MEAT & LIVESTOCK AUSTRALIA

on farm

Perennial Pastures for Animal Production in the High Rainfall Areas of Western Australia

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Feedbase and Pastures

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ABSTRACT

The aim of this project was to generate a better understanding of the costs of establishment, economic benefits, suitability and sustainability of perennial grass based pastures in the high rainfall areas when grazed by sheep and cattle.

The value and economic break-even period of sowing perennial pastures depends on the productivity of the sward being replaced. Failure to establish perennials at the first attempt because of shortcuts in the procedure doubles the period to break even and can make establishment uneconomic. **The best approach to establishing a perennial grass pasture is to treat it as a crop.**

Establishing perennial grasses is all about providing the conditions for not only seedling survival but also the development of adequate numbers of plants after the first 18 months. In these early months this necessitates a cost of foregoing grazing to encourage maximum plant size and survival.
To realise the benefits of perennial grasses, they must be managed for persistence and their grazing management has to be suited to their need. Once the plant is lost from the sward it cannot be regained without the cost of reseeding.

The value of perennials grasses in any farming enterprise needs to be viewed within the whole farm context, their strategic use may well enhance their persistence.

EXECUTIVE SUMMARY

The aim of this project was to generate a better understanding of the costs of establishment, economic benefits, suitability and sustainability of perennial grass based pastures in the high rainfall areas when grazed by sheep and cattle.

Perennial grasses are well suited to the high rainfall, long growing season, southern regions of Western Australia. Such pastures can provide benefits to the farming industry through:

- improved per hectare returns by providing superior summer/autumn feed supply and so reducing supplementary feed costs and improving the pattern of carcase turnoff.
- increased water usage and reduced soil erosion.

The use of perennials has not been extensive and a better understanding of the lack of producer confidence in their use is important if the value of these pastures is to be exploited.

This project commenced in 1992 and was completed in December 1996.
It has been conducted on 23 farm locations spread across the >600 mm rainfall areas of the south and west coasts of WA and has incorporated 3 types of activity.

- On-farm monitoring sites where animal and pasture performance was assessed on an existing perennial pasture.
- On-farm demonstration sites where we established a perennial pasture as part of the project and compared it with an adjoining annual sward.
- Three grazing experiments incorporating different perennial pasture species, grazed by either sheep or cattle

The perennial grasses examined were basically cocksfoot, phalaris, tall fescue, perennial ryegrass and Kikuyu grass.
Amidst many problems associated with long term grazing work on farms, changing agriculture plus 3 very dry summers, the main outcomes have been:

- With satisfactory control of annual weeds (nb grasses) and insects (nb RLEM) temperate perennial grasses can be established in autumn and Kikuyu grass in spring.
- Perennial grasses increased $/ha returns in 75% of comparisons with annuals when grazed by cattle.
- Persistence of perennial grasses is harder to achieve when they are grazed by sheep rather than by cattle. On farm stands of temperate grasses all declined severely when grazed by sheep, but not the sub-tropical kikuyu grass.
- Well established perennial grasses complement subterranean clover, limiting the invasion of broadleaf weeds (eg Capeweed).
- The number of temperate perennial plants in the first year is the highest that will exist in that sward.
- The main costs when establishing perennial pastures is seed ($30 to $50/ha) and the grazing foregone in the year of establishment (up to 60% of grazing days).
- Estimated number of years to break even when establishing perennial pastures ranges from 2 to >10 years depending on circumstances.
- The value of perennials should be looked at in a whole farm context especially in cropping areas and on the sandplain.
- The benefits of Kikuyu grass on the south coast is its tolerance to heavy grazing while reducing erosion risks on fragile soils.
- Data from many of the sites have been used by Dr A Moore and Dr J R Donnelly of CSIRO to help validate GRASSGRO.

All producers in the high rainfall areas of the south and west coasts of Western Australia have been notified of the work and the basic outcomes. At the same time they were offered a free copy of the booklet we have prepared as a result of this project *"Perennial Grasses for Animal Production in the High Rainfall Areas of WA"*, if they request it. This bulletin outlines the economics of establishing and growing perennial grasses as well as establishment techniques, management strategies and suitable species for different locations. This will

assist farmers that are contemplating establishing perennial grasses as well as those seeking more information on managing existing stands.

Cattle farmers can benefit from the use of perennial pastures immediately if they are contemplating renovating a deteriorated pasture. In this case it is likely to take 3 to 4 years to cover establishment costs whether they sow a perennial pasture or resow an annual pasture. However if a good annual pasture is to be replaced it would take at least 6 years to pay back establishment costs from the benefits of the perennial stand. Producers have to be convinced of the persistence of perennial grasses.
Kikuyu grass is likely to be the species of perennial most likely to benefit the sheep industry, in terms of the fibre strength of the wool and better control of soil erosion, especially on the south coast sand plane. Kikuyu pastures can be grazed more heavily than annual pastures with a reduced risk of wind erosion. The break even period when establishing kikuyu grass is similar to that for temperate grasses outlined above.
At the four demonstration sites where we established temperate perennials grasses while grazing with sheep, the perennial grasses did not persist. This effect was exacerbated by the 3 very dry years with associated late starts to the growing seasons.

The depressed state of the animal industries in recent years together with 3 very dry years on the south coast of WA has stretched the resources of many producers who traditionally rely on grazing enterprises. The rapidly increasing woodchip industry is targeting these high rainfall areas with the planting of bluegums in direct competition with the grazing industries. Initial work with kikuyu grass in this project has stimulated interest in its value for using ground water outside the normal growing season. Projects are now under way in the Sustainable Grazing Systems Program to investigate further the effects of increased water use by kikuyu in water recharge areas, both in the presence and absence of trees.

MAIN RESEARCH REPORT

(More detail of specific management and the results of each of these studies is included in the relevant appendix. A summary of each of the studies is provided below.)

BACKGROUND AND INDUSTRY CONTEXT:

Perennial pastures are well suited to the high rainfall, long growing season, southern regions of W.A. Their use however has not been widespread.

Historically emphasis has been placed on the annual pastures in our farming systems, more specifically on the development and use of subterranean clover. This approach has suited the soil types, our Mediterranean climate and our cereal cropping and sheep grazing systems as well as our developmental farming stage. However more recently with the general concern of rising ground water in our agricultural areas, a result of widespread clearing and use of shallow rooted annual plant systems, emphasis is on ensuring we are working towards sustainable grazing systems. Perennial grasses are likely to have a role (Cransberg and McFarlane 1993).

Considerable work has been conducted in the south west on the evaluation of perennial grasses in small plot experiments (eg Technical Bulletins 45 and 56, Fenwick 1987, Cransberg, Saunders). However there has been limited comparative grazing work, especially under cattle grazing. Arkell et al 1981 (Bulletin 57) reviewed perennial grass grazing experiments going back to 1952 and they reported on 6 'small plot trials' and 9 'large scale experiments'. Seven of these nine were grazed by sheep resulting in mixed success in the persistence of the perennial grasses, part of the failures they attributed to grazing management. They also suggested that grazing by cattle rather than sheep could favour the persistence of some perennial grasses.

Confidence in the persistence of perennial grasses is crucial to farmers wanting to incorporate them in renovation programs. Annual pastures can be excessively grazed and still regenerate satisfactorily, whereas the temperate component of perennial pastures will deteriorate if not carefully grazed. It is important that we better understand management systems where sheep and cattle graze perennial pastures to ensure the long term persistence of those stands.

Use of temperate perennials in the high rainfall areas is more likely to be associated with cattle production than sheep production. However on the south coast there are considerable areas of kikuyu grass which have persisted well under sheep grazing though there have been mixed comments about its value as a pasture base. There having been no comparative grazing work done with this species in this environment with grazing sheep it was important to develop better guidlines for its use. This species is virtually impossible to graze out in this environment and it is valuable for preventing wind erosion as it is well adapted to sandy soils.

The ultimate systems are likely to incorporate perennial pastures as separate entities on farms so they can be managed in combination with annual swards and cropping areas to get the greatest benefit from the whole farm. Studies of this nature will need to look at whole farm systems in situ or as farmlet type experiments.

PROJECT OBJECTIVES:

"Evaluating the role of perennial pastures in an annual pasture dominant area by quantifying animal and pasture productivity to provide the basis for economic analysis".

I. To define seasonal pasture and sheep and cattle production patterns from perennial pastures and compare with annual pastures in the high rainfall, long growing season, southern regions of Western Australia through on farm monitoring sites, producer demonstration sites and research sites.
II. To use the production patterns generated in (I), across a range of soil types and rainfall zones to validate the *Grazplan* model *Grassgro*.
III. To determine the economic feasibility of establishing perennial grass pastures using gross margin, pay back period and cash flow budget analyses and other economic analyses including *Grazplan* when it becomes available.
IV. To document producer management techniques of commercial perennial pastures that affect persistence.

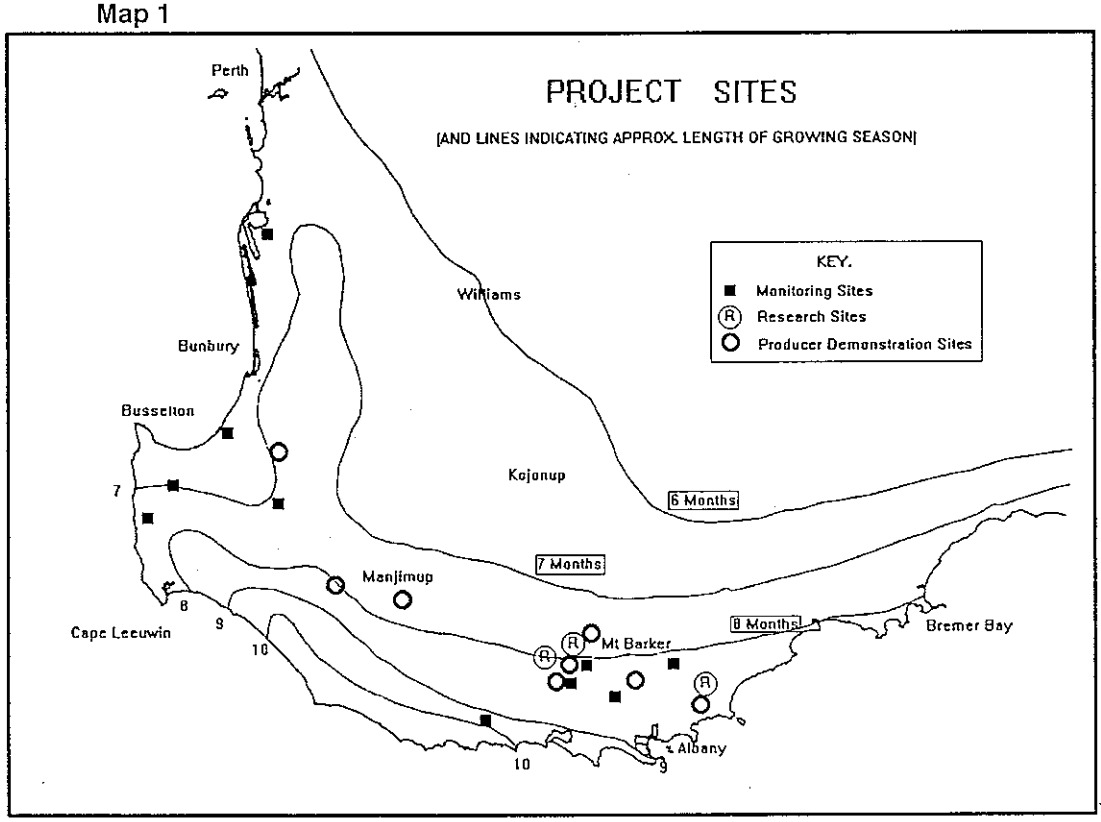
V. To have at least 50% of 1,560 potential end users, that is 730 beef producers and 330 mixed sheep meat and beef producers and 500 sheep producers aware of the information generated from this project on perennial pastures.
VI. To evaluate the production and persistence of new perennial grasses against commercial standard varieties under a cattle grazing system at two research trial sites.
VII. To quantify persistence and production of perennial grass species when grazed by sheep at Manypeaks research site and recommend appropriate grazing management to maximise production under sheep grazing.

METHODOLOGY, RESULTS SUMMARY AND DISCUSSION:

On-farm monitoring sites. (Appendices i to x)

Ten farmer paddocks that had been established to perennial grass previously were selected throughout the region (map 1).

Map 1



Aims:

1. To collect and use the data to help validate the GRASSGRO model.
2. To improve farmer skills in assessing pasture and animal performance.

Treatments:

The main perennial grasses monitored at the ten sites were:

- Cocksfoot (Jenkins)
- Perennial rye (Jenkins, McMiles, Ravenhill, K.Smith, Weightman,)
- Tall fescue (Jenkins)
- Phalaris (Denmoore, Scott)
- Kikuyu (Denmoore, Maidment, Scott, D.Smith, K.Smith, Ravenhill)
- Couch (Denmoore, McCormack)
- Paspalum (Denmoore, K.Smith)
- Strawberry clover (Denmoore, Maidment, K.Smith)

The paddocks were grazed in different ways:

- *continuous* grazing *cow/calf* systems where calves were removed at weaning (Jenkins, Ravenhill)
- A *cow/calf* herd *rotationally grazed* (Weightman).
- *Cattle* run for part of the year, the paddock then being used for *forage conservation* (Denmoore, McCormack, McMiles, Scott)
- Addition and removal of *cattle* during the year (Maidment, K.Smith)
- Running a core group of *sheep* with addition and removal of other *sheep* and *cattle* through the year (D.Smith)

Spring forage was conserved in different ways:

- no conservation (Jenkins, Maidment, D.Smith, Ravenhill)
- left as standing fodder (McCormack, McMiles, K Smith)
- as hay (Denmoore, Jenkins, McMiles Scott, Weightman)
- as silage (Denmoore, McMiles)

Measurements:
Soil parameters; rainfall; feed on offer(FOO); botanical composition and nutritional quality of FOO; perennial plant counts; number, liveweight and condition of animals and grazing days.

Results and Discussion:
Details of inputs and pasture and animal production at each site can be found in the appropriate appendix.

South Coast.
Denmoore (Appendix..i).
SUMMARY: Three of the four years we studied this site, exceptionally dry summer/early autumn periods were experienced with associated late starts to the growing season.
Over the 5 years sub clover levels varied between around 15% in summer to around 30% in spring. The established perennial components (phalaris/couch/strawberry clover/kikuyu) remained between 20 and 40% of the sward, varying with time of sampling and year. By 1996 the winter grass component had increased, a consequence of the late seasons of 1994 to 1996.
Changes made to management during the study, possibly as a consequence of our measurements, were a reduction in supplementary feed costs and a change from hay conservation to silage conservation on the study area.
Grazing pressures were around 11 DSE on a monthly basis over summer, autumn and winter with an average 3.73 t DM forage conserved in spring.
In the first 4 years at stocking rates of 1.8 to 2.1 heifers/ha the animals gained weight while on the study area. However with the very late season in 1996 and the increased stocking rate (2.6 heifers/ha) the animals lost weight up to September.

Jenkin's (Appendix..ii).
SUMMARY: Three of the four years we studied this site, exceptionally dry summer/early autumn periods were experienced with associated late starts to the growing season. The mixed temperate perennial grass component declined slightly over the duration (35% to 28%). Sub-clover declined from 45% in 1993 to about 15% in 1995 and recovered to more than 25% in 1996. Cape weed increased to about 40% in 1995 from less than 5% in 1993, however it declined to around 15% in 1996
In the 3 years the cattle were retained on the area for 12 months, average yearly grazing pressures ranged from 10.7 to 12.9 DSE, the highest being in 1993 following an early opening to the season
Hay was fed into the paddock at an average annual rate of 650 kg/head or 550 kg/ha.
Cows remained in good condition throughout the study and vealer liveweight production averaged 295 kg/head or 242 kg/ha. However in all years some vealers were sold early to obtain higher prices per kg and in 1995 the vealer production/ha was low because the cattle were removed from the study area in mid August to allow for hay conservation.
There was little difference in the soil analyses across the period other than a possible trend of increasing acidity and an increased potassium level to a more adequate level.

McMile's (Appendix..iii).

SUMMARY: Three of the four years we studied this site, exceptionally dry summer/early autumn periods were experienced with associated late starts to the growing season. There was a steady decline of the Brumby perennial rye grass over the period of the study. Initially this resulted in an increase in sub clover but subsequently the sub clover component declined as well only to be replaced by annual grasses, first brome and barley grass and finally silver grass and barley grass, correspondingly there was a small increase in weeds (cape weed, dock and flat weed)

Generally grazing pressures were high during early autumn and winter with no grazing over spring and summer. The windrowed conservation method used affected the persistence of the perennial by smothering plants during spring/summer and reducing seed set. The decline of ungrazed, dry residues was at a daily rate of 0.62% and 0.51% of the dry matter on offer. A similar figure (0.65 %) was calculated from standing caged material at Manjimup (Muirs Appendix xviii)

Animal production is difficult to summarise at this site because of the putting and taking of cows, calves and dry cattle. However annual grazing pressures were greatest early, around 14.3 DSE/ha but declined in the later years to around 9 DSE/ha. Without control treatments it is difficult to know whether the later decline was due to the run of dry summers and/or the change in pasture composition.

Ravenhill's (Appendix..iv).

SUMMARY: Subclover comprised 30 to 50% of the sward in the growing period and kikuyu grass ranging from 50% (summer/autumn) 30% (winter) and 20% (spring) changed little among years over the 5 year project. This pasture was grazed continuously by 1.25 British beef x dairy cows and their progeny per hectare over this period (~18 DSE/ha).

The April /May calving cows were only fed a small quantity of hay in the first year and non thereafter. Their calves were weaned in early to mid January at an average 359 kg/hd or 453 kg/ha. and sold through CALM to the vealer market. The 5 year average calving rate was 90%.

The liberal, average annual application of 320kg/ha of Super:potash 3:1 maintained soil phosphorus and potassium levels well.

D. Smith's (Appendix..v).

SUMMARY: In three of the four years we studied this site exceptionally dry summer/ early autumn periods were experienced with associated late starts to the growing season.

The Kikuyu grass component remained constant over the duration however sub-clover tended to decline with a corresponding increase of winter grass.

Average yearly grazing pressures ranged from 11 to 13.5 DSE, the highest being in 1993 following an early opening to the season. Hay was fed into the paddock at a rate of around 90 kg/ha with greasy wool production of 5.14 to 7.45 kg/head or an estimated per hectare production of 67 to 85 kg/ha.

There was little difference in the soil analyses across the period other than a trend of increasing acidity and a declining potassium level, however the level was still quite adequate.

West Coast

Maidment's (Appendix..vi).

SUMMARY: In all years the break to the seasons have been in May. A good germination occurred in March 1993 but was followed by relatively dry conditions. Over the years the pasture has comprised a low level of annual legumes (5 -15%) plus 10 to 30% perennial legumes. Annual grasses (40 - 60%) have dominated the sward along with up to 40% perennial grass (mainly kikuyu) in some years, while weeds have made up only about 5% of the sward.

The pasture balance appears stable under this management system.

Annual animal liveweight gain per hectare was not related to year round grazing pressure. The highest annual gain of liveweight (369 kg/ha) was in 1995 when the grazing pressure was lowest (17.4 DSE/ha) and the second highest annual gain of 286 kg/ha was in 1994 the year with the highest grazing pressure (22.8 DSE/ha)

McCormack (Appendix..vii).
SUMMARY: : The decision to terminate work at this site was in September 1995 when, for various reasons it became very difficult to monitor the stock as frequently as required.

Scott's (Appendix..viii).
SUMMARY: In 1993 the season broke in late March but not until mid May in the three following years.
The good early break in 1993 ensured high levels of subclover, in 1994 the percentage of sub in the sward fell to around 15 - 20%, this increased in 1995 and 1996 to between 20 and 35% depending on time of year, being higher in spring than in winter in all years. In 1996 weeds made up only a small proportion of the pasture. The perennial grass component (phalaris and kikuyu grasses) remained constant within seasons across the years at around 40% in winter and 25% in spring.
The pasture balance appears stable under this management system.
A summary of the productivity of the study area is provided below:

	Live weight gained (kg/ha)	DSE/ha	Hay fed kg/ha	Hay made t/ha
1993	394	12.5	?	3.6
1994	266	14.2	831	6.3
1995	164	12.5	1900	4.6
1996	155	12.7	?	5.2

This paddock has been used as a hay paddock since 1983 and during the life of the study the potassium levels declined to a marginal level of 83 ppm from 119ppm while the soil phosphorus levels are high at 60 - 70 ppm.

K.Smith's (Appendix..ix).
SUMMARY: This site did not receive the heavy rains in late March 1993 common at many other sites, consequently the break in all the years was around mid May or later.
Annual legumes were very poor when we started monitoring in 1993 but increased to about 20% of the sward in later years. the perennial grass component (kikuyu, paspalum and fog grasses) was quite dominant (50 - 65%) at the start, stabilised at 35 -40% in subsequent years. Annual grasses (mainly rye) made up about 30% of the sward throughout the study while the minor components weeds and perennial legumes made up about 10 % of the sward with perennial legumes declining over time.
The pasture balance appears stable under this management system however correction of the apparently declining and marginal levels of potash (71 ppm) should improve the legume component.
A summary of the productivity of the study area is provided below:

	Live weight gained (kg/ha)	DSE/ha	Hay fed kg/ha	Hay made t/ha
1993	465	9.0	831	nil
1994	298	15.8	1793	nil
1995	554	16.4	1266	nil
1996	401	16.8	1108	nil

Fodder was not conserved from this paddock. At no time did FOO fall below 2000 kg/ha but it did reach very high levels in summer while being spelled from grazing before calving cows were introduced.
It is difficult to interpret the production data in isolation from other farm paddocks. For example in 1993 the cows were only in this paddock for 2.5 months, they lost little weight associated with calving (59 kg/ha), and yearlings were introduced in August from which time they only gained weight. As a result all the weight gain benefits for these groups of animals

were accrued to this paddock, seasonal weight losses occurred in other paddocks, hence in a poor season with a low grazing pressure a high level of production was achieved! Compare this with 1994 were cows remained in the paddock for 4.5 months around calving and lost 315 kg/ha when they were stocked more heavily and were fed twice as much hay as in 1993.

Weightman's (Appendix..x).

SUMMARY: The summer autumn period has been very dry since 1992, with the break of season in June in 1996 and May in the intervening years.

As expected there was a consistent variation of subclover within each year, spring proportions being higher than winter. However there appears to have been a steady decline in subclover since the start of the study, this coincides with low levels of soil potassium of around 60 ppm at the start and end of the study (80 ppm are considered to be a minimum required level) as well as the late breaks.

The perennial plant counts (Victorian perennial Rye) have halved in number since 1993 but the proportion in the pasture was not very different on a seasonal basis among years. It should be remembered that the October estimates coincide with maximum levels of FOO, around hay making time. There was no consistent difference in the proportion of annual grasses and weeds between seasons and among years.

A summary of the productivity of the study area is provided below:

	Live weight gained (kg/ha)	DSE/ha	Hay fed kg/ha	Hay equiv.* made t/ha
1993	223	15.2	1881	2.7
1994	123	17.0	2127	2.8
1995	143	9.7	1488	2.8
1996	190	10.6	1639	2.7

(* Adjusted silage kg/ha x 35% DM ÷ 85% DM to estimate hay equivalent)

Quantities of forage conserved from the study area has been similar across the years, but the annual grazing pressure has declined. 1994 was the year of highest grazing pressure, lowest live gain per hectare and highest amount of hay fed. Reducing the grazing pressure by around 30 % (1995 and 1996) coincided with about 25 % less hay fed and an increase in live gain per hectare.

In 1994 and 1995 the high level of liveweight loss in June/July was associated with FOO levels below 1000 kg/ha, in the other two years FOO was more than 1200 kg/ha at this time and losses were considerably less.

In round figures during the life of the study this production system has produced 170kg/ha of live gain and a tonne of hay per hectare, with a year round grazing pressure of 13.1 DSE/ha.

Producer demonstration sites. (Appendices xi to xix)

Pasture and animal growth were compared between pairs of paddocks on each of **eight** farms (map 1). One of each pair was left as an annual pasture (control) while a second adjacent paddock was sown to a perennial grass based pasture.

Aims:

1. To determine the costs and production foregone when establishing perennial grass based pastures.
2. To compare production of newly established perennial based pastures with that of annual pasture grown under similar conditions.
3. To use the data to help validate the GRASSGRO model.
4. To improve farmer skills in assessing pasture and animal performance.

Treatments:
The perennial grasses sown (some as mixtures) at the sites were

- Currie cocksfoot (Muirs)
- Porto cocksfoot (Forbes)
- Wana cocksfoot (Neill, Taylor)
- Cajun tall fescue (Muirs)
- Demeter tall fescue (Taylor)
- Au Triumph tall fescue (Barclay, Degens, Forbes, Neill, Taylor)
- Brumby perennial rye (Degens, Fouracres, Taylor)
- Ellet perennial rye (Fouracres)
- Embassy perennial rye (Fry)
- Pacific perennial rye (Barclay)
- Roper perennial rye (Forbes, Muirs, Neill)
- Sirosa phalaris (Neill, Taylor)
- Strawberry clover (Barclay)

The paddocks were grazed in different ways:

- *Steers* continuously stocked up to staggered turn off dates, removing the same number from each paddock at the same time (Forbes).
- *Cattle* run for part of the year, the paddock then being used for *forage conservation* (Fry)
- Addition and removal of *cattle* during the year (Fouracres, Muirs, Neills when owned by Chalmers)
- Running a core group of *sheep* with addition and removal of other *sheep* and/or *cattle* through the year (Barclay, Degens, Neill, Taylor)

Spring forage was conserved at only one site:

- hay conserved (Fry)
- no conservation (Barclay, Degens, Forbes, Fouracres, Muirs, Neill, Taylor)

Measurements:
In each paddock the following were recorded: soil parameters; rainfall; pasture growth, feed on offer(FOO); botanical composition and nutritional quality of FOO; perennial plant counts; number, liveweight and condition of animals, grazing days, wool growth and quality and perched water table during winter and spring.

Results and Discussion:
Details of inputs and pasture and animal production at each site can be found in the appropriate appendix.

South Coast.
Barclay's (Appendix..xi).
SUMMARY: Sowing perennials in this study were associated with the need to renovate an annual pasture heavily infested with thistle and dock. Following a cropping phase, Pacific perennial rye grass was well established in autumn 1992. The Triumph tall fescue sown with the rye grass failed to establish.
Annual rainfall over the life of the study varied from 633 to 960 mm. The most productive year was associated with a break to the season in March 1993, the years after 1993 were typified by very dry summers and late breaks in May and June.
Use of 150 kg/ha of super potash 3:1 was not sufficient to arrest the decline in soil phosphorus levels over the life of the project. However the phosphorus levels by 1996 of 31 ppm are considered adequate for normal production.
The perennial component of the perennial pasture declined over the years to a negligible amount in 1995 and 1996 of about 5% of the FOO and less than 10 plants/sq m. The legume component of both paddocks was depressed in 1995 but was high in the early years and acceptible in 1996 at about 15 to 30% of the swards. The very late seasons of 1994 to 1996 encouraged the dominance of winter grass by 1996 in both paddocks. During spring and summer in all years there was more FOO in the perennial than the annual paddock and

Performance of sheep in terms of liveweight, grazing pressures, wool growth and wool quality favoured the perennial pasture. However direct comparisons need to take account for the different levels of supplements fed.

Degen's (Appendix..xii).

SUMMARY: Perennial grasses (Brumby perennial rye and Triumph fescue) were not successful at this site and by 1996 had disappeared from the area sown in autumn 1992. The main reasons for this are considered to be:

- the relatively high grazing pressure in the year of establishment, preventing the development of plant size
- the succession of late breaks and very dry summers (1994, 1995, 1996) with continued high grazing pressures.

Comparing production between paddocks can only be done realistically on a $ basis because differences in animal performance are not only related to the perennial grass content of one paddock but also to the grazing pressure and the amount of supplements fed. It is doubtful that the low perennial plant component of 10 to 15% in 1994 and 5% in 1995 affected production much?

Forbe's / Chapman's / Australian Forest Holdings (Appendix..xiii).

SUMMARY: The perennial grasses were slow to establish at this site, and it is the only site where we recorded an increase in perennial plant numbers during the study. Perennials, especially Porto cocksfoot were well represented in the perennial paddock at the end of the study. The paddock comparisons were compromised by the poor production from the highly acid 20% of the perennial paddock not identified in the crop stubble in the summer prior to the original subdivision.

In the first year approximately 50% of grazing was foregone (only 7 months recorded) through the process of establishing perennials and loss of grazing occurred before September.

1994 was the only year of continuous grazing, but it was a year of very poor pasture growth, and the very high level of hay fed may well have masked any paddock differences on animal performance. The farm was subsequently sold to tree cropping interests.

Neill's / Chalmer's / Hillboi Nominees (Appendix..xiv).

SUMMARY: The perennial grasses established well at this site in 1992. However in the second half of the establishment year about 50% of the grazing in the perennial paddock was foregone. Perennial were still well represented in late 1994 (~20% of FOO) and around 34 plants per sq m in summer 1995.

Animal production comparisons are not very meaningful owing to the changes in categories and species of animal during the two changes in ownership of the property within three years of starting the study. However, other than in the establishment year, grazing pressures were higher on the perennial pasture paddock than the annual paddock. The farm was subsequently sold to tree cropping interests.

Taylor's (Appendix..xv).

SUMMARY: The perennial component of the pasture declined over the 4 years. The main reasons for this are considered to be:

- the relatively high grazing pressure maintained on the perennial paddock albeit with extra supplements but they were not fed at a level sufficient to prevent sheep weight losses greater than those on the adjoining annual paddock.
- the succession of late breaks and very dry summers (1994, 1995 and 1996).

The decline in clover in the swards may well have been exacerbated by the halving of the soil potassium content from about 100 ppm following no application of potash over the life of the project.

There was little difference in wool characteristics between paddocks within years, however wool was different between years. Comparing 1993/4 wool with 1994/5 wool; grazing pressures were higher, greasy yields per head were lower and the wool was finer, weaker and the hauteur was shorter. These differences would be associated with the increased stress on the sheep which were illustrated by their lower 1993/4 autumn weights of 50 to 55 kg (CS about 1.5) compared with 63 to 66kg (CS 1.75 to 2.25) in 1994/5.

West Coast

Fouracre's (Appendix..xvi).

SUMMARY: The decision to terminate work at this site was in June 1994 at an annual review of Project DAW 046 including a field inspection attended by Agency staff from Albany, Bunbury, Esperance and Perth

With the transfer of key advisory staff from Manjimup to Busselton, communication with the farmer lapsed. This resulted in the paddock nominated for sowing to perennials not being preconditioned in the 1992 spring/summer for a 1993 autumn planting. The projects seeding operation was considered by the farmer to be too late. Other farm paddocks were successfully established (by the farmer using his normal technique) in mid March just prior to the first forecasted autumn cold front.

The seeding operation was difficult due to the large amounts of residual trash:

- *preventing the seeding machine`s discs from effectively cutting grooves on the soil surface and*
- *preventing the trailing harrows covering the topdressed seed with soil.*

The sown seed was not adequately covered and combined with infrequent light rainfall is likely to have desiccated, resulting in poor establishment.

The survival of the germinating perennial grass seedlings would also have been restricted by severe competition from the mixture of volunteer and sown annual grasses, and subclovers. Competition from weeds were not considered to be an important factor in the first two months after sowing. However, weeds did dominate the sward from late winter onwards.

Fry's (Appendix..xvii).

SUMMARY: The decision to terminate work at this site was in June 1994 at an annual review of Project DAW 046 including a field inspection attended by Agency staff from Albany, Bunbury, Esperance and Perth

Reasons for the lack of persistence of perennial ryegrass into the second and third years include:

- *No weed control in the spring prior to sowing and poor control in autumn 1993 coupled with strong competition from the sown annual ryegrass (cv Tetila). Both factors would have significantly limited the establishment, tillering and growth potential of the sown perennial ryegrass.*
- *The choice of perennial grass species was inappropriate as it is not tolerant of either summer drought (low soil moisture/high evapo-transpiration) or soil acidity (paddock pH was 4.1 in CaCl2). A more appropriate choice would have been Cocksfoot, Phalaris or Tall fescue. However the farmer favoured perennial ryegrass as he required the potential for a reasonably high hay yield in the planting year (and also in subsequent years).*
- *Inappropriate choice of the Embassy perennial ryegrass cultivar (only cv Embassy was available at the time of planting !). A more appropriate choice would have been cv Roper or Brumby, both of which have some drought tolerance.*
- *Hay was cut in the perennial paddock after hay cutting in the adjacent annual control paddock, both of which were considered to be late (in order to maximise yield). It is possible that the high leaf area at this time may have depleted soil water reserves for summer.*
- *Grazing the new (and still green) perennial ryegrass regrowth in late December and through the summer until mid May 1994*
- *The record long dry summer period (1993-94) in the establishment year. The only rainfall recorded was 19 and 2 mm on the 9th and 11th November 1993 respectively, together with a further 13 mm total up to mid May 1994. This was followed by another very dry summer (1994-95) when rain for November 1994 was 12 mm with only a further 14mm up to May 1995.*
- *The area was continuously grazed through the summer of 1994 -95 with no hay fed.*
- *The need for the farmer to cut hay each year from as much of his farm as possible and to graze paddocks as soon as possible thereafter.*

Muir's (Appendix..xviii).

SUMMARY: The summer autumn period has been very dry since 1993, with the break of season in June in 1996 and May in the intervening years.

As expected there was a consistent variation of subclover within each year, spring proportions being higher than winter. There has been a steady decline in subclover since 1993 which coincides with the late breaks. Levels of soil phosphorus and potassium are good and not likely to have limited legume content. The weed component of the pastures has comprised mainly capeweed, levels were comparatively low in 1993 following the early break and establishment of the perennial pasture. However since then it made up around 50% of the annual sward and up to 30% of the perennial sward though in 1996 levels were negligible in the perennial pasture. Annual grasses made up 30 to 40% of the annual pasture over the years and up to a maximum of 30% in the perennial pasture.

The perennial grass comprised between 40 and 70% of the sward in winter and 10 and 30% in spring. Of the perennial fraction, the proportion of *Roper perennial ryegrass* declined from 50% to 20% and the *Currie cocksfoot* increased from 45% to 80% over the period of the study. By 1996 the perennial pasture plant count was strong at 50 plants/sq m.

A summary of the productivity of the study area is provided below:

		Live weight gained (kg/ha)	DSE/ha	Hay fed kg/ha	Hay made t/ha
1992	Annual	254 (from June)	7.4		
	Perennial	4 (from Dec.)	-----		3.9
1993	Annual	276	12.0		
	Perennial	267	11.9		
1994	Annual	213	12.1	522	
	Perennial	233	12.2	800	
1995	Annual	147	8.2	198	
	Perennial	228	10.7	236	
1996	Annual	0 (being renovated)	1.6	87	
	Perennial	401	17.1	667	

In the year of establishing the perennial pasture, grazing pressures and production per hectare on the two paddocks was similar. In the following year the grazing pressures of the annual and perennial paddock were again similar but 9% more live gain was achieved on the perennial pasture though 53% more hay was fed.

In 1995 the year round grazing pressure on the perennial paddock was 30% higher than on the annual pasture, generating 55% more live gain but with the added cost of 20% more hay fed.

The annual pasture was only grazed for a short period in 1996 before it was renovated, but the perennial paddock carried a higher grazing pressure and produced more live gain per hectare than in other years though 670 kg/ha of hay was also fed.

A general conclusion is difficult because of the range of variables involved. However considering animals grazing the annual pasture had access to 25% more area albeit non pasture, by the second year after establishment the perennial pasture proved to be more productive than the annual pasture. It is also likely to persist considering the strong 50 perennial grass plants/sq m. remaining at the end of the study.

It is interesting to note that the establishment of this perennial sward incurred little to no cost in terms of production foregone in the year of establishment.

Establishment Demonstration (Appendix..xix).

SUMMARY: By winter 1994 it was obvious, for various reasons, that it would be a waste of time persisting with three of the west coast sites. Continued recording at these sites was subsequently terminated.

The sites included one *Monitoring site*: McCormack's at Pinjarra(appendix vii) and two *Producer Demonstration sites*: Fouracres at Manjimup (appendix xvi) and Fry's at Donnybrook (appendix xvii).

As an adjunct to the project it was then decided to develop three more small perennial pasture sites on farms to demonstrate establishment techniques.
During 1995 and 1996 these sites were used as focal points for extension on pasture establishment with discussion topics including:

- project DAW.046
- species selection
- time of seeding
- establishment techniques (seed quality, insects)
- proposed management
- survival and response to summer rain.

Research trial sites

(Details of inputs and pasture and animal production at each site can be found in the appropriate appendix.)

Mt Barker Research Station (Appendix..xx)

Aims:

To study the persistence and compare the productivity of perennial grasses with that of annual pastures when grazed by cattle.

Design:

5 treatments x 3 replicates x 3 steers/plot (2/ha)

Treatments:

1987 to Dec 1991 The site was used in a grazing management experiment, with 12 of the 15 plots sown to annuals and the other 3 sown to a perennial grass mixture which resulted in a strong stand of *Currie cocksfoot.*

Plot conditioning prior to the **autumn 1992** sowing of the current perennial grass pastures commenced in Dec 1991.

1987 - 1991 OLD EXPERIMENT

	All 15 plots sown in autumn 1987 using a combine following 2 cereal crops.
Currie mix.....	Retained in new experiment
Annual pastures:	
Continuous.....	Retained in new experiment
Spring deferred, heavy summer	(*Sown in autumn 1992 to perennial grasses, new expmt*
Summer deferred, heavy spring	(" " " " " " " " "
Autumn deferred	(" " " " " " " " "

1992 - 1996 NEW EXPERIMENT

	Sown autumn 1987
Currie mix.....	Retained
Annual.....	Retained
	Sown autumn 1992
Brumby ryegrass..	(***Summer 1992*** *variable grazing. Germination,* ***15/5*** *1L/ha Roundup*
Triumph fescue.....	(*CT, (****19/5*** *sown with 6.2kg/ha subterranean clover and either 5.8kg/ha*
Sirosa phalaris.....	(*Brumby or 7.6kg/ha Triumph or 5.4kg/ha Sirosa using a* ***combine.***
	(***29/5*** *350 mil/ha Imidan.*
	((*Each grass was sown into 1 of each of the old annual grazing system*
	(*treatment plots.)*
	(*Grazing commenced when FOO reached* ***1100 kg/ha***

1993 and 1994

Currie mix	3 plots	Continuously grazed
Annual	3 plots	Continuously grazed
Brumby ryegrass	2 plots.....	(1993 Perennials sown into the three spring
Triumph fescue	2 plots.....	(deferred, heavy summer grazing treatment plots of
Sirosa phalaris	2 plots.....	(the **old** experiment failed to establish densely
		(enough to be included in the **new** experiment, but
		(were grazed continuously in line with the
		(treatments

1995 and 1996

Currie mix	3 plots	)
Annual	3 plots	)
Brumby ryegrass	2 plots	) All continuously grazed with + or - hay.
Triumph fescue	2 plots	)
Sirosa phalaris	2 plots	)
Continuous + Grain	*3 plots*	(***Barley** supplement of **4kg/hd/d** was fed over*
		(autumn to steers grazing the 3 plots where we
		*(**failed** to establish the perennial grasses (see*
		(above)

Based on predetermined weight/condition welfare criteria hay was fed to steers on the plots as necessary and was recorded as a dependant variable.

Measurements:
soil parameters; rainfall; pasture growth (in one year), feed on offer and nutritional quality of FOO (monthly); botanical composition (twice a year); perennial plant counts; liveweight, condition scores (monthly), ultrasonic P8 fat measurements (live at start, finish and monthly from winter), carcase weights and P8 fat (slaughter); perched water table (during winter and spring); quantity and quality of supplements fed; clover seed yields (spring and early summer) and soil phosphorus and potassium levels in summer.

Results and Discussion:
SUMMARY: The successive, extremely dry summers have helped halve the counts of *Brumby ryegrass* and *Triumph fescue* at this site. However *Sirosa phalaris* and the long established *Currie cocksfoot* stands were still strong at the end of the study.
High levels of subterranean clover seed (>600 kg/ha) were available for germination each year, a decline in total seed from 1992/93 to 1995/96 is associated with the succession of late breaks and subsequent poor pasture growth. There was no obvious difference between treatments in the levels of clover seed in summer prior to any germination.
Over the years *Capeweed* has been an important component of the *annual* swards but not in the *perennial grass* pastures
In all years the *annual* pastures had the lowest levels of dry residues through summer and were the slowest to emerge. In 1993, , green FOO reached around 2000 kg/ha in all pastures by May, however subsequently this level of FOO was not reached until July in 1994 and August in 1995 and 1996.
The growth estimates were based on total FOO and not growth of the individual grass species within a treatment, resulting in little obvious difference between treatments.
Green FOO through the summer/autumn months was absent in the *annual* pasture except in 1993 following the early opening rains. In the *perennial* pastures green FOO was present, generally most in the *cocksfoot* pastures and least in the *perennial rye* swards.
The inclusion of perennial grass in the pastures reduced the hay requirement of steers to 20% - 67% of that of steers grazing the *annual* pastures.
On average the extra live gain and carcase gain over the *annual control* treatment were respectively 97 and 54kg/ha for *phalaris*, 46 and 20 kg/ha for *tall fescue* and 39 and 20 kg/ha for *cocksfoot*.
The pattern of growth of steers grazing the different pastures varied, with those grazing *cocksfoot* and *tall fescue* performing slightly better in late summer/autumn while those

grazing *phalaris* growing faster in winter/spring. Those grazing *perennial rye* consistently lost more weight than other treatments in autumn and were unable to make up the loss in the winter and spring.

Dollar value of differences in hay fed and carcase gained: On average over the 4 years, the steers grazing the *cocksfoot, tall fescue* and *phalaris* pastures provided dollar benefits over the annual *control*, however the *perennial rye grass* treatment was less economic than the *control*.

1993 to1996	hay cost $/ha @ $60/t	carcase benefit $/ha @ $2.00/kg carcase	outcome $/ha compared with the control
Annual control	- 28	0	---
Cocksfoot	- 6	40	62
Perennial rye	- 19	- 92	- 83
Tall fescue	- 7	40	61
Phalaris	- 9	108	127

Green FOO and steer growth: combining data for all treatments, when there are low levels dry FOO and before October when green feed quality can start declining, indicates that *2000 kg/ha* is a critical level when steer live gains start to exceed one kg/day, a rate sufficiently high for steers to improve in condition.

In *1995* despite the weight gain benefits from feeding grain through the autumn/early winter period, the steers were not sufficiently fat to market at the end of grain feeding. Compensatory gain in weight by steers only fed hay for their welfare had matched the gains made by grain fed steers by the time they had achieved a condition suitable for market in October/November.
In *1996* compensatory gain was not as complete as 1995 due to the severity of the feed restriction of the steers through winter. In this year grain fed animals could have been marketed approximately a month before those on pasture and hay only.

Pardelup Prison Farm (Appendix..xxi)

Aims:

To study the persistence and compare the productivity of perennial grasses with that of annual pastures when grazed by cattle.

Design:

5 treatments x 3 replicates x 3 steers/plot (2/ha)

Treatments:
The whole area was cleared 1983/4, cropped with lupins in 1985 with an undersowing of *Currie cocksfoot*. Subclover was then sown in 1986.
Between 1989 and 1991 there had been an experiment involving 9 plots (3 treatments by 3 replicates), these were increased to 15 in 1992 on adjoining land to provide a similar design and treatments as at Mt Barker Research Station (see earlier).

1989 - 1991	OLD EXPERIMENT
Annual Currie mix Brumby	(1989, summer cultivation, a disc drill was used to sow 3 plots each of (***Concord***, ***Currie*** mix and ***Brumby rye***. (Subsequently the ***Concord*** (plots reverted to annual subterranean clover only.)

1992 - 1993	NEW EXPERIMENT
Annual.....	**Retained, sown autumn 1989**
Currie mix.....	**Retained, sown autumn 1989**
Brumby.....	**Retained, sown autumn 1989**
Triumph fescue.....	(Extra treatments were sown on adjoining areas in **autumn 1992:**
Sirosa phalaris.....	(ploughed in March, *13/4 sprayed roundup CT, 15/5 harrowed, 20/5*
	(*sowed 7kg/ha* ***Triumph*** *and 5 kg/ha* ***Sirosa*** *+ 3 kg/ha each of*
	(*Esperance and Trikkala sub clover.*

1993

Annual	)
Currie mix	) **All continuously grazed**
Triumph	)
Sirosa	)
Brumby replaced by ***Kikuyu***	(***Brumby*** *performed no better than the annual plots and it was decided*
	(*to replace it with* ***Kikuyu grass,*** *this was done by:*
	(***8/9*** *Increased SR to 3.1/ha. and sprayed with 1l Roundup +0 .6l*
	(*Dicamba.*
	(***1/10*** *sowed* ***Kikuyu*** *(2.14kg/ha +120 of super)* ***Cross slot drill. 6/10***
	(*removed cattle.* ***3/11*** *sprayed 300ml/ha Imidan (RLEM)*
	(*Not stocked over summer*

1994

Annual.....	**13/5** using a Bettinson triple disc drill we sowed 4.3 kg/ha ***Wimmera rye*** into ***annual*** plots to try and reduce **bloat** that had been experienced in previous years on pastures of around 90% ***subterranean clover.***

Hay was not fed at this site as management wanted to avoid spreading weed seeds into recently developed paddocks and steers had to be removed from plots once they reached predetermined weight/condition welfare criteria.

Measurements:
Soil parameters; rainfall; feed on offer and nutritional quality of FOO (monthly); botanical composition (twice a year); perennial plant counts; liveweight, condition scores (monthly), carcase weights and P8 fat (slaughter when possible); perched water table (during winter and spring); periods steers spent outside the plots and their outgoing and return weights; clover seed yields (spring and early summer) and soil phosphorus and potassium levels in summer.

