herd could have led to measurements being made that would be inaccurate if extrapolated.

These and other factors — such as the co-operator's present farming system — determined that the herd size should be equivalent to approximately 30 MLU*.

An estimate of the grazing potential of the improved pasturage resulted in a decision that the minimum area of a project should be 20 hectares. Factors like topography, veld type, water availability and shape of farm determined the actual size which varied from 24 to 45 hectares.

After the site had been selected a study was made of the soil, particularly of its fertility status. It was considered vital that the introduced species by sufficiently well supplied with essential elements to ensure adequate growth, particularly as the young seedlings would be developing in a competitive environment.

Nitrogen and phosphorus were applied to the soil on all the sites. In some cases potassium and agricultural lime were also applied. Obviously the quantity of fertilizer varied according to circumstances: phosphorus was applied at about 25 kg/ha broadcast in late winter or early spring; nitrogen at the rate of 100 to 120 kg/ha was given in two equal dressings, the first of which was applied in early spring, the second about mid-summer. There was a dramatic response to the fertilizer.

The sites were fenced into six paddocks of more or less equal size so that a system of rotational grazing could be followed. Water points were laid on in each paddock so that management would be simplified.

Animal mass determinations were made and grazing commenced when grass growth was 100 to 150 mm in height.

Sward changes in each paddock were carefully observed. As the season progressed certain paddocks were selected for overseeding. Paddocks in which the sward was most 'open' were chosen for this purpose. These selected paddocks were then more heavily grazed than others in order to facilitate germination and growth of the grass seed to be oversown.

In the RVI process it is essential that an 'improver' grass be introduced into the sward as soon as possible. Sward and soil conditions as well as correct timing of the oversowing operation must be optimum for seedling development. The latter part of summer or early autumn was chosen in most cases becasue, at that time, veld grasses had passed their period of maximum growth and therefore offered reduced competition to the introduced species.

Local environmental conditions determined the choice of species for oversowing into fertilized veld. There are, no doubt, numbers of genera which would be suitable for any one site. Experience has shown, however, (Theron 1973), that for the higher rainfall areas of Natal and East Griqualand, Cocksfoot *(Dactylis glomerata)* is a most satisfactory grass. It develops a deep root system early in its life cycle and is able to compete adequately with the native vegetation. Thus it was the grass chosen for most sites.

Other grasses which have shown promise and which have been successfully oversown on one site in the Natal Midlands are the Fescues *(Festuca spp.)* and *Paspalum dilatatum.* The latter is particularly suitable for moister sites. The choice for drier aspects was *Eragrostis curvula.* On one site Italian Ryegrass *(Lolium multiflorum)* has been included in a mixture with Cocksfoot and *Paspalum.*

When field conditions were considered most favourable, seed of the selected grass was broadcast evenly over the 'open' veld sward. Stock were kept in the overseeded pad-

*MLU = 500 kg

dock for three or four days after broadcasting of the seed. This helped to trample seed into the soil and to knock down seed which had been caught on the leaves of the veld grasses. After this period the animals were removed from the over-sown paddock.

It was usually possible to graze the paddock lightly about six weeks after over-sowing.

Preliminary Results

Because the projects are only in the early stages of development, results must be considered to be of a preliminary nature. These can be summarized as follows:

The carrying capacity of the fertilized veld has been increased about three fold when compared with unfertilized areas. It is anticipated that this figure may improve further when the oversown grass has become well established and optimum managerial practices have been developed.

In East Griqualand, an area of 31 hectares was fertilized at the beginning of December 1973. In mid-December, 55 head were put to graze on the area. At the beginning of April 1974 there was still a considerable quantity of herbage available and it is expected that grazing will be able to continue for some time. Two paddocks were selected for over-seeding in March 1974. In order to 'open' the sward an additional 140 head were grazed on the area for three weeks.

An area of 40 hectares in the Eastern Orange Free State has supplied grazing for 40 cows, 37 calves and 1 bull from the beginning of November 1973 until early April 1974. Grazing continues. The calves have gained an average of 930 grammes per head per day.

At the end of October 1973 an area of 45 hectares of veld in the Eastern Cape was fertilized. In mid-November 40 cows, 28 calves and 2 bulls commenced grazing on the site. At the end of March 1974 there was still a considerable quantity of herbage on offer.

On a 24 hectare site in the Natal Midlands 7 661 grazing days have been achieved from early November until mid-February.