Results and Discussion:
SUMMARY: At this site *Triumph fescue* has maintained its superiority in terms of animal production, with all *fescue* plots still supporting very strong stands. All the temperate perennials plant counts decreased by 15% to 30% over 1994/95 but did not change 1995/96. *Kikuyu* grass has established well in one (sandy surfaced) plot. The successive, extremely dry summers has slowed its spread on the other plots but plants persist and have the capacity to spread in the future
High levels of seed (>600 kg/ha) were available for germination each year.
There is no obvious, consistent difference between treatments in the levels of clover seed in summer prior to any germination.
Subclover levels in all the swards over the years have been high and the *broadleaf weed* component negligible. The *kikuyu grass* is expected to increase steadily and would be more obvious in a summer sampling, while the proportion of the other perennial grasses has remained fairly stable with *tall fescue* being the most strongly represented.
Blocks within this experiment are associated with soil type and suitability of the perennial species used to the soils of this site are:

	Description	Cocksfoot	Kikuyu	Phalaris	Fescue
Block1	Sandy surface	√	√√	√	√√
Block2	Ironstone at surface(ridge)	√	x√ ?	x	√
Block 3	Lower lying, prone to water logging	x	√	√	√√

(x = not suited, √ suited, √√ = most suited)

No hay was fed to steers on the plots in this project. However when necessary animals were removed from plots on welfare criteria and grazed elsewhere.
Use of fescue (1994, 1995 and 1996) and kikuyu grass (1996) at this site reduced the need for alternative grazing over the autumn/early winter months.
Over the 4 years
Over the past 4 years the *fescue* treatment has been grazed the longest, between 10 and 15 percentage units more than the other treatments and this benefit has come when feed is short. *Fescue* has shown to be a valuable source of feed through our seasonal feed 'gap', and in years with more summer rain it is likely to be even more beneficial. In the spring months (1995) performance of steers grazing phalaris was superior, the same effect has occurred in the Mt Barker experiment (see earlier).
Dollar value of differences in agistment *and carcase gained:* On average over the 4 years, the steers grazing all the *perennial* pastures at this site provided dollar benefits over the annual pasture (control) of up to $88/ha.

Green FOO and steer growth:. The level of 2000 kg/ha and its effect on steer growth is not as clear cut as in the Mt Barker data. It appears that the 1993 data does not fit the pattern and its removal restores the pattern of steer growth in relation to green FOO reported for Mt Barker. This may well be associated with animal condition as in 1993 the steers grew faster earlier following an early break and their average body condition in June, July and August were higher steers in subsequent years.

Manypeaks, Mike and Robyn Doveys farm (Appendix XXII)

Aims:

1. To compare sheep production on an annual-only pasture to those containing the perennial grasses kikuyu, tall fecue, phalaris and perennial ryegrass.
2. To examine the productivity and persistence of perennial grasses on a infertile sand.

Treatments:

Year	Pasture type	Grazing management	Stocking rate (dse/ha)	No. of replicates
1993	Annual	Set stocked	8	2
			10	2
			12	2
	Kikuyu	Set stocked	10	3
		Rotationally grazed	10	3
			14.5	3
	Temperate perennial mix[1]	Set stocked	10	3
		Rotationally grazed	10	3
			14.5	3
1994	Annual	Set stocked	9.5	2
			11.5	2
			12	2
	Kikuyu	Set stocked	11.5	3
		Rotationally grazed	11	3
			14.5	3
	Temperate perennial mix	Set stocked	11	3
		Rotationally grazed	11	3
			14.5	3
Jan to June 1995	Annual	Set stocked	9.5	2
			11.5	2
			12	2
	Kikuyu	Set stocked	11.5	3
			14.5	3
			17.5	3
	Tall fescue	Establishment phase	-	9
Jul 1995 to Dec 1996	Annual	Set stocked	11.5	3
			14.5	3
			16.5	1
	Kikuyu	Set stocked	11.5	3
			14.5	3
			17.5	3
	Tall fescue (start Jan 1996)	Rotationally grazed	11.5	3

[1] Consisted of perennial ryegrass (cv Brumby), phalaris (cv Sirosa) and tall fescue (cv Au Triumph).

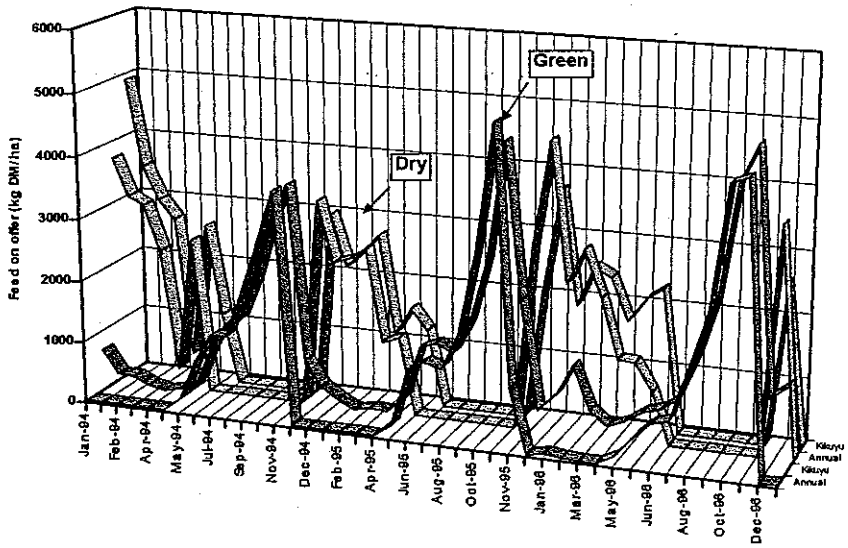
Measurements:

Climate: rainfall, soil and air temperature, solar radiation, wind speed and direction and relative humidity.
Pasture: growth, feed on offer, botanical composition, digestibility, crude protein, clover seed bank and plant persistence either by plant counts or % groundcover.
Sheep: liveweight, condition score, wool yield and wool characteristics.
Soil: annual soil sampling 0 – 10cm, soil moisture, groundwater height and risk of wind erosion.

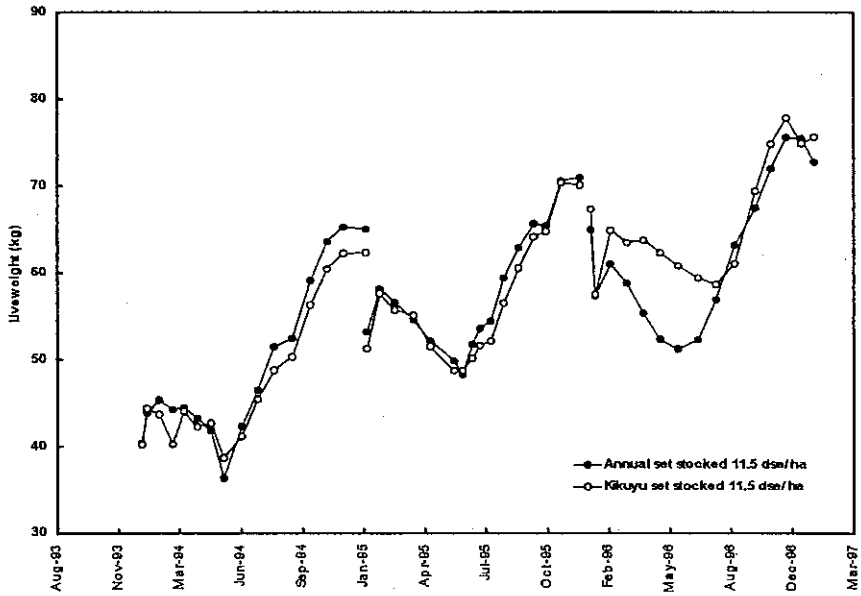
Results:

A detailed report of results is contained in Appendix XXII. The small number of results presented here is simply to illustrate concisely the differences between pasture types.

Annual vs kikuyu pasture set stocked at 11.5 dse/ha 1994 to 1996



The above feed profile clearly shows that a well managed kikuyu pasture is the equal of an annual sward within the growing season. However, outside the growing season kikuyu remains green providing superior feed for livestock at this time of year. Even in the hot and dry summers of 1993/94 and 1994/95 the perennial grass kikuyu provided green pick. When summer rainfall does occur, as it did in 1995/96, kikuyu responds quickly, increasing the amount of green feed available.



A comparison of sheep liveweight is presented above for the kikuyu and annual treatments set stocked at 11.5 dse/ha. In the absence of summer rain, in 1994 and 1995, kikuyu demonstrated no significant benefit to liveweight except in the autumn of 1994 in which it held up sheep weights prior to the break of season. At higher stocking rates livestock benefits become more apparent (refer to Appendix XXII). The summer rainfall in 1995/96 is reflected in the liveweight performance of the sheep through the summer and autumn of 1996. During this time livestock grazing kikuyu were up to 9 kg heavier than those on the annual treatment.

Yield, characteristics and value of wool produced on Manypeaks trial 1993 to 1996

		Management	Stocking rate (wethers/ha)	Lupins fed (kg/ha)	Clean wool (kg/ha)	% yield	Micron	Staple strength (N/ktx)	Staple length (mm)	Hauteur (mm)	Net return per ha, indicator 900c/kg	Net return per ha, indicator 600c/kg
1993	Annual pasture	Set stocked	8	0	45.8	77	24	27.9	124	92	$138	$50
		Set stocked	*10*	0	61.2	81	24	28.1	128	94	$195	$83
		Set stocked	*12*	0	68.9	78	23	31.2	123	92	$250	$115
	Kikuyu pasture	Set stocked	*10*	0	57.5	81	23	41.0	121	95	$192	$81
		Rotational	*10*	0	56.7	78	24	38.4	123	96	$176	$70
		Rotational	*15*	0	80.3	78	22	33.8	117	89	$384	$195
	Temperate	Set stocked	*10*	0	53.1	79	23	29.4	120	89.0	$163	$62
	perennials	Rotational	*10*	0	44.5	78	22.0	29.4	109	83	$167	$65
		Rotational	*15*	0	72.3	78.0	22	24.3	109	80	$320	$154
1994	Annual pasture	Set stocked	*9.5*	0	41.3	70	22	23.2	112	81	$173	$71
		Set stocked	*12*	0	49.8	73	21	19.8	110	78	$299	$150
		Set stocked	*12*	0	50.7	71	20.0	16.2	111	76	$469	$261
	Kikuyu pasture	Set stocked	*12*	0	51.7	76	21	26.4	109	82	$317	$161
		Rotational	*11.0*	0	47.8	76	20	26.4	111	81	$401	$219
		Rotational	*15*	0	53.8	75	20	24.0	107	76	$446	$240
	Temperate	Set stocked	*11*	0	44.6	77	20	23.2	104	76	$358	$191
	perennials	Rotational	*11*	0	40.2	74	19	20.7	102	72	$330	$172
		Rotational	*15*	0	53.6	73	20	19.0	99	70.0	$467	$255
1995	Annual pasture	Set stocked	*12*	0	51.9	74	22	20.1	107	76.8	$217	$95
		Set stocked	*15*	0	60.1	75	21	18.0	105	74.9	$352	$177
		Set stocked	*17*	0	60.8	73	21	16.3	99	70.0	$365	$181
	Kikuyu pasture	Set stocked	*12*	0	56.5	80	22	34.2	110	84.0	$240	$110
		Set stocked	*15*	0	55.0	79	21	31.4	102	76.4	$320	$157
		Set stocked	*17.5*	0	64.6	79	20	23.4	100	72.3	$518	$295
1996	Annual pasture	Set stocked	*12*	78	55.3	77	22	30.6	105	82	$230	$97
		Set stocked	*15*	477	61.1	74	21	25.8	101	76	$302	$112
		Set stocked	*17*	1,301	62.8	76	20	25.9	95	71	$283	$39
	Kikuyu pasture	Set stocked	*12*	0	62.6	80	23	48.6	111	89	$214	$91
		Set stocked	*15*	50	62.8	78	22	37.6	105	81	$264	$115
		Set stocked	*17.5*	361	72.3	79	21	31.4	104	78	$370	$156
	Tall fescue	Rotational	*12*	177	48.2	74	21.0	15.0	100	69	$256	$109

The wool production (see above table) highlights were:

- In 60% of cases, more clean wool was produced on kikuyu than annual pastures at similar stocking rates due mostly to higher % yield e.g. 1995 at 11.5 wethers/ha.
- Statistically there were no differences in micron between kikuyu and annual pastures at similar stocking rates; however, increasing the stocking rate reduced micron e.g. 1996, kikuyu.
- Each year, kikuyu produced stronger wool because of green feed in summer/autumn e.g. 1996.
- Increased stocking rate reduced the staple strength e.g. 1996.
- Overall there was little difference in staple length between kikuyu and annual pastures.
- Hauteur is consistently higher on kikuyu pastures e.g. 1996.
- The difference in lupins fed out in autumn 1996 indicates the value of the kikuyu pasture at this time of year.
- Overall net returns per ha from wool production were higher on kikuyu, primarily because the pasture could sustain higher stocking rates. In any one year, the highest stocking rate on kikuyu was always more profitable than the highest stocking rate on annuals.

In summary, sheep grazing kikuyu pastures consistently produced more fine to medium wool which was sound. For example, compare a high stocking rate on annuals (14.4 wethers/ha) in 1996 to the potential on kikuyu at 17.5 wethers/ha. Kikuyu produced 11 kg/ha more wool which was finer and of similar strength!

Discussion:
The experimental annual pasture was similar to those in paddocks on farms surrounding the trial. As such this treatment provided an excellent indicator as to the expected farm performance of the perennial grasses tested.
The introduction of the perennial grass kikuyu into a annual pasture consistently provided benefits to wool production - when compared to a annual only pasture - in both wet and dry summers. This increase in wool production on kikuyu resulted due to the pastures ability to sustain a higher stocking rate without damaging the pasture or soil.

This benefit arose as a result of the following characteristics of kikuyu:

- Summer activity and drought tolerance.
- Good companion species to subclover and annual grass.
- Tolerance to high rates of defoliation i.e. grazing.
- Deep rooted nature.
- Frost tolerance.
- Stolon and rhizome structure which binds the soil together and allows the plant to spread.
- Displaces broadleaf weeds such as capeweed.
- Productive in infertile soils.

This study highlights the fact that to realise the full potential of kikuyu it is critical to maintain a strong annual component in the sward (particularly clover) which provides the pasture growth during late autumn, winter and early spring. Other benefits include biologically fixed N via an annual legume to provide N for grass production. The characteristics of a well managed and balanced kikuyu pasture is production equal to an annual only pasture in the growing season, high legume density and available green feed through summer and autumn. Maintenance of the annual component requires, insect control (e.g. red legged earth mite), adequate nutrients (i.e. fertiliser) and sward management via grazing. Of particular importance is the need to reduce dry residues prior to the break of season to enhance seed softening and allow seedlings access to light, water and nutrients.

Poorly managed kikuyu pastures have led to the belief amongst growers that kikuyu has no place in pastures in the region. This is not surprising since these swards are characterised by little or no annual component and rank kikuyu, which is unpalatable and low in digestibility. This investigation demonstrates to these growers that the key to the productive kikuyu pastures is a strong annual component coupled with the appropriate grazing management.

The ability of kikuyu to fill the late summer/early autumn feed gap - which occurs annually in the mediterranean climate of southwest Australia - presents farmers with the opportunity to either raise stocking rates or reduce the amount of supplementary feed used at this time, providing increased returns per ha. For the trial the approach of increasing stocking rates was adopted since there was no supplementary feed. In

hindsight this is the best approach since it efficiently utilises the feed base and provides the correct grazing management for kikuyu i.e. continuous and at times heavy grazing pressure.

The rotational grazing treatment applied to kikuyu swards as part of this trial failed since liveweight performance was poorer than that on the equivalent set stocked treatment. Rotational grazing was imposed in late spring with the objective of increasing the available green feed in summer, unfortunately the areas that were locked up in spring became rank and unpalatable, while the amount of feed on the area that was grazed, limited intake. This situation arose since stocked were moved 6 weekly, not on the basis of pasture criteria e.g. amount of feed. The benefits of rotationally grazing kikuyu are restricted however, this tactic could be used to increase production if feed is limited and the leaf area index of the sward is below the optimum for growth.

The mixed temperate perennial pasture provided more feed in the year following establishment (1993) compared to the annual pasture. However, under a set stocking regime the animal liveweight performance was similar to the annual and under rotational grazing poorer, due to sheep being moved 6 weekly rather than on the basis of feed availability. In the second year there was no benefits with the temperate perennial pasture doing worse overall in terms of animal and pasture performance.

The mixed temperate perennial pasture failed to perform any better than a annual pasture because the perennials were only active during the growing season and dormant in summer/autumn. As a consequence overall the pasture possessed a green and dry feed profile similar to an annual sward. The only differences being green pick available in late spring/early summer and the potential to hold green feed on the paddock for summer feed if the pasture was locked up in late spring. Unfortunately, these benefits are unlikely to remain for long since the temperate perennials persist poorly under set stocking and only marginally better under the rotational treatments due to stock removing and killing plants in summer. Interestingly, phalaris persisted well under rotational grazing, but poorly under set stocking while perennial ryegrass lacked persistence under both.

Tall fescue cv Au Triumph replaced the temperate perennial mix. Assessment began in 1996 following a good establishment in the autumn of 1995. Unfortunately, only one years worth of data was collected on this pasture type which prevented us exploring the full potential of this species. However, in that year tall fescue showed promise due to its ability to provide green feed in summer/autumn thereby filling the feed gap. While tall fescue cannot raise stocking rates as high as kikuyu, it can provide higher quality feed in summer for finishing stock out of season and a area for autumn deferment. As in the trial, if grazed by sheep it must only be grazed outside the growing season if there is sufficient green feed available otherwise plants will be removed and the pasture will revert to an annual only sward. The sheep on tall fescue did not perform as well as those on the annual treatments due to a particularly difficult autumn in which they were confined to the annual plot in the rotation with low amounts of feed. In addition, it appears that the sudden change in diet due to the rotation resulted in tender wool. In spite of these results tall fescue is a promising perennial grass if used strategically for out of season sheep meat production and/or autumn deferment.

The soil moisture data collected at the site is limited since the deepest moisture probe (35 cm) fell far short of the rooting depth of kikuyu which went below the laterite. The only preliminary conclusions that can be drawn from the data is that at 35cm there is consistently more soil moisture under the kikuyu pasture than the annual possibly as a result of variation in the soil profile across the site or kikuyu roots altering the moisture holding capacity of the soil. Also when the soil is wetted up in summer/autumn there is a tendency for the soil below kikuyu to be drier suggesting, that the perennial grass is using soil moisture during this period.

The success of the tropical grass kikuyu in a mediterranean environment is unexpected and opens up the possibility of other warm season perennial grasses being as equally or more successful given the required agronomic characteristics and suitability to southwest Australia. Other future directions include the possibility of developing a high input kikuyu system (e.g. tactical use of nitrogen, increasing annual ryegrass density) and finding a suitable companion perennial legume. Within the temperate perennial grasses the summer active types (e.g. tall fescue cv Au Triumph) will provide the largest benefit to animal production. (see above table)
The additional advantage of summer active perennials is they are likely to dry out soil profiles during the dry season thereby reducing groundwater recharge and subsequent salinisation.

Producer Survey (Appendix xxiii)

A survey involving 52 farmers whose farms had areas under pasture ranging form 57 to 4200 hectares was conducted. Included in these pasture areas were 85 separate areas of perennial pastures which ranged in size from a total of 12 to 2400 hectares. These areas varied from part of, to the whole farm.
Data was collected by interview using a questionnaire (Appendix xxiii). The majority were interviewed on farm but due to time and distance constraints some were interviewed by telephone.

The main enterprises carried out on the farms were:
Beef - 24 farms, 15 were sole enterprises, 9 mixed
Wool - 22 farms, 2 were sole enterprises, 20 mixed
Prime Lamb - 3 farms, all had mixed enterprise
Cropping - 2 farms, both had mixed enterprises
Dairy - 1 farm also had mixed enterprise
(Secondary enterprises were Beef, Wool, Prime Lamb, Cropping and Horticulture.)

The survey extended from Wellstead, 100 km east of Albany to west of Manjimup and north to Frankland (See map). It was in an area with an average annual rainfall in excess of 600mm and the growing season varying from 6 months to 10 months, generally decreasing in a north easterly direction.

Results and Discussion
SUMMARY: The wide variety of farm location, climate, property size, grazing enterprise and experience of farmers provided a wide range of subjective opinions reported in the survey. However several common themes surfaced, many of which were supported by evidence in the on farm and experiment studies.
General management and Grazing:
Growers claimed better carrying capacity of perennials over annuals.
Few used N, though it was considered important to have a clover base to provide nitrogen. Insecticides were basically used to maintain the clover base, though their use was also identified as important at the perennial grass seedling stage.
Generally, paddock suitability (topography, smoothness, position) were stronger determinants of selecting an area for conserving fodder than targeting the pasture species!
They considered management was basically different for *Kikuyu* grass than for the *temperate perennial* grasses

It was suggested the best performance of *Kikuyu grass*: was based on heavy stocking by sheep or cattle, notably in autumn, to prevent rank growth. Kikuyu was highly suited to coastal sandy soils, but was spreading inland on a range of soils. Once established on unproductive deep sands it created a micro-environment enhancing clover establishment. The main problem with kikuyu was where growth became rank which affected the growth of other annuals in winter.

Temperate perennial grasses:

There was a diversity of views on the management systems suitable for *perennial ryegrasses*, though 'extra' management was considered necessary for it to persist and produce. Problems noted were: poor persistence in sands and gravels in prolonged dry periods, selective grazing by sheep in autumn, the need to resow every 5 to 6 years, palatability to wingless grasshoppers and 30% of growers had experienced rye grass staggers in sheep or cattle, though generally it was not considered important?
Phalaris (notably *P.tuberosa*) persisted well on heavier soils and needed heavy spring grazing to prevent it from getting rank. Problems identified were: mild sporadic cases of phalaris toxicity in both sheep and cattle reported by 30% of producers, poor palatability once rank, wingless grass hopper damage and it was considered to make poor quality hay.
Cocksfoot Generally considered not to persist, but with strong exceptions. It was suggested to be a strong competitor with other grasses and to be a highly productive and palatable as a hay crop. Its main problem was its poor persistence under grazing.
Fescue was considered to persist poorly under grazing and when sown in mixtures, though success was claimed where *Demeter* had been sown in wet areas. Favourable comments were made about the new variety *Triumph.*

Veldt grass combined with serradella was successfully managed on deep sandy areas, being deferred in spring to allow seed set and grazed in summer by cattle.
Mixtures of up to 6 varieties of *perennial grasses* plus annuals were used by 40% of the farmers. Persistence of the newer *phalaris* varieties, *Sirosa* and particularly *Sirolan* was considered poor. Of the growers who included cocksfoot or fescue in their mixtures, only 10% and 25% respectively reported their persistence.
Virtues of perennial pastures identified by growers: soil stabilisation; reduction in rate of acidification; increased carrying capacity (30 to 100%); decreased need for hay; as hay, perennials improved production and quality.
Suggested problems when growing perennial grasses were the high cost of establishment though this was not unanimous; caution with sowing the whole farm as it can reduce management flexibility; better varieties not performance tested yet; possible increase in endo-parasitism, notably in sheep.

Table of management techniques considered, by growers, to be essential for success with the different perennial grass species:

	Kikuyu	Ryegrass	Mixtures	Cocksfoot	Fescue	Phalaris	Veldt
Good establishment	Yes	Yes	Yes	Yes	Yes 2 to 3 yrs	Yes	Yes
Graze hard	autumn & winter					in spring	
Fertilise well	Yes		Yes	Yes	Yes	Yes	
Allow seed set		in late spring	Yes			if gets thin	Yes
Re-sow		5 to 6 years					
Controlled grazing		care in winter, autumn & summer	after summer rains			sheep in summer	Yes
Control competition			hay or spray top				
Nothing special		Yes	Yes				

Establishment: Most growers acknowledged a number of failed attempts as well as their successes. Failures were attributed to : sowing too deep; time of sowing; the pattern of rainfall around seeding; sowing kikuyu grass between June and August; (success with temperates was from seeding between April to June); unsuitable equipment, (generally ease of access to equipment rather than the preferred approach determined the method of seeding) and finally low seeding rates because of economic constraints
Suggestions for successful establishment of perennials included:
Good control of competition starting the year prior to seeding,
shallow seeding, insect control, fine seed bed,
plant as early as possible to benefit from the temperature (Kikuyu in spring),
lime acid soils, use of adequate amounts of seed and fertiliser and finally treat it like a crop.

Perennial Pasture Establishment Model (Spreadsheet) (Appendix xxiv)

Aims:

Provide a means to draw together the important economic components in the establishment and productivity of perennial pastures.

Type:

The model was generated using Microsoft Excel application software. It consists of a series of spreadsheets, dialogue boxes, dropdown boxes, toggle boxes and input cells drawn together using the Visual Basic language for applications (VBA).

Use:

The model was developed to determine the cost and break even period by calculating the costs of pasture establishment and maintenance as well as animal returns over a 10 year period. From a range of combinations of "current pasture" and selected "pasture development pathways", four pasture systems comparisons can be run concurrently, one of the four being used as a base or "control" system.

As we do not have the answers to all the combinations and interactions of perennial pasture establishment and management systems, all biological variables in the model have to be supplied by the operator. However sensitivity to different components of the pasture systems can be compared.

Validation of 'Grassgro' *(Appendix xxv)*

"Computer simulation of beef and sheep production in research and on-farm trials in south-western Australia" prepared by A.J. Moore (CSIRO, Jan 1966)

SUMMARY: This report forms part of a larger research and extension project which is evaluating perennial grasses in south-western Australia. We have validated the GRAZPLAN pasture and animal simulation models (as implemented in the GrassGro and Ausfarm computer programs) against data from a total of twenty data sets, eleven of which have been collected on farm. The simulations cover a range of climates, soil types and management systems, including both sheep and cattle enterprises. This study is the first use of the GRAZPLAN models in conjunction with on-farm measurements, and also its first use with pastures containing kikuyu, cocksfoot and capeweed.

The results of simulations of research site data for annual pastures, particularly at Mt Barker are at least as good as previous validations of the GRAZPLAN models. There is a general tendency of the model to under predict late autumn growth, especially with perennial based pastures; this did not have serious effects on predictions of animal production from annual pastures, but animal production was under predicted on perennial pastures. Simulation of kikuyu-based pastures were unsuccessful; the cause was an oversimplification in the pasture model of the dynamics of competition for light, combined with the different pattern of growth in kikuyu relative to sub clover. The simulations of the research trial data show the GRAZPLAN pasture models can realistically reproduce much of the behaviour of annual pastures in this part of western Australia.

The accuracy of the simulations of on-farm data is limited by a lack of site specific soil information. Nevertheless, the models correctly produce the general patterns of pasture availability and animal weight change in the on-farm plots. The results of the on-farm simulation work support the conclusions about the adequacy of the GRAZPLAN model which were arrived at on the basis of research trial simulations. When sites to be simulated have only rainfall records, it appears to be possible to synthesise adequate daily weather inputs by use of ESOCLIM software and nearby, more complete weather data sets.

Soil Moisture Measurements *(Appendix xxvi)*

DRW Microlink System equipment was purchased in the project to investigate the effect of different perennials on the change in soil moisture, with the aim of determining the magnitude of the benefit of the different perennials compared with an annual pasture in their use of soil water.

At Mt Barker, the perennials reduced the estimated surface and sub-surface drainage, (ie rain not accounted for in the soil moisture changes in the top 0.5m of soil) by **23mm per year.**

Once established the *DRW* recording system worked well, our main problems were associated with the calibration of the probes and lack of replicate recordings owing to the expense of the probes, loggers and field stations.

Brochure and Booklet *(Appendix xxvii)*

Producers in the high rainfall areas in the south west of the State were circulated with a **brochure**, approximately 5200 were direct mailed. In the **brochure** we outlined very briefly the contents of the perennial grass **booklet** ***"Perennial Grasses for Animal Production in the High Rainfall Areas of WA"*** and offered a free copy to any interested parties.

The **booklet** is in a glossy format, comprising 5 chapters:

- **Introduction** (Ecology of annual and perennial grasses, environment, benefits and problems of perennial grasses).
- **Economics** (Financial benefits of perennial grasses - *cattle and sheep*, economics of establishment).
- **Establishment** (Site preparation, sowing objectives and practice, sowing mixtures and after soing management)
- **Management** (Rules of thumb, principles, grazing with cattle, grazing with sheep).
- Characteristics (general agronomic characteristics of *tall fescue, perennial rye grass, cocksfoot, phalaris* and *kikuyu grass*).

To date approximately 950 of the 1000 copies printed have been circulated in response to direct requests. A data base of requested copies and their distribution is supplied with this report to MRC as requested by them.

SUCCESS IN ACHIEVING OBJECTIVES:

The general aim of the project was:
"Evaluating the role of perennial pastures in an annual pasture dominant area by quantifying animal and pasture productivity to provide the basis for economic analysis".
We attempted to achieve this through the range of subsidiary objectives discussed below. However the task is extensive and as was pointed out at the pre experiment meeting in Bunbury (4 March 1992) the best we could hope to achieve with the on farm sites regards the biology of the systems was to help validate the *Grassgro* component of the *Grazplan* model. The only way to accommodate all the variables in a topic of this magnitude was to use simulation models and ensure their integrity through field comparisons. This was considered to be especially true with the on farm *monitoring* sites, if they were of no use for validating *Grasgro,* they were of little value as data from stand alone paddocks other than indicators of productivity.
They did, however, provide valuable foci for pasture and animal production field day/walk discussions because they were sites with recorded histories.
Good examples of this were:

Denmoore, where with regular measurements and our influence we demonstrated a similar per head production with a reduction in the amount of conserved feed plus an increase in stocking rate.

Ravenhills, where for 5 years we demonstrated that in that environment combined with April/May calving and January weaning it was possible to turn off 350kg vealers from cows stocked at 0.8ha per breeder without feeding any hay.

Jenkins, where the temperate perennial component of the sward only declined from 35% to 28% under continuous grazing by cattle through 3 very dry seasons.

It should be noted that all the west coast sites (*monitoring* and *demonstration* sites) involved grazing cattle as did most of the *monitoring* sites (D Smith excepted) on the south coast. It was for this reason that we concentrated on sheep grazing systems in our *demonstration* sites on the south coast (Four out of five). One of these sites was lost to tree farming but the temperate perennials on the other 3 had failed to persist satisfactorily by the end of the study.

Subsidiary objectives

"1) To define seasonal pasture and sheep and cattle production patterns from perennial pastures and compare with annual pastures in the high rainfall, long growing season,

southern regions of Western Australia through on farm monitoring sites, producer demonstration sites and research sites."
Pasture production patterns were obtained on one of the experimental sites and on all the producer demonstration sites. Patterns of feed on offer and pasture quality (% moisture, % DMD, metabolisable energy concentration and % crude protein) and animal production patterns were obtained at all sites. Other production parameters such as quantity and quality of supplements fed botanical composition and perennial plant counts were recorded where appropriate. These base data are documented in detail in the appendices where comparisons are drawn between and among pasture swards at the demonstration and research sites.

"2) To use the production patterns generated in (1), across a range of soil types and rainfall zones to validate the Grazplan model Grassgro."
This was conducted and reported (Appendix xxv). The researchers reported that owing to the volume of data they were unable to simulate every treatment at every site and that they endeavoured to cover a range of pasture types, environments and management systems. This involved 5 monitoring sites, 3 demonstration sites and the 3 research sites, in all 20 validations were carried out with the data sets varying from 2 to 8 years.
The need to incorporate this validation work within the time frame of the project precluded the use of all 1996 data and in some cases part of 1995 data.
The modellers commented on aspects of this study that extended the use of *Grazplan*, these included:

- Pastures containing Kikuyu, cocksfoot and capeweed had not previously been simulated.
- This was the first use of the model to simulate production on commercial paddocks.
- The first use of the model to simulate soils with very sandy surface horizons. Because of their low water holding capacity, small errors in soil moisture budget inputs can result in large errors in predictions of soil water stress.

"3) To determine the economic feasibility of establishing perennial grass pastures using gross margin, pay back period and cash flow budget analyses and other economic analyses including Grazplan when it becomes available."
Owing to the complex nature of this objective, we resolved it by developing the spreadsheet model *"What is the cost of Establishing a Perennial Pasture"* This approach accommodated the variable animal components in a range of grazing systems as well as the expected effect of the different pasture management on grazing pressure when pastures or cropped areas are being renovated and sown to annuals or perennial based pastures.
The limited computing skills of the original research team necessitated outside assistance for development of the model and though it is quite functional further development is required to make it more 'user friendly'.
This model does provide an opportunity for workers to assess a range of options and look at sensitivities of most variables. It also provides for a 10 year budget plan.

"4) To document producer management techniques of commercial perennial pastures that affect persistence."
Early in the study we interviewed 52 farmers representing 85 areas of perennial grass ranging from 12 to 2400ha to document their experiences in maintaining perennial grasses. Their responses are summarised above ("Producer Survey") and generally concur with our extension messages for success.

"5) To have at least 50% of 1,560 potential end users, that is 730 beef producers and 330 mixed sheep meat and beef producers and 500 sheep producers aware of the information generated from this project on perennial pastures."
During the course of the project there have been many off and on farm activities (eg seminars, field days and farm walks) as well as mass media presentations informing producers and rural service providers of the work being undertaken in this project and the outcomes as they emerged.
Numbers of these interactions recorded are given below, however recording of some events may have been overlooked. Also in the farmer and professional participation numbers there are likely to be repeat attendances over time.
Professionals attending farm walks, meetings and seminars: about 280

Farmers attending farm walks, meetings and seminars: about 550
8 - 10 Radio talks, at least 5 article in *Southland* a local rural publication (circulation 1600 - 1800), at least 2 articles in the *Countryman* (circulation 18000), in the Beef Improvement News and in the Esperance Ag Memo. Displays and/or presentations were given at the Australian Society of Animal Production Biennial Conferences, Meat Profit Day (Murdoch University), Second Australasian Perennial Grass workshop (Tasmania), Jerramungup Agricultural Research Expos. and the Albany Show.
Our most recent approach to contact most producers and service providers has been to direct mail and distribute close to 6000 brochures advising of the work and provide an opportunity for recipients to request a perennial pasture booklet which is an outcome of this project. A database recording the destination of the booklets provides an indication of the numbers of interested clients and also a mailing list for the distribution of the *"Prograzier"* publication, part of the national Sustainable Grazing Systems Program.
There has been very positive feed back from producers that have received the booklet.

"6) To evaluate the production and persistence of new perennial grasses against commercial standard varieties under a cattle grazing system at two research trial sites."
This provided a rare opportunity to look at the basic range of perennial species (cocksfoot, fescue, perennial rye and phalaris) at two sites and compare the performance of grazing cattle among the species and with annual pastures.
The comparisons were undertaken at Mt Barker Research Station and Pardelup Prison Farm. Though these properties were only 20 km apart, over the life of the project they differed by 150 mm annual rain (25%). The site at Mt Barker RS comprised heavier soils that were better drained and had been cultivated for many more years, consequently having a longer fertiliser history than those at Pardelup. As a result the sites were suited to different perennial species. Sirosa phalaris and Currie cocksfoot were most productive and persisted best at Mt Barker, while Triumph fescue was most productive and persisted best at Pardelup. This clearly illustrates the importance of ensuring selection of the most suited species for a specific combination of environmental factors.

"7) To quantify persistence and production of perennial grass species when grazed by sheep at Manypeaks research site and recommend appropriate grazing management to maximise production under sheep grazing."
The work conducted at this site has clearly identified the value of Kikuyu grass for grazing by sheep in the sand plane regions of the south coast. Its ability to with standing high grazing pressures while maintaining soil stability makes it an obvious selection when looking to sustainable grazing systems in this region. Although wool production per head was similar to that of the annual pastures we showed that Kikuyu ensures high wool fibre strength. Considerably lower summer/autumn supplements are required for sheep grazing kikuyu swards because of growth responses to any summer rain. Being an aggressive warm season grass kikuyu is more likely to deplete soil moisture reserves in late spring, summer and autumn than other species, and so help act as a buffer to ground water drainage the following year.
In comparison, fescue was much more sensitive to grazing management, though it did respond to summer rain, it was not to the same extent of kikuyu grass. Being a temperate species it is less likely to provide as good a buffer to ground water as does Kikuyu grass. However because of the increased control problems especially with kikuyu grass, it is unlikely any perennial grass species will be included in paddocks suitable for cropping in the lower rainfall areas. Another possible problem/limitation of this species is the concern regarding its effect if it were to become established along the natural stream and river systems.

IMPACT ON MEAT AND LIVESTOCK INDUSTRY

The changing profile of agriculture in the high rainfall areas of the south west has if anything accelerated over the life of this project, to the detriment of the grazing enterprises. Alternative enterprises with higher returns have and are forcing land values up, especially along the west coast south of Perth but also, gradually, from west to east along the south coast. The main components of this change have been:

- the severe down turn in returns to wool and beef producers,
- in the short term, three consecutive dry seasons have exacerbated the poor returns
- competition from horticulture, viticulture, tree plantations for wood chips and timber, dairying, tourism, and hobby farms.

As the grazing industries move east to the drier areas cropping becomes an important alternative and the feasibility of growing perennials in cropping areas then becomes another issue. These areas are more likely to be grazed by sheep, therefore kikuyu grass, in suitable areas, is likely to be preferred over temperate perennials. As identified in this project the cost of pasture renovation to perennials will take at least 3 to 4 years to pay back when establishing temperate species or 2 to 3 when establishing kikuyu grass, perennial grasses then become a questionable proposition in these areas other than in niche locations or those that are not likely to be cropped.

Sustainability of grazing systems is the important issue in the longer term. This revolves around controlling deep drainage in recharge areas and maintaining returns per hectare to ensure viability. Along with surface drainage and strategic placement of tree plantations, suitable perennial pastures will have a role in increasing the soil water deficit in late spring/summer/early autumn to help buffer the excess water in winter. It appears that currently, the most active species in this respect is Kikuyu grass. This species has been shown to be valuable on the sandy soils of the south coast from Denmark to Esperance.

CONCLUSIONS AND RECOMMENDATIONS (NB FUTURE WORK TO COMMERCIALLY EXPLOIT THE RESULTS)

In some quarters it was thought that this project was established to promote the widespread sowing of perennial grasses. This was never an objective, our objective was to look at the suitability and benefits if any of perennial grasses in our environment.

As such we have developed a clearer view of the value of a range of perennials. However grazing management of temperate perennials, especially with sheep remains an important issue that is only partly resolved. In part we think the old habits of farmers to use any available paddock feed in summer and autumn (this may be while feeding supplements) is a difficult practice to change, this is to the detriment of the persistence of temperate perennial grasses. With the relatively higher grazing pressures used for sheep than for cattle and the intermittent toxicity problems of phalaris, it is unlikely temperate perennials will be established widely in sheep grazing areas. However as has been emphasised earlier Kikuyu grass has a place providing areas are not to be cropped in the future. Currently we are not sure of how far we can extend the sowings of this species in the medium to low rainfall areas.

The approach of the Western Australian research component of the Meat Research Corporation's new *Sustainable Grazing Systems Key Program* is to further develop our understanding of the key elements (surface drainage, trees, kikuyu grass) and their effect on production and water use.

A problem with trying to evaluate perennials in the way we have in this project is our inability to fairly assess their value. Unless some way of evaluating the strategic benefits to whole farm systems of the different perennial species is developed it appears the true value of perennials cannot be determined and their value is likely to be understated. Grazing systems within defined paddocks (eg for species comparison in our experiments) and putting and taking animals and fodder (eg on the monitoring and demonstration sites) take no account of the complementarity of a specific perennial pasture with other annual or perennial pastures available on the farm at specific times of the year. Whole farm monitoring is one possible approach.

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Agriculture
Meat Program

Meat
Research
Corporation

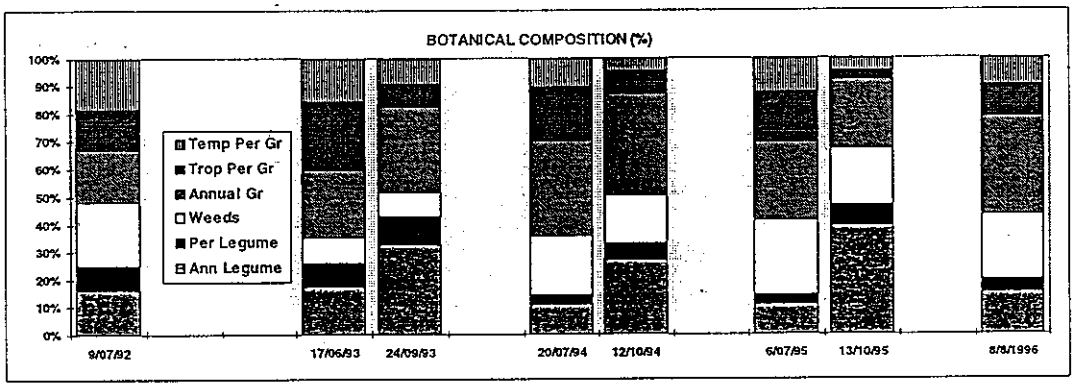
"PERENNIAL PASTURES FOR ANIMAL PRODUCTION IN THE HIGH RAINFALL AREAS OF WESTERN AUSTRALIA"

APPENDECES
I to XXVI

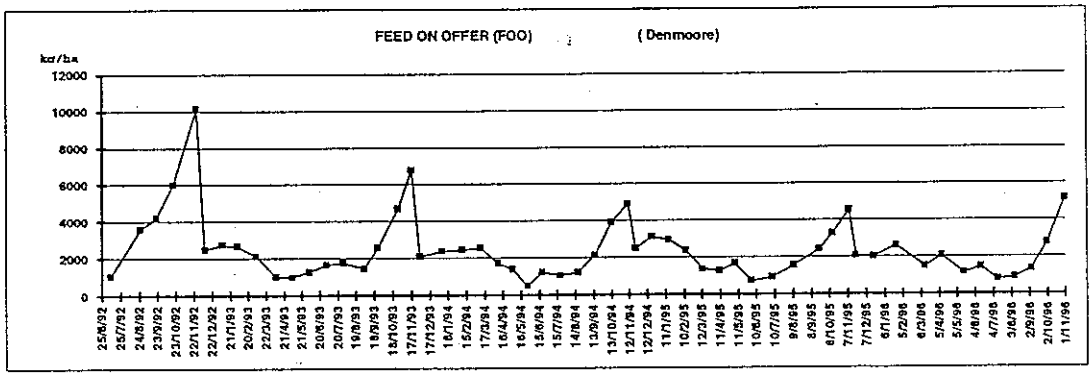
DAW 046

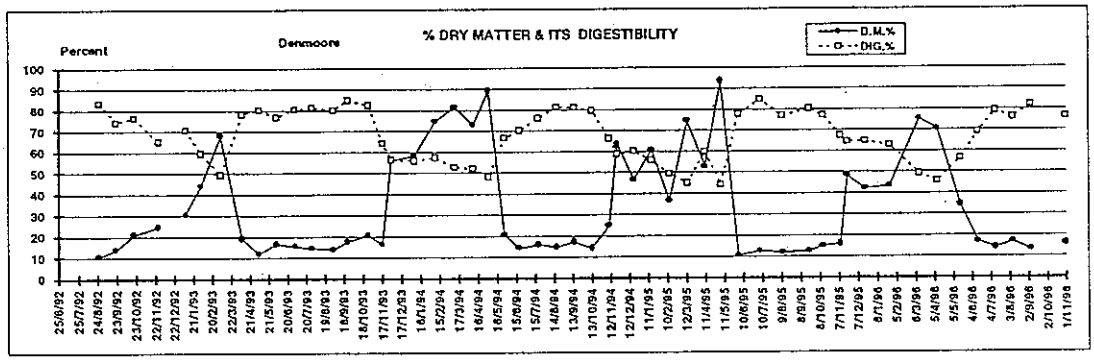
A joint project of
Agriculture WA
and
The Meat Research Corporation

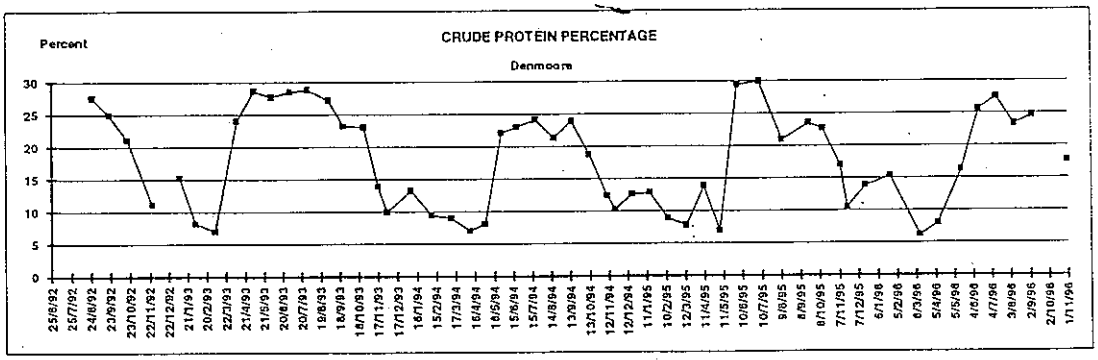
Pasture Composition (see graphs)



Quantity and Quality of Feed On Offer (FOO).

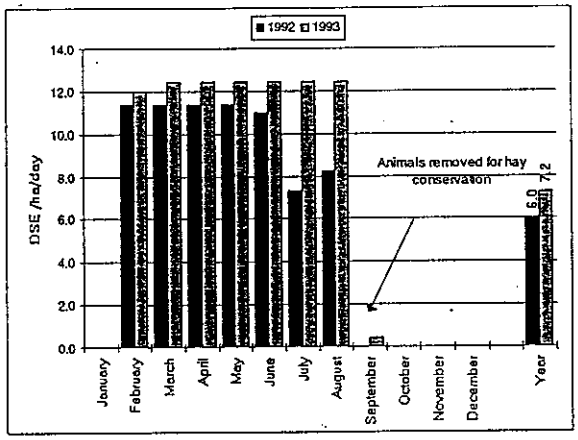


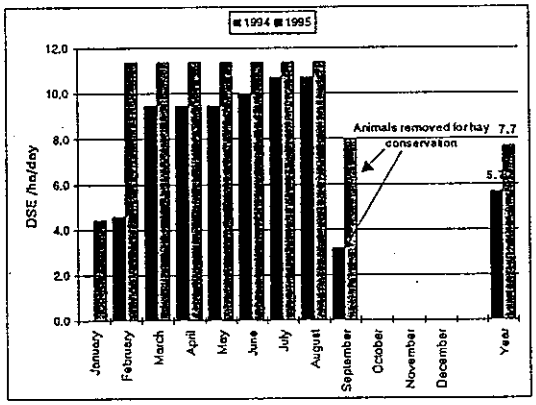


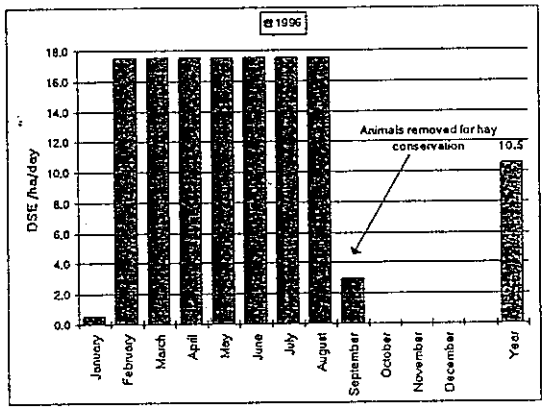


Appendix I

Estimated average grazing pressure each month during the project.