On another site grazing in the 1972/73 season was extended until the end of July 1973. From early summer until that time heifers had gained 730 grammes per head per day. Animals started to lose mass during August.

During the 1972/73 season another site of 32 hectares supplied grazing for 61 cows and 61 calves.

A veld fertilization project was commenced in Natal in the 1970/71 season. The fertilized area is 34 hectares and it has not been oversown. The fertilized sward which consisted chiefly of *Eragrostis plana* supplied 12 863 grazing days during the 1972/73 season as against 5 061 days from an equal area of unfertilized veld. Calving percentages were 84 on fertilized veld and 68 on the unfertilized area.

The Future

Oversowing of the existing projects is planned for completion by autumn 1975. Once the introduced grasses have become established, stable production systems can be put into operation.

It is planned to use the sod-feeder on two sites in Natal. Giant Bermuda grass NK-37 *(Cynodon sp)* has been selected for these sites where rainfall is lower and temperatures higher than in the Midlands area.

Consideration will later be given to the inclusion of a legume, such as white clover, in the fertilized veld on some of the better watered sites. It will be necessary to ensure that the phosphorus content of the soil is sufficiently high. It may also be necessary to apply agricultural lime.

Eragrostis curvula projects

Eragrostis curvula is a grass which is well adapted to a wide range of environmental conditions. Provided attention is paid to the preparation of a seed-bed of fine tilth, establishment can usually be assured. This is an important factor which has led to a fairly wide acceptance of this species.

*The grass responds well to applications of fertilizer. For example, Altona (1965) found in an experiment over a three year period that the hay yield from unfertilized *Eragrostis curvula* was 2,47 tonnes per hectare per annum. In the treatment which received 29 kg P and 395 kg N per ha the yield increased to 15,24 tonnes.

*At the Döhne Research Station, Birch (1967) reported a marked response of *Eragrostis curvula* to applications of nitrogenous fertilizers. A near linear response was obtained as applications increased to 159 kg per ha. At an application rate of 212 kg the DM yield was about 10 tonnes per hectare, whilst the no nitrogen treatment yielded approximately 2 tonnes.

*At Bapsfontein Research Station, Hyam & Clayton (1968) reported a hay yield of 8,76 tonnes per ha when 133 kg of nitrogen were applied. Unfertilized *Eragrostis curvula* yielded 2,89 tonnes.

*Mappledoram & Theron (1970) working at the Cedara College of Agriculture found that the annual mean hay yield of four cultivars of *Eragrostis curvula* over a three year period was 10,87 tonnes per hectare. The basal fertilizer applications were 2,12 t of agricultural lime and 795 kg of superphosphate. Annual applications of 1 060 kg of limestone ammonium nitrate and 212 kg of potassium chloride were

given. At N'tabamhlope Research Station DM yields averaged 14,60 t when annual topdressings of 1 060 kg of superphosphate, 689 kg of potassium chloride and 954 kf of urea were given.

*In an NxPxK agricultural lime experiment conducted for five years at N'tabamhlope Research Station, Edwards & Mappledoram (1972) showed the importance of balanced application of fertilizers : no response was obtained from application of lime; there was no advantage in increasing the levels of nitrogen above 440 kg, P above 96 kg and K above 218 kg per hectare per annum; the main effects of 440 kg N were to produce an annual mean of 17,46 tonnes.

Procedure

The objective of the three projects on which grazing commenced during the 1973/74 season was to initiate the development of a 'closed' production system for beef cattle based on *Eragrostis curvula* pasture. The pasture supplied grazing during the summer months. Hay made from the projects will be fed to the animals during the winter months.

One site of 42 hectares, in the Ermelo district, was sown to a mixture of teff and *Eragrostis curvula* during the 1972/73 season. Grazing began in the spring of 1973. A smaller project of 12 hectares near Lothair is on a pasture of three year old *Eragrostis curvula*. A third site near Harrismith was sown to a mixture of teff and *Eragrostis curvula* in the 1973/74 season and has not yet come into production.

The Ermelo project was fertilized during 1973/74 with P at 15 kg, K at 15 kg and N at 200 kg per hectare. The latter was given in three dressings: 75 kg in spring, 125 kg in two equal dressings — one in early summer, the other in late summer. Fertilizer application rates at Lothair were 27 kg P, 160 kg K and 257 kg N (in three dressings).