Quantity and Quality of fodder conserved. (Mean and Standard Deviation).

Cut	Bale No	Av.B Wt	t/ha	%DM	t DM/ha	%DMD	MJ/kg	%CP
1991	hay			90.5		56.6	7.6	13.5
1992	198 hay	422.7	5.77t	87.2	5.03t	58.2	8.1	9.5
StD		39.6		1.7		2.23	0.34	1.47
22/10/93	99 sil	590	3.892	14.7	0.572	66.4	9.4	17.4
17/11/93	106 hay	370	2.705	89.8	2.429	63.6	9.0	12.3
9/11/94	125 hay	387	3.455	90.4	3.124	67.1	9.5	11.1
10/11/95	160 sil	408 kg	4.663	52.5	2.448	62.0	8.8	14.6
StD		35.4						
30/10/96	64 sil	450 kg	4.230	45	1.935	76.3	10.9	17.6
13/11/96	66.hay	376 kg	3.399	91.8	3.120	64.4	9.1	12.2

Quantity and Quality of hay fed.

Year	Bale No	Yearlings	kg/head	kg/ha	Start	Stop
1992	25	26	406	729	????	????
1993	15	30	211	437	3/2/93	3/4/93
1994	20	25	296	529	1/4/94	3/5/94
1995	0	30	0	0	------	------
1996	0	41	0	0	------	------

APPENDIX I On Farm Monitoring Site

Denmoore Charolais Stud Trial Number 92AL34

Map Reference: 550000 mE, 6164000 mN, Zone 50 (Map 2428-IV)

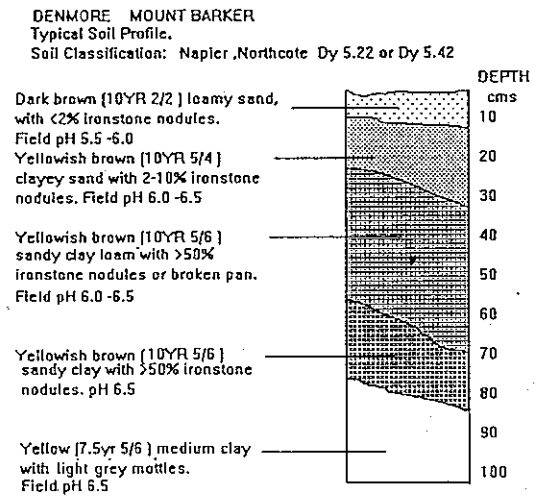
Area: **1993** 14.5 ha **1994** to 1996 14.0 ha

Base pasture: An old established mixed perennial/annual pasture. The perennial component comprising mainly phalaris, couch and strawberry clover with some kikuyu grass the main annual pasture components being sub clover and winter grass.

Animals Over the duration of the study the farm's replacement yearling heifers were run in the area starting from around early February each year until late August/early September when the area was closed up for conserving hay and/or silage. These Charolais heifers were not mated until they were 27 months age to first calve as 3 year olds.

Soil Description :...Napier or **Dy 5.22** or **Dy 5.42** (with bleached A_2)

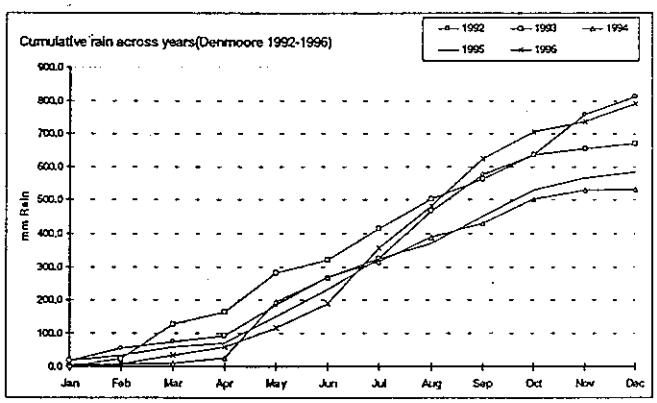
A typical profile.....:



Depth range	Description	pH	% gravel
15cm	Dark brown loamy sand	5.5.-.6.0	<2
25 - 35cm	Yellow brown clayey sand	6.0 - 6.5	2 -10
60 - 70cm	Yellowish brown sandy clay loam. Sometimes with pan, sometimes with bleached A_2 horizon.	6.0 - 6.5	>50
80 - 90cm	Yellowish brown sandy clay with gravel	6.5	???
>100 cm	Yellow medium clay with mottles		

Appendix I

Cumulative rainfall patterns over 5 years have been:



Analyses of the top 10cms of soil before and at the end of the study.

Soil Test :CSBP analysis	Date:	April 1992.		21 Feb 1996
		Phalaris	Couch	All
Nitrogen :Nitrate	ppm	30	17	16
Ammonium	ppm	9	6	16
Phosphorus	ppm	60	46	54
Potassium	ppm	97	97	87
Sulphur	ppm	NA	NA	11
Organic carbon	%	3.97	3.41	3.25
	Status	V.Good	V.Good	V.Good
Reactive Iron (ppm)	ppm	1817	609	1278
	Status	V.High	Medium	High
Salt	E.C dS/m	.26	.17	.11
	Status	V.Low	V.Low	V.Low
pH	(1:5 $CaCl_2$)	4.8	5.2	4.7
	Status	Normal	Medium	Normal

Fertiliser applied:

Date	Fertiliser	Amount (kg/ha)
Feb '92	Lime	151
May '92	Super : Potash 3:2	90
Aug '92	Super : Potash 3:1	31.5
5/2/93	Superphosphate	151
11/5/93	Muriate of Potash	90
6/8/93	Urea	31.5
1/7/94	Superphosphate	151
1/7/94	Muriate of Potash	90
20/3/95	Superphosphate	250
22/2/96	Superphosphate	90
22/2/96	Muriate of Potash	90

Quantity and description of concentrates fed.

Year	Tonnes	kg/head	kg/ha	%Hay	%Oats	%Barley	%Lupin
1992	3.24	125	223	21	49	10	20
1993	1.80	36	74	21	49	10	20
1994	0.265	10.6	18.9	21	49	10	20
1995	nil						
1996	nil						

Start feed	Stop feed	%DM	%DMD	MJ/kg	%CP
??	??	??	??	??	??
3/2/93	??	??	??	??	??
6/4/94	15/4/94	89.9	67.9	9.6	9.0

Hay and concentrate ration were fed when animals were introduced to the area, in 1993 this was on 3rd February. The project commenced in July 1992 but no records are available before that time.

Results

1992

Rain = 813ml. Break of season was early May with a dry late October/early November period. Good rains were received in mid November and mid December. The sward comprised about 40% perennial species in winter and about 15% sub clover. Weaner Charolais heifers gained 830 g/hd/day from the commencement of monitoring on July 9 to August 26. They were fed **406 kg hay** and **125 kg grain mix** per head (respectively **729kg** and **223kg per ha**) during the summer/autumn. Hay (DMD 58.2% and CP 9.5%) was conserved on the paddock in spring yielding **5.77 t hay/ha (5.037 t DM/ha)**.
The annual stocking capacity was **6.0 DSE/ha**. ranging from 7.5 to 11.5 DSE/ha on a monthly basis when stocked.

1993

Rain = 672ml. Break of season mid March with little rain after mid October. The paddock was restocked on February 3 with a new batch of weaner heifers which remained until September 1. Growth rates varied from 1.07 kg/hd/day (August), to a loss of 0.03 kg/hd/day during March. Total weight gain from February was **480 g/hd/day**. They were fed **211 kg hay** and **36 kg grain mix** per head (respectively 437 **kg** and **74 kg per ha**) during the summer/autumn.
Conserving silage (DMD 66.4%, CP 17.4%) yielded **3.9 t/ha (0.572 t DM/ha)** in October and hay (DMD 63.6%, CP 12.3%) yielded **2.705 t/ha (2.429 t DM/ha)** in December.
The annual stocking capacity was **7.2 DSE/ha**. around 12 DSE/ha on a monthly basis when stocked.

1994

Rain = 532ml. Break of season mid May with little rain after early October. Management was similar to 1993. Total weight gain from February was **240 g/hd/day**. The animals lost weight during winter at 0.4 kg/day, but gained up to 0.8 kg/day by the final spring weighing. They were fed **296 kg hay** and **10.6 kg grain mix** per head (respectively **529 kg** and **18.9 kg per ha**) during the summer/autumn. Conserving hay (DMD 67.1%, CP 11.1%) yielded **3.455 t/ha (3.124 t DM/ha)** in November.
The annual stocking capacity was **5.7 DSE/ha**. around 10 DSE/ha on a monthly basis when stocked.

1995

Rain = 585ml. Break of season mid May and little rain after end of October. Management was similar to 1993 and 1994. Total weight **gain** from January was **130 g/hd/day** The animals lost weight during winter at 0.41 kg/day, but gained up to 1.0 kg/day at the final spring weighing. **No supplements** were fed. Conserving silage (DMD 62.0%, CP 14.6%) yielded **4.663 t/ha (2.448 t DM/ha)** in November.
The annual stocking capacity was **7.7 DSE/ha**. around 11.5 DSE/ha on a monthly basis when stocked.

1996

Rain = 793ml. Break of season mid June with good rains up to late October and heavy falls in mid November and in mid December. Management was similar to previous years. A weight **loss of 130 g/hd day** was recorded over the whole period of grazing. **No supplements** were fed.
Conserving silage (DMD 76.3%, CP 17.6%) yielded **4.23 t/ha (1.235 t DM/ha)** in October and hay (DMD 64.4%, CP 12.2%) yielded **3.399 t/ha (3.120 t DM/ha)** in November.
The annual stocking capacity was **10.5 DSE/ha**. ranging from 17.5 DSE/ha on a monthly basis when stocked.

SUMMARY

Three of the four years we studied this site, exceptionally dry summer/ early autumn periods were experienced with associated late starts to the growing season.
Over the 5 years sub clover levels varied between around 15% in summer to around 30% in spring. The established perennial components (phalaris/couch/strawberry clover/kikuyu) remained between 20 and 40% of the sward, varying with time of sampling and year. By 1996 the winter grass component had increased, a consequence of the late seasons of 1994-6.
Changes made to management during the study, possibly as a consequence of our measurements, were a reduction in supplementary feed costs and a change from hay conservation to silage conservation on the study area.
Grazing pressures were around 11 DSE on a monthly basis over summer, autumn and winter with an average 3.73 t DM forage conserved in spring.
In the first 4 years at stocking rates of 1.8 to 2.1 heifers/ha the animals gained weight while on the study area. However with the very late season in 1996 and the increased stocking rate (2.6 heifers/ha) the animals lost weight up to September.

APPENDIX II On Farm Monitoring Site

Gerald and Marion Jenkins Trial Number: 93AL29

Map-Reference: 540000 mE, 6155000 mN, Zone 50 (Map 2328-I)

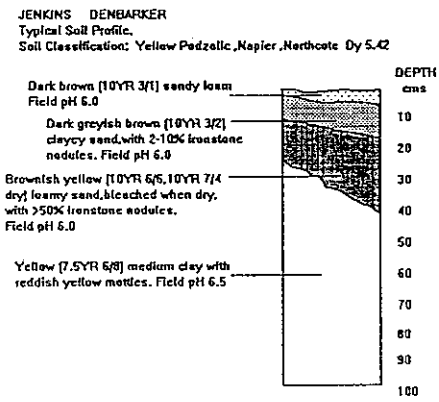
Denbarker **Area:** 36.2 ha (89.4.acres)

Base Pasture The pasture was sown in **May 1990** with a total of 5 kg of grass seed comprising equal amounts by weight of Currie cocksfoot (1.7kg), Demeter fescue (1.7kg) and Victorian perennial rye (1.7kg). The paddock was worked up twice, and no herbicides were used. The seed was mixed with oats and topdressed through a spreader and then harrowed in lightly.

Animals The area was grazed by the same group of cross bred cows for the duration of the study. At the start in 1993 they were 3year old 2nd calvers (1/2 Shorthorn, 3/8 South Devon, 1/8 Devon.

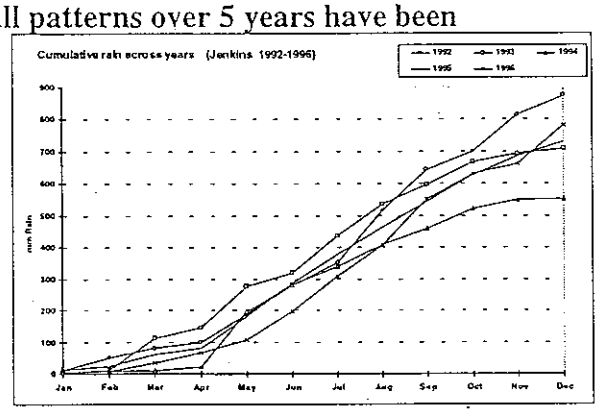
Soil Description :...Dy 5.42.

A Typical Profile.....:



Down to:	Description	pH	% gravel
5cm	Dark brown sandy loam	6.0	
10 - 15cm	Dark greyish brown clayey sand with ironstone nodules	6.0	2 -10
25 - 45cm	Brownish yellow loamy sand. Bleached when dry. Ironstone nodules.	6.0	>50
>100 cm	Yellow medium clay with reddish yellow mottles	6.5	-----

Cumulative rainfall patterns over 5 years have been



Appendix II

Analyses of the top 10cms of soil before, at of and at end of the study.

Soil Test :CSBP analysis	Date:	Mar/Apr 1993	21 Feb 1996
Nitrogen :Nitrate	ppm	9	11
Ammonium	ppm	20	8
Phosphorus	ppm	28	25
Potassium	ppm	87	114
Sulphur	ppm	NA	7
Organic carbon	%	3.31	1.93
	Status	V.Good	Good
Reactive Iron (ppm)	ppm	832	375
	Status	High	Normal
Salt	E.C dS/m	.05	.06
	Status	V.Low	V.Low
pH	(1:5 $CaCl_2$)	4.5	4.3
	(1:5 water)		
	Status	Normal	Low

Fertiliser applied:

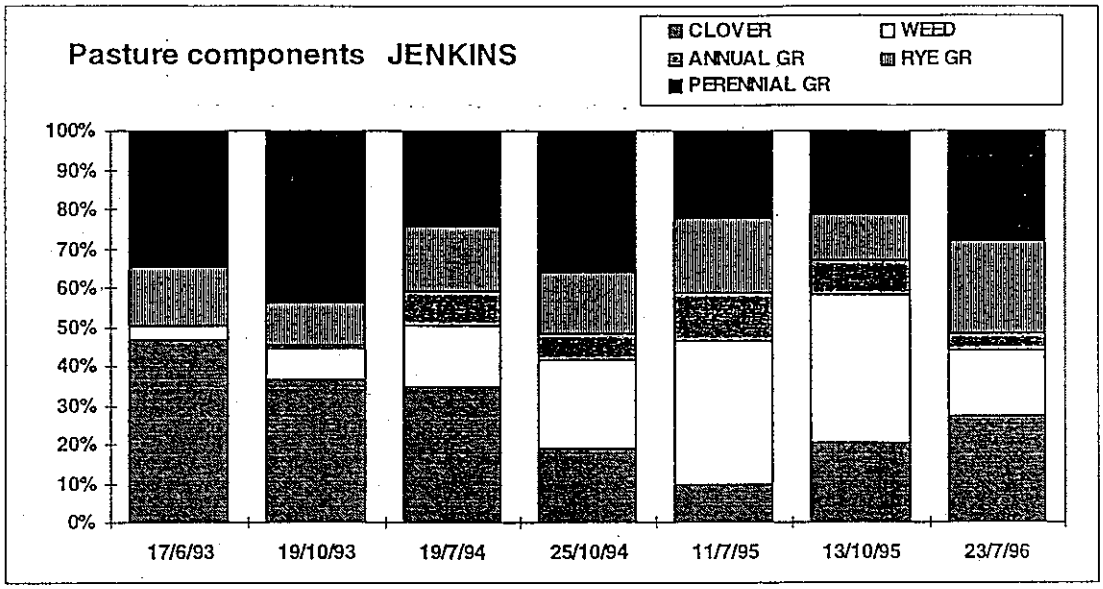
Date	Fertiliser	Amount (kg/ha)	Comments:
1990	Superphosphate	138	Mixed with seed at seeding
1991	Super : Potash 3:2	138	In September
1992	Superphosphate	138	In May
1992	Super : Potash 3:2	138	In September
1993	Super : Potash 3:2	138	In May
1994	Super : Potash 3:2	138	In May
1995	Superphosphate	116	9th Feb
1996	Super : Potash 3:2	124	21st May

Counts of perennial plants (Plants/sq m)

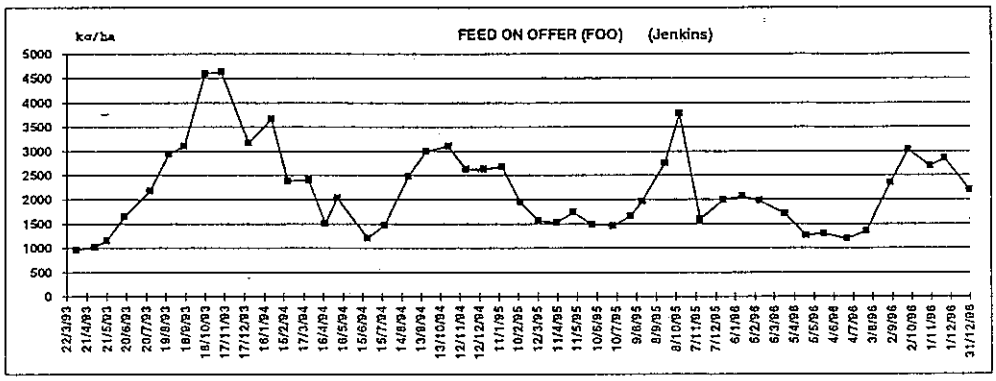
Date	Total	Per Rye *Victorian*	Cocksfoot *Currie*	Fescue *Demeter*	Phalaris
1993 April	72	31	31	8	2
1994 May	54	16	27	6	5
1995 March	40	13	16	9	2
1995 May	53	26	20	5	2
1996 March	35	12	20	3	0

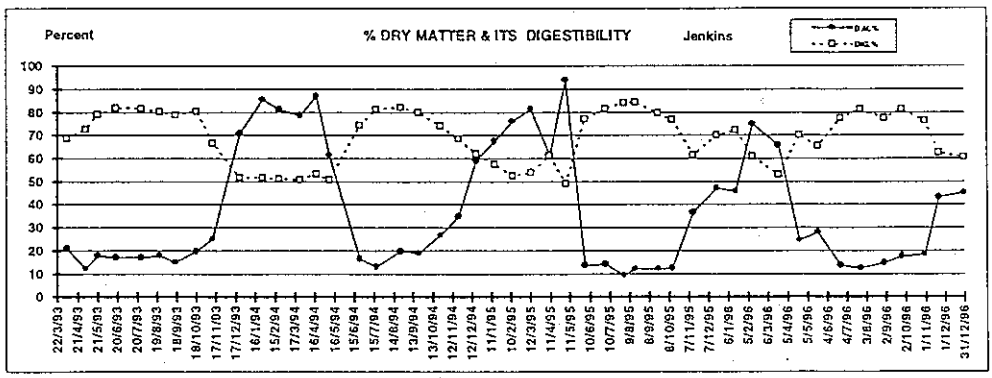
Pasture Composition (see graphs)
The temperate perennial grasses (cocksfoot, fescue and perennial rye) were well developed plants when we commenced the study in 1993, making up approximately 40% of the feed on offer.

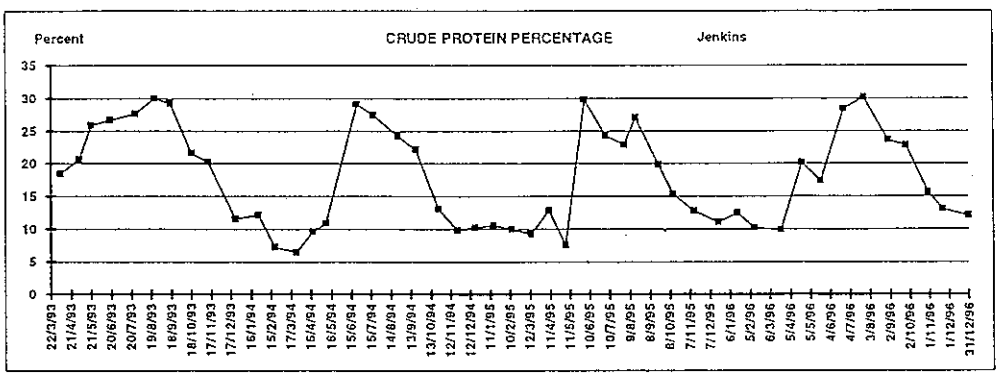
Appendix II



Quantity and Quality of Feed On Offer (FOO).

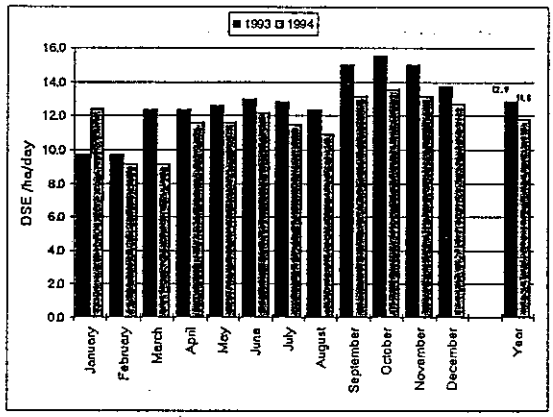


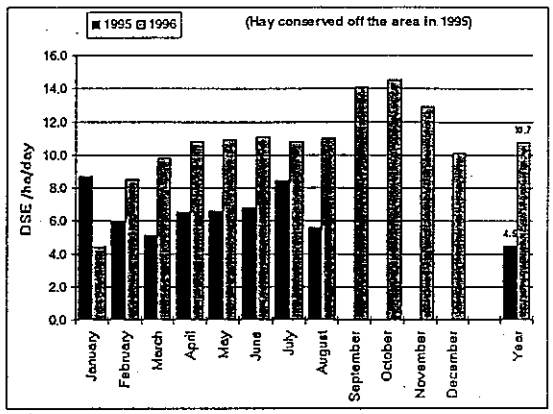




Appendix II

Estimated average grazing pressure each month during the project.





Quantity and Quality of hay conserved.

Year	Bale No	Av.B Wt	t/ha	%DM	t DM/ha	%DMD	MJ/kg	%CP
1990	300	300						
1992	386	300 (estd.)	3.200					
1995	212	297.3	1.739	90.2	1.569	59.9	8.4	10.9
StD		23.96						
	Cut & Baled 31/10 - 3/11							

Quantity and Quality of hay fed.

Year	Bale No	No Cows	kg/head	kg/ha	%DM	%DMD	MJ/kg	%CP
1991	50	28 heif	536	414				
1992	50	30	500	414				
1993	45	32	422	373				
1994	96	30	960	796	93.1	63.2	8.9	5.7
1995	48	28	514	442				
	Cows also had extra 24 ha of similar pasture from 7/2 to 20/5							
1996	70	28+1b	717	574	90.2	59.9	8.4	10.9

Period of feeding

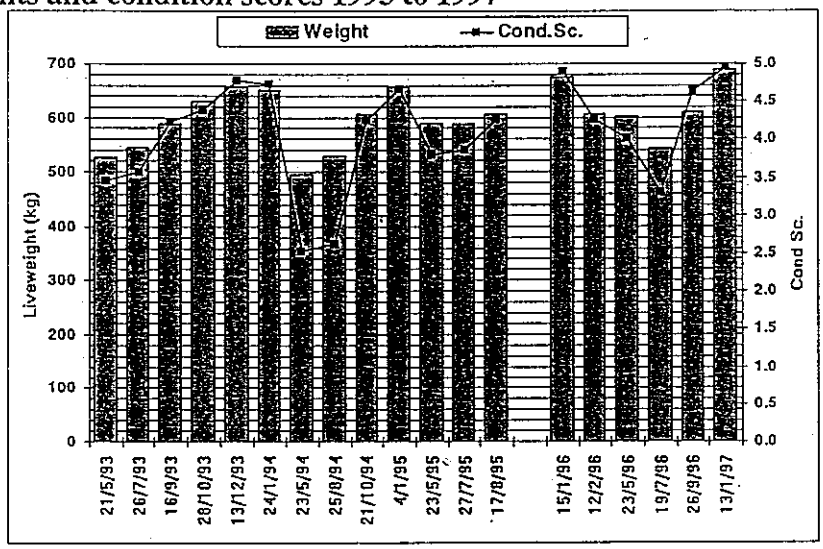
	Start feeding	End feeding	Days	Rate
1993				
1994	15/2/94	16/7/94	152	to 30 cows
1995	1/3/95	26/5/95	88	1 roll to 29 animals every 2nd day plus 5 after 26/5
1996	26/2/96	17/7/96	142	1 roll to 29 animals every 2nd day

Bulls used in the different years

	No	Bull Breed	Date in	Date out
1992		Devon		
1993	2	Devon	21/5/93	26/7/93
1994	2	Devon	18/5/94	25/8/94
	1	Devon	23/5/94	25/8/94
1995	1	Dev/Saler	21/5/95	27/7/95
1996	2	Dev/Saler	15/5/96	19/7/96

Appendix II

Cow weights and condition scores 1993 to 1997



Results

1993

Rain: 708 ml. Break of season mid March and little rain after end of October. The perennial plant density of **72/sq m** was recorded at the start of the study in the well established Victorian ryegrass/Currie cocksfoot/Demeter fescue/phalaris based pasture. The Shorthorn x Devon cross cows calved from March 1 to April 1 and were fed hay at **422 kg/hd (373 kg/ha)**. From the May weighing (**528 kg, CS 3.5**) cow liveweights increased to **657 kg, CS 4.8** in mid-December. Production of liveweight of veal was **341 kg/hd (301 kg/ha).**
The annual stocking capacity was **12.9 DSE/ha.** ranging from 10 to 15.5 DSE/ha on a monthly basis.

1994

Rain: 551 ml. Break of season mid May and little rain after mid October. Cows were fed **960 kg/hd (796 kg/ha)** and their liveweights ranged from **495 kg** (CS 2.5) kg to **657 kg** (CS 4.7) in Dec. Production of liveweight of veal was **298 kg/hd** (230 **kg/ha).**
The annual stocking capacity was **11.8 DSE/ha.**, ranging from 9 to 13 DSE/ha
Plant counts were **54/sq m**, with a predominance of cocksfoot and perennial ryegrass.

1995

Rain: 732 ml. Break of season mid June (false break late March) and little rain after early November except for ~40mls in late Dec. Cows were fed **514 kg/hd (442 kg/ha)** and had access to an extra 24 ha of similar pasture from 7/2 to 20/5. Their liveweights ranged from **583 kg** (CS 3.9) kg to **676 kg** (CS 4.9) in Dec. Production of liveweight of veal was **192kg/hd (148 kg/ha).**
The annual stocking capacity was **4.5 DSE/ha.** ranging from 0 to 8.5. The cattle were removed from the area from 17/8/95 to 15/1/96 when hay was conserved on the paddock yielding **1.57 t DM/ha** (1.74t hay/ha).
Plant counts were 40/sq m in March but **53/sqm in** May, the increase being mainly in better recognition of perennial rye plants.

1996

Rain: 780 ml. Break of season mid June with rains going through to mid Dec (~95mls) though falls were light in November. Cows were fed **717 kg/hd (574 kg/ha)** and their liveweights ranged from **543 kg** (CS 3.3) kg to **689 kg** (CS 5.0) in Dec. . Production of liveweight of veal was **349kg/hd (289 kg/ha).**

The annual stocking capacity was **10.7 DSE/ha**. ranging from 4.5 to 14.5.
Plant counts were **35/sq m** in March with a low proportion of perennial rye plants, counts were not recorded later.

SUMMARY

In three of the four years we studied this site exceptionally dry summer/early autumn periods were experienced with associated late starts to the growing season. The mixed temperate perennial grass component declined slightly over the duration (35% to 28%). Sub-clover declined from 45% in 1993 to about 15% in 1995 and recovered to more than 25% in 1996. Cape weed increased to about 40% in 1995 from less than 5% in 1993, however it declined to around 15% in 1996
In the 3 years the cattle were retained on the area for 12 months average yearly grazing pressures ranged from 10.7 to 12.9 DSE, the highest being in 1993 following an early opening to the season
Hay has been fed into the paddock at an average annual rate of 650 kg/head or 550 kg/ha.
Cows remained in good condition throughout the study and vealer liveweight production averaged 295 kg/head or 242 kg/ha. However in all years some vealers were sold early to obtain higher prices per kg and in 1995 the vealer production/ha was low because the cattle were removed from the study area in mid August to allow for hay conservation.
There was little difference in the soil analyses across the period other than a possible trend of increasing acidity and an increased potassium level to a more adequate level.

APPENDIX III On Farm Monitoring Site

Don & Janet McMiles Trial Number: 92AL35

Map-Reference Easting: 593000 mE, Northing: 6165000 mN.

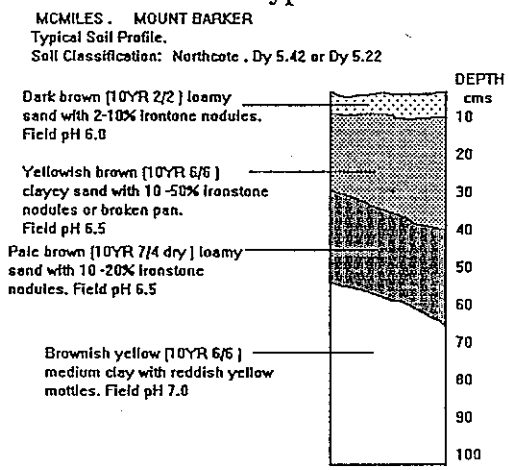
Area: 14.6 ha (36.0 acres)

Base Pasture: Brumby Ryegrass

Animal Species **Mainly Murray grey cows/calves.**

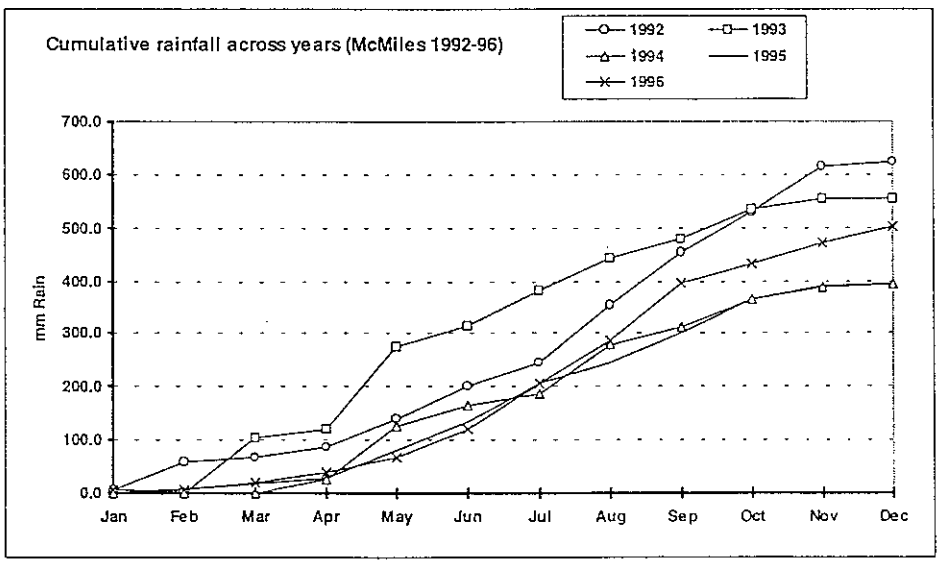
Soil Description: Dy 5.42 (Dy 5.22 where no bleached A_2)

Typical Profile.....



Depth range	Description	pH	% gravel
12cm	Dark brown **loamy sand**	6.0	2 - 10
35 - 40m	Yellow brown **clayey sand** with gravel or broken pan	6.5	10 - >50
55 - 65cm	Pale brown (7/4 dry) **sand or sandy loam.**	6.5	10 - 20
>100 cm	Medium **clay** (brownish yellow) with reddish yellow mottles	7.0	
	(Top soil is not hard setting)		

Cumulative rainfall patterns over 5 years have been:



Appendix III

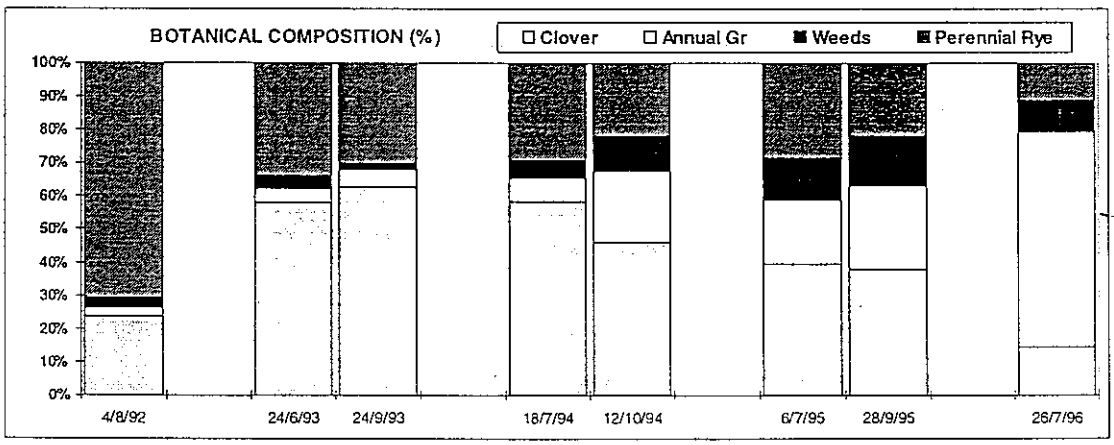
Analyses of the top 10cms of soil before, at of and at end of the study.

Soil Test :CSBP analysis	Date:	April 1992	15 February 1996
Nitrogen :Nitrate	ppm	6	30
Ammonium	ppm	17	12
Phosphorus	ppm	37	40
Potassium	ppm	110	175
Sulphur	ppm	NA	6
Organic carbon	%	3.18	3.36
	Status	Good	V.Good
Reactive Iron (ppm)	ppm	444	368
	Status	Medium	Normal
Salt	E.C dS/m	.05	0.08
	Status	V.Low	V.Low
pH	(1:5 $CaCl_2$)	4.6	4.6
	Status	Normal	Normal

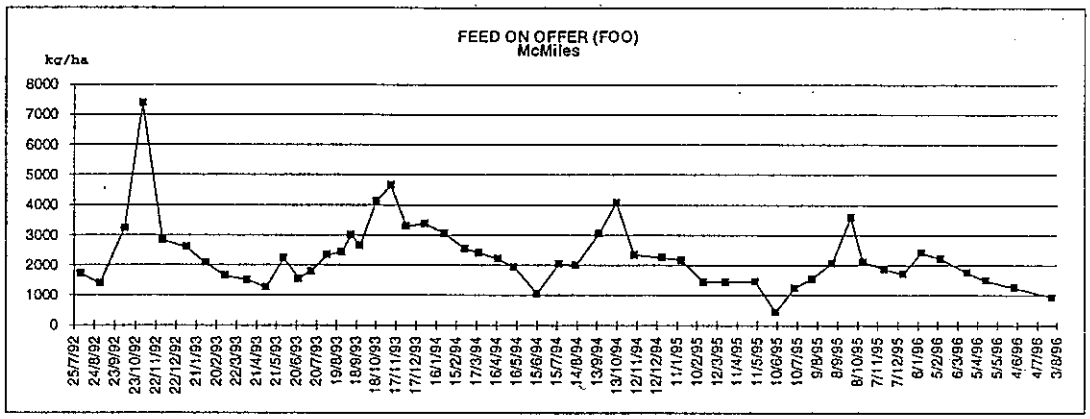
Fertiliser applied:

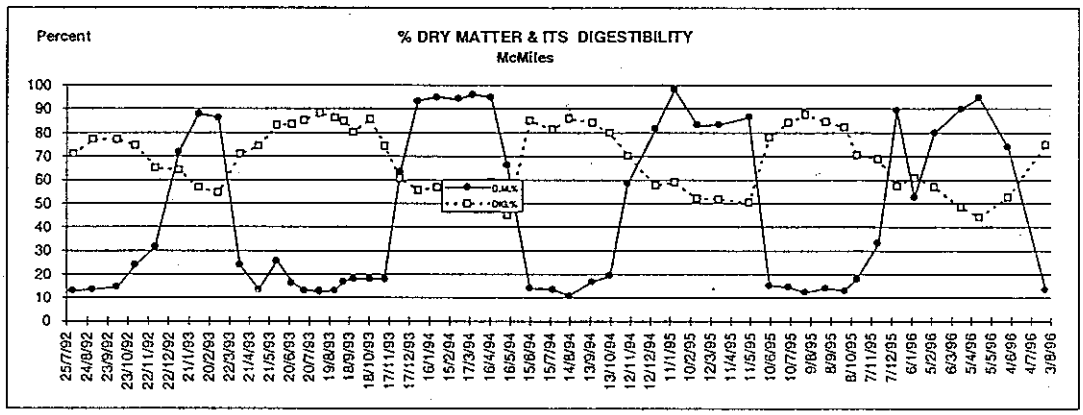
Date	Fertiliser	Amount (kg/ha)	Comments:
1992	Superphosphate	100	
1993	T.S.P.	50	20 % phosphorus
	Elemental Sulphur	10	98 % sulphur
1994	Superphosphate	100	
1995	Superphosphate	110	
1996	Superphosphate	125	

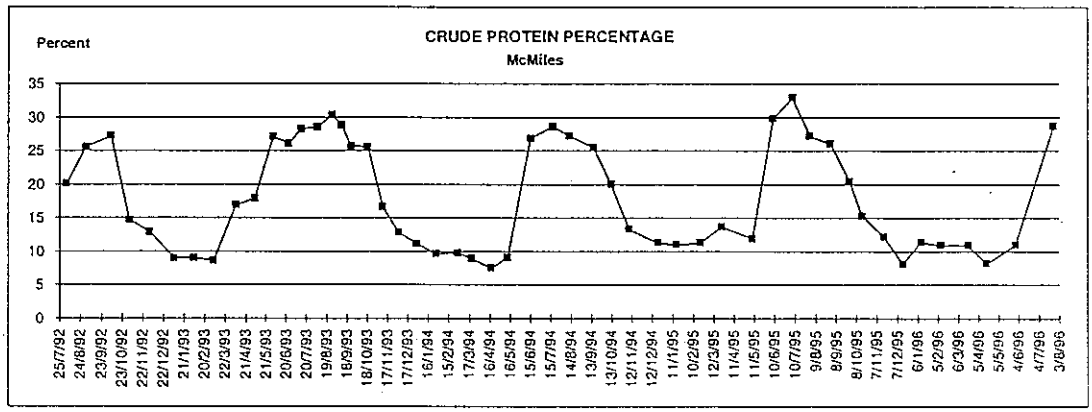
Pasture Composition:



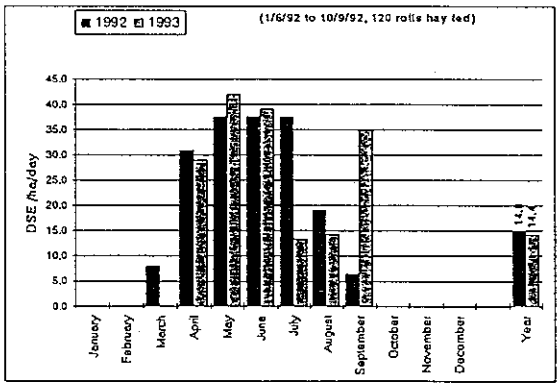
Quality and Quantity of Feed On Offer (FOO).

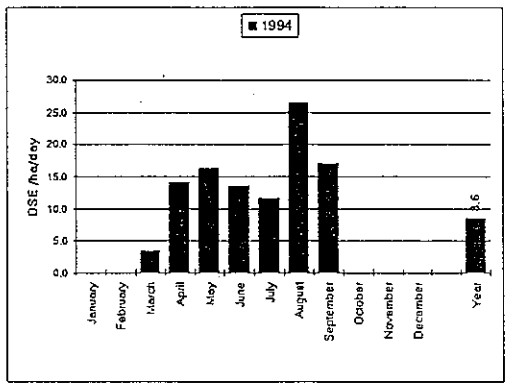




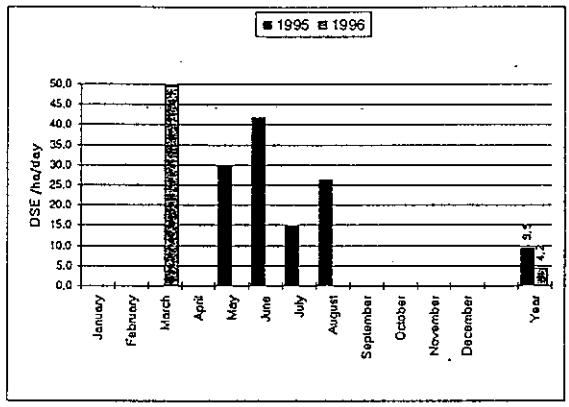


Estimated average grazing pressure each month during the project.





Appendix III



Quantity and Quality of hay conserved (Mean).

Year	Bale No	Av.B Wt	t/ha	% DM	t DM/ha	% DMD	MJ/kg	% CP
1992	Cut and windrowed only (see below)							
1993	No conservation							
1994	Cut and windrowed only (see below)							
1995								
Sil~13.5ha	137	645	6.55	29.6	1.94	74.0	10.7	14.0
Hay~1.1ha	windrows		4.93	71.3	3.51	68.6	9.7	13.5

In **1992** hay was not conserved conventionally. The paddock was mowed on **3/11/92,** windrowed and left in the paddock. Estimated FOO at this time was 7340 kg/ha and after cutting and windrowing 300 to 500 kg/ha was left below the mower height ie. there was approx **6840** kg/ha in the windrows.
On **4/2/93** it was estimated that 10.08% of the area was covered by these windrows.
On **7/4/93** we estimated **2600** kg/ha left in windrows. **A dry matter disappearance** of **4240 kg/ha** or **62%** occured from 3/11/92 to 7/4/93 (**156** days) or **30.4** kg/ha/day from weathering over an extremely dry summer following a wet November.
The **perennial rye grass** under the windrows was smothered and **failed to persist** through summer.

		3/11/92	4/2/93	7/4/93
Decline of Quality	FOO.....	6840		2600
	DDM%.....	74.7	56.7	48.7
	ME.....	10.7	7.9	6.7
	CP%.....	14.7	12	11.8

In **1994** pasture was cut and windrowed on **22-23/10/94** resulting in ~2450 kg/ha in windrows.
Windrowed material was sampled before any grazing on **20/2/95** resulting in **1325** kg/ha, covering 6.4% of the area. This was a direct loss of **1125** kg/ha (**46%**) over **120** days or **9.4** kg/ha/day

		23/10/94	20/2/95	8/6/95
Decline of Quality	FOO.....	2450	1325	1125
	DDM%.....	75	52	
	ME.....	10.7	7.2	
	CP%.....	13.2	11.3	

Appendix III

Estimated decline in FOO (%/day) in ungrazed situations:

	On a **fixed*** daily amount (%/day)	On a **reducing*** daily amount (%/day)
McMiles 1992 (windrows)	**0.397**	**0.618**
McMiles 1994 (windrows)	**0.383**	**0.511**
Muirs 1994 (standing)	0.358	0.654

* The calculation based on fixed daily amount was an average rate per day for the period while that calculated on a reducing daily amount is more real, with high losses (kg/ha) initially and declining in time.

Quantity and Quality of forage fed.

Year	Forage	Amount	Unit wt	kg/head/d	kg/ha	DMD %	ME	CP %
1992	Hay(1/6-10/9)	120 bales	~20		~164			
1993								
1994								
1995	Wheat Straw	4000kg		2.9	317	42.7	5.8	3.3

Results

1992

Rain = 624 ml. Break of season late May and little rain after mid November. The established Brumby ryegrass was well represented in the first sampling of the study. In November the paddock was mowed, **windrowed** and left on the ground as conserved feed. Between November 3 and April 7 the dry matter declined from 6.8 t/ha at a daily rate of **0.62%/day**. The quality declined from DMD of 75% and CP% of 14.7% to 49% and 11.8% respectively.
The annual stocking capacity was **14.8 DSE/ha.** ranging from 0 to 37 DSE/ha on a monthly basis with peak levels (around 35 DSE/ha) over April to July.
Approximately 164 kg/ha hay were fed into the paddock over autumn.

1993

Rain = 555 ml. Break of season in mid March though April was dry with further good rains in early May. There was little rain after mid October. There was a loss of perennial ryegrass plants under the 1992/93 windrows. The perennial rye grass declined to about 35% of the sward, about half the 1992 level, and sub clover increased in its place. Perennial ryegrass counts in April were **33/m²**. No feed was conserved this year.
The paddock was stocked with Murray grey x Charolais cross cows on April 7 where they calved before being removed in mid-September.
The annual stocking capacity was **14.4 DSE/ha.** ranging from 0 to 42 DSE/ha on a monthly basis with peak levels (30 40 DSE/ha) during April, May, June and September. No hay was fed.

1994

Rain = 392 ml. A very dry summer/early autumn. Break of season mid May and little rain after mid October. Perennial rye grass and clover levels declined slightly with a small increase in annual grasses (brome and barley grasses).
Paddock management was again tailored to providing feed for a herd of calving cows. The paddock remained vacant from September, 1993 until April, 1994 and stock were again removed in September.

In October the paddock was mowed, **windrowed** and left on the ground as conserved feed. Between October 23 and February 20 the dry matter declined from 2.45 t/ha at a daily rate of **0.51%**. The quality declined from DMD of 75% and CP% of 13.2% to 52% and 11.3% respectively.
The annual stocking capacity was **8.6 DSE/ha**. ranging from 0 to 26 DSE/ha on a monthly basis but mainly around 13 DSE /ha through April to September
In terms of animal production, a gain of **0.55 kg/hd/day** (total for cows plus calves) was attained while the animals were on the paddock.

1995
Rain = 393 ml. Again an extremely dry summer/ early autumn period with the break of season around mid May and little rain after end October. The perennial rye remained at a similar proportion of the sward as 1994 and barley grass increased at the expense of sub clover. Perennial ryegrass counts in June were **30/m².**
During May and early June the area was strip grazed by calving cows to minimise wastage of the windrowed material. Wheat straw (**317 kg/ha**) was fed to animals in the area.
Conserved silage (DMD 74%, CP 14%) yielded **6.55 t/ha (1.94 t DM/ha)** in October and hay (DMD 68.6%, CP 13.5%) yielded **4.93 t/ha (3.51 t DM/ha)** in November.
The annual stocking capacity was **9.5 DSE/ha**. ranging from 0 to 41 DSE/ha on a monthly basis with 15 to 41 DSE/ha during May, June, July and August.

1996
Rain =503 ml. Another very dry summer and autumn with the break not occurring until June. A fairly dry finish with about 35ml fell in each of the last 3 months after a wet September. The perennial rye grass recorded in winter had declined to **11%** of the sward (cf 70% in winter 1992). Barley grass and winter grass made up 65% of the FOO substituting sub clover and the perennial rye. Perennial ryegrass counts in March were **12/m²** however this early count may be an underestimate as has happened at other sites in other years.
The area was bulk grazed during March by 800 wethers after which the paddock was amalgamated into another paddock with the removal of fences.
The annual stocking capacity was **4.2 DSE/ha**. ranging from 0 to 50 DSE/ha on a monthly basis. No hay was fed.

SUMMARY

In three of the four years we studied this site exceptionally dry summer/early autumn periods were experienced with associated late starts to the growing season. There was a steady decline of the Brumby perennial rye grass over the period of the study. Initially this resulted in an increase in sub clover but subsequently the sub clover component declined as well only to be replaced by annual grasses, first brome and barley grass and finally silver grass and barley grass, correspondingly there was a small increase in weeds (cape weed, dock and flat weed)
Generally grazing pressures were high during early autumn and winter with no grazing over spring and summer. The windrowed conservation method used affected the persistence of the perennial by smothering plants during spring/summer and reducing seed set. The decline of ungrazed dry residues was at a daily rate of 0.62% and 0.51% of the dry matter on offer. A similar figure (0.65 %) was calculated from standing caged material at Manjimup (Muirs)
Animal production is difficult to summarise at this site because of the putting and taking of cows, calves and dry cattle. However annual grazing pressures were greatest early, around 14.3 DSE/ha but declined in the later years to around 9 DSE/ha. Without control treatments it is difficult to know whether the later decline was due to the run of dry summers and/or the change in pasture composition.

APPENDIX IV On Farm Monitoring Site

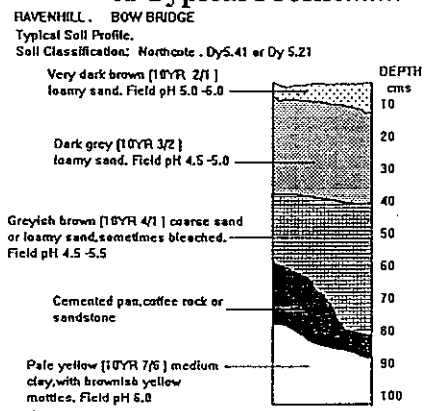
L. T. & D. Ravenhill Trial Number: 92AL33

Map-Reference: 492000 mE, 6132000 mN, Zone 50 (Map 2228-II)

Walpole **Area:** 38..ha (95..acres)
Base pasture: **Kikuyu grass**, perennial ryegrass, subclover and low levels of volunteer annual legumes, grasses and weeds.
Animals **Cows & calves.** Friesian cross cows mated to Hereford bulls. Cows were retained over the trial period except for replacement on death, neo-natal calf deaths, when empty at pregnancy testing or when culled for age. All calves were implanted with Compudose 200 at marking at the end of calving

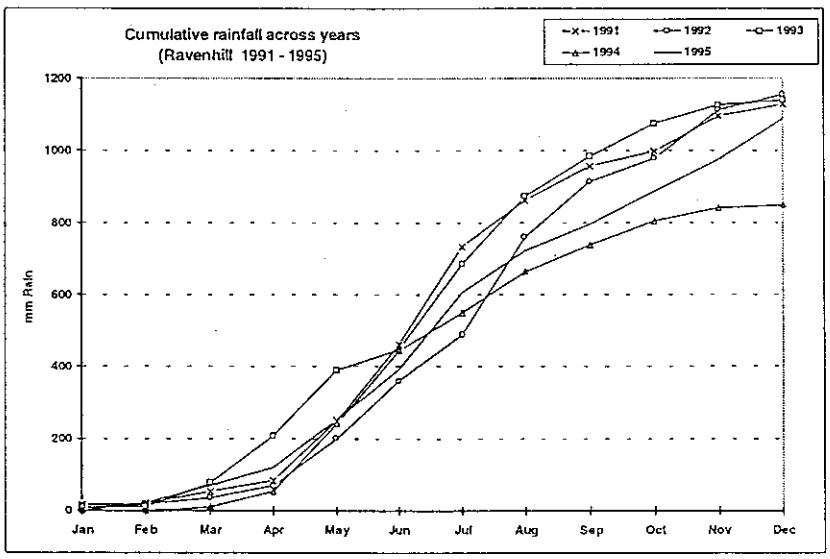
Soil Description :...Humus podsol Uc 2.21

A Typical Profile.....:



Down to:	Description	pH
7 - 10cm	Very Dark brown **loamy sand** (not hard setting)	5.0.-.6.0
40cm	Dark grey loamy sand	4.5 - 5.5
60 - 85cm	Greyish brown **sand or loamy sand**. Sometimes bleached sand. Very coarse sands.	4.5 - 5.5
80 - 90cm	Cemented Pan in some soils either **sandstone or coffee rock.**	
>100 cm	Pale yellow medium **clay** with brownish yellow mottles	

Cumulative rainfall patterns over 5 years have been



Appendix IV

Analyses of the top 10cms of soil before and at the end of the study.

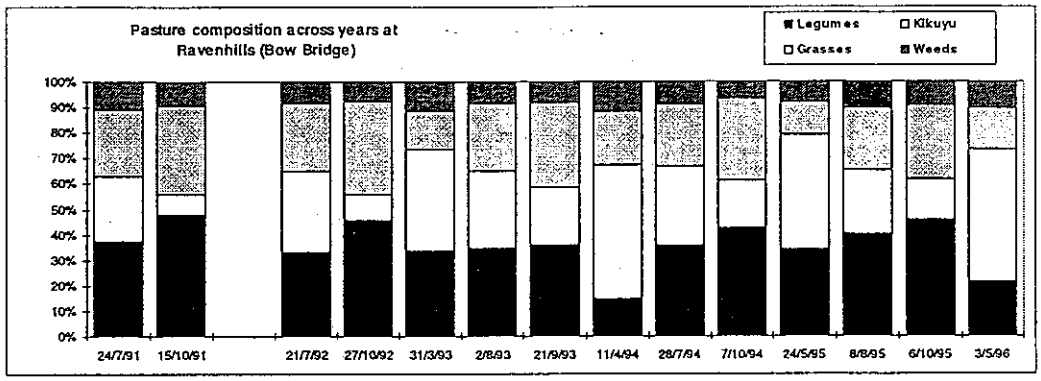
Soil Test :CSBP analysis Date:	April 1993.	Pad 1	Pad 2	Pad 3
Nitrogen :Nitrate	ppm	16	12	19
Ammonium	ppm	20	20	20
Phosphorus	ppm	33	47	47
Potassium	ppm	255	254	249
Organic carbon	% Status	3.77 V.Good	3.61 V.Good	3.80 V.Good
Reactive Iron (ppm)	ppm Status	156 Low	229 Normal	484 Medium
Salt	E.C dS/m Status	.17 V.Low	.20 V.Low	.13 V.Low
pH	(1:5 $CaCl_2$) Status	4.2 Normal	4.0 Low	4.3 Low

Soil Test :CSBP analysis Date:	Feb 1996.	Pad 1	Pad 2	Pad 3
Nitrogen :Nitrate	ppm	16	15	7
Ammonium	ppm	20	17	20
Phosphorus	ppm	20	62	40
Potassium	ppm	419	211	236
Sulphur	ppm	9	6	11
Organic carbon	% Status	4.68 V.Good	4.50 V.Good	3.82 V.Good
Reactive Iron (ppm)	ppm Status	165 Low	615 Medium	463 Medium
Salt	E.C dS/m Status	.11 V.Low	.08 V.Low	.11 V.Low
pH	(1:5 $CaCl_2$) Status	4.2 Normal	4.3 Normal	4.1 Low

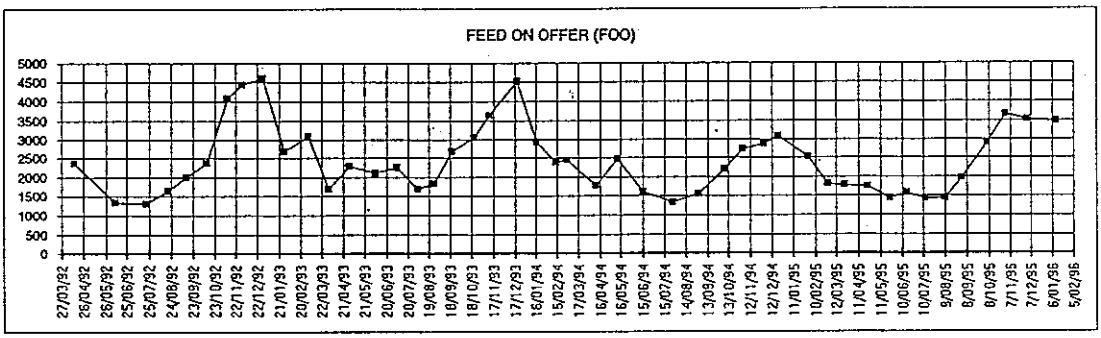
Fertiliser applied:

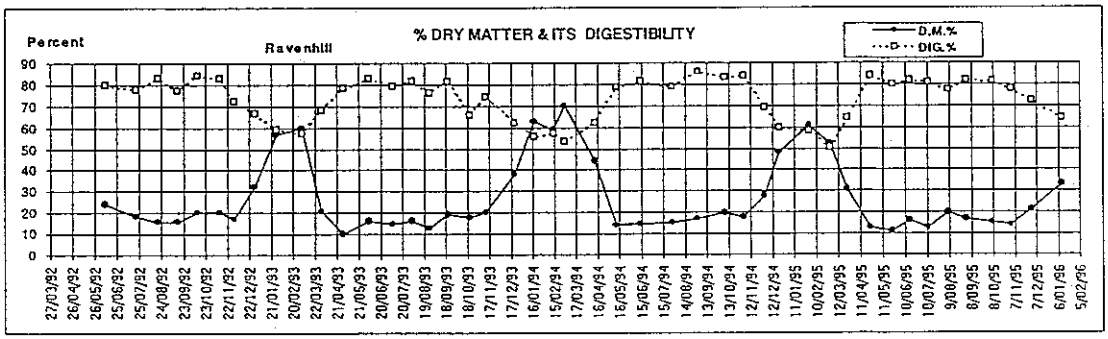
Date	Fertiliser	Amount (kg/ha)	Comments:
Apr/May '91	Super : Potash 3:1	350	
Apr/May '92	Super : Potash 3:1	350	
Feb/Mar '93	Super : Potash 3:1	237	Some with Se
Mar/Apr '94	Super, Cu Co Se	210	
Sept 1994	Super : Potash 1:1	50	to only 7.5ha (pl 3 & W pl 2)
8th Feb1995	Super : Potash 3:1	400	

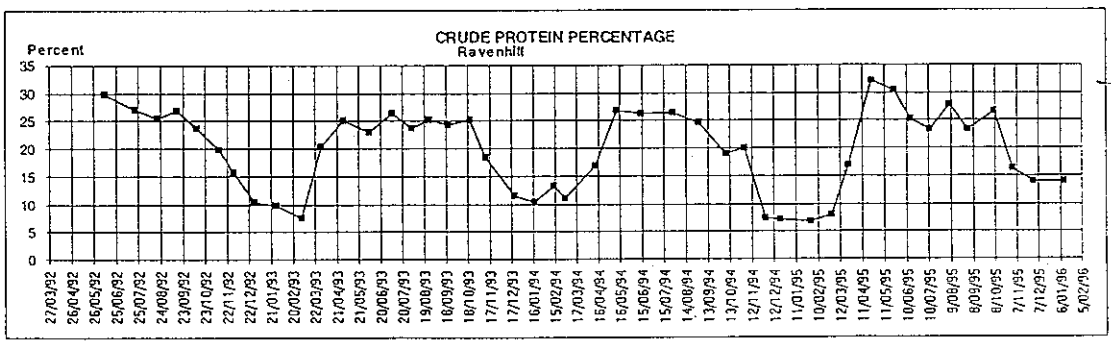
Pasture Composition:



Quantity and Quality of Feed On Offer (FOO).

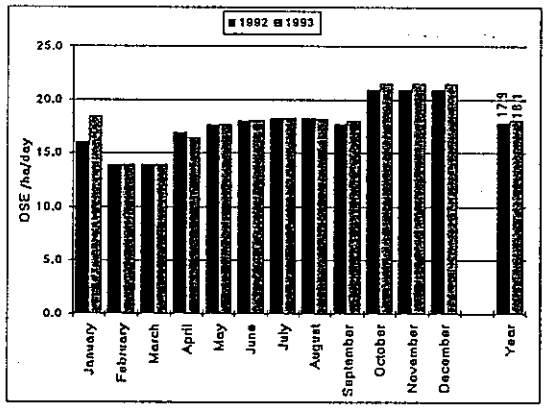


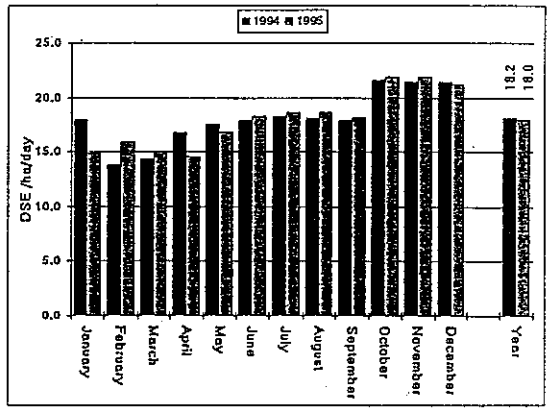




Appendix IV

Estimated average grazing pressure each month during the project.

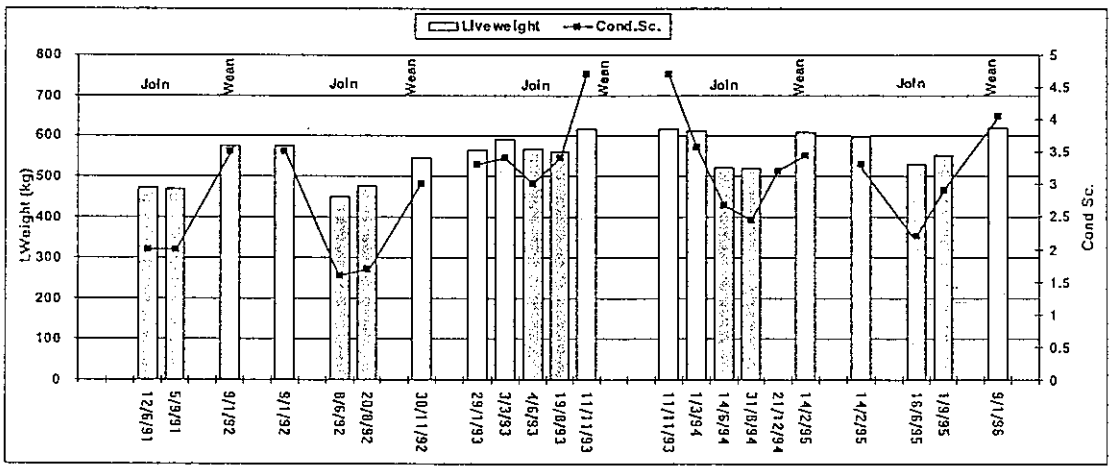




Quantity and Quality of hay fed.

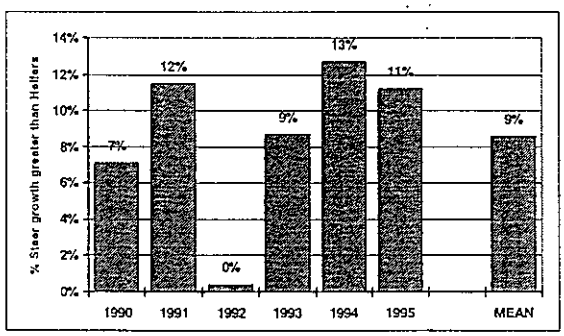
Year	Bale No	Bale Wt	Cows	kg/head	kg/ha
1991	10.5	350	40	92	97
1992 -'95	Nil	-----	-----	-----	-----

Liveweight and Condition Scores of cows (1991 to 1995)

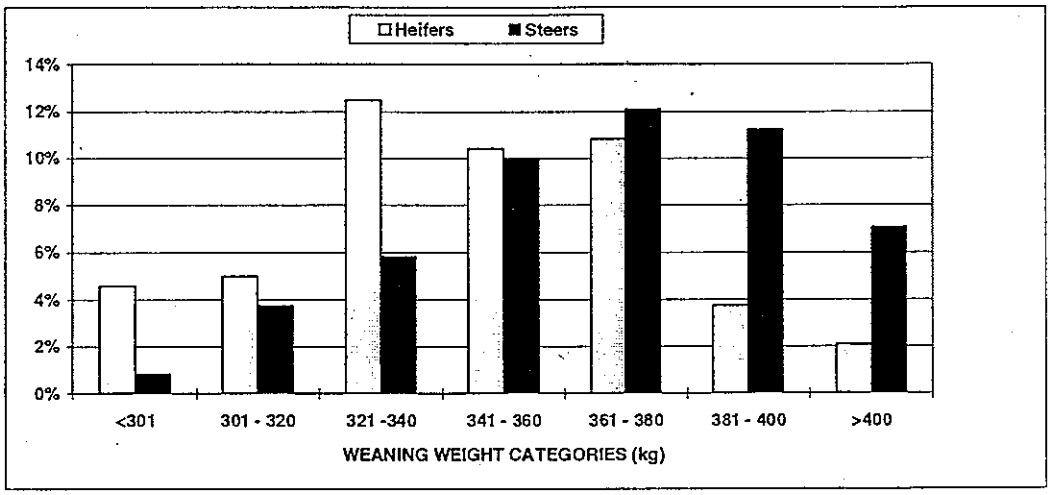


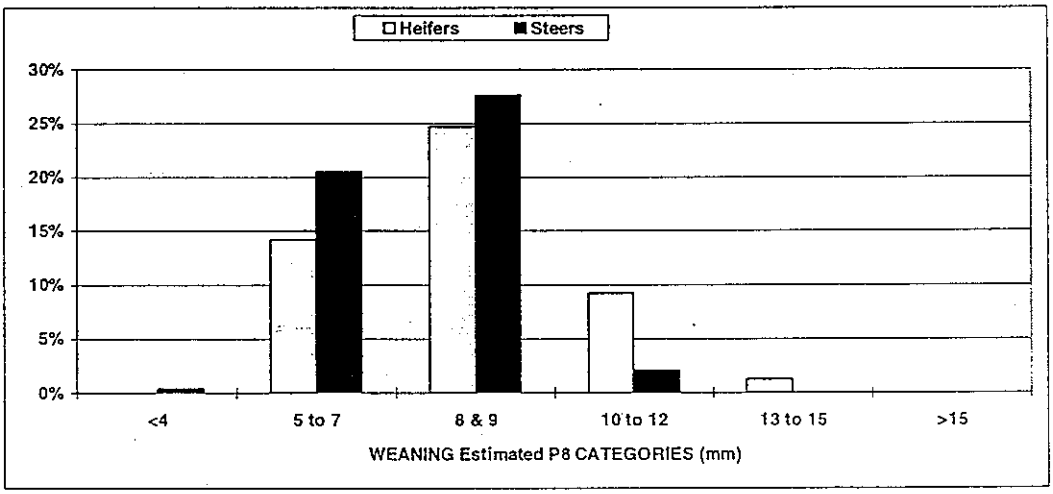
Performance of calves over the 5 years of the project 1991 to 1995 (incl)

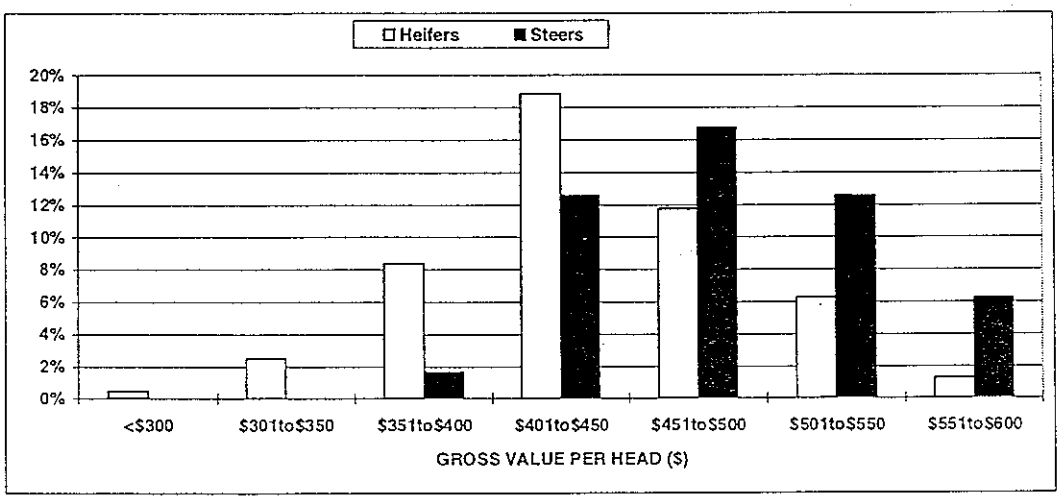
- 240 vealers were weaned from the 38 ha ie **1.26 ha/year** (51% steers and 49% heifers).
- Each year average steer growth was up to 13 % greater than heifer growth.



- Distribution of weaning weights, P8 fat thickness and gross values per head of calves reared in the project 1991 to 1995 (inclusive). Gross values based on each year's sale prices.







Appendix IV

5 YEAR AVERAGE (1995 vealer price)

Month	Costs	1995 Value($)	Amount	
Jan	hectares ($) (No)	2250	38	
Jan	Cows ($/kg live) (No)	0.8	48	
Jan	Cows (Live wt BOYr)	594		
Dec	Replacements ($/kg live) (No)	0.9	11	Av wt
Dec	Replacements (Live wt)(No)	5545	11	523
Dec	Preg Test ($/hd) (No)	5	48	
Jun	Compudose ($/hd) (No)	4	48	
Jun	Ear Tags ($/hd)	1		
Dec	Calm Commission (%)	3.5		
Dec	Assess Fee ($/hd)	4		
Dec	Transaction levy ($/hd)	4		
All	Bulls($/yr)	900	1	
All	Deaths	1		
Dec	Pregnant (%) (No non-p)	90%	5	
Dec	Other culls (No)	4		
Dec	Increased graz. pressure	0		
Jun	Opportunity cost (%)	7		
Jun	Super :K 3:1 ($/t) (kg)	203	322	
Jun	Freight ($/t carted)	15		
Jun	Mix/Spread ($/t)	4		
Jun	Agset ($/t) (kg/ha)	6000	0.8	
Jun	Hay ($/t) (t)	70	0	
All	Repairs ($/ha)	10		
	Returns			
Dec	Cows sales ($/kg live) (No)	0.80	9	Av wt
Dec	Tot Cow Lwt (Dr%)	5030		547
Dec/Jc	Weaner sales ($/kg carc) (No	2.60	48	
Dec/Jc	Weaner sales (Live wt) (Dr%)	359	53%	
Dec/Jc	Weaner sales (Carc wt)($/hd)	191	$496	

ECONOMICS

COSTS	$ per hectare: 1995
Capital	
Land and Improvements	$2,250
Cows	$600
TOTAL	$2,850
Operating :	
General	
Opportunity cost	$200
Super/Potash 3:1	$65
Freight & mix/Spread	$6
Agset	$5
Hay	$0
Repairs	$10
Animal :	
Replacements	$134
Pregnancy test	$6
Compudose	$5
Bull cost	$24
Ear tags	$1
Selling :	
Commission (Calm)	$22
Assessment fee	$6
Transaction levy	$5
TOTAL (-opportunity cost)	$288
TOTAL (+opportunity cost)	$488

GROSS RETURNS	$ per hectare: over 5 yrs
Cow sales	$106
Weaner sales	$621
Total Sales	$727

NET RETURN	$ per hectare: all years
Excluding opportunity costs	$439
Percentage on investment	15.4%
Including opportunity costs	$239
Percentage on investment	8.4%

Results

1991

Rain: 1127ml. Break of season late March, a dry late September/early October followed by rains to late November and again in late December. The pasture started with **sub clover** at around **30%** in winter increasing to **45%** in spring with a corresponding seasonal decline in the proportion of **kikuyu grass from 25% in winter to 10% in spring**. Cows calved in April and May, were fed **92 kg /hd** (97kg/ha) hay. Cows maintained their weight and condition during joining from **470kg (CS 2.0)** to **468kg (CS 2.0)**, which then recovered to an average of **575kg (CS 3.5)** by weaning.

Production of liveweight of veal was **354 kg/hd** (447 kg/ha) **(CS 3.2 and P8, 8.3mm).**

Cow conception rate was **98%.** and calves were weaned in early January 1992

1992

Rain: 1155ml. Break of season mid April, a dry middle/late October and early November was followed by rains up to mid December. **Sub clover** remained at **25 to 30%** with a seasonal decline in the proportion of **kikuyu grass from 30% in winter to 10% in spring**. Cows calved in April and May and **were not fed hay.** Cow weight and condition were low during joining, changing from **448kg (CS 1.6)** to **475kg (CS 1.7)**, which then recovered to an average of **563kg (CS 3.3)** by weaning.

Production of liveweight of veal was **318 kg/hd (CS 3.3)** (393 kg/ha)
The annual stocking rate was **17.9 DSE/ha.** ranging from 13.9 to 21 DSE/ha. through the year. Cow conception rate was **90%.** Calves were weaned in late Dec/Jan.

1993
Rain: 1140ml. Patchy rains occurred before the break of season in early April and then rains continued through to mid November. **Sub clover** remained at around 35% with a seasonal decline in the proportion of **kikuyu grass from 40% in summer/autumn to 20% in spring.** Again **hay was not fed** to the April/May calving cows. Cow weight and condition were good during joining (changing from **567kg (CS 3.0) to 562kg (CS 3.4)**, the average weight then recovered to **618kg** (CS 4.7) by weaning.
Production of liveweight of veal was **370 kg/hd** (467 kg/ha) **(P8 8.1).**
The annual stocking rate was **18.1 DSE/ha.** ranging from 13.9 to 21.5 DSE/ha. through the year. Cow conception rate was **83%** (high percentage old cows). Calves were weaned in mid-Jan. '94.

1994
Rain: 848ml. Break of season was in the last week of April with dry conditions occurred in late October to mid November followed by further rain until the end of November. The pasture retained **sub clover** between **35 and 40%** in the growing season, with a seasonal decline in the proportion of **kikuyu grass from 50% in summer/autumn to 20% in spring.** Again **hay was not fed** to the April/May calving cows. Cow weight and condition were good during joining, changing from **521kg (CS 2.7) to 518kg (CS 2.4)**, the average weight then recovered to **608kg** (CS 3.4) by weaning.
Production of liveweight of veal was **361 kg/hd** (456 kg/ha) **(P8 8.6).**
The annual stocking rate was **18.2 DSE/ha.** ranging from 14.4 to 21.6 DSE/ha. through the year.
Cow conception rate was **83%.** Calves were weaned in early Jan '95.

1995
Rain: 1090ml. Break of season early April with dry late April/early May. Patchy rains continued through to late December. The **subclover** was between **40 and 45%** of the sward in the growing season with the seasonal decline in the proportion of **kikuyu grass was from 45% in summer/autumn to 15% in spring.** Again **hay was not fed** to the April/May calving cows. Cow weight and condition were good during joining changing from **528kg (CS 2.2) to 550kg (CS 2.9)**, and average weight recovered to **620kg (CS 4.1)** by weaning.
Production of liveweight of veal was **352kg/hd** (445 kg/ha) **(P8 7.2).**
The annual stocking rate was **18.0 DSE/ha.** ranging from 14.5 to 21.9 DSE/ha. trough the year.
Cow conception rate was **96%.** and calves were weaned in early Jan '96.

SUMMARY

Subclover comprised 30 to 50% of the sward in the growing period and kikuyu grass ranging from 50% (summer/autumn) 30% (winter) and 20% (spring) changed little among years over the 5 year project. This pasture was grazed continuously by 1.25 British beef x dairy cows and their progeny per hectare over this period (~18DSE/ha).
The April /May calving cows were only fed a small quantity of hay in the first year and none thereafter. Their calves were weaned in early to mid January at an average 359 kg/hd or 453 kg/ha. and sold to the vealer market. The 5 year average calving rate was 90%.
The liberal, average, annual application of 320kg/ha of Super:potash 3:1 maintained soil phosphorus and potassium levels well.

APPENDIX V On Farm Monitoring Site

Dan. Smith Trial Number: 93AL30

Map-Reference: 566000 mE, 6147000 mN, Zone 50 (Map 2428-III)

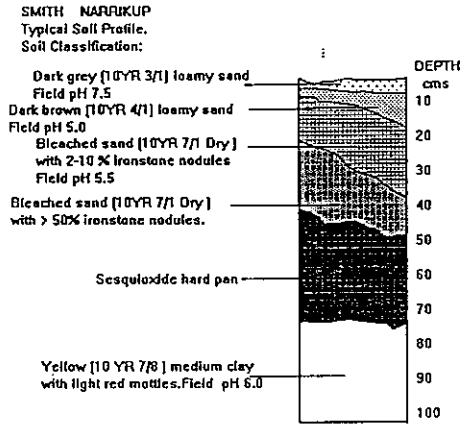
Narrikup **Area:** 6.11..ha (15.2.acres)

Base pasture: Kikuyu grass, subclover and volunteer annual grasses and weeds. **Kikuyu grass** covered **64 %** of the area February 1992

Animals **Sheep.** A base flock of 30 wethers starting as hoggets in 1993 were run continuously on the area for the duration of the study. They were weighed and condition scored and bulked wool production was weighed at shearing each year from this group. Other sheep and odd cattle were added to and taken from the paddock over the years at the farmers discretion. These extra animals were taken into account when estimating grazing pressures (DSE's/ha) and patterns

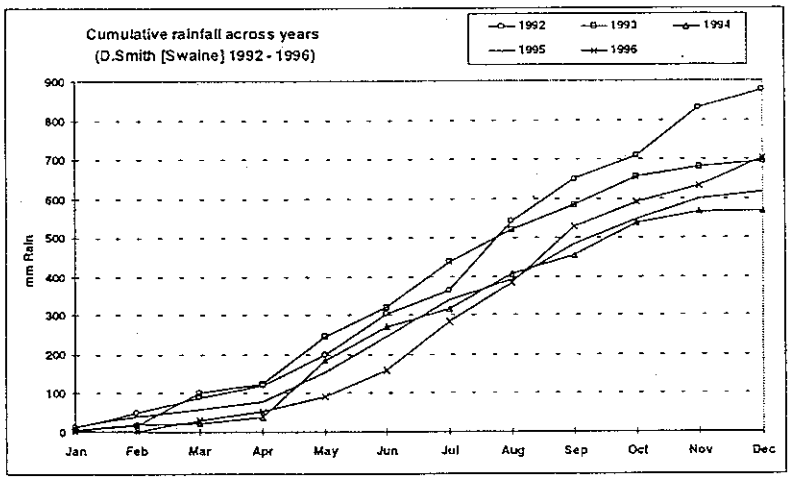
Soil Description : Dy 5.84

Typical Soil Profile.....



Down to:	Description	pH	% gravel
4 - 7cm	Dark loamy sand	7.5	
8 - 18cm	Dark brown loamy sand	5.0	
23 - 40cm	Bleached sand with ironstone nodules	5.5	2 - 10
40 - 50cm	Bleached sand with ironstone nodules		>50
75cm	Sesquioxide hard pan		
>100 cm	Yellow medium clay with light red mottles	6.0	

Cumulative rainfall patterns over 5 years have been:



Appendix V

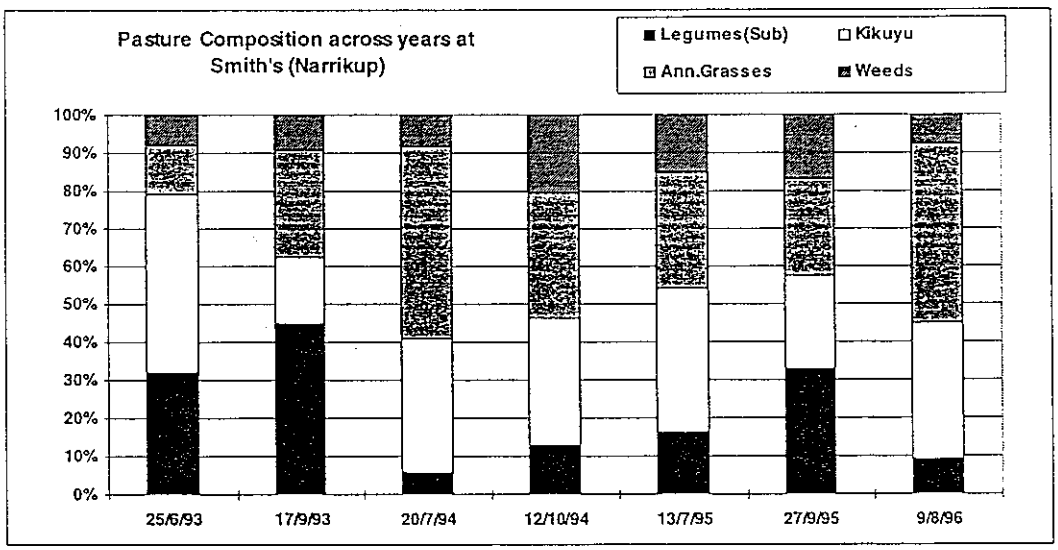
Analyses of the top 10cms of soil before, at the start of and at end of the study.

Soil Test :CSBP analysis	Date:	Jan DAg 1990	23/1/90	9/3/93	15/2/96
Nitrogen :Nitrate	ppm	---	11	7	30
Ammonium	ppm	---	20	20	17
Phosphorus	ppm	---	27	30	27
Potassium	ppm	---	252	247	156
Sulphur	ppm	---	NA	NA	7
Organic carbon	%	---	2.65	3.61	3.20
	Status	---	Good	V.Good	V.Good
Reactive Iron (ppm)	ppm	---	262	326	257
	Status	---	Normal	Normal	Normal
Salt	E.C dS/m	---	.12	.09	.13
	Status	---	V Low	V Low	V Low
pH	(1:5 $CaCl_2$)	3.9	---	4.9	4.5
	(1:5 Water)	5.0	5.6	---	
	Status	---	Normal	Normal	Normal

Fertiliser applied:

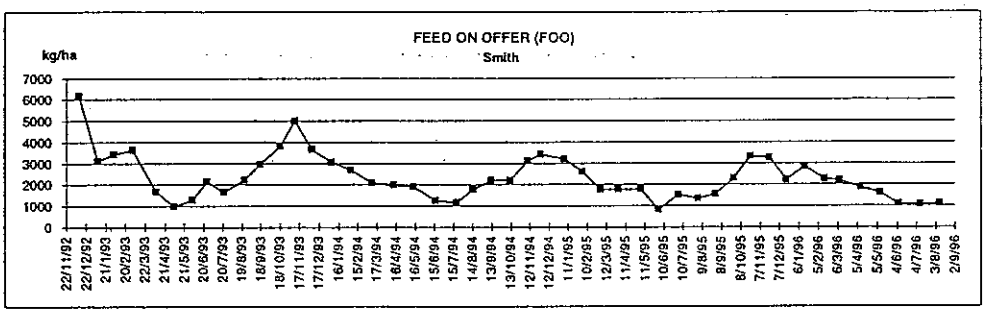
Date	Fertiliser	Amount (kg/ha)
May '90	Lime	2500
May '90	Super : Potash 3:2	69
15/2/91	Super : Potash 3:1	47.5
Sept '91	Super : Potash 3:2	35.5
13/3/92	Super : Potash 3:2	35.5
11/5/93	Super	124
19/3/94	Neomin	115
20/9/94	Super	61
13/9/95	Summit Hay (13.5%N,3%P,16%K,12.5%S)	110
25/5/96	Summit Compound (19.6%N,8%P, 13%S,0.15%Zn)	180

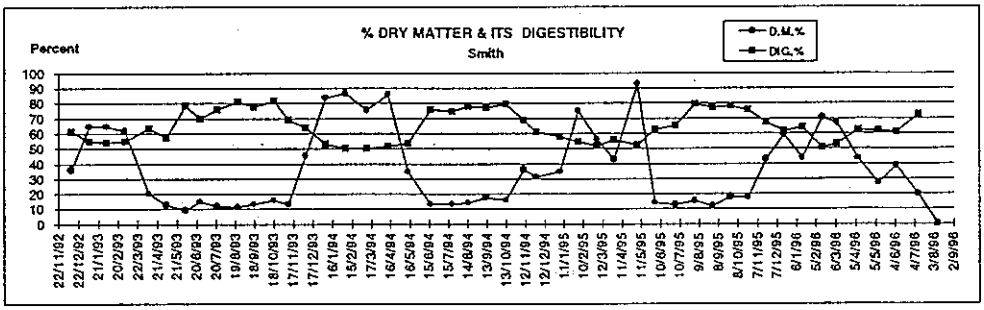
Pasture Composition (see graphs)
At the start of the study (September 1993) Kikuyu grass covered 64% of the area. Estimated proportions of the sub clover cultivars were: Dinninup 30%, Mt Barker 20%, Woogenellup 30%, Dwalganup 30% and a trace of Yarloop.

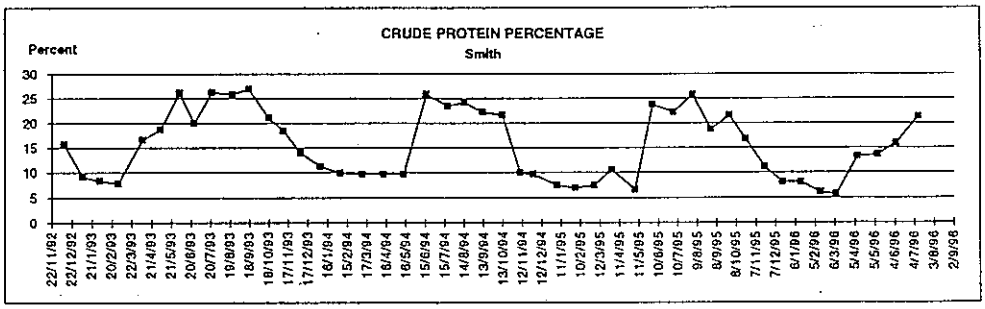


Appendix V

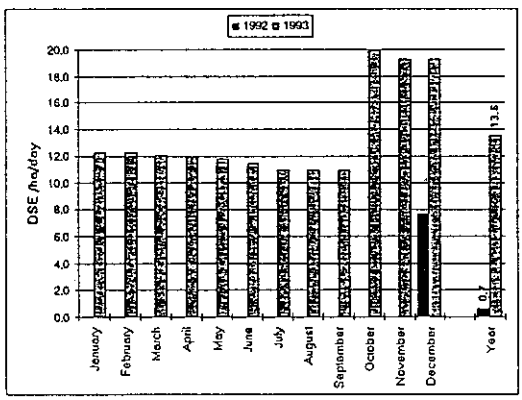
Quantity and Quality of Feed On Offer (FOO).

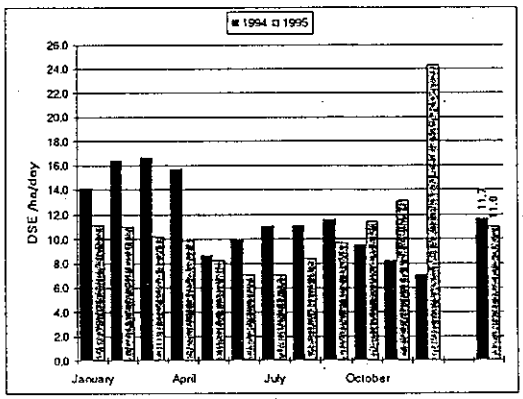


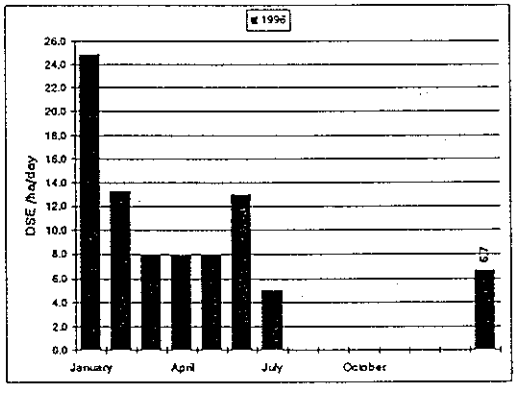




Estimated average grazing pressure each month during the project.







Appendix V

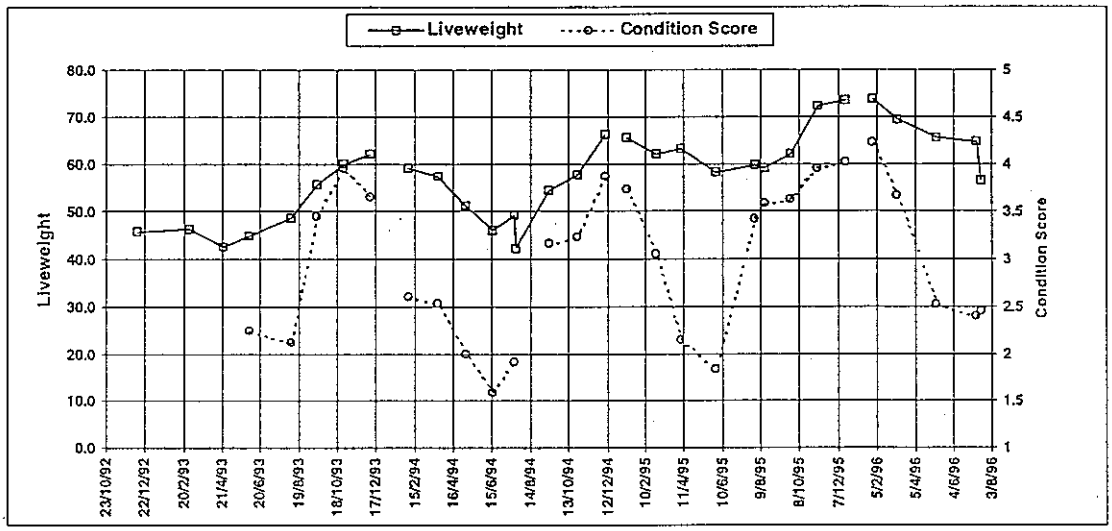
Anthelmintic treatments of sheep.

Date	Chemical	Amount	Comments	
6/3/93	Seponver	10mls		
13/3/93	Admin mix	10mls	30mls/l water	
10/5/93	Levamesole	12mls		
1/7/93	Ivomec	13mls		
20/7/94	Ivomec	8mls		
10/3/95	Jetamec	10mls		
10/3/95	Admin	60kg	????	

Quantity of hay fed into the study paddock (quality was not determined).

Year	Bale No	Sheep Equivalents	kg/head	kg/ha
1992	Nil			
19/3/93	1 roll			40
1/2/94 to 3/6/94	42 x 19.1kg	~ 80	10	131
1/2/95 to 8/5/95	27 x 20	~ 65	8	88
1/3/96 to 31/5/96	15 x 20	~ 50	6	65

Change in liveweight and condition score of study group of sheep.



Wool Cut :

Date	Period	No Sheep	Wool Type	kg	kg/ sheep	kg/ ha	Adjusted kg/ha
9/8/93	10 2	29w	Bellies,Pcs,Lcks	40.37	1.39	6.61	
	mths		Fleece	108.41	3.74	17.74	/(30/6.11)x13.6
			Total	148.78	**5.13**	**24.35**	**67.4**
21/7/94		30w	Bellies,Pcs,Lcks				
			Fleece				/(30/6.11)x12.8
			Total	170.1	**5.67**	**27.8**	**72.5**
10/8/95		30w	Bellies,Pcs,Lcks	33.0	1.1	5.4	
			Fleece	190.5	6.35	31.18	/(30/6.11)x9.32
			Total	223.5	**7.45**	**36.57**	**69.42**
18/7/96		29w	Bellies,Pcs,Lcks	31.5	1.09	5.16	
			Fleece	176	6.07	28.8	/(30/6.11)x12.28
			Total	207.5	**7.16**	**33.96**	**84.93**

Results

1993
Rain = 696 ml. Break of season mid March and little rain after mid October.. The established kikuyu grass based pasture is persisted well, with sub-clover at ~35%. The paddock supported an annual stocking rate of **13.6 DSE/ha.** Shearing in early August (10 months and 1 week since last shearing) realised **5.13 kg/head** total greasy wool which when adjusted for grazing pressure is approx **67.4 kg/ha.** Owing to the early break little hay was needed and the sheep gained approximately **15kg/head** over the year.

1994
Rain = 568 ml. Break of season mid to late May and little rain after late October. An average stocking pressure of **11.7 DSE/ha** was carried through the year. Sheep produced on average **5.67 kg/head** of total greasy wool which when adjusted for grazing pressure is approx. **72.5 kg/ha.** In terms of liveweight, sheep gained approximately **6.5 kg/head** over the year with about **131kg/ha of hay** being fed. The late break affected the level of clover established (~10%) in the sward resulting in high levels of winter grass and some capeweed. Kikuyu grass remained around 30% of the feed on offer in winter and spring.

1995
Rain = 617 ml. Break of season late May early June and little rain after early November. An average stocking pressure of **11 DSE/ha** was carried through the year. Sheep produced on average **7.45 kg/head** of total greasy wool which, when adjusted for grazing pressure, is approx. **69.4 kg/ha.** They also gained a further **6kg/head** liveweight with about **88kg/ha of hay** fed. Another late break had a similar affect on the annual pasture component as in 1994. Kikuyu grass remained around 30% of the feed on offer in winter and spring.