Preliminary Results

At the Ermelo site grazing began in mid-November 1973. The 42 hectare project has supplied grazing for 49 cows, 15 heifers and 34 calves. When mass measurements were taken on 20 March 1974 it was found that the calves had gained an average of 920 grammes per head per day. The carrying capacity of the pasture was calculated at 2 MLU per hectare. In addition to grazing, hay made from the area has yielded approximately 7 tonnes per hectare.

Animal mass gains at the Lothair site were an average of 680 grammes per day for the female calves and 740 grammes per day for the young bull calves. These figures were for a 78 day period.

Cenchrus ciliaris projects

Areas of Southern Africa which have high temperatures and a summer rainfall of 450 to 600 millimetres are particularly suitable for the growing of *Cenchrus ciliaris* pastures. If well managed this grass is readily taken by stock. As it cures well, hay of good quality can be made. Improved sowing and planting techniques have made it easier to ensure successful establishment of a pasture.

**Cenchrus ciliaris* is a high yielding grass. Rodel & Boultwood (1971) fertilized the Mondorro cultivar of *Cenchrus ciliaris* annually for four years with 450 kg N, 19,6 kg P and 54 kg K at Henderson Research Station in Rhodesia. The mean annual rainfall for the period was 731 mm and the grass yielded 13 680 kg of DM per hectare.

*Kelk (1972) found that for good seedling development, phosphorus was the most important element. Nitrogen is the other important element for satisfactory growth.

*Similar results were reported by du Toit, Rabie & Grunow (1973). Pot experiments showed that nitrogen and phosphorus are the two main nutrients which are required for good production of *Cenchrus ciliaris* on soils of the Bontberg series. Application of sulphur had an ameliorating effect on production.

*Du Toit (1973) stated that *Cenchrus ciliaris* is known to be a grass which has a high phosphorus requirement. It is particularly important that phosphorus be well supplied at sowing time. At the Towoomba Researh Station, 350 grazing days per hectare were obtained from *Cenchrus ciliaris* which had been fertilized with 45 kg of N. At the Roodeplaat Research Station well fertilized *Cenchrus*, under irrigation, carried 35 reproducing Dorper ewes per hectare per annum.

Procedure

Three sites have been planned: one in the Springbok Flats; one in the Northern Cape and one in the Western Transvaal. The latter tow are in the early stages of development.

The site in the Springbok Flats is designed as a **'closed'** project with the objective of developing a production system for beef animals based on *Cenchrus ciliaris* pasture. The pasture was grazed in summer and hay made on the project will be fed to the animals in winter. The trial commenced at the beginning of the 1873/74 season on an area of 30 hectares of three year old pasture. The site is fenced into six paddocks. Fertilizers applied were 16 kg P (applied in one dressing) and a total of 60 kg N which was applied in two equal dressings.

In the Western Transvaal the objective is to use the *Cenchrus ciliaris* pasture in conjunction with silage and grain to develop a beef production system. The pasture was sown during the 1973/74 season and should be in production in the spring of 1974.

The Northern Cape site is one in which *Cenchrus* will be used for summer grazing. This will enable veld to be rested during the summer period so that it can carry the animals during the winter months. The trial is planned to commence in spring 1974.

Preliminary Results

Grazing of the 30 hectares site in the Springbok Flats began in mid-November 1973 when 30 cows and 30 calves were introduced to the pasture. The pasture supplied grazing for 145 days and in addition, 77 tonnes of hay have been made. In early April 1974 there was a large quantity of good quality herbage on offer and it was anticipated that grazing would be able to continue for some time. Calves have gained an average of 786 grammes per head per day.

Conclusion

With increase in intensification of a farming enterprise it becomes most important that management skills be at a high level. It is vital that the improved herbage be used efficiently to the benefit of both the animal and the pasture. It was particularly apparent with RVI that no hard and fast rules could be laid down. Flexibility had to be the key-note.

Good record keeping is essential in order that an enterprise can be correctly evaluated. It is planned to obtain more data on animal performance during the coming season.

Another aspect which could be investigated is an evaluation of foggage. This could perhaps tie up with chemical analysis of herbage on a regular basis. This would help considerably in the evaluation of material on offer.

As the projects develop it may be necessary to consider integration of pasture usage with feeding of silage and fodder crops. The inclusion of other grass species either separately or in combination with existing swards could help to eliminate production troughs by keeping herbage supply at a peak for longer periods.

Certain of these projects are being carried out jointly by Faculties of Agriculture of the universities of Natal, Orange Free State and Pretoria. From these projects more basic additional data could be obtained regarding eg intake and digestibility, carcass composition and the conversion of nutrients into animal products.

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