1996
Rain = 704 ml. Break of season mid June with good late rains up to mid December An average stocking pressure of **11 5DSE/ha** was carried through the first 7 months of the year, until the study was ceased.. Sheep produced on average **7.16 kg/head** of total greasy wool which, when adjusted for grazing pressure, is approx. **84.9 kg/ha.** Hay fed was about 65kg/ha and the sheep lost approx. **7kg /head** between Dec and July when measurements ceased. Another late break had a similar affect on the annual pasture component as in 1994. Kikuyu grass remained around 30% 0f the feed on offer in winter and spring.

SUMMARY

In three of the four years we studied this site exceptionally dry summer/ early autumn periods were experienced with associated late starts to the growing season.
The Kikuyu grass component remained fairly constant over the duration however sub-clover tended to decline with a corresponding increase of winter grass.
Average yearly grazing pressures ranged from 11 to 13.5 DSE, the highest being in 1993 following an early opening to the season. Hay was fed into the paddock at a rate of around 90kg/ha with greasy wool production of 5.14 to 7.45kg/head or an estimated per hectare production of 67 to 85kg/ha.
There was little difference in the soil analyses across the period other than a trend of increasing acidity and declining potassium level, however the was still quite adequate.

APPENDIX VI On Farm Monitoring Site

Geoff Maidment Trial Number: **92Bu24**

Map- Reference: 35957mE, 6285622mN

Capel **Area** 7.0 ha. (17.5 acres)

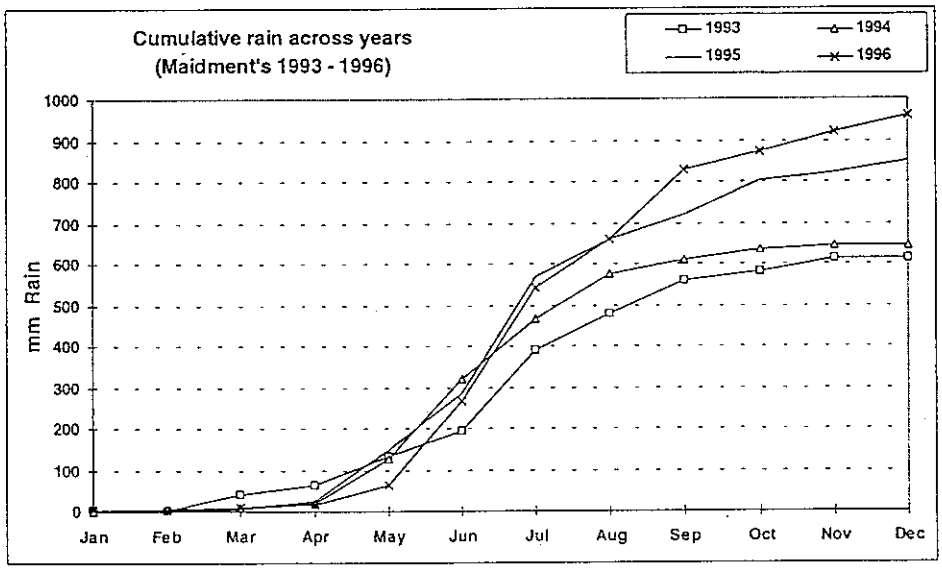
Pasture species included kikuyu grass and strawberry clover covering about 50% of the paddock. At the start annual legumes made up about 10 - 15% of the sward, and annual grass 40 - 45%.

Cattle herds were moved into and out of the paddock throughout the year. In 1993 and 1994 the paddock was grazed on block while in 1995 and 1996 the paddock was strip grazed.

Northcote: Dy 4.53, Dy 5.53
This was a flat paddock backing onto a coastal flood plain with the following soil profile:

Depth (cm)	Description	pH
0 - 20	black **sandy loam**	8.5
20 - 50	grey with yellow/ brown mottles **light clay**	8.8
50 - 90+	light brown/grey with orange/yellow/ brown mottles **clayey sand**	-

Cumulative rainfall patterns over 3 years at this site (from Capel PO):



Analyses of the top 10cms of soil before and at the end of the study:

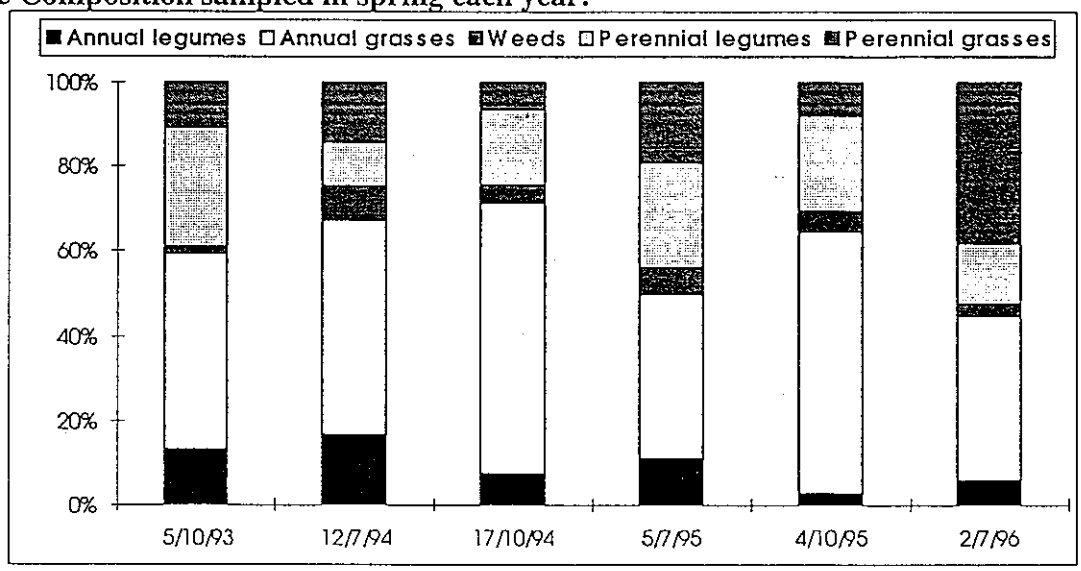
Soil Test:		7th Jan 1994	30th Jan 1996
Nitrogen. Nitrate	ppm	30	21
Ammonium	ppm	20	12
Phosphorus	ppm	41	45
Potassium	ppm	297	285
Reactive iron	ppm	880	1144
Organic Carbon	%	11.6	4.4
Salt	E.C. mS/m	54	89
pH	1:5 CaCl2	7.0	6.9

Appendix VI

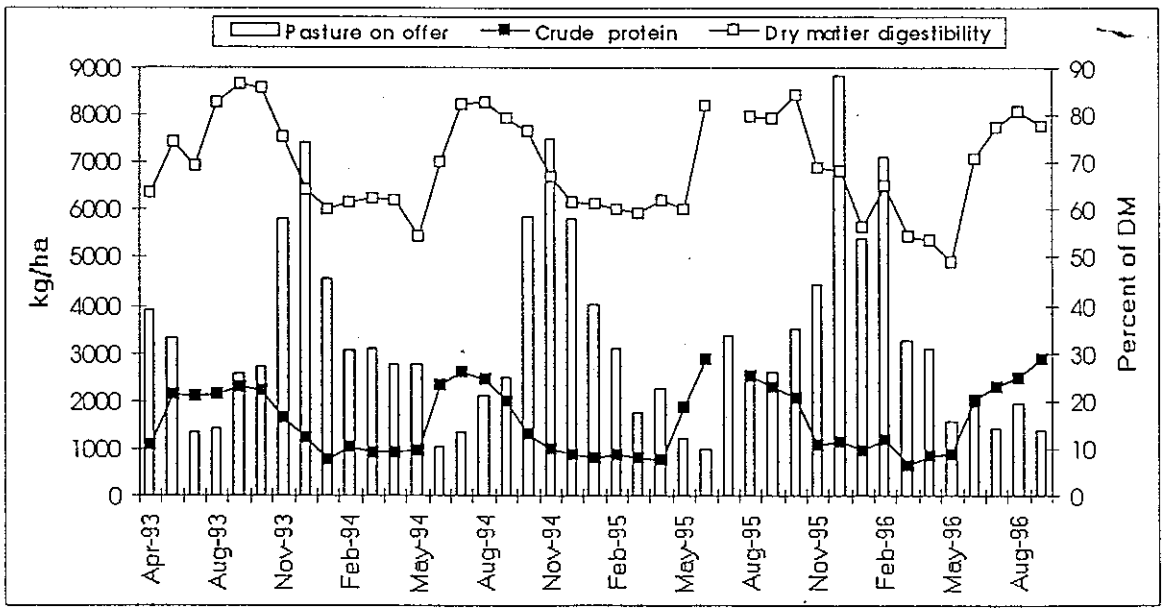
Fertiliser applied:

Date	Fertiliser	Amount (kg/ha)	Comments
1992	Superphosphate	250	February
1993	Superphosphate	250	June (only 2/3 of paddock)
	Super : Potash 3:2	200	June (across whole paddock)
	Urea	100	June (across whole paddock)
1994	Superphosphate	250	February
1995	Superphosphate	250	March

Pasture Composition sampled in spring each year:

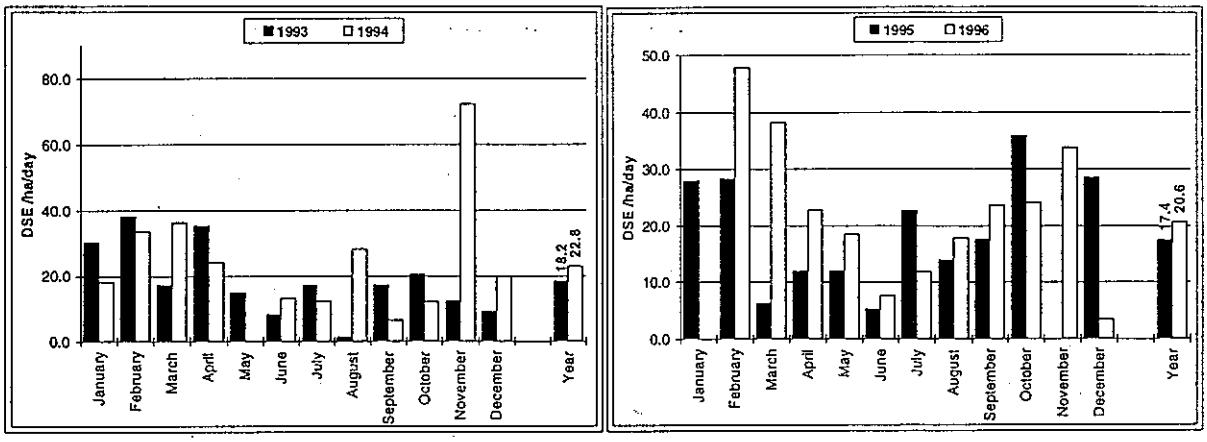


Feed on offer (FOO), dry matter digestibility and crude protein of pasture during the study were:



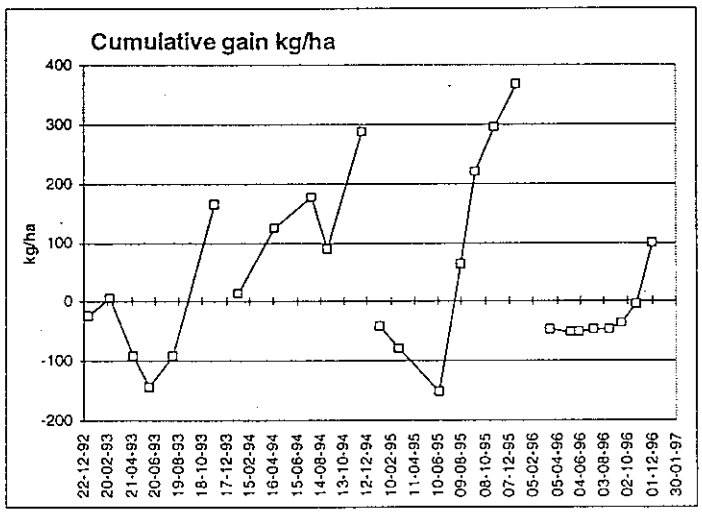
Appendix VI

Estimated average grazing pressure each month during the project:



No hay is made from this paddock and **no hay was fed** to cattle in the paddock.

The weight gained per hectare by the young stock (less than 2years old) grazing the paddock each year was:



	Live weight gained (kg/ha)	DSE/ha
1993	164	18.2
1994	286	22.8
1995	369	17.4
1996	100	20.6

SUMMARY

In all years the break to the seasons have been in May. A good germination occurred in March 1993 but was followed by relatively dry conditions. Over the years the pasture has comprised a low level of annual legumes (5 -15%) plus 10 to 30% perennial legumes. Annual grasses (40 - 60%) have dominated the sward along with up to 40% perennial grass (mainly kikuyu) in some years, while weeds have made up only about 5% of the sward.
The pasture balance appears stable under this management system.
Annual production per hectare was not related to year round grazing pressure. The highest annual gain of liveweight (369 kg/ha) was in 1995 when the grazing pressure was lowest (17.4 DSE/ha) and the second highest annual gain of 286 kg/ha was in 1994 the year with the highest grazing pressure (22.8 DSE/ha)

APPENDIX VII On Farm Monitoring Site

McCormack A. Trial number: 93HA9

Map - reference: 384550mE, 6336002mN, zone 50

Area: Perennial paddock 40 ha

Paddock topography: A paddock with grey white sands with a perched water table located on flat coastal plain with depressions.
Paddock history: The paddock was cleared in 1975 and was then left to establish as volunteer pasture. Nothing else has been done to this paddock. Recent fertiliser applications are detailed later

Soil Description:

Deep bleached sand **Uc 1.82**
Location: flats, depressions

Depth (cm)	Description	pH	Gravel %
0-10	grey sand	-	-
10-50	white sand	-	-
50-100	white with brown mottles sand	-	-
100-125	grey clayey sand	-	-
125+	sandy clay	-	1

Analysis of the top 10 cm of soil in the monitored perennial paddock, sampled in January 1994

Nitrate Nitrogen	ppm	4
Ammonium Nitrogen	ppm	20
Phosphorus	ppm	12
Potassium	ppm	91
Reactive Iron	ppm	134
Organic Carbon	%	2.6
Salt	E.C. mS/m	12
pH (1:5 CaCl2)		3.9

Rainfall: Annual rain received in 1993 was less than that in 1994 (648mm vs 768mm) but better distributed. In 1994 the break occurred in May with only 17 mm over the first 4 months with little rain after October.

Fertiliser applied:

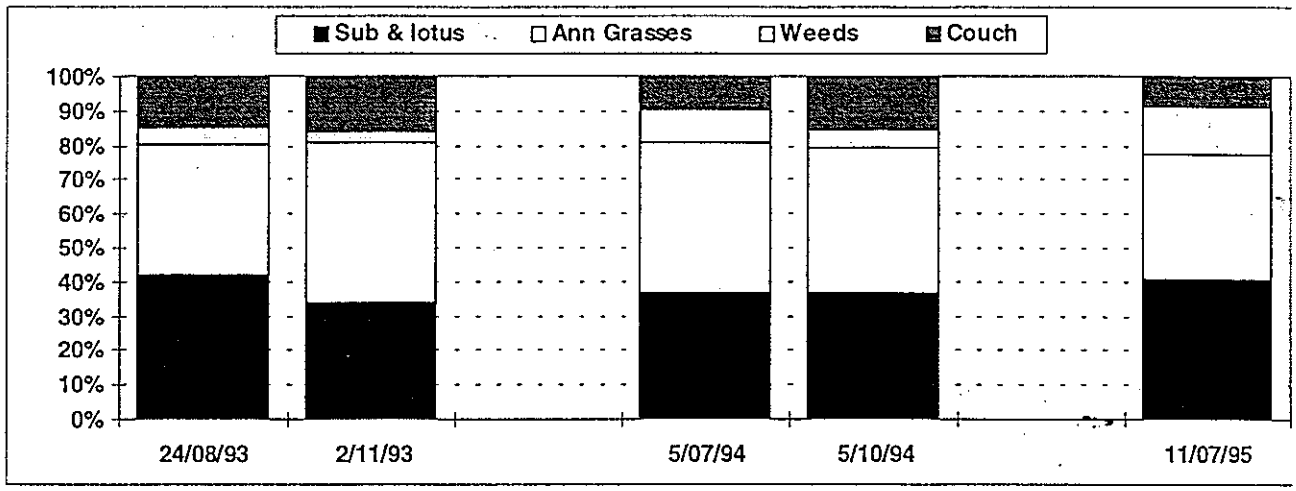
1994	Feb	90	3:2 super:potash
1995	Feb	200	superphosphate + Cu, Zn and Mo

The perennial component was couch (cv Indian runner) with an estimated cover in May each year recorded as % of ground cover was:

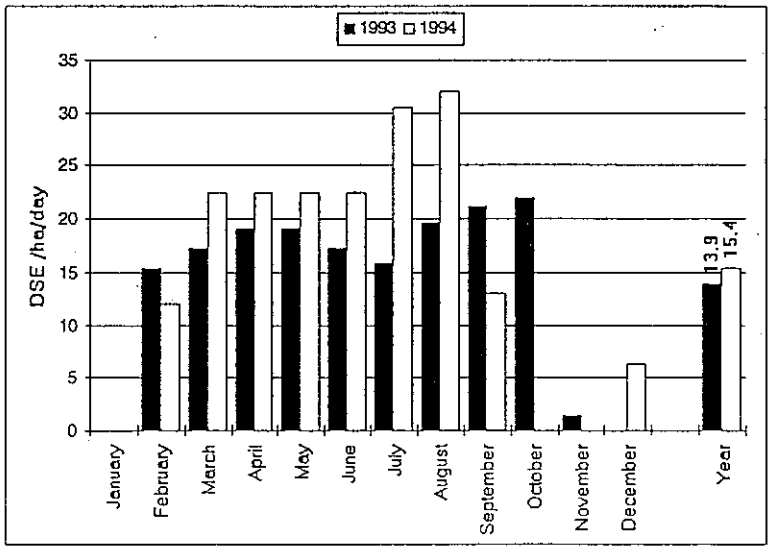
Year	cover
1993	25%
1994	33%
1995	19%

Appendix VII

Pasture composition (as % dry matter)



Estimated Average Grazing Pressure each month during the project



In **1993** the yearlings grazing the paddock gained approximately **265 kg/ha** live gain. While in 1994 the yearlings grazing the paddock gained approximately **58 kg/head**, starting with an average condition score of 1.5 in February and finishing at 1.75 in September. This gain adjusted for grazing pressure yielded around **115 kg /ha.**

Grazing management.
The animals that went into the paddock were those unsuitable for market at weaning (unfinished animals due to poor performance or late drop). Stock commenced grazing in February and remained in the paddock until they reached marketable weight and condition. The paddock was then left ungrazed from October as standing pasture for the following years draft.

Results:
Pasture quantity and quality were monitored on a monthly basis throughout the trial period. The energy concentration of the pasture was very low from January through to May inclusive in all the years (1993 to 1995). No hay was produced on this paddock.

Discussion:
This farmer runs in excess of 2000 head and neither conserves nor buys hay. He runs a low input operation and allows the herd to achieve marketable weight on grass alone. Lack of autumn/winter supplements and a long calving period result in a wide spread of weaning weights (170kg-316kg). A proportion of these animals were also being marketed at below desired abattoir carcass weights.

It was very difficult to weigh stock as frequently as necessary at this site. The changing group of animals needed regular weighings to obtain adequate data of live gain. For various reasons this was not possible. In September 1995 the decision to terminate this monitoring site trial was made.

APPENDIX VIII On Farm Monitoring Site

Chris Scott Trial Number: 92MA25

Map- Reference: 388784 mE, 6243541 mN.

Nannup **Area** 6.1 ha. (15.1 acres)

This pasture was established in 1980 to oats and annual ryegrass following deep ploughing. Phalaris (cv. Australian) was established in 1982 and in 1983 subclover (cv. Mt Barker) was sown across the whole paddock and kikuyu in the low areas. Between 1983 and 1992 the paddock was oversown with Mt Barker clover.

In spring 1993 the **Pasture** comprised 60 - 65% sub clover, 10 - 15% annual grasses, about 20% phalaris and 1% kikuyu grass with the remainder mainly cape weed.

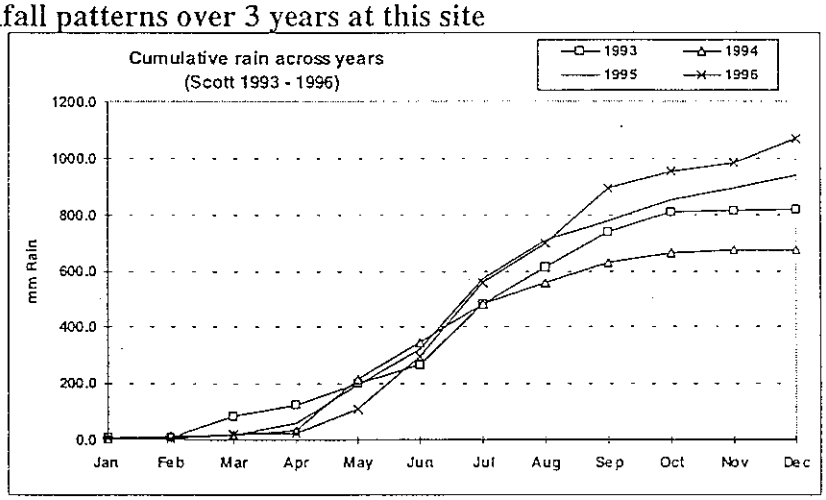
Cattle: This paddock has been used as a hay paddock since 1983. Between December 1992 and September 1996 the paddock was block grazed by 11 separate groups of steers. Hay was made each year, the paddock being closed up in the first week in September and opened for grazing again in December.

Soils: The paddock is in a valley with a winter creek and a permanent soak.. The mid to upper slopes are gravelly/clay and the lower and flats are loam soils.
Soil description: Gn 2.12, Gn 3.12, Gn, 4.12
Location: mid, lower and foot slopes.

Depth (cm)	Description	pH	Gravel%
0-15	dark brown to dark grey **clayey sand to loam**	5.5	0-15
15-40	strong brown **loam to light sandy clay loam**	6.0	0-20
40-60	strong brown **light clay**	6.0	0-20
60-90+	strong brown with yellow grey mottles **light to heavy clay**	6.5	-

Depth (cm)	Description	pH	Gravel%
0-10	dark brown **loam**	5.0	1
10-30	dark brown **sandy clay loam**		2
30-50	dark yellowish brown **light clay**		2
50+	rock	-	-

Cumulative rainfall patterns over 3 years at this site



Appendix VIII

Analysis of the top 10 cms of soil at the start and end of the study:

Soil Test:		11th Mar 1993	7th Feb 1996
Nitrogen. Nitrate	ppm	16	19
Ammonium	ppm	19	16
Phosphorus	ppm	74	60
Potassium	ppm	119	83
Reactive iron	ppm	2664	2699
Organic Carbon	%	3.0	3.5
Salt	E.C. dS/M	.07	.07
pH	1:5 CaCl2	4.3	4.4

Fertiliser applied:

Date	Fertiliser	Amount (kg/ha)	Comments
1980 -- 1994	Superphosphate	160	By plane
1983 -- 1994	Super/potash 3:2	160	For hay
1995 Feb	Superphosphate	90	By plane
April	Muriate of Potash	200	

Counts of perennial plants (plant/sq.m.) in May of each year:

	1993	1994	1995	1996
Phalaris	30	20	27	32
Kikuyu grass % cover of paddock	45	29	11	17

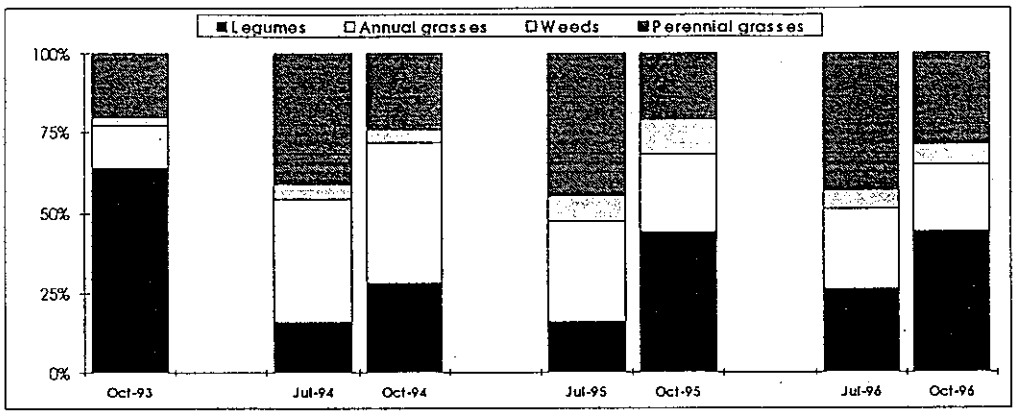
Quantity and Quality of hay conserved. (Mean and Standard Deviation).

	Date cut	Roll No:	Ave. wt (kg)	t/ha	%DMD	Mj/kg	%CP
1992	Nov 26	64	390	3.6			
1993	Nov 9	84	461	6.3	65.3	9.2	14.1
1994	Nov 1	78	362	4.6	64.3	9.1	9.5
1995	Nov 10	76	413	5.2	61.8	8.7	10.0

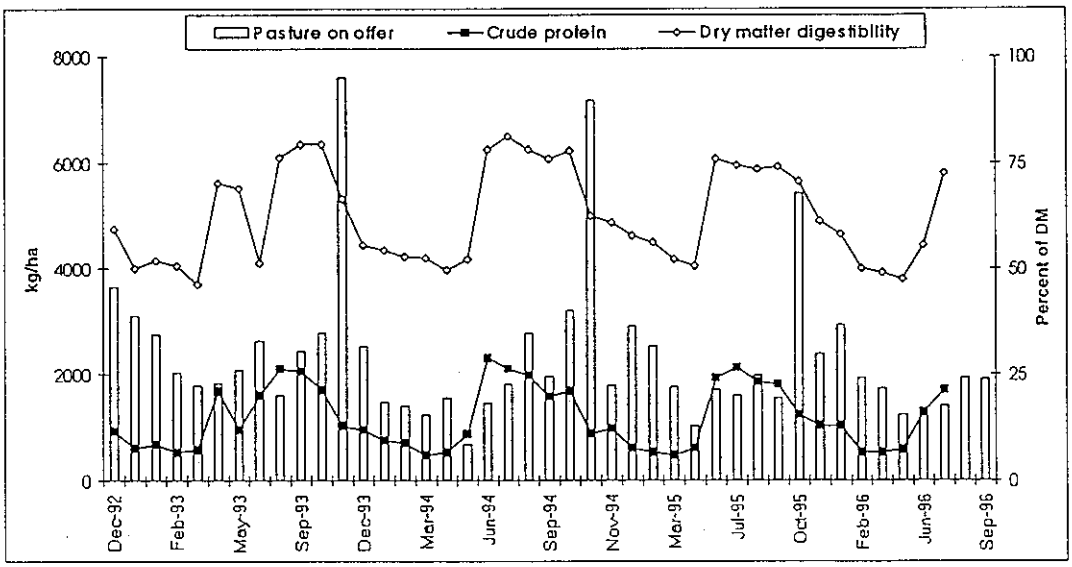
Quantity of hay fed.

Year	kg total	kg/ha	Start	Stop
1993/4	922	151	Dec	Jan
1994	4149	680	Feb	May
1994/5	5792	950	Dec	Jan
1995	5792	950	Mar	May

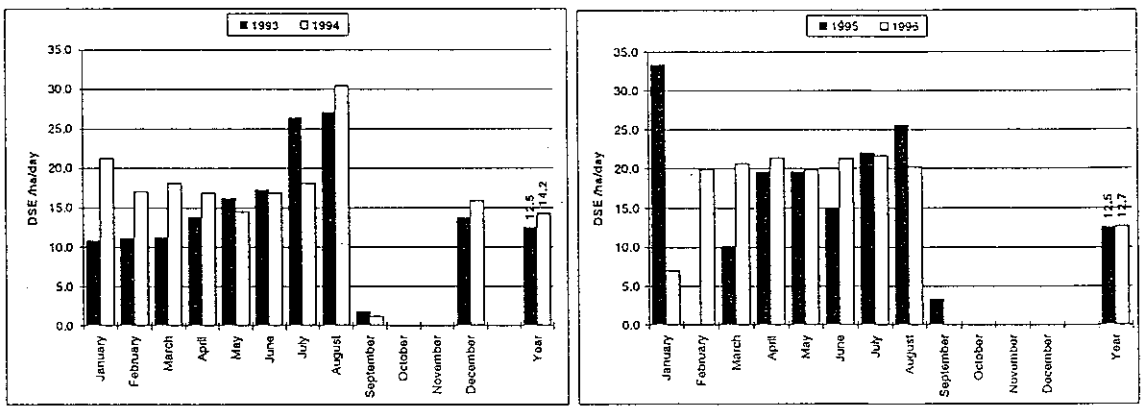
Pasture composition sampled in spring each year (as % dry matter):



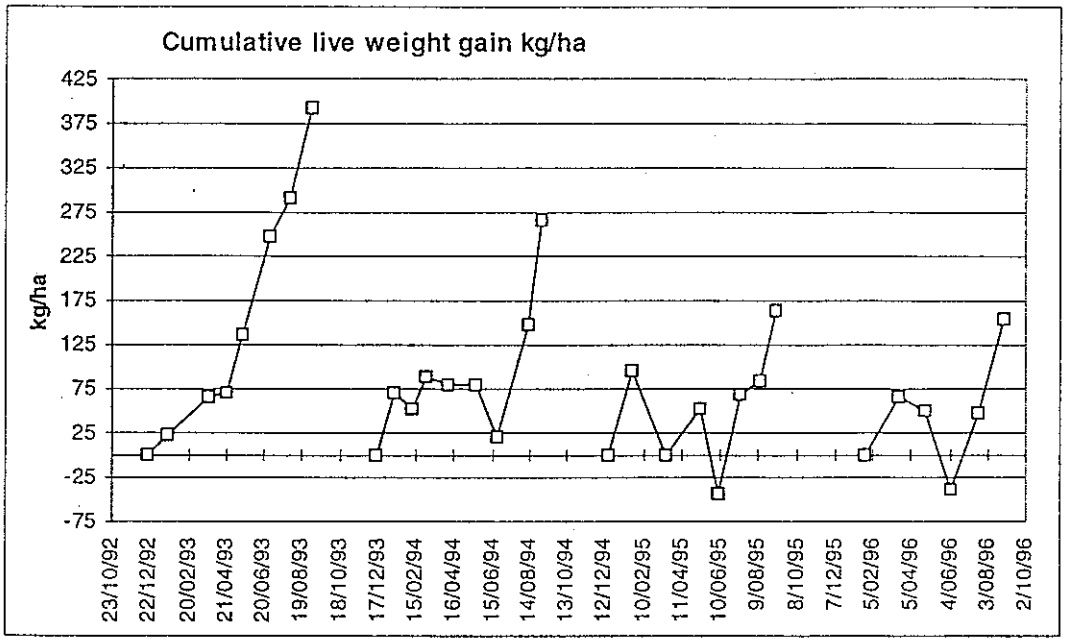
Feed on offer (FOO), dry matter digestibility and crude protein of pasture during the study were:



Estimated average grazing pressure each month during the project:



Cumulative growth of yearling cattle grazed on the paddock over the years:



SUMMARY

In 1993 the season broke in late March but not until mid May in the three following years.
The good early break in 1993 ensured high levels of subclover, in 1994 the percentage of sub in the sward fell to around 15 - 20%, this increased in 1995 and 1996 to between 20 and 35% depending on time of year, being higher in spring than in winter in all years. The annual grass component (phalaris and kikuyu grasses) was high in 1994 (40%) but has declined since to about 25%. In 1996 weeds made up only a small proportion of the pasture. The perennial grass component remained constant within seasons across the years at around 40% in winter and 25% in spring,.
The pasture balance appears stable under this management system.
A summary of the productivity of the study area is provide below:

	Live weight gained (kg/ha)	DSE/ha	Hay fed kg/ha	Hay made t/ha
1993	394	12.5	?	3.6
1994	266	14.2	831	6.3
1995	164	12.5	1900	4.6
1996	155	12.7	?	5.2

This paddock has been used as a hay paddock since 1983 and during the life of the study the potassium levels declined to a marginal level of 83 ppm from 119ppm while the soil phosphorus levels are high at 60 - 70 ppm.

APPENDIX IX On Farm Monitoring Site

Kevin Smith Trial Number 93BU11

Map Reference: 336175 mE, 6255435 mN.

Treeton **Area:** 13 ha. (32.1 ac)

This paddock is in undulating country that has a winter creek and permanent seepage areas throughout summer and autumn. The western side has sandy soils and annual grasses, while the eastern side around the mid to lower slope comprised loamy clay soils

In winter 1993 the **pasture** comprised high proportions of perennials with 50 to 60% perennial grasses (kikuyu, paspalum, rye and fog grass) and 5 to 10 % strawberry clover. Subclover was weak at around 5%, annual grasses at25 to 30% and the weed component was negligible.

Cattle: The paddock was stocked with cows as they calved from February or March each year. Cow and calf remained in the paddock until about July after which separate herds graze the area until November when stock were removed and the paddock was left ungrazed until calving the following year.

Soil description: Gn 2.82
Location: mid to lower slope

Depth (cm)	Description	pH	Gravel %
0-15	dark brown **sandy loam**	5.5	-
15-30	light brownish grey with orange mottles **sandy loam**	6.0	0-10
30-70	pale grey brown with orange mottles **sandy clay loam**	5.5	0-10
70-100+	light grey to white with orange mottles **sandy light clay**	-	0-10

Soil description: Gn1.81
Location: -

Depth (cm)	Description	pH	Gravel %
0-10	dark brown **sandy clay loam**	-	10
10-30	reddish yellow **sandy clay loam**	-	5
30-50	pink **sandy light clay**	-	5
50-70	white **sandy light clay**	-	-

Soil description: Uc 2.23
Location: mid-slope, western side of valley

Depth (cm)	Description	pH	Gravel %
0-15	grey brown **loamy sand**	-	-
15-40	pale brown **loamy sand**	-	-
40-100	light grey **sand**	-	-

Analysis of the top 10 cms of soil at the start and end of the study:

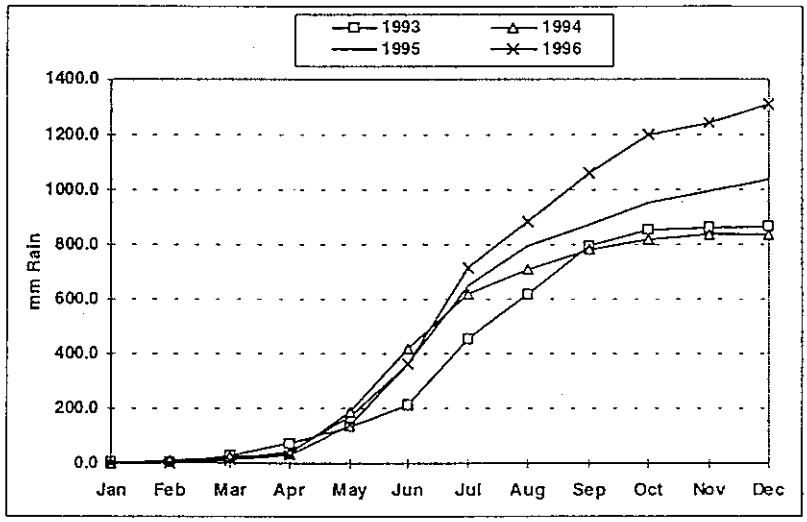
Soil Test:		7th Jan 1994	12th Feb 1996
Nitrogen. Nitrate	ppm	9	2
Ammonium	ppm	20	20
Phosphorus	ppm	52	44
Potassium	ppm	110	71
Reactive iron	ppm	1254	1170
Organic Carbon	%	5.5	4.7
Salt	E.C. mS/m	14	11
pH	1:5 CaCl2	4.3	4.3

Appendix IX

Fertiliser applied

Date	Fertiliser	Amount (kg/ha)	Comments
1992	Superphosphate	80	
1996	Superphosphate	200	March
1994	Superphosphate	200	March
1995	Superphosphate	200	March
1996	Summit Pasture +Se	100	March

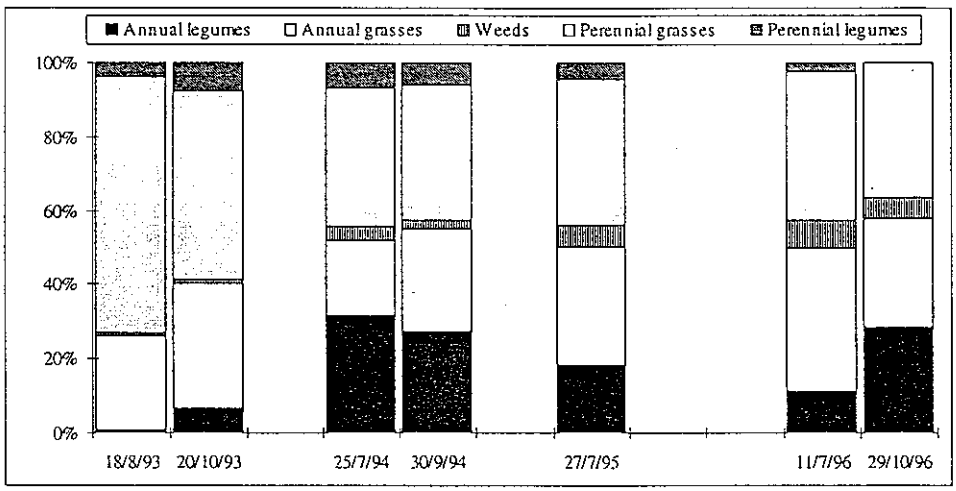
Cumulative rainfall patterns over 3 years at this site



Quantity of hay fed.

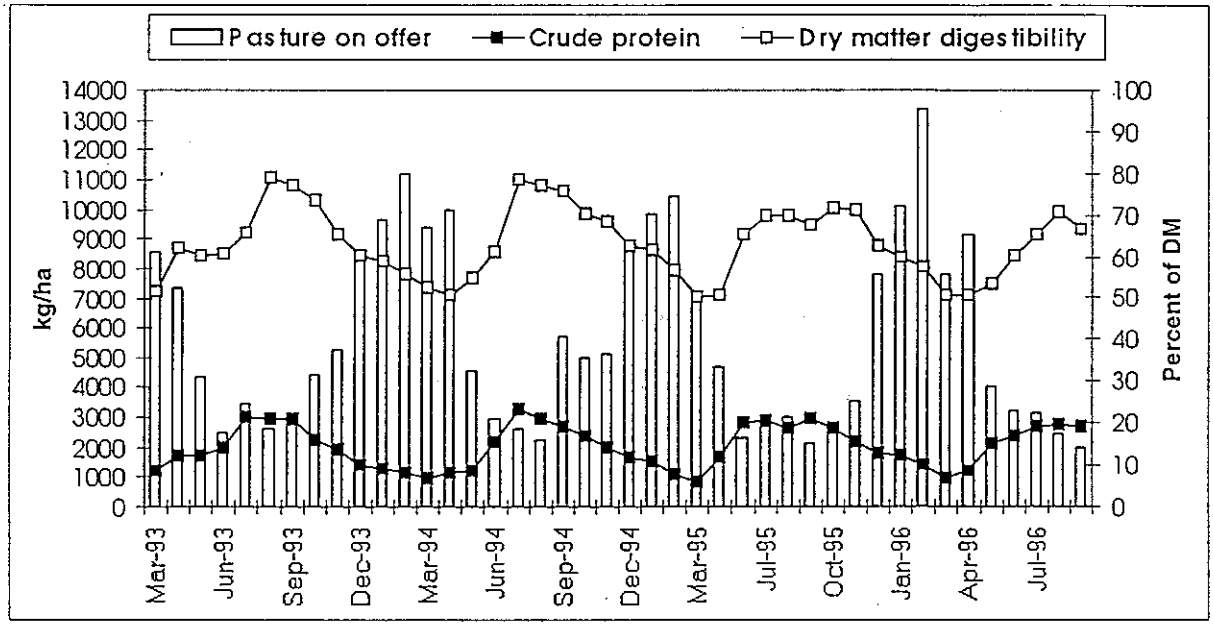
Year	kg total	kg/ha	Start	Stop
1993	10800	831	Mar	Jun
1994	23307	1793	Feb	Jun
1995	16452	1266	Feb	Jun
1996	14400	1108	Mar	May

Pasture composition sampled in spring each year (as % dry matter):

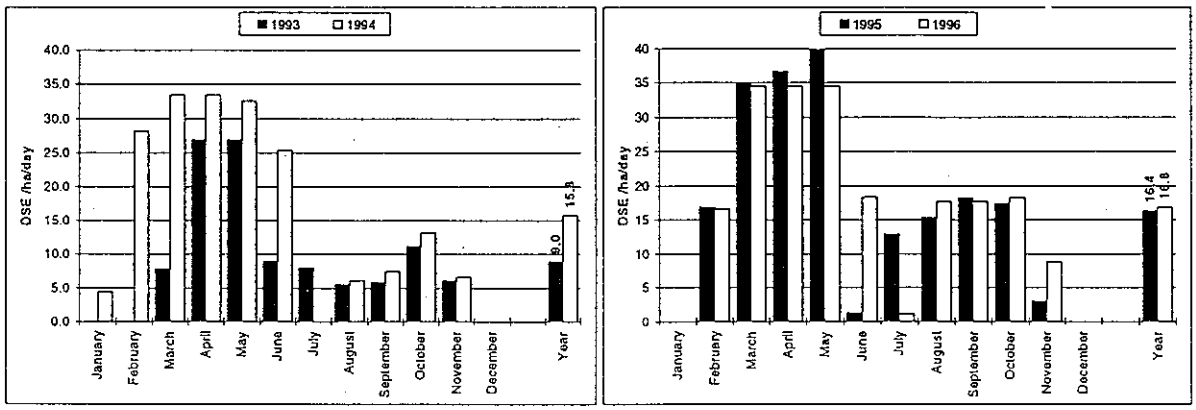


Appendix IX

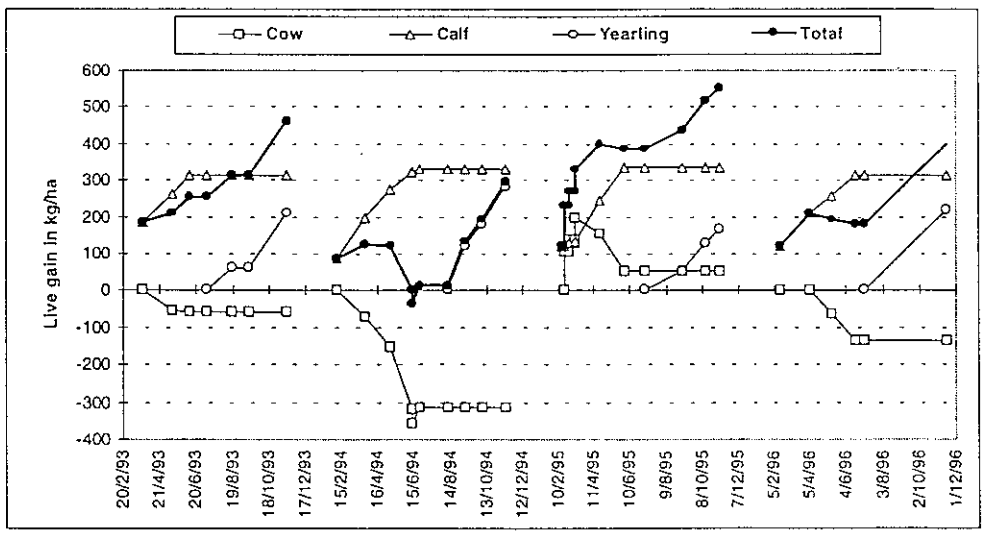
Feed on offer (FOO), dry matter digestibility and crude protein of pasture during the study were:



Estimated average grazing pressure each month during the project:



Cumulative growth of the different cattle categories grazed on the paddock over the year:



SUMMARY

This site did not receive the heavy rains in late March 1993 common at many other sites, consequently the break in all the years was around mid May or later.
Annual legumes were very poor when we started monitoring in 1993 but increased to about 20% of the sward in later years. the perennial grass component (kikuyu, paspalum and fog grasses) was quite dominant (50 - 65%) at the start, stabilised at 35 - 40% in subsequent years. Annual grasses (mainly rye) made up about 30% of the sward throughout the study while the minor components weeds and perennial legumes made up about 10 % of the sward with perennial legumes declining over time.
The pasture balance appears stable under this management system however correction of the apparently declining and marginal levels of potash (71 ppm) should improve the legume component.
A summary of the productivity of the study area is provide below:

	Live weight gained (kg/ha)	DSE/ha	Hay fed kg/ha	Hay made t/ha
1993	465	9.0	831	nil
1994	298	15.8	1793	nil
1995	554	16.4	1266	nil
1996	401	16.8	1108	nil

Fodder was not conserved from this paddock. At no time did FOO fall below 2000 kg/ha but it did reach very high levels in summer while being spelled from grazing before calving cows were introduced.
It is difficult to interpret the production data in isolation from other farm paddocks. For example in 1993 the cows were only in this paddock for 2.5 months, they lost little weight associated with calving (59 kg/ha), and yearlings were introduced in August from which time they only gained weight. As a result all the weight gain benefits for these groups of animals were accrued to this paddock, seasonal weight losses occurred in other paddocks, hence in a poor season with a low grazing pressure a high level of production was achieved! Compare this with 1994 were cows remained in the paddock for 4.5 months around calving and lost 315 kg/ha when they were stocked more heavily and were fed twice as much hay as in 1993.

APPENDIX X On Farm Monitoring Site

David Weightman Trial Number 92BU23

Map Reference: 322489 mE, 6238576 mN.

Margaret River **Area:** 29.9 ha. (74 ac)

When the farm was purchased in 1965 **the monitoring paddock** had already been well established to perennial ryegrass (cv Victorian), legumes (subclover) and annual grasses. The area was divided into three smaller paddocks which were rotationally grazed during the life of the study. During the growing season the paddock is strip grazed with front and rear electric fences. Rotation speed was determined by the rate of emergence of the third leaf of the rye grass plants.
The monitoring paddock has been cut for hay since 1976.

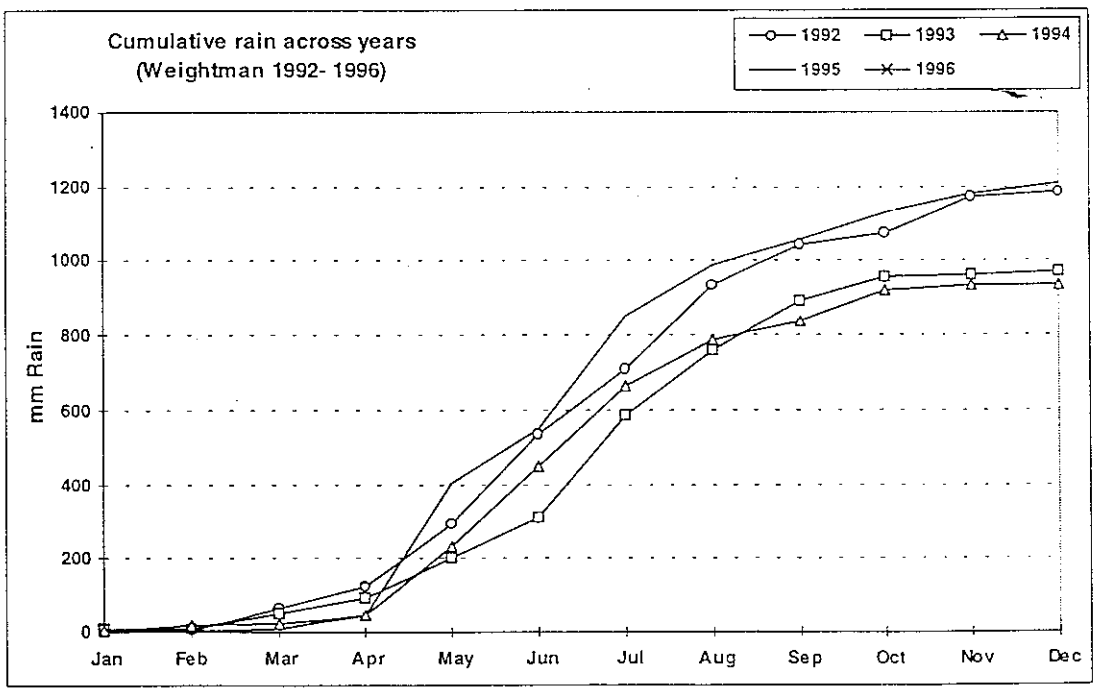
In winter 1993 the **pasture** comprised 35% perennials (Victorian rye grass and traces of kikuyu grass and strawberry clover), 25% subclover, 30% annual grasses (half of which was rye grass) and about 10 % weeds (mainly cape weed).

Cattle: Grazing was by groups of large framed Simmental/Hereford cross heifers. Each year the herd number was built up following weaning in summer and the selected heifer yearlings then remained in the paddock until it was closed for hay in early spring. Hay is fed during the first half of the year with the aim of at least maintaining liveweight.

Soil Description: Gn 2.82
Location: flats to undulating

	Description	pH	Gravel (%)
0-10	dark brown **sandy loam**	6.0	-
10-25	brownish yellow **sandy clay loam**	5.0	0-1
25-50	very pale brown with orange mottles **sandy light clay**	6.0	-
50->100	very light grey with orange mottles **sandy clay**	5.5	-

Cumulative rainfall patterns over 3 years at this site



Appendix X

Analysis of the top 10 cms of soil at the start and end of the study:

Soil Test:		Jan 1994	Jan 1996
Nitrogen. Nitrate	ppm	22	9
Ammonium	ppm	20	12
Phosphorus	ppm	40	41
Potassium	ppm	58	60
Reactive iron	ppm	1120	1173
Organic Carbon	%	5.0	4.5
Salt	E.C. mS/m	12	8
pH	1:5 CaCl2	4.8	4.6

Fertiliser applied

Year	Fertiliser	Amount (kg/ha)	Date
1993	Super, copper, zinc, molybdenum	205	
1994	Superphosphate	205	April
	Sulphate of ammonia	67	September
	Muriate of potash.	25	September
1995	Superphosphate	200	February
1996	Superphosphate	200	February
	Muriate of Potash	82	September

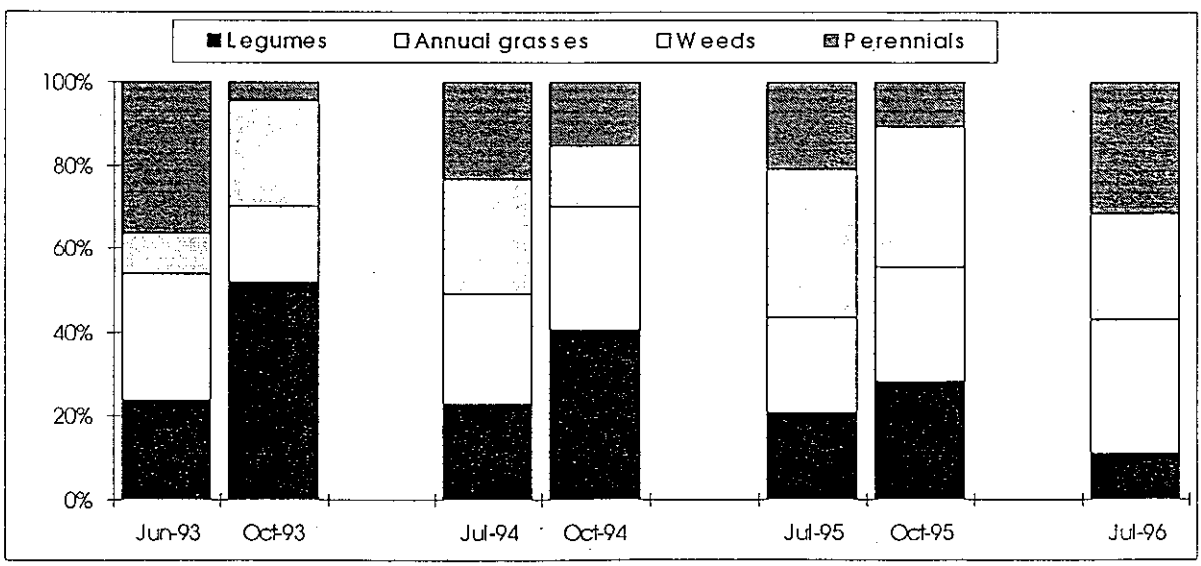
Quantity and Quality of fodder conserved. (Mean and Standard Deviation).

	Date cut	Roll No:	Ave. wt (kg)	t/ha	%DMD	Mj/kg	%CP
1993	Nov	Silage 115	600	2.3	49.2	9.8	8.4
1993	Nov	Hay 89	*563*	*1.7*			
1994	Nov	150	563	2.8	67.5	9.6	10.0
1995	Nov	168	500	2.8	65	9.2	11.7
1996	Nov	152	*530*	*2.7*			

Quantity of hay fed.

Year	kg total	kg/ha	Start	Stop
1993	56236	1881	Feb	May
1994	63595	2127	Jan	Jun
1995	44477	1488	Feb	Jun
1996	49000	1639	Feb	Jun

Pasture composition sampled in spring each year (as % dry matter):

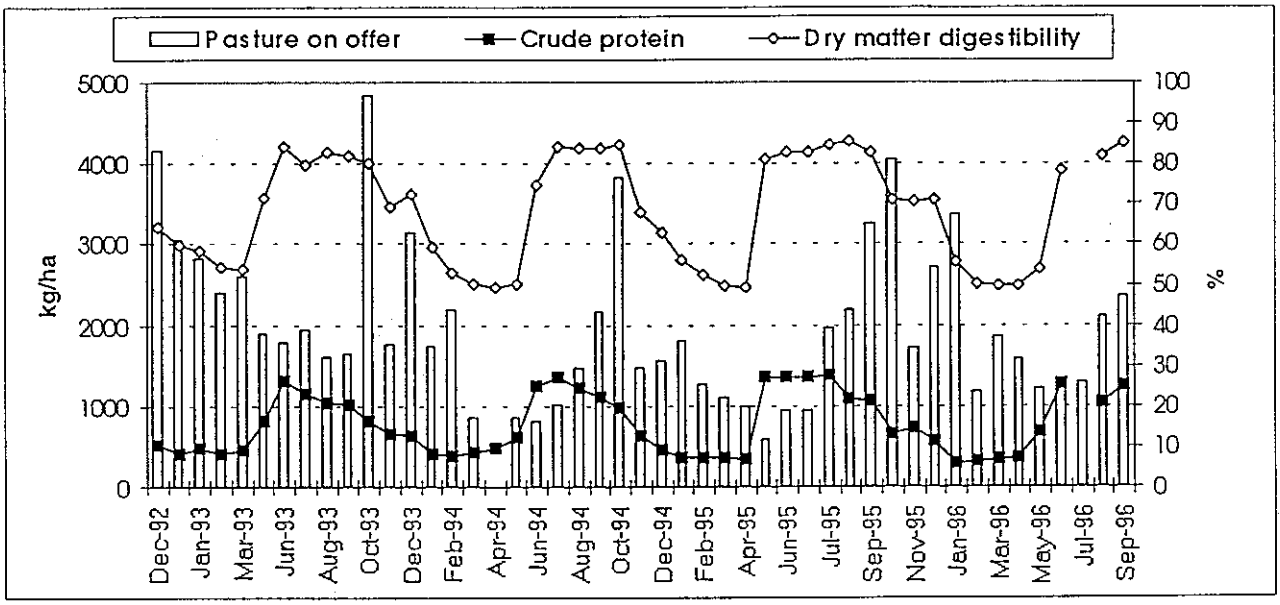


Appendix X

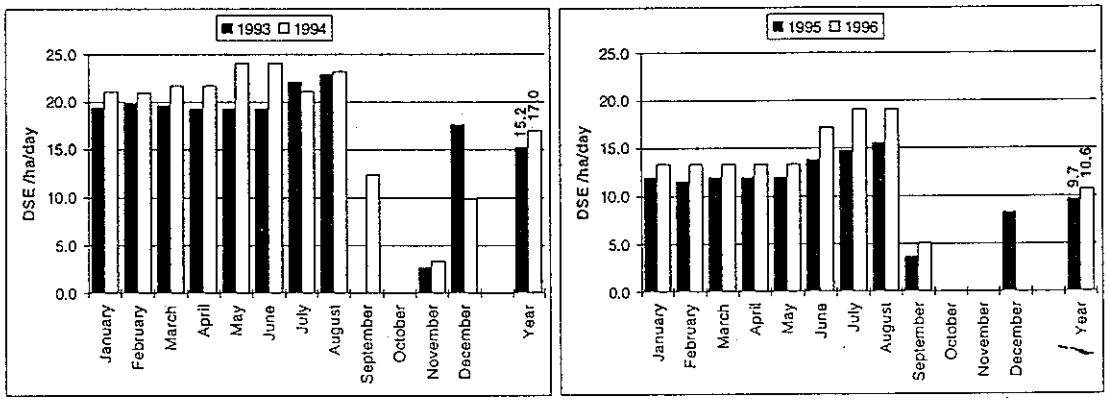
Counts of perennial plants (plant/sq.m.) in May of each year:

	1993	1994	1995	1996
Victorian Perennial Rye		29	18	17

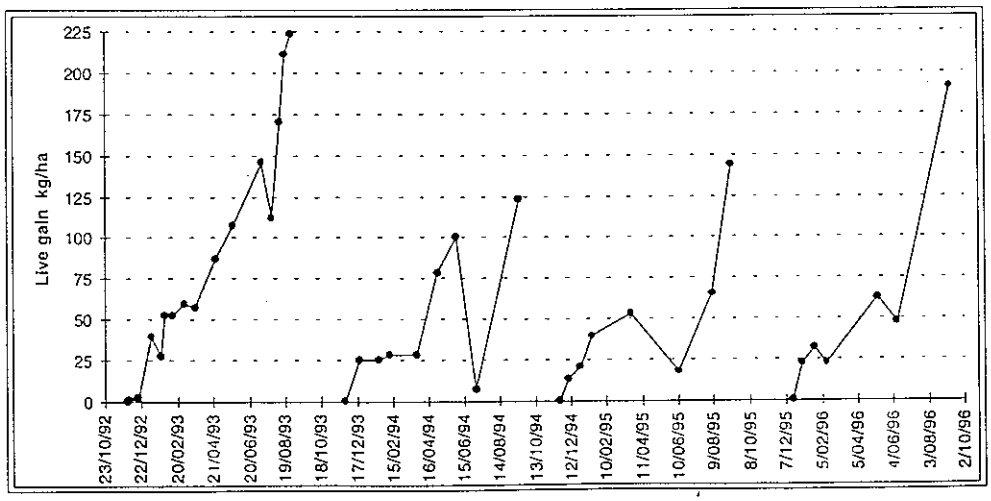
Feed on offer (FOO), dry matter digestibility (%) and crude protein (%) of pasture during the study were:



Estimated average grazing pressure each month during the project:



Cumulative growth of yearling cattle grazed on the paddock over the years:



SUMMARY

The summer autumn period has been very dry since 1992, with the break of season in June in 1996 and May in the intervening years.
As expected there was a consistent variation of subclover within each year, spring proportions being higher than winter. However there appears to have been a steady decline in subclover since the start of the study, this coincides with low levels of soil potassium of around 60 ppm at the start and end of the study (80 ppm are considered to be a minimum required level) as well as the late breaks.
The perennial plant counts (Victorian perennial ryegrass) have halved in number since 1993 but the proportion in the pasture was not very different on a seasonal basis among years. It should be remembered that the October estimates coincide with maximum levels of FOO, around hay making time. There was no consistent difference in the proportion of annual grasses and weeds between seasons and among years.
A summary of the productivity of the study area is provide below:

	Live weight gained (kg/ha)	DSE/ha	Hay fed kg/ha	Hay equiv.* made t/ha
1993	223	15.2	1881	2.7
1994	123	17.0	2127	2.8
1995	143	9.7	1488	2.8
1996	190	10.6	1639	2.7

(* Adjusted silage kg/ha x 35% DM ÷ 85% DM to estimate hay equivalent)

Quantities of forage conserved from the study area has been similar across the years, but the annual grazing pressure has declined. 1994 was the year of highest grazing pressure, lowest live gain per hectare and highest amount of hay fed. Reducing the grazing pressure by around 30 % (1995 and 1996) coincided with about 25 % less hay fed and an increase in live gain per hectare.
In 1994 and 1995 the high level of liveweight loss in June/July was associated with FOO levels below 1000 kg/ha, in the other two years FOO was more than 1200 kg/ha at this time and losses were considerably less.
In round figures during the life of the study this production system has produced 170kg/ha of live gain and a tonne of hay per hectare, with a year round grazing pressure of 13.1 DSE/ha.

APPENDIX XI Producer Demonstration Site

Ross & Dianne Barclay Trial Number: 92AL30

Map- Reference: 612000 mE, 6142000 mN, Zone 50 (Map 2528-III)

Manypeaks **Area:** Annual 11.74 ha. (29.0 acres)
Perennial 6.88 ha. (17.0 acres)

Base Pasture: Two similar adjoining paddocks were selected for this demonstration:

Annual Paddock: In August 1992 this paddock was subclover dominant (55%) with 35%weeds, mainly cape weed and thistle and 10% annual grasses, mainly winter grass.

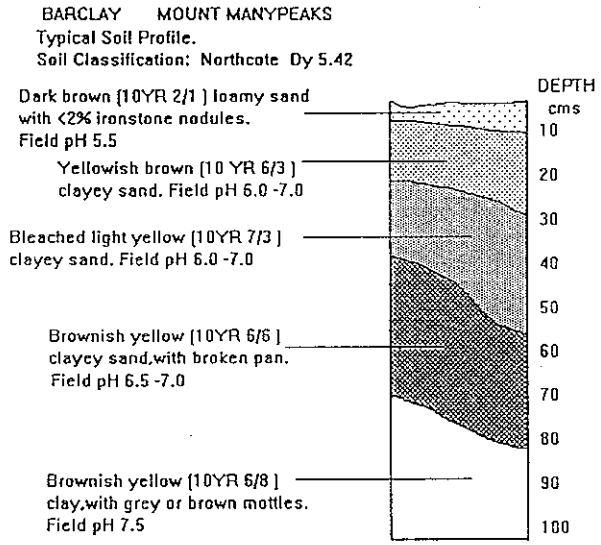
Perennial Paddock: Prior to 1991 this paddock was infested with thistle and dock. On March 15 1991 the area was scarified lightly to promote weed germination and then sprayed (May 16) with Roundup (400 ml/ha) and Ally (5 g/ha). Mortlock oats (90 kg/ha) was sown (May 25), this was grazed intermittently from July 7 to September 17. The area was then spray grazed (October 3) using Dicamba (500 ml/ha). After closing up for hay, the pasture was cut and baled in early November.

Following a good germination in April 1992 the paddock was sprayed with Roundup (400 ml/ha) and then sowed (May 10) with a mixture of Pacific ryegrass (3kg/ha), Triumph fescue (2 kg/ha), Strawberry clover (1kg/ha) and Trikkala and Karridale subclovers, each at 3kg/ha. The paddock was later sprayed with Rogor (85 ml/ha) and first stocked at 7.2DSE on August 13.

Animals A base flock of 30 ewe hoggets were run continuously on each paddock from August 1992 until the end of October 1994. They were replaced with new sheep at the end of October (15 ewe hoggets & 15 wether hoggets per paddock) until the end of the study. They were weighed and condition scored regularly and wool production was weighed at shearing. Samples of wool from each sheep were taken to determine clean yield and fibre length and strength. Other sheep were added to and taken from the paddocks over the years at the farmers discretion.

Soil Descriptions Dy 5.42 (or Dy 5.22)

A Typical Profile.....



Appendix XI

Deep Soils

Down to:	Description	pH	% gravel
8 - 15cm	Dark brown **loamy sand** not hard setting	5.5	<2
25 - 30cm	Yellow brown **sand** or **clayey sand**	6.0 - 7.0	
40 - 60cm	Bleached light yellow **sand** or **clayey sand.**	6.0 - 7.0	
60 - 80cm	Brown/yellow **sand/clayey sand. ± gravel** or **broken pan**	6.5 - 7.0	???
>100 cm	Brownish yellow **clay** with yellow/brown or grey mottles.	7.0 - 7.5	

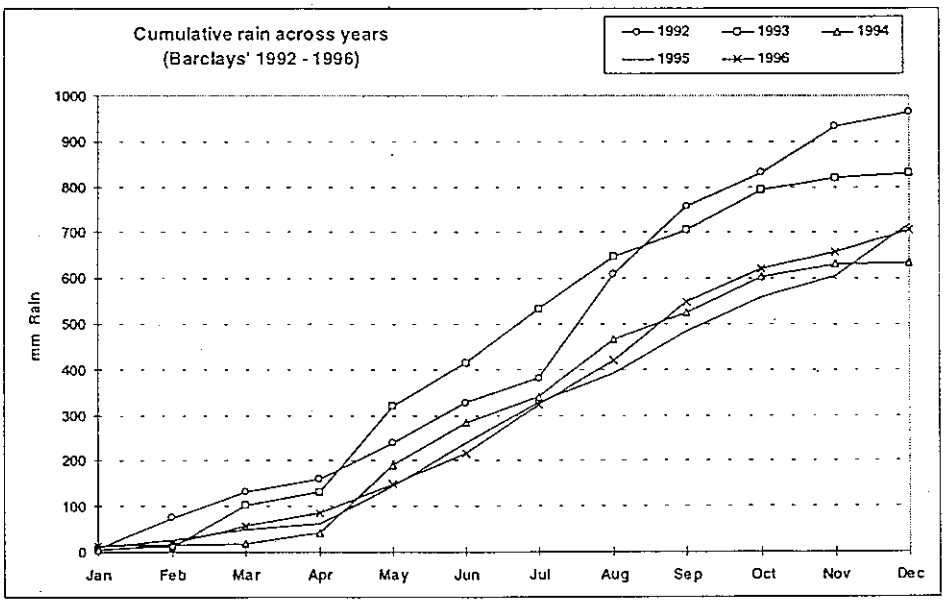
Down to:	SOIL	% Clay	% Silt	% Sand	% H2O 1/3 bar	% H2O 15 bar	Bulk Dens.
8 - 15cm	**loamy sand**	19	8	73	9	5	1.65
25 - 30cm	**sand** or **clayey sand**	12	7	81	9	4	1.6
40 - 60cm	**sand** or **clayey sand.**	12	7	81	9	4	1.6
60 - 80cm	**clayey sand**	12	7	81	9	4	1.6
>100 cm	**clay**	65	12	23	21	16	2.1

Shallow Soils

Down to:	Description	pH	% gravel
5 - 10cm	Dark brown **loamy sand** not hard setting	5.5	<2
12 - 20cm	Yellow brown **clayey sand.** Can be bleached	5.5	
>100 cm	Brown/yellow med. **clay** + yellow/red or pale grey mottles.	6.0	

Down to:	SOIL	% Clay	% Silt	% Sand	% H2O 1/3 bar	% H2O 15 bar	Bulk Dens.
5 - 10cm	**loamy sand**	19	8	73	9	5	1.65
12 - 20cm	**clayey sand**	12	7	81	9	4	1.6
>100 cm	**clay**	65	12	23	21	16	2.1

Cumulative rainfall patterns over 5 years have been :



Appendix XI

Analyses of the top 10cms of soil before and at the end of the study:

		13 March 1992		15 February 1996	
Soil Test :CSBP analyses		**Annual**	**Perennial**	**Annual**	**Perennial**
Nitrogen :Nitrate	ppm	30	30	30	30
Ammonium	ppm	20	12	20	20
Phosphorus	ppm	48	66	31	32
Potassium	ppm	181	166	166	175
Sulphur	ppm	NA	NA	11	9
Organic carbon	%	3.30	4.11	4.45	4.46
	Status	V.Good	V.Good	V.Good	V.Good
Reactive Iron (ppm)	ppm	2677	2521	2919	2294
	Status	V.High	V.High	V.High	V.High
Salt	E.C dS/m	.26	.25	.20	.14
	Status	V.Low	V.Low	V.Low	V.Low
pH	(1:5 $CaCl_2$)	4.3	4.2	4.4	4.3
	(1:5 Water)				
	Status	Low	Low	Low	Low

Fertiliser applied:

Date	Fertiliser	Amount (kg/ha)	Comments:
28/5/91	Superphosphate	200	(Perennial pad.)
	Agras No1	40	Oats sown as cleaning crop (Perennial pad.)
30/6/91	Urea	60	(Perennial pad.)
1991	Superphosphate	120	(Annual pad)
May1992	Superphosphate	100	At sowing of pasture (Perennial pad.)
1992	Nil		Too wet at application time (Annual pad)
1993	Super : K 3 : 1	150	(Annual and Perennial. pads)
1994	Super : K 3 : 1	150	(Annual and Perennial. pads)
23/4/95	Super	150	(Annual and Perennial. pads)
28/3/96	Super :K 3 : 1	150	(Annual and Perennial. pads)

Quantity and Quality of supplements fed.

Year	HAY	kg/head	kg/ha	Date Start	Date End	g/sh/d
1993	Annual	6.8	43.5	15/2	26/3	174
	Perennial	---	---	---	---	
1994	Annual		292	8/4/94	12/7/94	275
	Perennial		465	4/5/94	12/7/94	405
1995	Annual		419	Feb	May	
	Perennial		368	Feb	May	

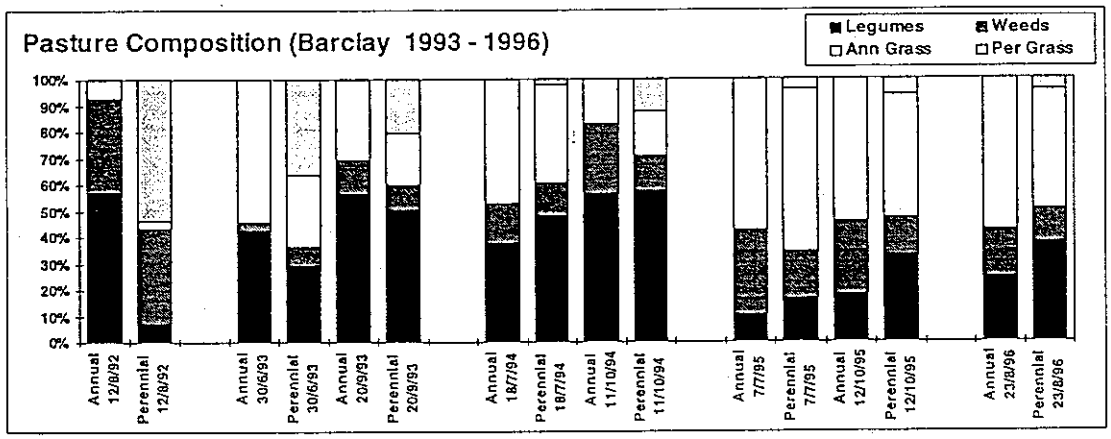
Year	GRAIN	t.	kg/ sheep	kg/ ha	% Oats	% Barley	% Lupin	Date Start	Date End	g/sh/d
1993	Annual	0.58	7.71	49.5	---	41	59	15/2	26/3	198
	Perennial	---	---	---	---	---	---	---	---	
1994	Annual	1.04		89			100	15/1	7/4	114
	Annual	1.6		136	100			8/4	17/5	399
	Perennial	0.44		64	100			10/5	11/6	87
1995	Annual	2.0		170	2.5		97.5	Feb	May	
	Perennial	0.8		116			100	Feb	May	
1996	Annual	???								
	Perennial	???								

Hay was only conserved in the perennial paddock in 1991 as part of the establishment procedure.

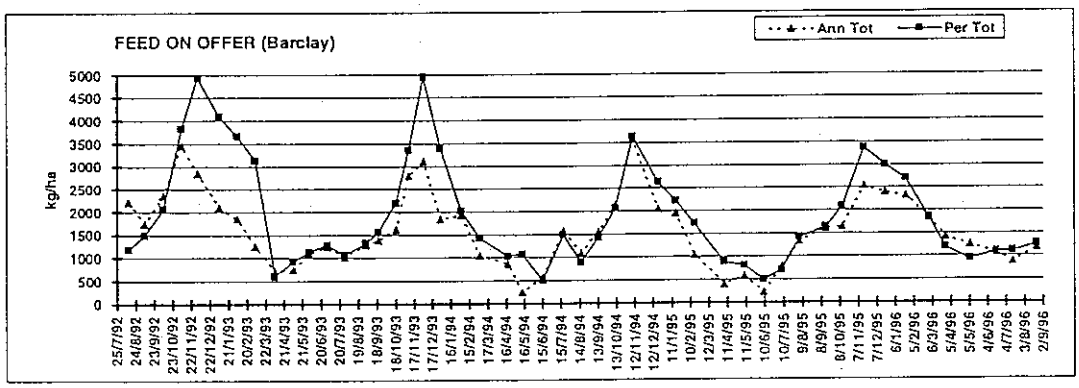
Counts of perennial plants (plant/sq.m.)

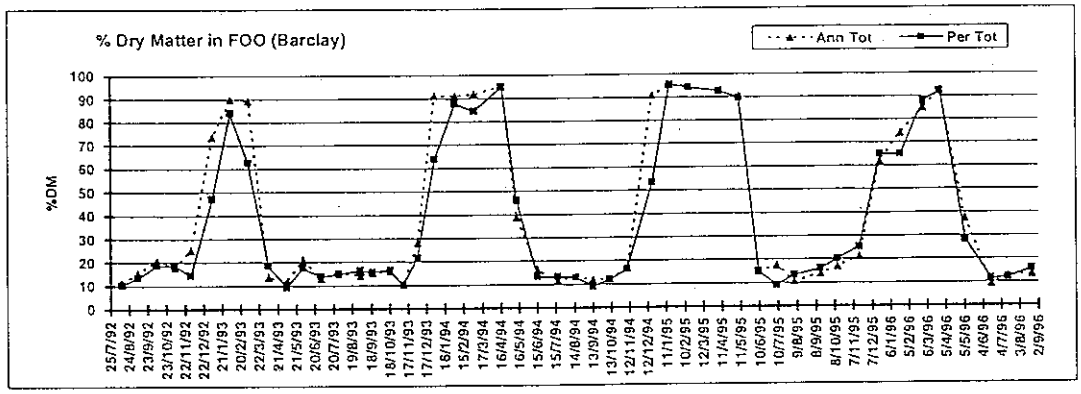
	26/6/92	6/4/93	18/4/94	8/6/95	27/3/96
Pacific ryegrass		39	39	12.5	7
Triumph fescue		1	1	0	0
OVERALL	82	40	40	12	7

Pasture composition:

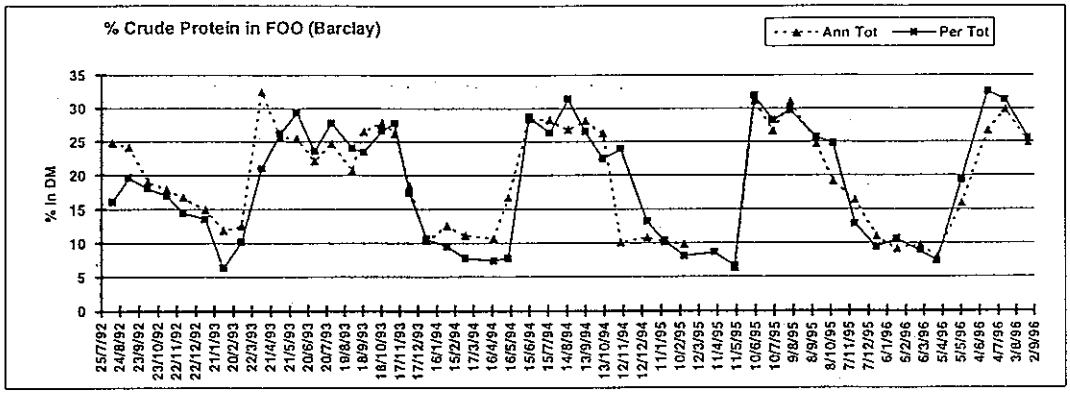


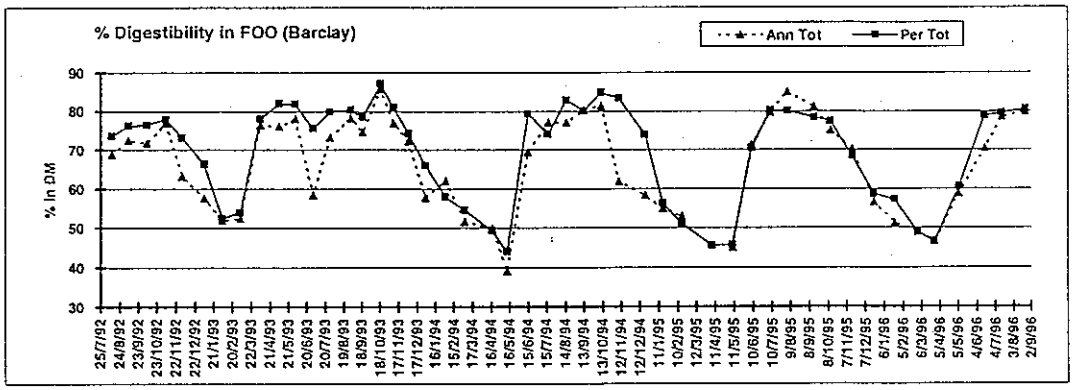
Quantity and Quality of Feed on Offer



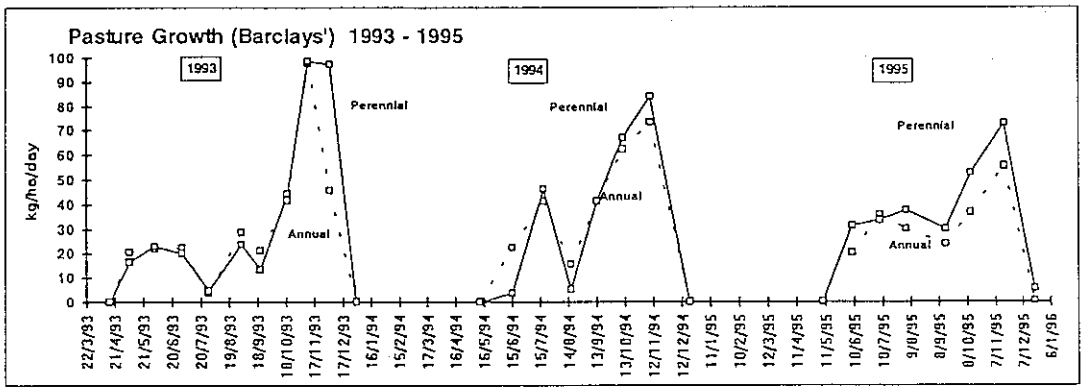


Appendix XI

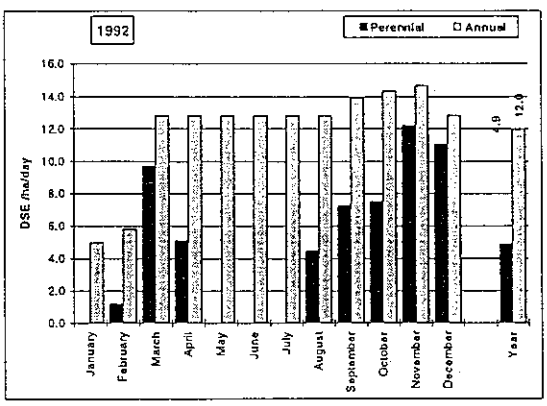


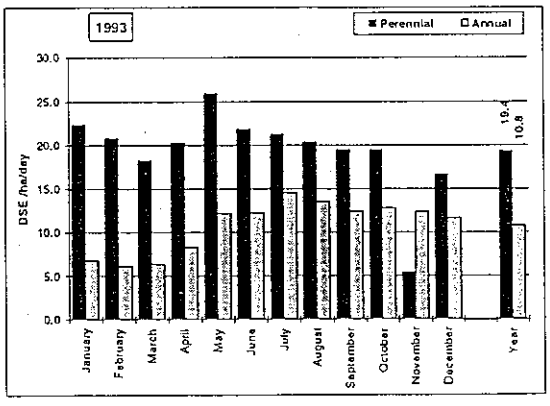


Pasture growth on the two paddocks:

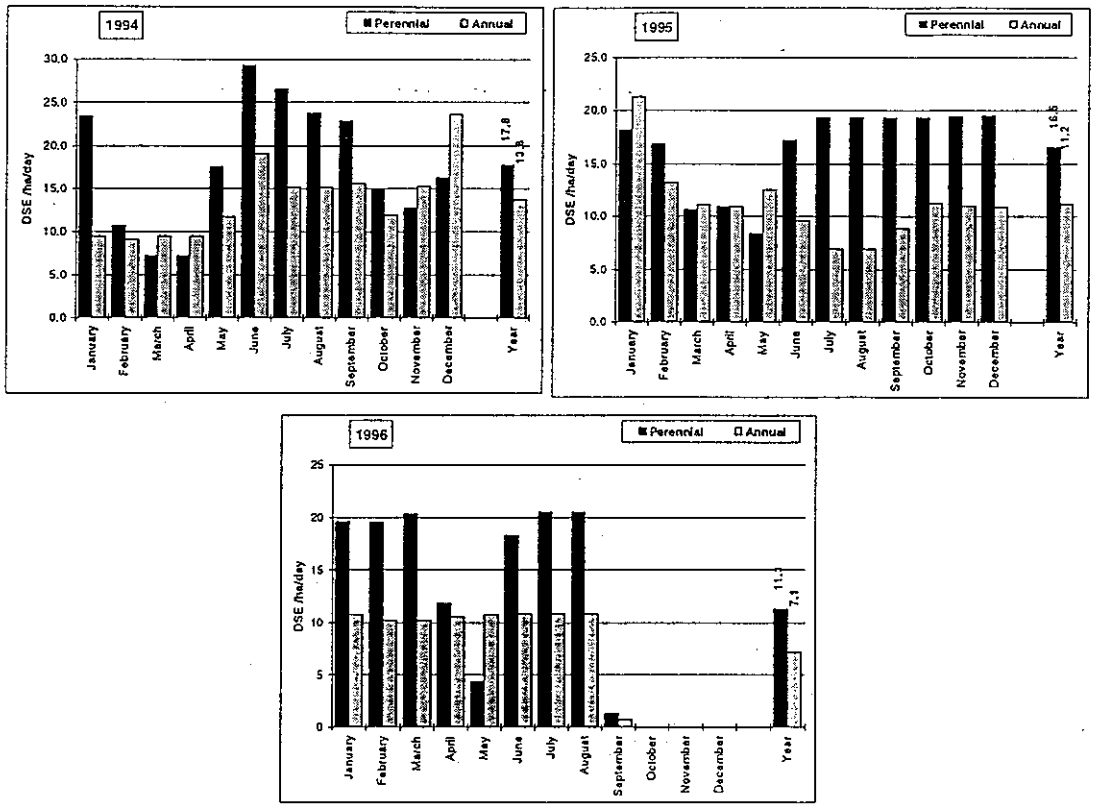


Estimated Average Grazing Pressure each month during the project:

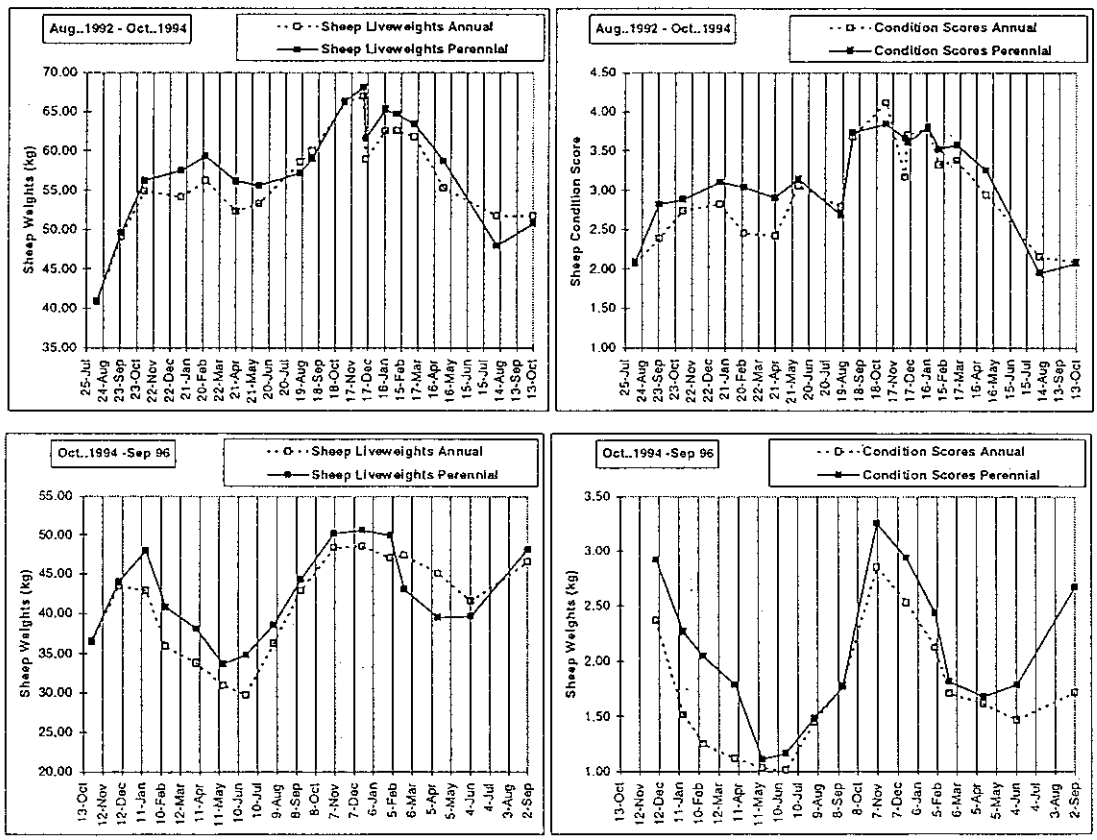




Appendix XI



Weight and condition of score sheep in the different paddocks:



Appendix XI

Summary of wool data

		1992/3	1993/4	1994/5	1995/6
Period of wool growth.....Start		23/12/92	11/12/93	26/10/94	19/1/95
.....End		8/12/93	17/10/94	19/1/95	19/2/96
Greasy wool production (g/hd)	Annual	6083	3708	1358	4181
	Perennial	5861	3750	1386	4582
Yield (%)	Annual	72.9	69.0	66.7	70.7
	Perennial	73.4	72.6	70.6	72.2
Staple length (mm)	Annual	108	85	34	94
	Perennial	115	86	40	100
Staple strength (N/Ktex)	Annual	36	19	16.6	17.9
	Perennial	48	26	16.1	17.2
Point of break (from tip)	Annual	25	52	na	21
	Perennial	41	58	na	23
Date of break	Annual	19-Mar	21-Apr	na	11-Apr
	Perennial	6-May	15-Apr	na	20-Apr
Fibre Diameter (mean)	Annual	24.1	20.7	19.0	19.4
	Perennial	23.6	21.3	18.9	19.7
Hauteur (mm)	Annual	88	59	65	68
	Perennial	93	63	66	71
cV Hauteur	Annual	44	55	52	51
	Perennial	43	53	52	52
Clean wool production (kg/ha)	Annual	48.4	33.1	14	15.9
	Perennial	75.7	53.2	11	33.9
Sheep stocking rate (/ha)	Annual	10.8	12.9	20.7	10.5
	Perennial	17.5	19.4	15.2	16.7
Wool growth period (days)	Annual	350	310	85	396
	Perennial	350	310	85	396
Clean wool growth rate (g/hd/day)					
summer	Annual	13.5	10.9	7.9	6.1
	Perennial	16.4	12.3	8.9	7.7
autumn	Annual	11.0	4.5	na	5.3
	Perennial	10.6	5.6	na	5.4
winter	Annual	13.5	4.5	na	8.4
	Perennial	11.3	5.6	na	9.7
spring	Annual	13.1	10.5	na	13.1
	Perennial	13.3	9.3	na	12.5

Results

1992

Rain: 965 ml. A good germination occurred in early April but the break of season was not until the second week in May. Reasonable falls carried through until mid November.

The newly sown pasture established well. In early spring the **annual pasture** was **clover dominant** (55%) with cape weed (21%) thistle (7%) and winter grasses (7%). The paddock sown to **perennials** comprised mainly the sown **Pacific ryegrass** (54%) and crassula(31%) and only **7% clover.** By late June the perennial plant count was **80/sq m.**

Average year round grazing in the perennial paddock was about **40%** (4.9 DSE/ha) that in the annual paddock **(12 DSE/ha).**

Sheep in the perennial paddock were heavier by December than those in the annual paddock. No wool data was available for 1992.

1993

Rain: 829 ml. The break of season was in mid March followed by a dry April and there was little rain after early October.

By spring **clover** in both paddocks was around **50%** of the feed on offer. However in the annual pasture **winter grass** (**31%**) and chickweed (9%) were the other main components while in the perennial paddock **Pacific ryegrass** (**21%**) and winter grass (19%) were. Perennial plant counts were **40/sq. m**.
The lighter grazing pressure during 1992 resulted in high levels of dry matter over the early part of 1993. Grazing pressures of 20 DSE/ha were maintained from January till October on the perennial paddock. Over the year the **perennial paddock (19.4 DSE/ha)** carried twice the number of sheep as the **annual paddock (10.8 DSE/ha).** In addition to this the sheep in the **annual paddock were supplemented** with **43kg/ha of hay** and **50 kg/ha of barley lupin** grain mix while the sheep on the perennial pasture were not supplemented.
Live weight of core sheep in the perennial paddock remained higher than those in the annual paddock until June and again from October to the end of the year. Of the three years recorded production of greasy wool production per head and clean per ha was highest in 1993 **(Per. 5.9 kg/hd, Ann. 6.1 kg/hd and Per.75.7 kg/ha, Ann. 48.4 kg/ha),** a result of the early break to the season. The wool from the sheep grazing the perennial paddock had a similar fibre diameter but was stronger **(48 vs 25 N/Ktex)** than that from the annual pasture. This years wool was thicker and stronger than in later years. Wool growth rate tended to be greater in summer, lower in winter and similar in the other seasons in the perennial paddock compared with the annual paddock.

1994
Rain: 633 ml. The break of season was not until the mid May and little rain was received after mid October.
By spring, **clover** in both paddocks was between **55 and 60%** and winter grass around 15% of the feed on offer. However the annual pasture had more chick weed, cape weed and thistles than the perennial pasture with its **13% Pacific ryegrass.** Perennial plant counts were had remained at **40/sq. m**
25% more grazing
The perennial ryegrass pasture again supported a higher stocking rate (25%) year round than the annual pasture, **17.8** and **13.8 DSE/ha** respectively. To achieve this **465kg of hay and 64kg of oats** per hectare was fed into the perennial paddock and **292kg hay and 225kg of oats and lupins** per hectare into the annual paddock (approx. **283 kg vs 320 kg** digestible energy).
The first draft of sheep, allocated in August 1992 were sold in October off shears and replaced by another allocation. The sheep on the perennial pasture were heavier through summer and autumn but lighter during winter than those on the annual paddock. The **10 months** of greasy wool yield per head from these sheep was **3.7 kg/hd** from each paddock but production of clean wool per ha was greater from the perennial paddock (**53 vs 33 kg/ha**). Wool from both paddocks was of similar diameter (**21.3 vs 20.7 microns**) but that from the perennial paddock was stronger (**26 vs 19 N/Ktex**). Wool growth rate tended to be greater in summer/autumn and winter in the perennial paddock but lower in spring than in the annual paddock.

1995
Rain: 718 ml. The break of season was not until the mid May. Patchy falls occurred from September to mid November and heavy falls in late December
The **clover** content in the annual pasture ranged between **10 and 15%** compared with **15 to 30%** in the perennial pasture. However both pastures were dominated by **winter grass** (**around 50 %** of each sward)the perennial ryegrass only made up around 5% of the sward in the perennial paddock and numbers of plants in June had declined to **12/sq.m.**
Even though the perennial component of this pasture was now low this paddock still supported a higher stocking rate year round than the annual pasture, **16.5** and **11.2 DSE/ha** respectively and had higher levels of feed on offer during spring and summer.

To achieve this **368 kg of hay** and **116 of lupins** per hectare was fed into the perennial paddock and **419 kg hay, 4 kg of oats** and **166 kg lupins** per hectare into the annual paddock.

Throughout 1995 the core sheep weights in the perennial paddock were greater than those in the annual paddock and the condition of both groups came close to a condition score of 1 in May/June, the lowest in the duration of the study. Of the 3 years wool this was the finest and weakest wool, with little difference between the two paddocks.(**19.7, 19.4 microns and 17.2, 17.9 N/Ktex**).

1996

Rain: 705 ml. Patchy rains occurred through May with the break occurring in mid June. However patchy rain carried on from late October to early December.
In August the pasture composition of both paddocks was similar to 1995, but with higher proportions of **clover**(annual paddock **25%** and perennial paddock **38%**) and the perennial plant numbers had declined further to **7/sq.m.**
Up to the end of the study at shearing in September the perennial paddock had again carried a higher stocking rate than the annual pasture, **16.9** vs **10.6 DSE/ha** respectively. Feeding data for this year is not available.
Weights of the core sheep in 1996 up to the end of the study were greater in the annual paddock than the those in the perennial paddock. No wool data was collected over this period.

SUMMARY

Sowing perennials in this study were associated with the need to renovate an annual pasture heavily infested with thistle and dock. Following a cropping phase, Pacific perennial rye grass was well established in autumn 1992. The Triumph tall fescue sown with the rye grass failed to establish.
Annual rainfall over the life of the study varied from 633 to 960 mm. The most productive year was associated with a break to the season in March 1993, the years after 1993 were typified by very dry summers and late breaks in May and June.
Use of 150 kg/ha of super potash 3:1 was not sufficient to arrest the decline in soil phosphorus levels over the life of the project. However the phosphorus levels by 1996 of 31 ppm are considered adequate for normal production.
The perennial component of the perennial pasture declined over the years to a negligible amount in 1995 and 1996 of about 5% of the FOO and less than 10 plants/sq m. The legume component of both paddocks was depressed in 1995 but was high in the early years and acceptable in 1996 at about15 to 30% of the swards. The very late seasons of 1994 to 1996 encouraged the dominance of winter grass by 1996 in both paddocks. During spring and summer in all years there was more FOO in the perennial than the annual paddock. and
Performance of sheep in terms of liveweight, grazing pressures, wool growth and wool quality favoured the perennial pasture. However direct comparisons need to take account for the different levels of supplements fed.

APPENDIX XII Producer Demonstration Site

Bill & Kay Degens Trial Number: 92AL31

Map-Reference: 574000 mE, 6156000 mN, Zone 50 (Map 2428-I)

Narrikup **Area:** Annual Paddock 14.5 ha (36 acres)
Perennial Paddock 11 ha (27.2 acres)

Base Pastures:

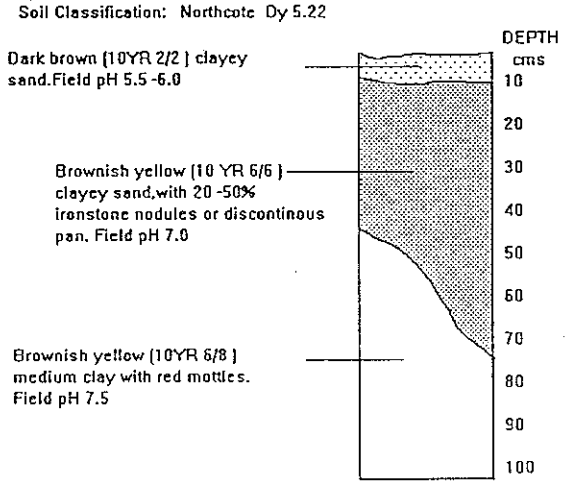
Annual Paddock In August 1992 predominantly subclover (63%) with about 20% of annual grasses(mainly winter grass) and of weeds (mainly cape weed).

Perennial Paddock Following sowing in May 1992 (22/4 sprayed with 1.5l *Sprayseed*; 3/5 direct seeded with 3.6kg **Brumby Rye**, 3.6kg **Triumph fescue**, 10kg sub clover mix Esperance and Trikkala varieties per hectare; 17/5 applied 50ml *Lemat* and *Rogor* on 2/11)
In August predominantly sub clover (80%) with 3% winter grass, 6% weeds (mainly cape weed) and about 11% grasses which included the perennial species and annual ryegrass.

Animals: A base flocks of 40 ewes, 20 each of 18 month old and 30 month old were run continuously on each paddock for the life of the trial. These sheep were weighed and condition scored regularly and wool production was weighed and assessed at shearing. Other farm stock (mainly sheep) were added to and taken from the paddocks during the course of the project at the farmers discretion.

Soil Description:....Dy 5.22

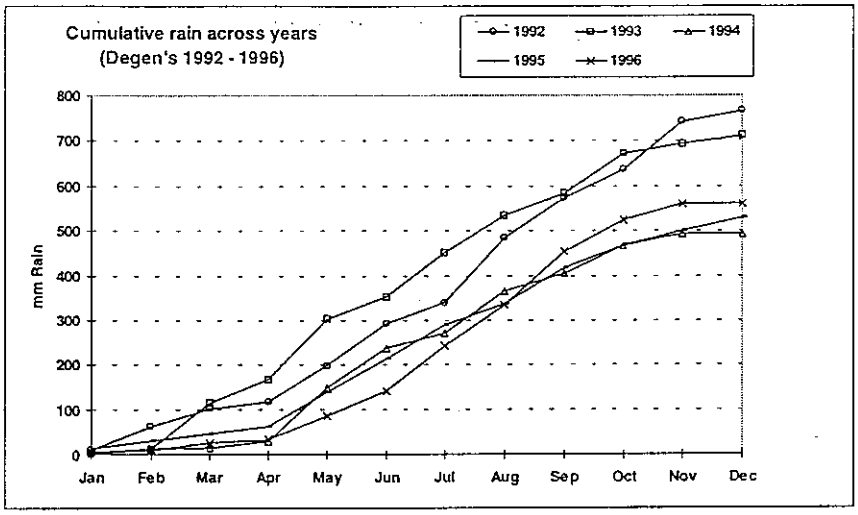
A Typical Profile.....:



Down to:	Description	pH	% gravel
10cm	Dark brown **clayey sand,** not hard setting	5.5 - 6.0	
45 - 80cm	Brownish yellow **clayey sand.** With gravel or discontinuous pan	7.0	20 - >50
>100 cm	Brownish yellow medium **clay** with mottles.	7.0 - 7.5	

Appendix XII

Cumulative rainfall patterns over the 5 years have been:



Analyses of top 10cms of soil before and at the end of the study:

Soil Test :CSBP analysis	Date:	Mar 1992.		15 Feb 1996	
		Annual	Perennial	Annual	Perennial
Nitrogen :Nitrate	ppm	30	30	30	30
Ammonium	ppm	12	4	20	13
Phosphorus	ppm	47	60	57	49
Potassium	ppm	356	133	249	186
Sulphur	ppm	NA	NA	15	12
Organic carbon	%	4.27	3.81	4.13	3.70
	Status	V.Good	V.Good	V.Good	V.Good
Reactive Iron (ppm)	ppm	1981	1571	1919	1700
	Status	V.High	V.High	V.High	V.High
Salt	E.C dS/m	0.29	0.17	0.16	0.16
	Status	V.Low	V.Low	V.Low	V.Low
pH	(1:5 $CaCl_2$)	5.0	4.4	4.8	4.9
	(1:5 Water)				
	Status	Normal	Low	Normal	Normal

Fertiliser applied:

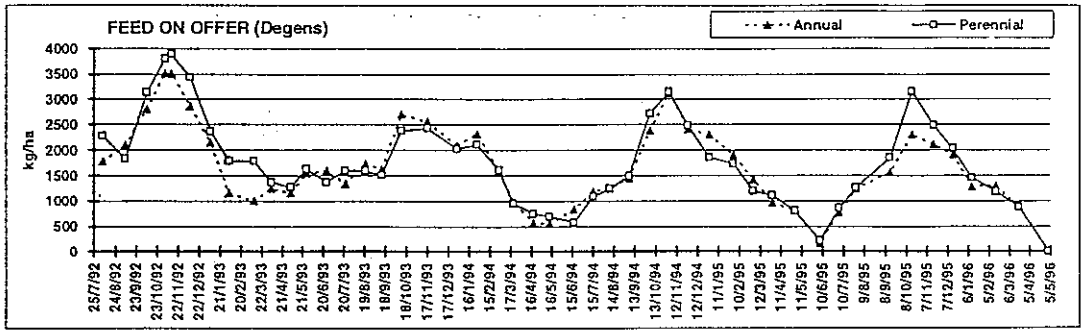
Date	Fertiliser	Amount (kg/ha)	Comments:
15/4/92	Lime	2500	(Perennial)
31/7/92	Gypsum	57	(Perennial)
May 1992	Superphosphate	100	At sowing of perennial
1992	Gypsum	57	(Annual)
10/9/93	Gypsum	57	(Perennial & annual)
3/7/94	Superphosphate	203	(Perennial & annual)
30/6/95	Superphosphate	203	(Perennial & annual)

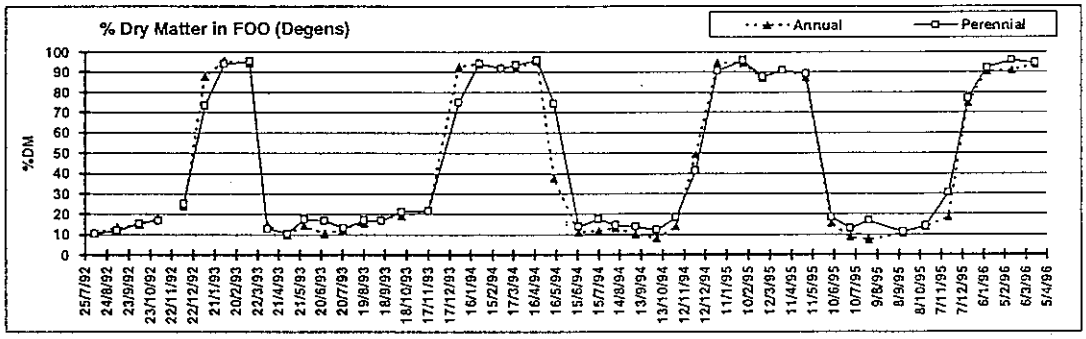
Counts of perennial plants (Plants/sq m)

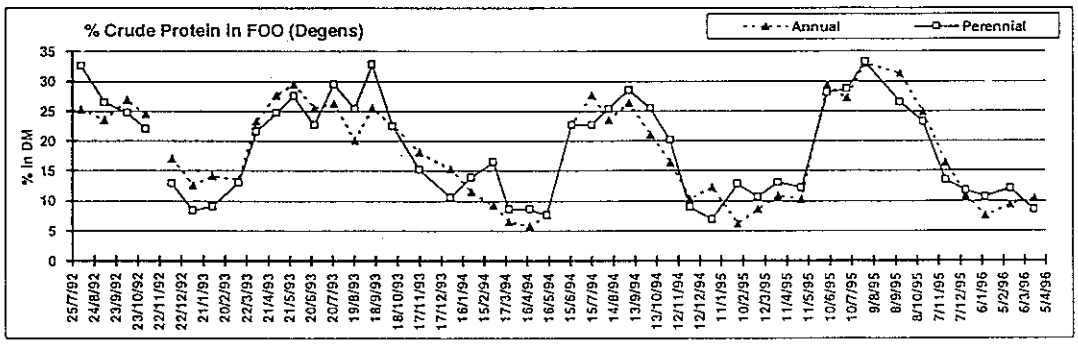
	26.6.92	5/4/93	13/5/94	6/6/95	15/1/96	12/8/97
Brumby Rye grass		38	18	11	5	0
Triumph Fescue		14	0	0	0	0
Total	81	52	18	11	5	0

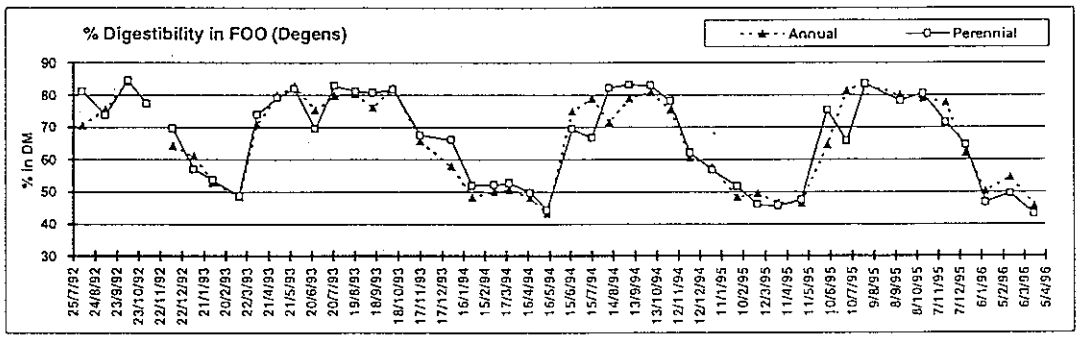
Appendix XII

Quantity and Quality of Feed On Offer (FOO).

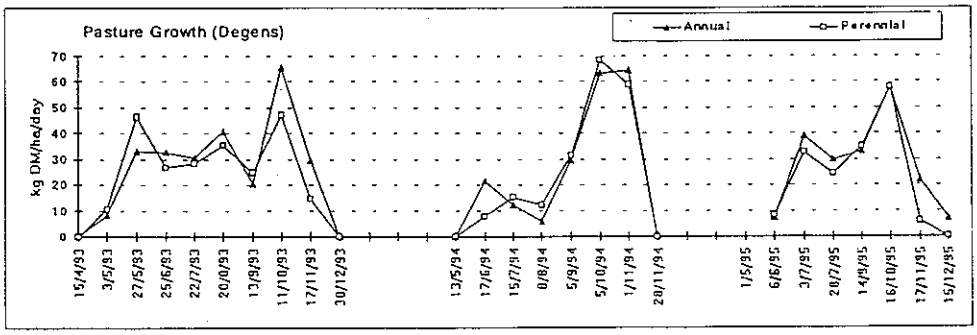






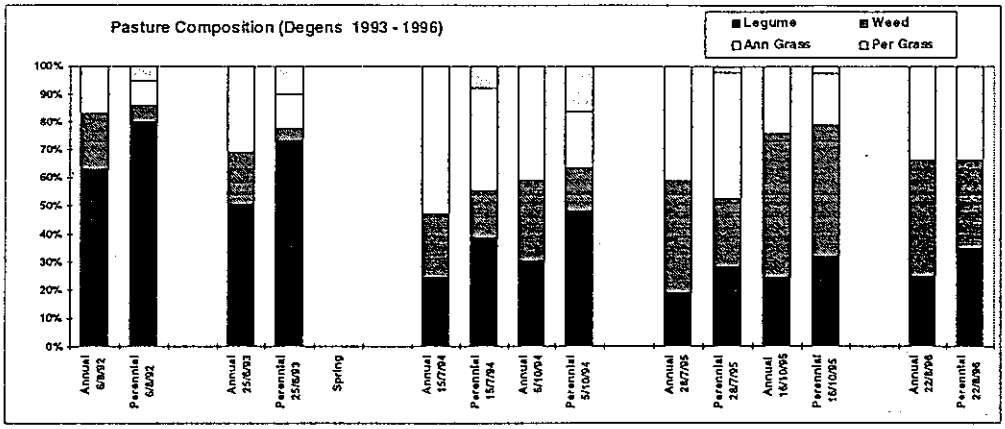


Pasture growth on the two paddocks:

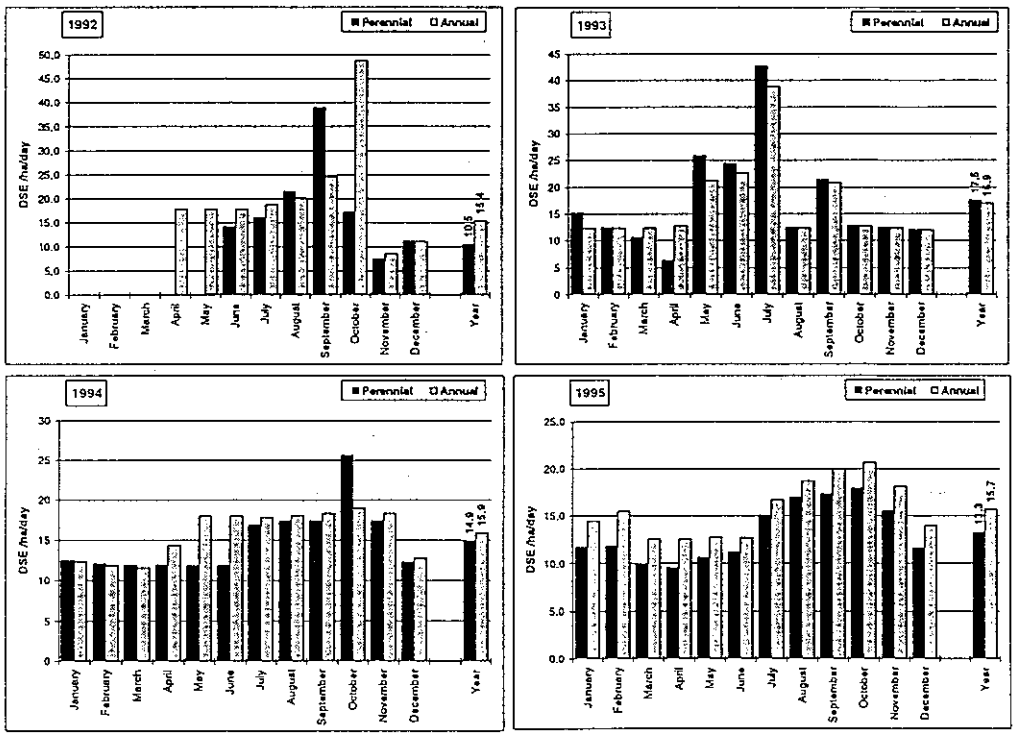


Appendix XII

Pasture composition



Estimated average grazing pressure each month during the study:



Quantities of hay and grain fed:

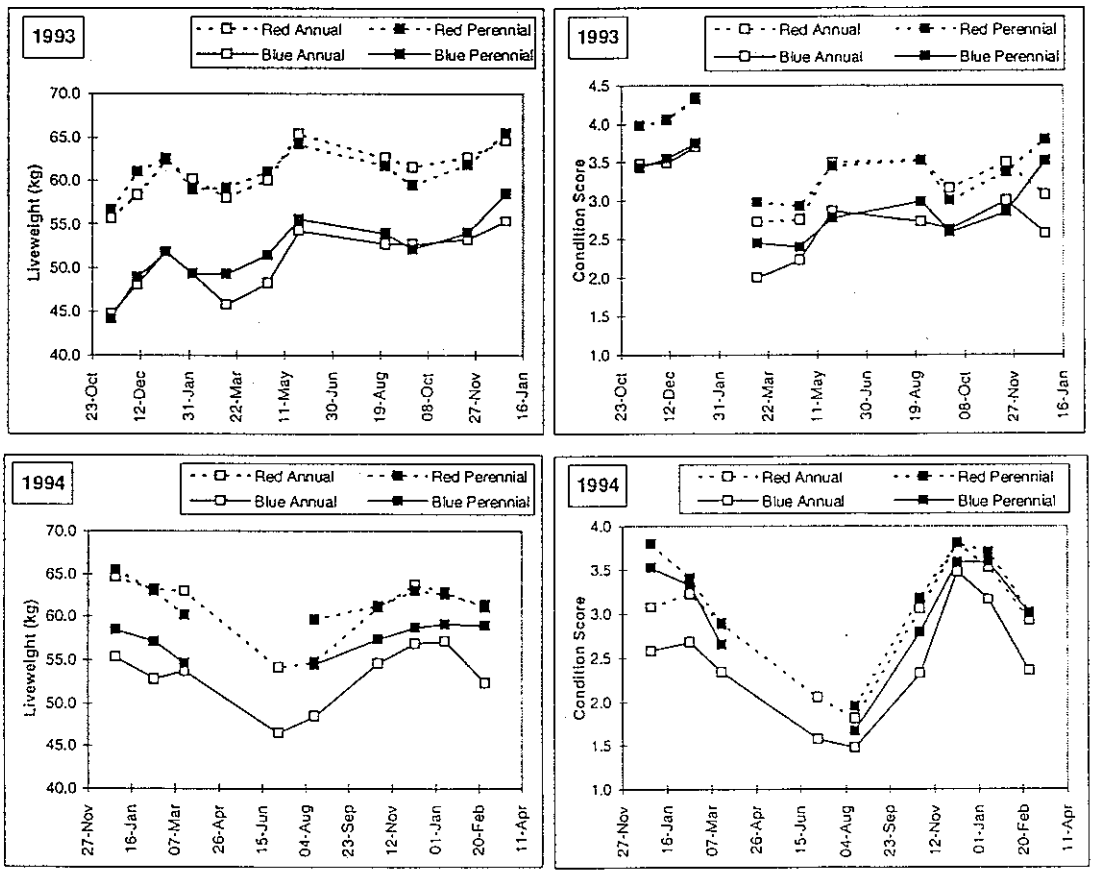
Year		kg/ha Hay	kg/ha Grain	%Oats	%Lupin
1992	Perennial	90			
	Annual	68			
1993	Perennial	120			
	Annual	68			
1994	Perennial	2040	281	100	
	Annual	1138			
1995	Perennial	1890	341		100
	Annual	2184	72		100
			482	80	20

NOTE: the high levels of hay and grain fed in 1994 and 1995 was during February to July.

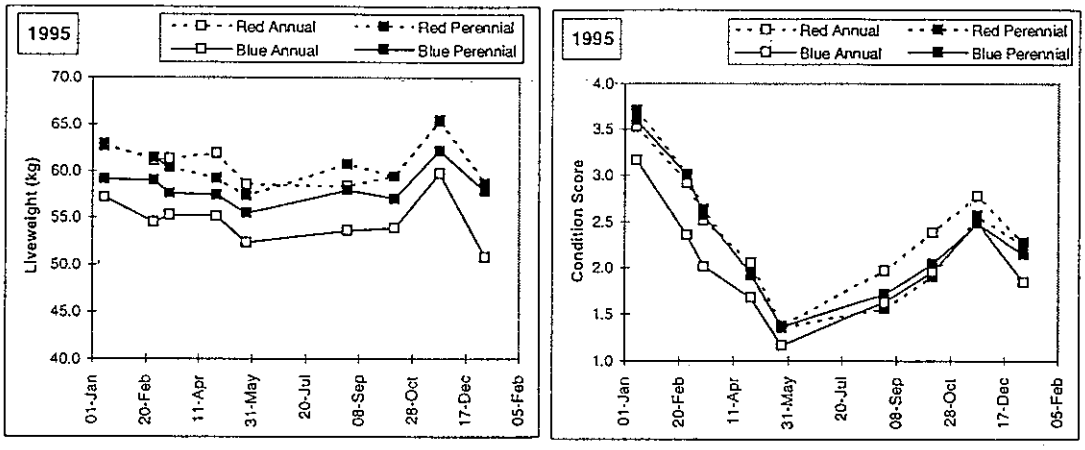
Sheep treatment program

Date	Treatment	Perennial	Annual
12/12/92	Nilverm	15 mls	
4/2/93	Valbazen	15 mls	15 mls
12/4/93	Valbazen	15 mls	15 mls
27/5/93	Cheesy Vac.		
20/10/93	Valbazen	15 mls	15 mls
10/1/94	Valbazen	15 mls	15 mls
6/6/94	Valbazen	15 mls	15 mls
7/1/95	Closal	15 mls	15 mls
10/5/95	Closal	15 mls	15 mls

Liveweight and condition scores of sheep:



Appendix XII



Sheep in the perennial paddock were not weighed in June 1994 because they were in the middle of lambing. The lambing dates were different for the ewes in the two paddocks in that year.

Summary of wool data:

		1992/3	1993/4	1994/5
Greasy wool production (g/hd)	Annual	5797	4322	5466
	Perennial	6364	4654	5708
Yield (%)	Annual	75.1	76.0	78.0
	Perennial	74.4	78.2	78.6
Staple length (mm)	Annual	61	89	90
	Perennial	76	94	103
Staple strength (N/Ktex)	Annual	na	22	29
	Perennial	na	26	33
Point of break (from tip)	Annual	na	68	66
	Perennial	na	71	71
Date of break	Annual	na	6-Apr	1-Jun
	Perennial	na	21-Apr	18-May
Fibre Diameter (mean)	Annual	23.0	20.9	22.8
	Perennial	24.0	22.1	23.6
Hauteur (mm)	Annual	na	60	66
	Perennial	na	65	74
cV Hauteur	Annual	na	57	54
	Perennial	na	56	54
Clean wool production (kg/ha)	Annual	30.0	21.2	27.5
	Perennial	31.1	23.6	23.0
Sheep stocking rate (/ha)	Annual	7.0	14.5	15.3
	Perennial	6.6	13.1	10.8
Wool growth period (days)	Annual	335	316	383
	Perennial	335	316	383
Clean wool growth rate (g/hd/day)				
spring	Annual	16.2	18.3	21.6
	Perennial	17.6	19.7	22.8
summer	Annual	16.2	7.6	11.2
	Perennial	17.6	9.7	11.9
autumn	Annual	11.8	6.5	7.3
	Perennial	13.1	8.4	7.7
winter	Annual	11.0	10.0	7.6
	Perennial	11.9	na	7.7

Results

1992

Rain: 765 ml. Break of season mid/late May and little rain after mid November Base pasture and the newly sown pasture established with high proportions of **legumes (60-80%).** Sowing the perennial grasses in May reduced the weed component and provided a good perennial plant count of approximately **80/sq.m.** by late June

Following establishment the perennial pasture was grazed at more than **15 DSE/ha** during the growing season from June, little less than the annual pasture. Though this did not seriously deplete the perennial plant numbers in the first year it restricted their size by the first summer. Project sheep were allocated on 11 November and no earlier performance was recorded.

1993

Rain: 711 ml Break of season mid/late March though April was fairly dry and little rain after mid October. By autumn the perennial plant counts were **52/sq.m.**, 25% of which were Triumph fescue and by June the perennial component made up approx 10% of the sward. Proportions of sub clover were still high in both swards at approx. 50 and 70%, with winter grass making up 25% of the annual sward.

The average carrying capacity of the perennial and annual pastures was similar at **17.5** and **16.9 DSE/ha** respectively.

The early break ensured both age groups of sheep on both treatments maintained a **condition score** of better than **2** throughout the year. During autumn the **younger sheep** tended to perform a little better on the perennial pasture than on the annual.

Of the three years recorded, this year resulted in the highest yield of greasy wool per hd and clean wool per ha (**Per. 6.4, Ann. 5.8 kg/hd and Per. 31.1, Ann 30.0 kg/ha**), a result of the early break to the season and reflected in the growth of wool in autumn. The wool was shorter (**Per. 76 and Ann. 61 mm**) than other years probably a result of younger sheep, while the yield of clean wool (**Per. 74.4 and Ann. 75.1 %**) and the fibre diameter (**Per. 24 and Ann. 23 microns**) tended to be respectively lower and higher than the later years. In this year more hay was fed to animals in the perennial paddock than to those in the annual paddock (respectively **120 and 68 kg/ha**).

1994

Rain: 492 ml. Break of season mid May with little rain after mid October. By May the perennial plant numbers were a third (**18/sq.m**) of the previous year's count with no fescue recorded. The perennial component of the pasture was between 8 and 15% of the FOO between winter and spring. The proportion of legume was lower than the previous year at around **25% (annual** pasture) and **45% (perennial** pasture). In both pastures winter grass was about 20% of the sward.

The annual average carrying capacity of the perennial and annual pastures was similar at **14.9** and **15.9 DSE/ha** respectively.

Sheep on the perennial pasture were heavier through the winter /spring months than those on the annual pasture.

Greasy wool per hd and clean wool per ha (**Per. 4.6, Ann. 4.3 kg/hd and Per. 23.6, Ann 21.2kg/ha**) was low, a result of the short growing season. The short season was

also reflected in the large amount of supplements fed (ie **Per. 2 t hay plus 281 kg oats** and **Ann. 1.1 t hay** per ha). All the important wool parameters favoured the perennial paddock compared with the annual paddock (see table above) **but** sheep were run at a slightly lower stocking rate and were fed more supplements on the perennial paddock.

1995

Rain: 528 ml. Break of season mid May with patchy rains after mid October to mid December. Perennial plant counts declined further to **11/sq.m** with perennials making up less than 5% of the sward. The legume component also declined further to around **22% (annual** pasture) and **30% (perennial** pasture), cape weed became dominant at around 35% (annual pasture) and 39% (perennial pasture).
The carrying capacity of the perennial pasture was lower than the annual every month, at annual averages of **13.3** and **15.7 DSE/ha** respectively.
The younger sheep on the perennial pasture maintained their heavier weight throughout the year compared with those on the annual pasture.
Greasy wool per hd and clean wool per ha **(Per. 5.7, Ann. 5.5 kg/hd and Per. 23.0, Ann 27.5kg/ha)** again reflected the very late break to the season. Also the short season resulted in the large quantities of supplements having to be fed (ie **Per. 1.9 t hay plus 341 kg grain** and **Ann. 2.2 t hay plus 554 kg grain** per ha). Again all the important wool quality parameters favoured the perennial paddock when compared with the annual paddock (see table above), though sheep were run at a lower stocking rate they were also fed less supplements on the perennial paddock.

1996

Rain: 589 ml. The break of season was at the end of May with patchy rains after October to mid December. Perennial plant counts declined further to **5/sq.m** with perennials making up a negligible proportion of the sward. The legume component was around 25% (**annual** pasture) and 35% (**perennial** pasture), annual grasses at 35% in both paddocks and the rest weeds, mainly cape weed and dock.

SUMMARY

Perennial grasses (Brumby perennial rye and Triumph fescue) were not successful at this site and by 1996 had disappeared from the area sown in autumn 1992. The main reasons for this are considered to be:

- the relatively high grazing pressure in the year of establishment, preventing the development of plant size
- the succession of late breaks and very dry summers (1994, 1995, 1996) with continued high grazing pressures.

Comparing production between paddocks can only be done realistically on a $ basis because differences in animal performance are not only related to the perennial grass content of one paddock but also to the grazing pressure and the amount of supplements fed. It is doubtful that the low perennial plant component of 10 to 15% in 1994 and 5% in 1995 affected production much?

APPENDIX XIII — Producer Demonstration Site

Kevin & Lyn. Forbes	**1993-1994**	Trial Number	93AL28
Ivan & Sharon Chapman	**1995-1996**		
Australian Forest Holdings.	**1996**		

Map Reference: 538000 mE, 6156000 mN, Zone 50 (Map 2328-I)

Denbarker

Area:		
	Annual	10.1 ha (24.9 ac)
	Perennial	10.1 ha (24.9 ac)

Base Pasture The area used commenced as a single paddock. The paddock was cropped to lupins in 1992 and the stubble was well grazed by sheep over summer, the remaining stubble was windrowed and burnt in autumn. The area was divided in two and following good, late March rains the respective areas were developed as follows:

Annual Paddock: Denmark and Trikkala sub clovers each at 2.5kg/ha and annual rye grass *seconds* were combined into the **annual** area at the end of April. With follow up rain this provided quick early feed in this paddock.

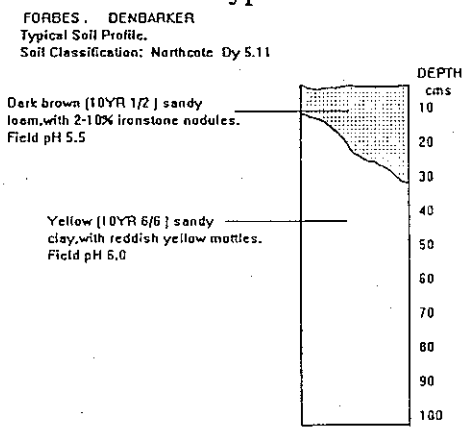
Perennial Paddock: Following the early germination the area was sprayed with Roundup (early April) and cultivated with a combine in mid April followed by a light working again later in April. On May 6, using a combine with the tines just touching the ground plus following finger harrows the area was sown to Triumph fescue (4.4kg/ha), Porto cocksfoot (1.8kg/ha) and Roper rye (4.4kg/ha) plus 2.2kg/ha each of Denmark and Trikkala subclover and oversown with oats.

Animals: From the start of the project steers (Shorthorn and Shorthorn x South Devon) were run on the trial areas until the property changed hands in January 1995. During this time they were regularly weighed and condition scored. Numbers varied over the period as they were sold for slaughter and replaced at the farmers discretion.

After the property changed hands (Jan 1995) dairy cross cows and their calves were grazed on the areas. These small paddocks were convenient to the house and were used as calving paddocks on a put and take basis by the new owners. Only grazing days and stock numbers were recorded May 1996 when the property again changed hands. At this stage the study was abandoned as the paddocks were destined to bluegum plantings.

Soil Description :... 5.11

Typical Profile



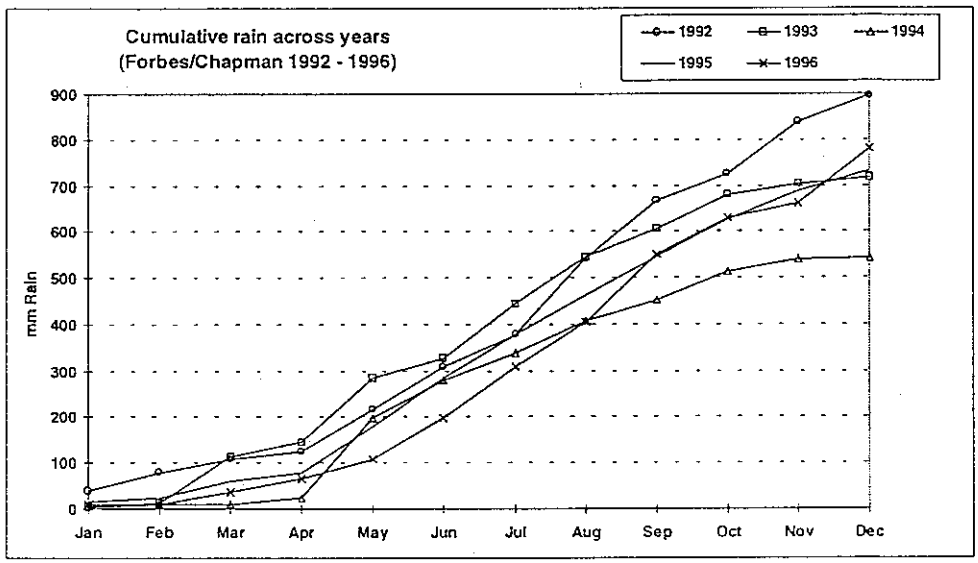
(Dy 5.11) Covering the annual paddock and about 80% of the perennial paddock.

Down to:	Description	pH	% gravel
10 - 30cm	Dark brown **sandy loam,** not hard setting	5.5	2 - 10
>100 cm	Yellow **sandy clay** with reddish yellow mottles.	6.0	

(Dy 5.21) Covering 20% of the perennial paddock.

Down to:	Description	pH	% gravel
25cm	Coarse Black **loamy sand,** (nodules)	3.4	2 - 10
80cm	Brownish yellow **clayey sand** (segregation)	5.5	2 - 10
>100 cm	Yellow **sandy clay** with pale yellow mottles	5.5	

Cumulative rainfall pattern over 5 years:



Analyses of the top 10cms of soil at the start and at the end of the study:

	Date:	12 Mar 1993.		21 Feb 1996	
Soil Test :CSBP analysis		Annual	Perennial	Annual	Perennial
Nitrogen :Nitrate	ppm	30	30	30	30
Ammonium	ppm	20	20	12	14
Phosphorus	ppm	54	24	73	50
Potassium	ppm	112	244	257	253
Sulphur	ppm	NA	NA	7	6
Organic carbon	%	4.30	3.76	3.56	3.246
	Status	V.Good	V.Good	V.Good	V.Good
Reactive Iron (ppm)	ppm	522	832	489	396
	Status	Medium	High	Medium	Medium
Salt	E.C dS/m	0.11	0.11	0.13	0.10
	Status	V.Low	V.Low	V.Low	V.Low
pH	(1:5 $CaCl_2$)	4.8	4.9	4.8	4.8
	Status	Normal	Normal	Normal	Normal

Fertiliser applied:

Date	Fertiliser	Amount (kg/ha)	Comments:
1992	Super	135	Lupin crop
6/5/93	Super : Potash 3 : 2	135	At seeding
1994	Super	135	
26/5/95	Super : Potash 3 : 1	200	
1996	nil		

No hay was conserved from either paddock during the life of the study.

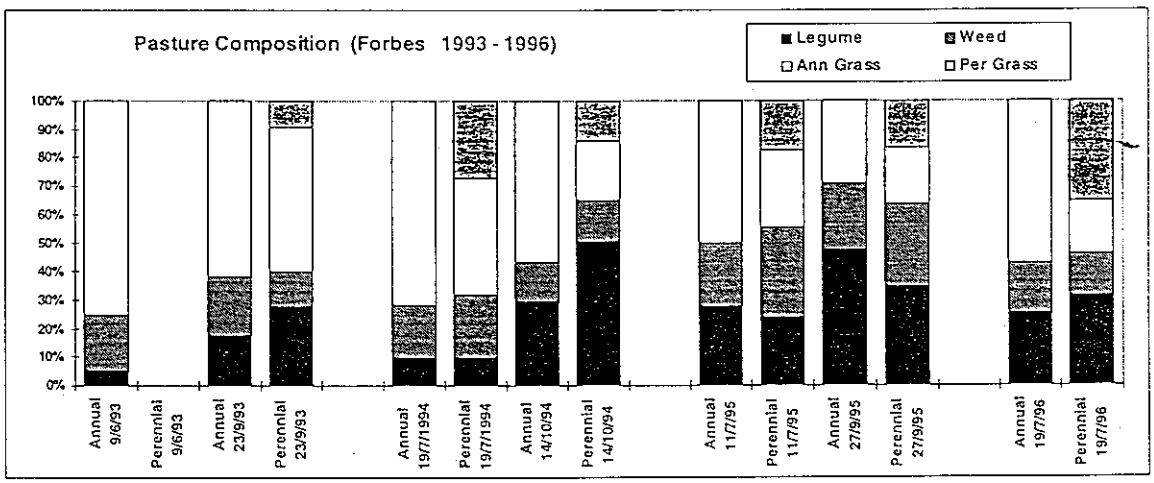
Quantity of hay fed.

Year	kg/head	kg/ha	Period
1994 Annual	1000	1782	3 bales/wk for 5 months
Perennial	1000	1782	3 bales/wk for 5 months
1995 Annual		440	1/4 to 22/7 (111d)
Perennial		832	28/2 to 9/4 (40d)

Counts of perennial plants (plants/sq.m)

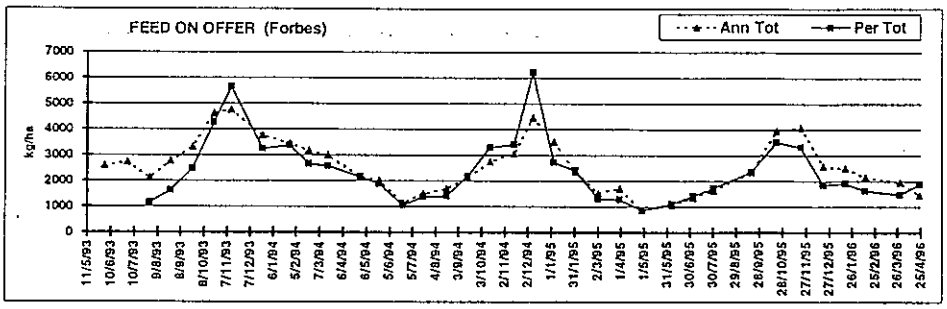
	18/5/94	9/3/95	12/8/96
Roper ryegrass	5	2	9
Porto cocksfoot	15	22	29
Triumph fescue	3	4	7
OVERALL	23	28	44

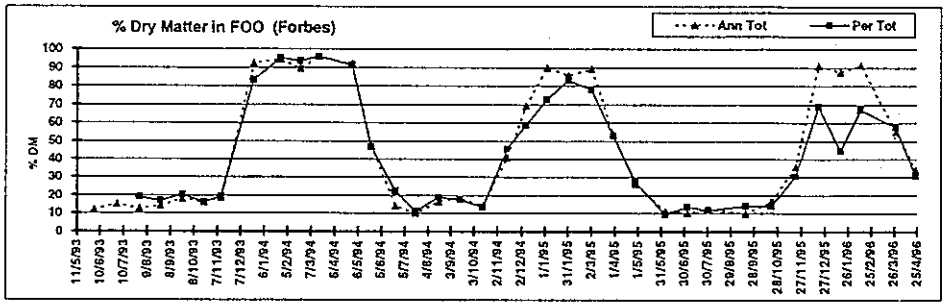
Pasture composition:

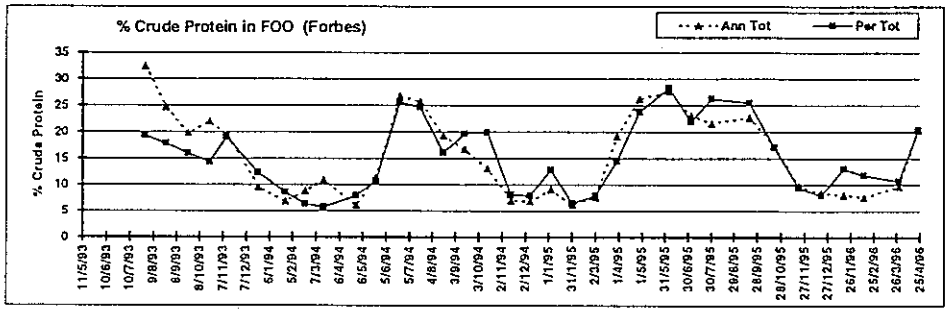


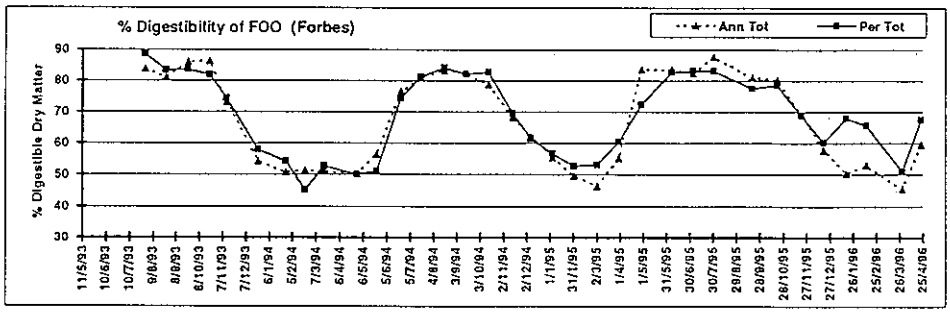
Appendix XIII

Quality and Quantity of Feed on Offer (FOO).

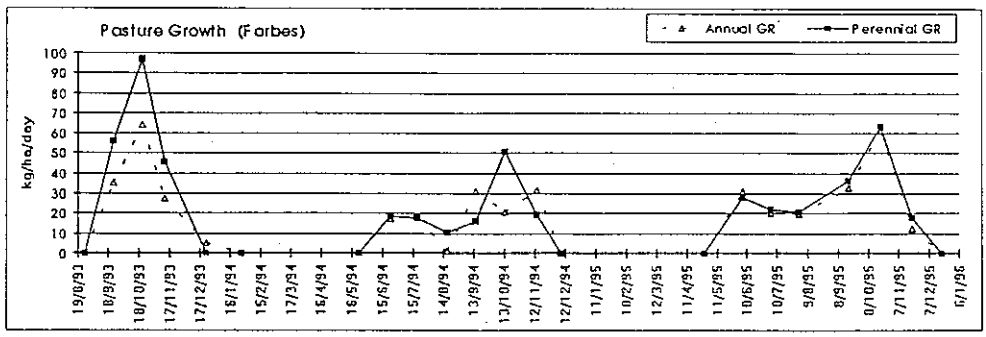






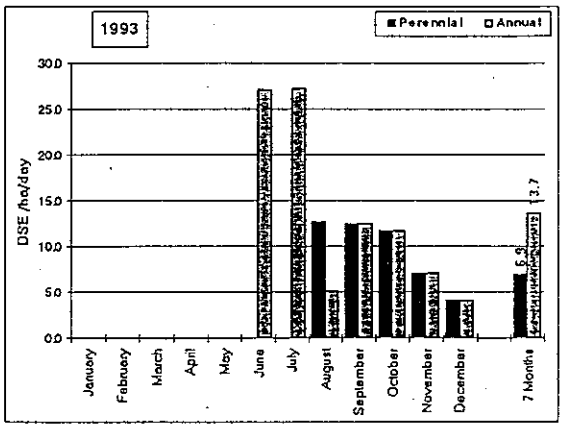


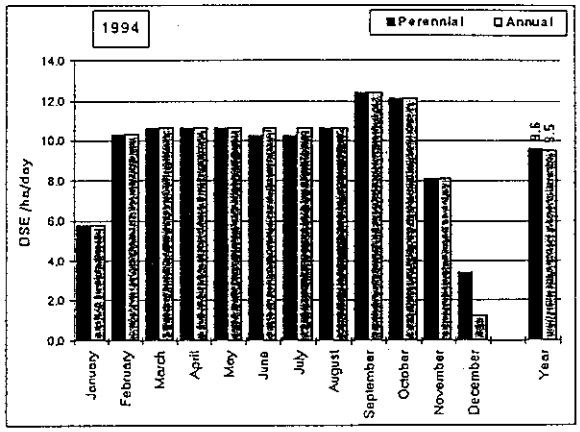
Pasture growth on the two paddocks:

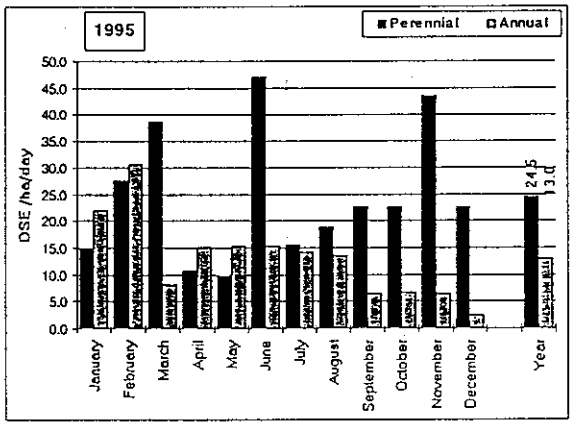


Appendix XIII

Estimated average grazing pressure each month during the project:





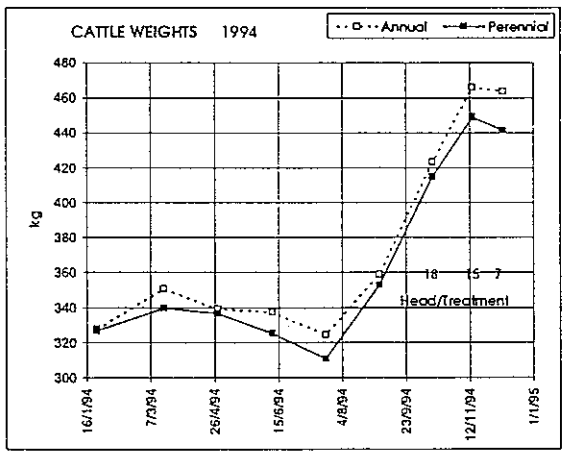


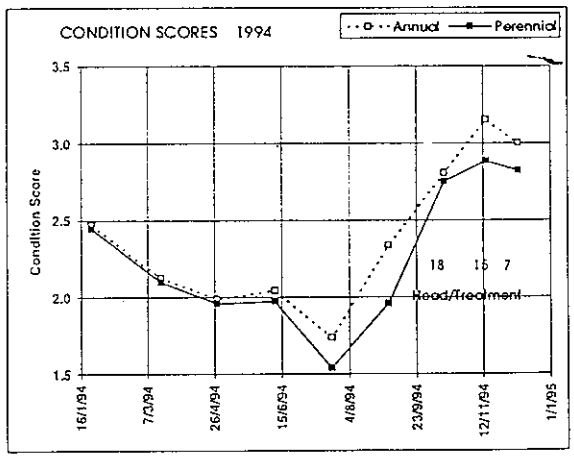
Performance of Cattle

1993

Liveweight gained 1/9/93 to 24/1/94	
Annual	Perennial
174.1 kg/ha	171.5 kg/ha

1994





Results

1993

Rain: 708ml. Break of season was in mid March followed by a relatively dry April, with little rain after the middle of November.

In early June the **annual** pasture was ryegrass dominant (70% of FOO) with 20% weeds and very little clover (4%), by spring the ryegrass had decreased to 60% and the clover increased to about 20%.

In June the **perennial** pasture was too sparse to assess, and by spring it comprised 25 - 30% clover, about 50% annual grasses and oats, about **10%** recognisable **perennial grasses** and the rest weeds.

Once the perennials emerged, a well defined area of approximately 20% of the perennial paddock showed up as yellowing of the monocotyledon plants. This section coincided with the more acid soil type. Over sown oats, and to a lesser extent the rye and fescue and least of all the cocksfoot were affected, while subclover looked healthy.

The **annual** pasture was stocked at double the planned rate from June 3 when the pasture exceeded **2500kg/ha**, from the start of September both areas were grazed about **12 DSE/ha**

From the start of grazing (June 3) approximately twice as much grazing was achieved on the annual than on the perennial paddock (**6.9 vs 13.7 DSE/ha**). However, liveweight gains from September 1 to January 24 were similar (**174.1 vs 171.5 kg/ha** for annual and perennial pasture respectively). The main production loss was incurred before September.

1994

Rain: 551ml. Break of season was in mid May with little rain after mid October.

The subclover component of both pastures was about **10%** in winter increasing to **30%** in the annual paddock and **50%** in the perennial paddock in spring. The sown perennial grasses made up **15- 30%** of the sward depending on time of year. Perennial plant numbers were low at **23/sq.m.**, with more than half being cocksfoot

FOO on both paddocks remained below 2000kg/ha until late September and excessive amounts of **hay** were fed into the paddocks (**1000kg/hd, 1782/ha**), a lot of which appeared to be wasted. Limitation on animal growth up to September was the low quantity of green FOO (pasture growth was less than 20kg/ha/day) and possibly low quality hay.

The average annual stocking rates on the two pastures were similar (**9.5 and 9.6 DSE/ha**). Equal numbers steers were turned off from each paddock in late October, November and December. Liveweight gained by steers over the year was 146kg/hd (**258 kg/ha**) on the annual paddock and 133kg/hd (**237 kg/ha**) on the perennial pasture.

1995

Rain: 732ml. The break of season was in mid May following a germination in late March. Little rain was received between early November and late December (~40mls).

The subclover component of both pastures was about **25%** in winter increasing to **45%** in the annual paddock and **35%** in the perennial paddock in spring. The sown perennial grasses made up **15- 20%** of the sward depending on time of year. There were **28 perennial plants/sq.m.**, 75% being Porto cocksfoot.

The annual average grazing pressure and the amount of hay fed on the perennial paddock were twice that on the annual paddock (**24.5 vs 13.0 DSE/ha and 832 vs 440 kg/ha** respectively). The high grazing pressure on the perennial pasture through spring are resulted in the low levels of FOO recorded through this period. Pasture growth for 1995 was almost twice that of 1994.

1996

Rain: 780ml. The break of season was not until mid June with rains carrying through to mid December. At the final assessment of pasture composition in July the subclover component of the annual paddock was **25%** and in the perennial paddock **30%**. The sown perennial grasses made up about **35%** of the sward most of which was Porto cocksfoot. There were **44 perennial plants/sq.m.**, 65% being Porto cocksfoot.

SUMMARY

The perennial grasses were slow to establish at this site, and it is the only site where we recorded an increase in perennial plant numbers during the study. Perennials, especially Porto cocksfoot were well represented in the perennial paddock at the end of the study. The paddock comparisons were compromised by the poor production from the highly acid 20% of the perennial paddock not identified in the crop stubble in the summer prior to the original subdivision.

In the first year approximately 50% of grazing was foregone (only 7 months recorded) through the process of establishing perennials and loss of grazing occurred before September.

1994 was the only year of continuous grazing, but it was a year of very poor pasture growth, and the very high level of hay fed may well have masked any paddock differences on animal performance.

APPENDIX XIV — Producer Demonstration Site

S. Neill 1992-1993 Trial Number 92AL32
Phil. & Nicole Chalmer 1993-1995
Hillboi Nominees 1995

Map Reference: 541000 mE, 6165000 mN, Zone 50 (Map 2328-I)

Denbarker **Area:** Annual 25.4 ha (62.7 acres)
Perennial 31.2 ha (77.0 acres)

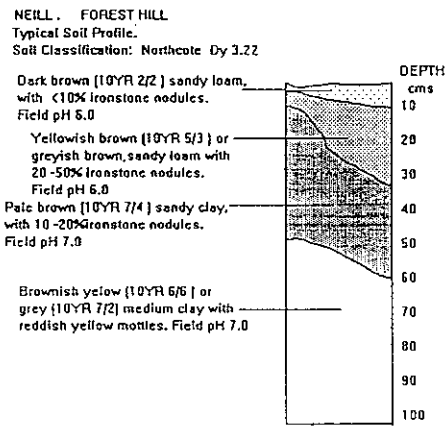
Base Pasture: **Annual Paddock:** In late winter 1992 this pasture comprised 70 % subclover with 20% annual grasses and 10% weeds.

Perennial Paddock: This area was cropped in 1991. Following germination in 1992 the area was sprayed with Roundup (600ml/ha) and Ally (3.5g/ha) on May 19. On May 27, using a Bettinson drill the area was sown in two sections: a low area (10ha) to Triumph fescue (3kg/ha), Sirosa phalaris (3kg/ha) and Roper rye (3kg/ha)and a high area (20ha) to Triumph fescue (5kg/ha) and Wana cocksfoot (3kg/ha). The paddock was also sprayed with Lemat (50ml/ha).

Animals From the start of the project (31/7/92) until the property changed hands in May 1993, base flocks of 30 wether hoggets were run on each paddock. They were weighed and condition scored regularly and wool was weighed at shearing. Other sheep were added to and taken from the paddocks at the farmers discretion. The property changed hands in 1993 and after May cattle were grazed on the paddocks until the end of December 1994 when the property again changed hands and all stock were finally removed.
The project was abandoned as the paddocks were destined for grape vines and bluegums.

Soil Description :... Dy 3.22

A Typical Profile:.....



Soils: annual low and high levels and perennial low level.

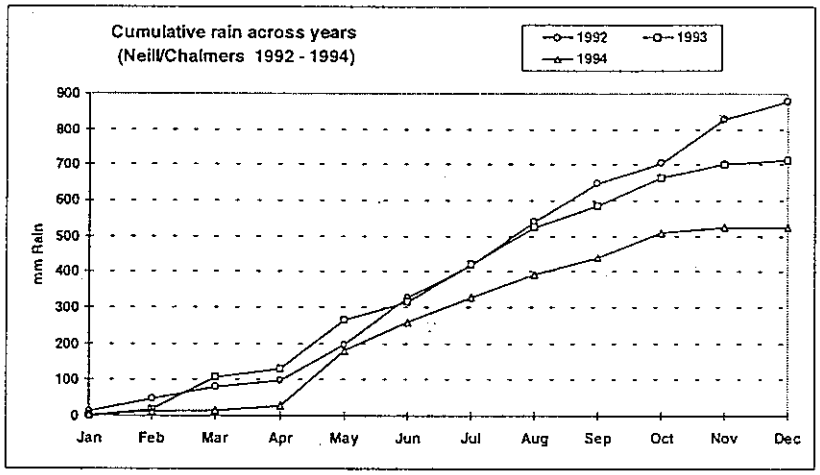
Down to:	Description	pH	% gravel
5 - 15cm	Dark brown **sandy loam**, hard setting	6.0	
45 - 50cm	Greyish brown and yellowish brown **sandy clay loam**	6.5 - 7.0	10 - >50
>100 cm	Brownish yellow **clay** with reddish yellow mottles.	7.0	

Appendix XIV

Soils: perennial high level

Down to:	Description	pH	% gravel
5 - 10cm	Dark brown **sandy loam**, hard setting (2 - 10% segregation's)	6.0	2 - 10
15 - 32cm	Greyish brown or yellowish brown **sandy loam**	6.0	20 - >50
50 - 60cm	Pale brown **sandy clay**	7.0	10 - 20
>100 cm	Brown/yellow (or grey) medium **clay** with red/ yellow mottles	7.0 - 8.0	

Cumulative rainfall patterns over 3 years have been:



Analyses of the top 10cms of soil at the start of the study.

Soil Test :CSBP analysis	Date:Mar/Apr1993.	Annual	Perennial
Nitrogen :Nitrate	ppm	30	10
Ammonium	ppm	20	20
Phosphorus	ppm	44	36
Potassium	ppm	97	167
Organic carbon	%	3.65	3.99
	Status	V.Good	V.Good
Reactive Iron (ppm)	ppm	384	875
	Status	Medium	High
Salt	E.C dS/m	.11	.06
	Status	V.Low	V.Low
pH	(1:5 $CaCl_2$)	4.7	4.8
	(1:5 Water)		
	Status	Normal	Low

Fertiliser applied:

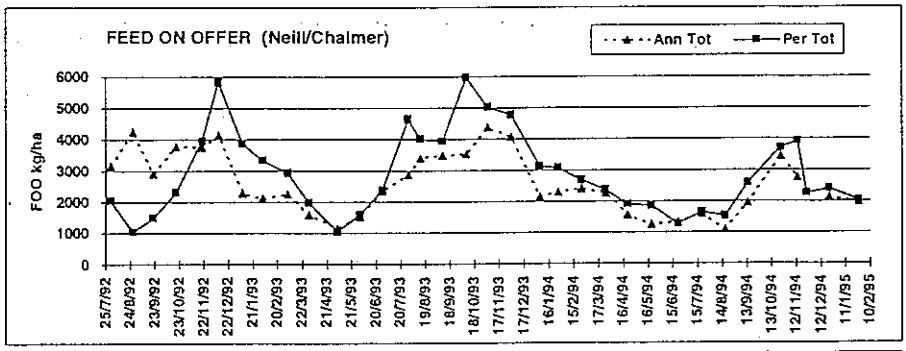
Date	Fertiliser	Amount (kg/ha)	Comments:
1992	Superphosphate	100	At seeding
1993	Nil (farm sale)		Change over mid 1993
1994	Nil (farm sale)		Change over early 1995
1995/96	Canola, Trees, Grapes!		

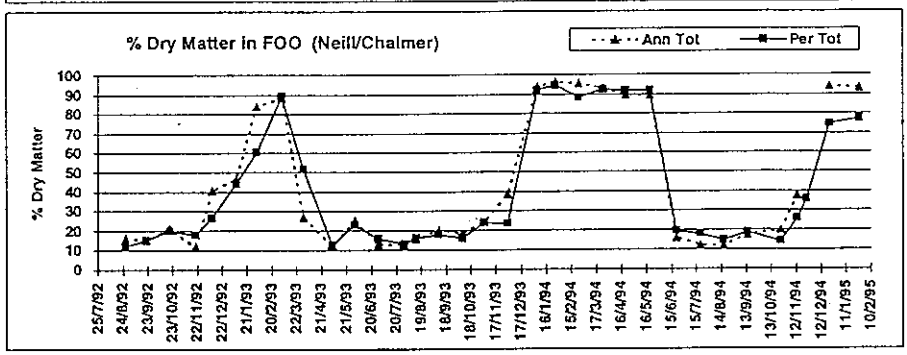
Only in 1994 was **hay conserved** on the high portion of the perennial paddock. Based on the whole paddock area this amounted to **622kg/ha** of hay that was 91.5% dry matter, **68.3% digestibility** and **12.8% crude protein.**

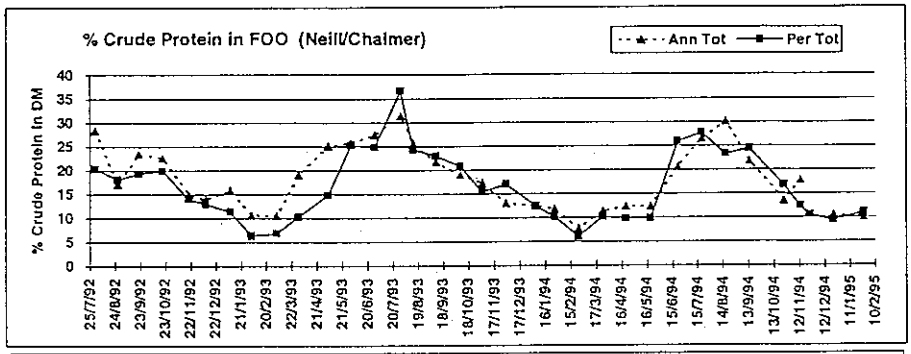
Grain was never fed and **hay** was only fed in 1994 when **64.1kg/ha** (25.3/head) was fed to cattle in the perennial paddock.

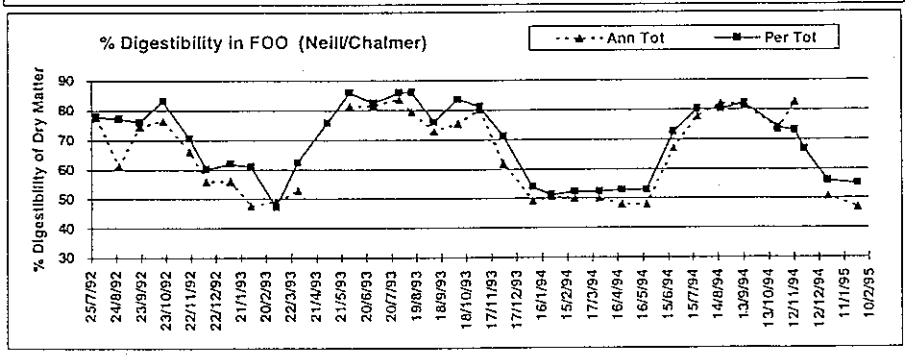
Appendix XIV

Quality and Quantity of Feed on Offer.

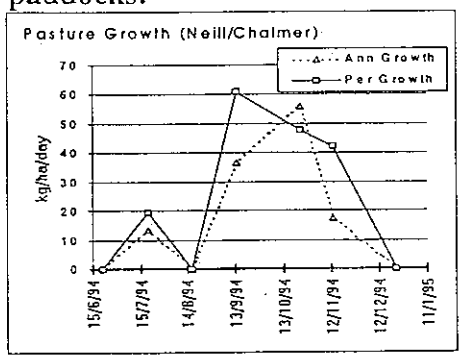








Pasture growth on the two paddocks:

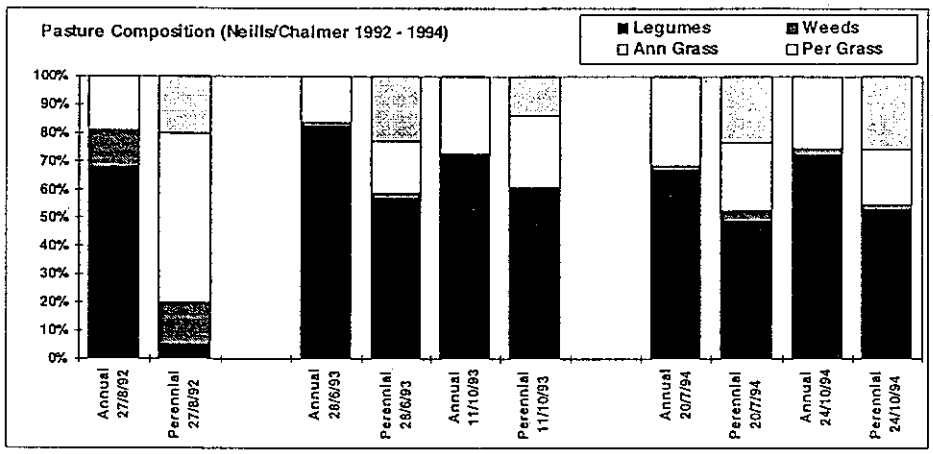


Appendix XIV

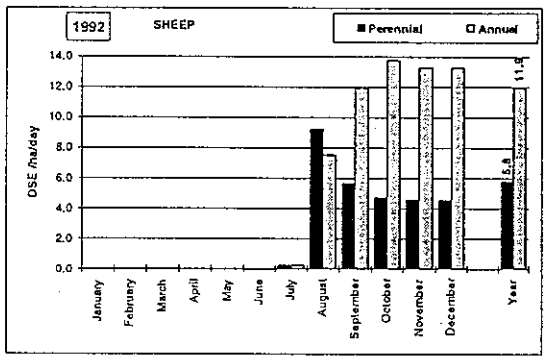
Counts of perennial plants (plants/sq.m)

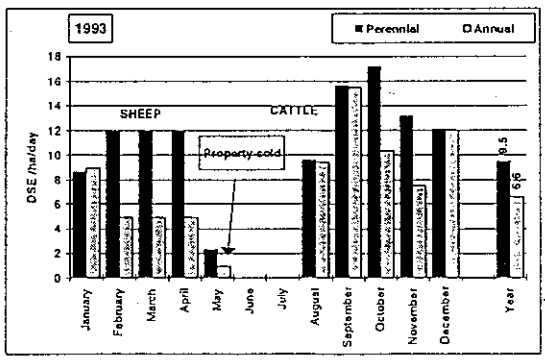
	26/3/93		26/5/94		9/3/95	
	Low	High	Low	High	Low	High
Roper Ryegrass	37		31	1	16	
Sirosa phalaris	8		5		2	
Triumph fescue	15	29	1	4	8	1
Wana Cocksfoot	1	66	1	51		37
OVERALL	84		50		34	

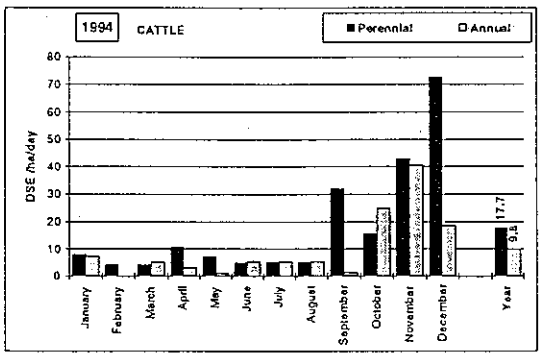
Pasture composition:



Estimated average grazing pressure each month during the project:







paddock. Over the year the perennial and annual pastures were stocked at 9.5 and 6.6 DSE/ha respectively.

Sheep in the perennial paddock gained extra weight per head and per hectare in summer compared with the those in the annual paddock. However this could be attributable to a lower grazing pressure in spring 1992 on the perennial pasture compared with the annual paddock.

Cattle. There was more FOO on the perennial paddock than on the annual paddock throughout the growing season. However when cattle were introduced to the area in August FOO in both paddocks was in excess of 3000 kg/ha and did not fall below this level for the rest of the growing season. It is therefore difficult to explain the better growth of steers on the perennial paddock.

1994

Rain = 525ml. Break of season was in mid May with little rain after mid October. The subclover component of the pastures remained high, 65-70% in the annual paddock and about 40-50% in the perennial paddock. The sown perennial grasses made up 35- 40% of the sward and there was a low level of weeds. Perennial plant numbers had declined to almost half the first years numbers, 56 and 38 per sq.m. in the high and low lying areas respectively.

Cattle. There was more FOO on the perennial paddock than on the annual paddock throughout the growing season. However when cattle were introduced to the area on June 3, FOO in both paddocks was around 1500 kg/ha and remained below 2000 kg/ha until mid August. Hay (64 kg/ha) was fed to the yearlings in the perennial paddock. The young cattle were finally removed in early September because of their poor performance. Subsequently approximately 150 cows and their calves were grazed in the perennial and annual paddocks providing extremely high grazing pressures over spring/early summer.

Over the year the perennial and annual pastures were stocked at 17.7 and 9.8 DSE/ha respectively, and a section of the perennial paddock was cut for hay, yielding on a total paddock basis 622 kg/ha. The spring grazing was excessive with only about 2000 kg/ha remaining by early November. However the third owner of the property since 1992 planned to plant trees over the site.

1995

The property was again sold, this time for commercial tree farming purposes. No further data collection was possible. However perennial plant counts taken in March (a little early to get the best estimate of numbers) were 38 on the high and 26 per sq.m. on the low lying land.

SUMMARY

The perennial grasses established well at this site in 1992. However in the second half of the establishment year about 50% of the grazing in the perennial paddock was foregone. Perennial were still well represented in late 1994 (~20% of FOO) and around 34 plants per sq m in summer 1995.

Animal production comparisons are not very meaningful owing to the changes in categories and species of animal during the two changes in ownership of the property within three years of starting the study. However, other than in the establishment year, grazing pressures were higher on the perennial pasture paddock than the annual paddock.

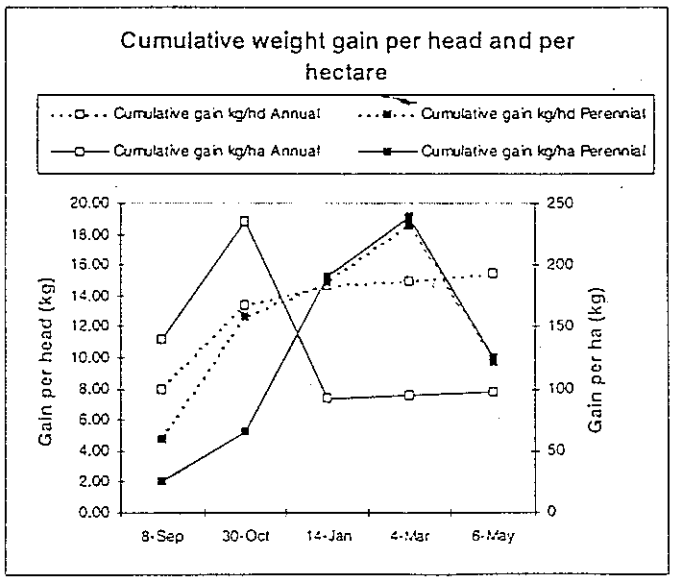
Appendix XIV

Sheep data 1992

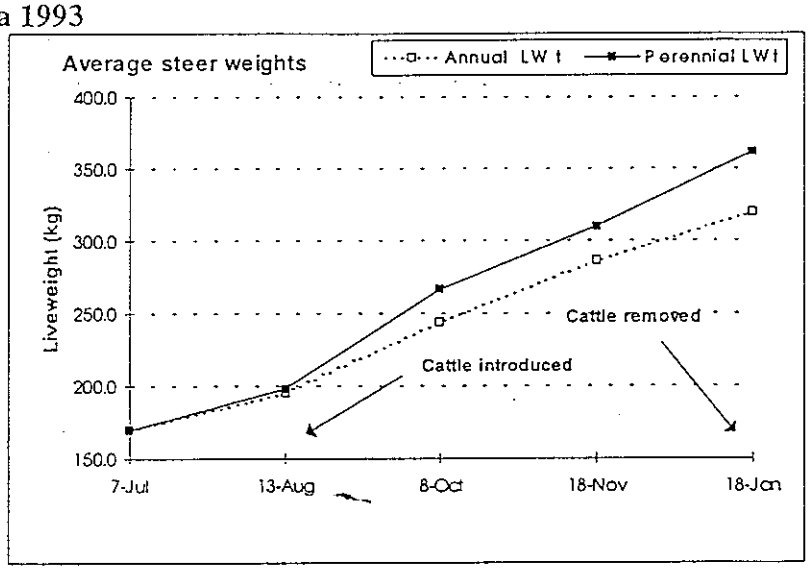
July 31 to Dec 21		1992
Clean wool production (g/hd)	Annual	1476
	Perennial	1554
Yield (%)	Annual	75.7
	Perennial	76.2
Staple length (mm)	Annual	38.3
	Perennial	38.7
Fibre Diameter (mean)	Annual	22.5
	Perennial	23.8
Clean wool production (kg/ha)	Annual	17.4
	Perennial	9.2
Sheep stocking rate (DSE/ha)	Annual	11.8
	Perennial	5.9
Wool growth period (days)	Annual	143
	Perennial	143
Clean wool growth rate (g/hd/day)		
July 31 - December 21	Annual	10.3
	Perennial	10.9

Sale Lines

		% of fleeces
Top line, sound (AAAM)	Annual	19.0
	Perennial	27.8
Weakness, part tender (AAAM P/T)	Annual	42.9
	Perennial	33.3
Combing, broader type (AAA COM)	Annual	9.5
	Perennial	
Definite break (AAA FLC)	Annual	19.0
	Perennial	
Coloured, fleece rot (AAA)	Annual	
	Perennial	38.9
Cots, matted (Cot)	Annual	9.5
	Perennial	



Cattle data 1993



Cattle data 1994

	3 June 94		8 Sept 94		
	Weight (kg)	Condition Score	Weight (kg)	Condition Score	Wt. Change (kg)
Annual	216	1.2	249	1.3	33
Perennial	226	1.2	230	1.2	5

Results

1992

Rain = 877ml. Good rains were received in mid to late March but were followed by a dry April. The break of season followed in early May with rain extending into the middle of December.

The annual pasture was subclover dominant (70%). The perennial pasture established well with perennial grasses making up about 50% the sward and subclover about 5%.

The carrying capacity for this year was only recorded from the end of July (153 days). Over this period the grazing pressure was halved on the perennial pasture compared with the annual paddock (5.8 vs 11.9 DSE/ha).

It is difficult to deduce anything from the weight change and wool production data in the first and only year. See comments in 1993 results. Shearing was on December 21 and wool data is presented for 5 months growth. There was little difference in the wool characteristics from each of the paddocks. However, as wool production per ha is related to grazing pressure, the sheep on the annual paddock yielded twice the amount per ha as those of the perennial paddock.

1993

Rain = 714ml. Break of season was in mid March followed by a relatively dry April, with little rain after the middle of November.

The subclover component of the pastures remained high, 70-80% in the annual paddock and about 55% in the perennial paddock. The sown perennial grasses made up 25- 30% of the sward and there were virtually no weeds in either paddock. The perennial plant numbers were 95 and 61 per sq.m. on the high and low lying areas respectively

The grazing pressure over the first 5 months in the perennial pasture was double that of the annual pasture, at the time sheep were grazing the site. Cattle grazed the site from August and grazing pressures were higher in the annual than the perennial

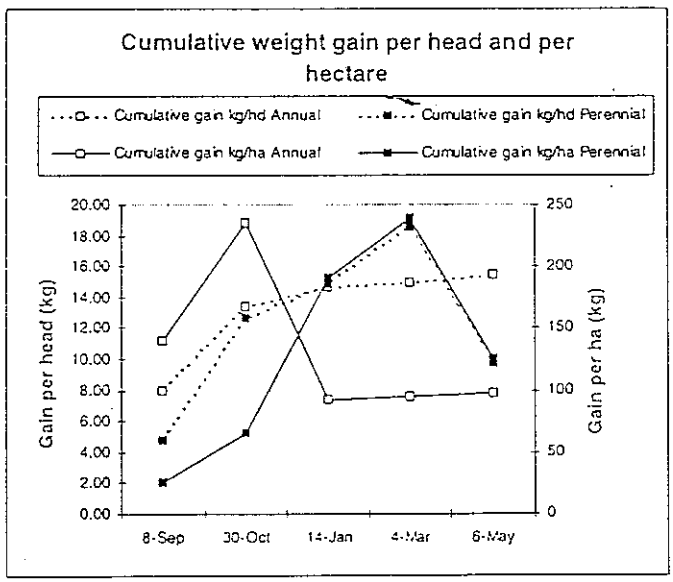
Appendix XIV

Sheep data 1992

July 31 to Dec 21		1992
Clean wool production (g/hd)	Annual	1476
	Perennial	1554
Yield (%)	Annual	75.7
	Perennial	76.2
Staple length (mm)	Annual	38.3
	Perennial	38.7
Fibre Diameter (mean)	Annual	22.5
	Perennial	23.8
Clean wool production (kg/ha)	Annual	17.4
	Perennial	9.2
Sheep stocking rate (DSE/ha)	Annual	11.8
	Perennial	5.9
Wool growth period (days)	Annual	143
	Perennial	143
Clean wool growth rate (g/hd/day)		
July 31 - December 21	Annual	10.3
	Perennial	10.9

Sale Lines

		% of fleeces
Top line, sound (AAAM)	Annual	19.0
	Perennial	27.8
Weakness, part tender (AAAM P/T)	Annual	42.9
	Perennial	33.3
Combing, broader type (AAA COM)	Annual	9.5
	Perennial	
Definite break (AAA FLC)	Annual	19.0
	Perennial	
Coloured, fleece rot (AAA)	Annual	
	Perennial	38.9
Cots, matted (Cot)	Annual	9.5
	Perennial	



APPENDIX XV Producer Demonstration Site

Colin & Shirley Taylor Trial Number 93AL31

Map-Reference: 531000 mE, 6175000 mN, Zone 50 (Map 2428-IV)

Mount Barker **Area:** Annual 3.98 ha (9.83 acres)
Perennial 4.72 ha (11.65 acres)

Base Pasture: In June 1993 when we started recording at this site:

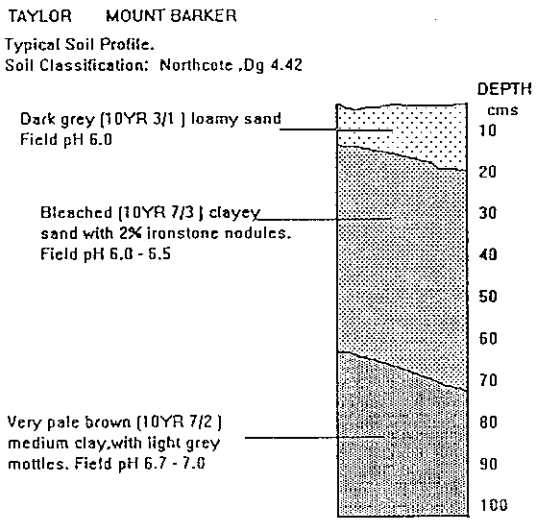
The **Annual** paddock comprised approximately 40% subclover, 40% annual grasses(silver and barley grasses) and 20% weeds (dock, sedge and cape weed).

The **Perennial** paddock comprised approximately 35% subclover, 15% annual grasses (silver and barley grasses) and 20% weeds (dock, sedge and cape weed) and **30% perennial grasses.** On May 25 1991 this paddock was sprayed with Roundup(450 ml) and Ally (4 g) to control a March germination. It was then sown on June 5 using a Connor Shea Napier direct drill, seeding to a depth of 12-15 mm. A mixture of perennial grasses; Wana cocksfoot 1.5kg/ha, Triumph fescue 1.5kg/ha,, Demeter fescue 1.5kg/ha, Sirosa phalaris 1kg/ha and Brumby ryegrass 3kg/ha. were sown.

Animals A base flocks of 30 wethers were run continuously on each paddock for the life of the study. They were weighed and condition scored regularly and wool production was weighed at shearing. Clean wool yield and fibre length and strength were determined from samples taken from each sheep. Other sheep were added to and taken from the paddocks at the farmers discretion.

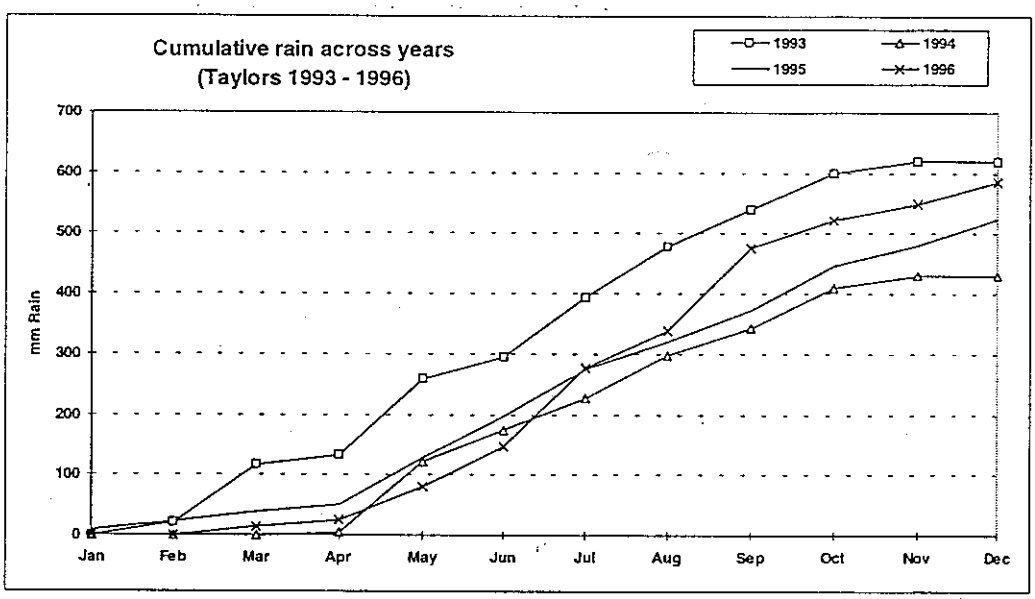
Soil Description :... Dy 4.42

Typical Profile.....



Down to:	Description	pH	% gravel
15 - 25cm	Dark grey **loamy sand.**	6.0	
65 - 80cm	Bleached **clayey sand** with 2% ironstone nodules running down to up to 10 % ironstone nodules.	6.0 - 6.5	2 - 10
>100 cm	Very pale brown **medium clay** with light grey mottles sandy clay with pale yellow mottles	6.5 - 7.0	

Cumulative rainfall patterns over 4 years have been:



Analyses of the top 10cms of soil before and at the end of the study:

	Date:	12 Mar 1993.		20 Feb 1996.	
Soil Test :CSBP analysis		**Annual**	**Perennial**	**Annual**	**Perennial**
Nitrogen :Nitrate	ppm	29	27	30	30
Ammonium	ppm	20	20	17	19
Phosphorus	ppm	76	24	64	61
Potassium	ppm	103	106	52	64
Sulphur	ppm	NA	NA	8	13
Organic carbon	%	3.84	3.50	3.84	3.82
	Status	V.Good	V.Good	V.Good	V.Good
Reactive Iron (ppm)	ppm	415	505	385	431
	Status	Medium	Medium	Medium	Medium
Salt	E.C dS/m	0.10	0.14	0.13	0.22
	Status	V.Low	V.Low	V.Low	V.Low
pH	(1:5 $CaCl_2$)	4.6	4.7	4.6	4.7
	(1:5 Water)				
	Status	Normal	Normal	Normal	Normal

Fertiliser applied:

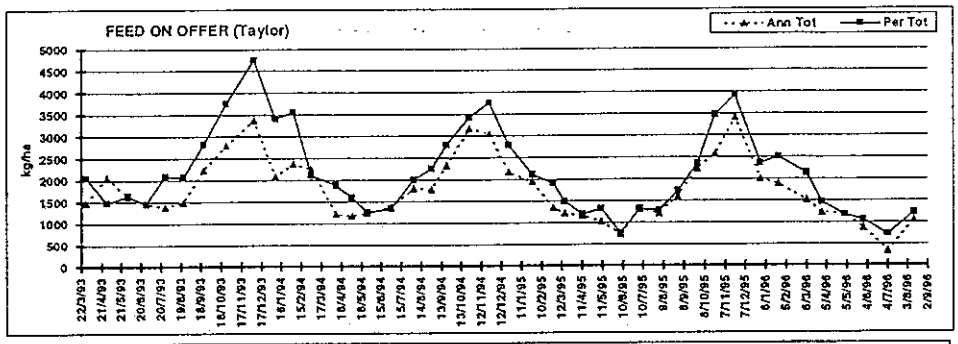
Superphosphate at **120 kg/ha** was applied to each of the paddocks in summer/autumn each year from 1991 to 1996.

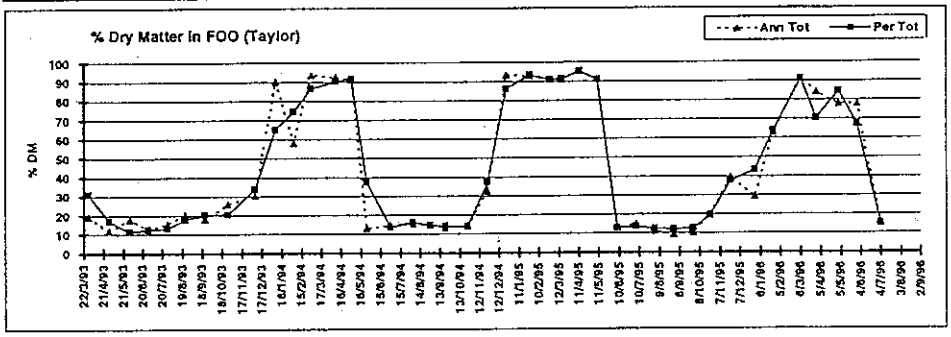
Counts of perennial plants (plants/sq.m)

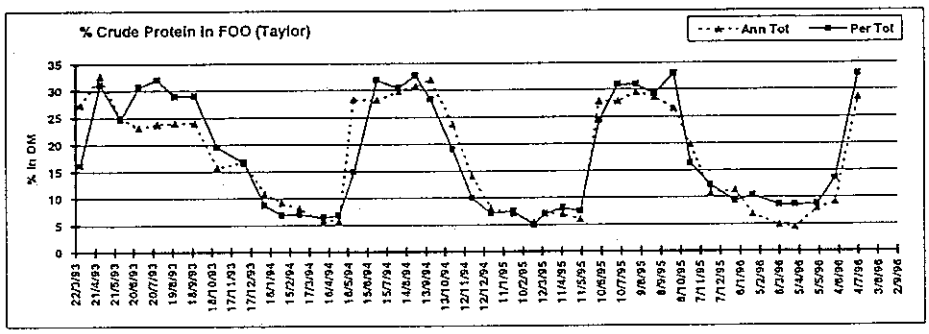
	29/3/93	25/5/94	7/6/95	29/3/96
Brumby Ryegrass	10	26	16	2
Triumph/Demeter fescue	6	0	1	0
Wana Cocksfoot	16	9	11	1
Sirosa phalaris	7	1	0	0
TOTAL	39	36	28	3

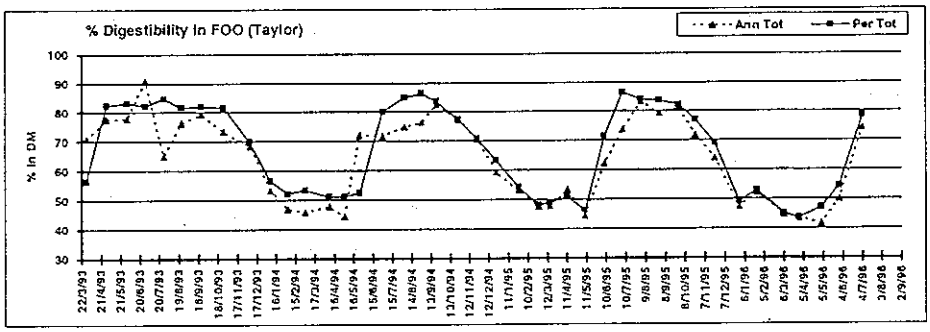
Appendix XV

Quantity and Quality of Feed On Offer (FOO):

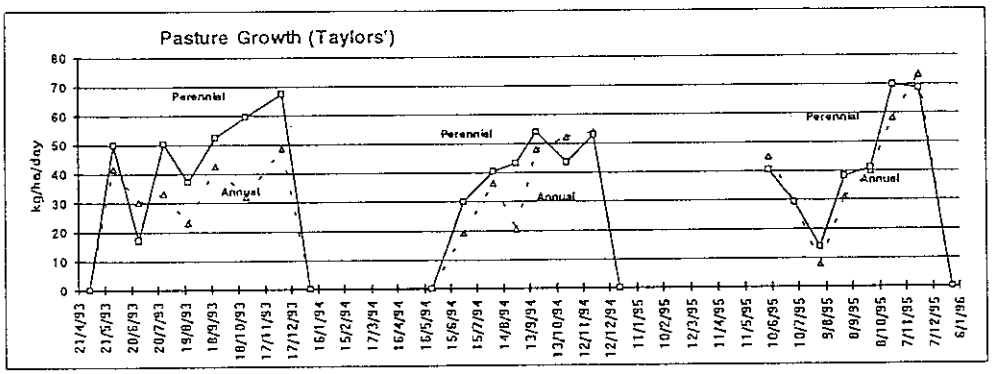






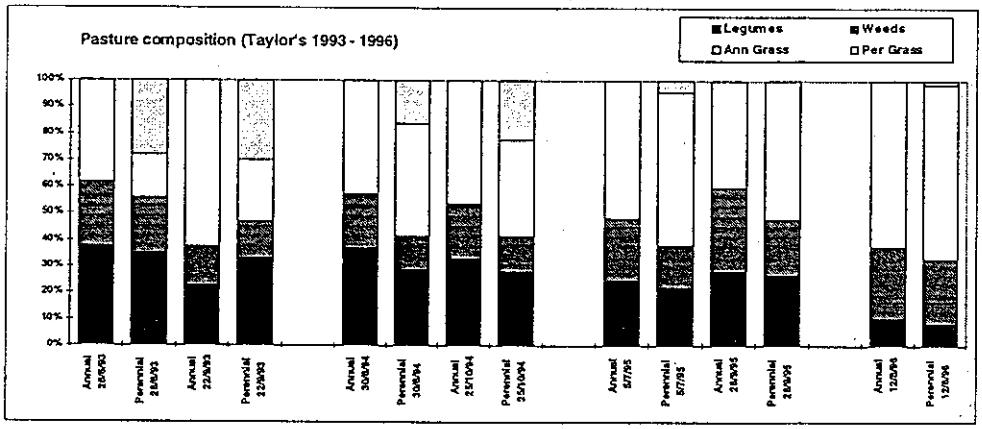


Pasture growth on the two paddocks:

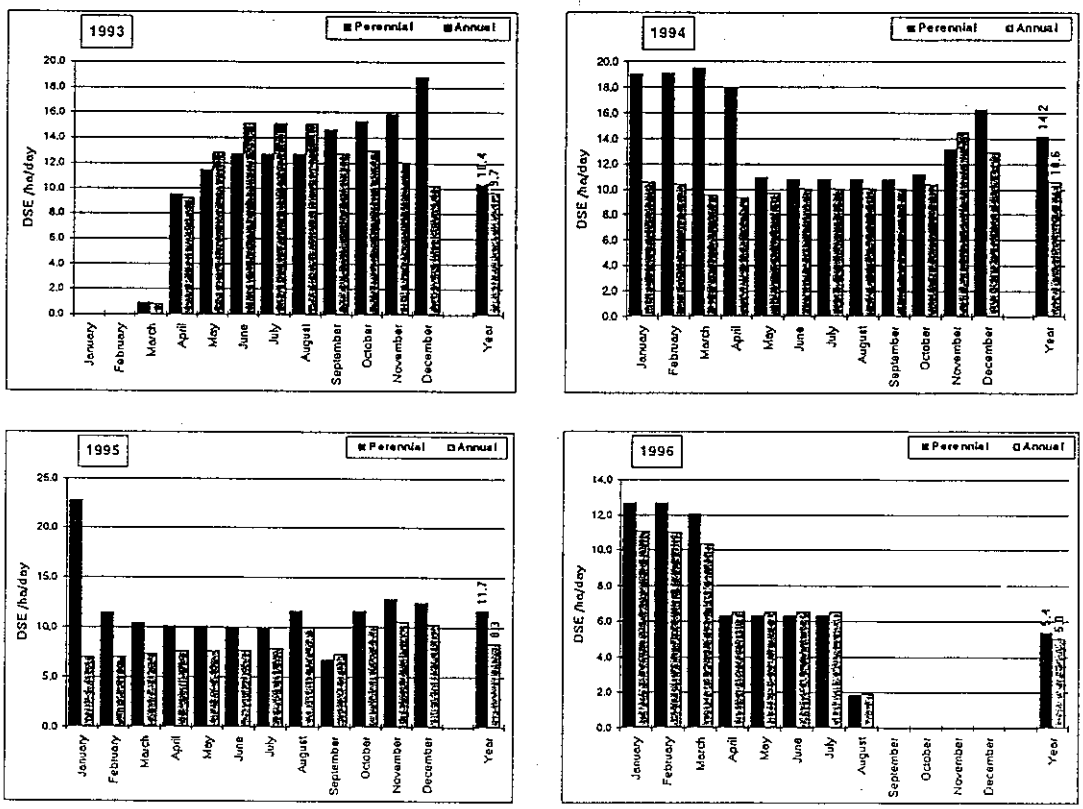


Appendix XV

Pasture Composition:



Estimated average grazing pressure each month during the project:

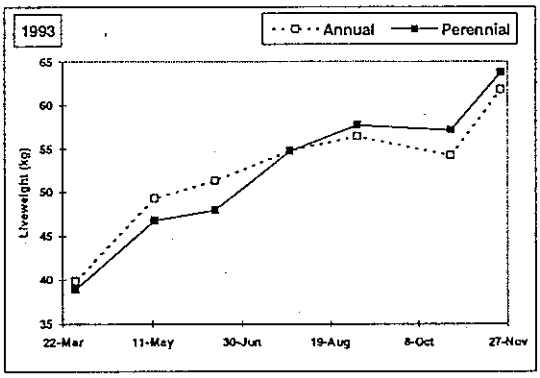


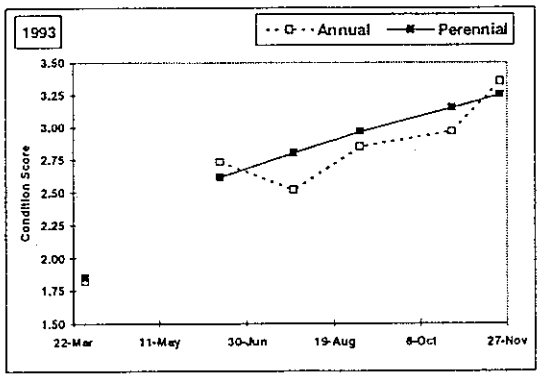
Quantities of hay and grain fed:

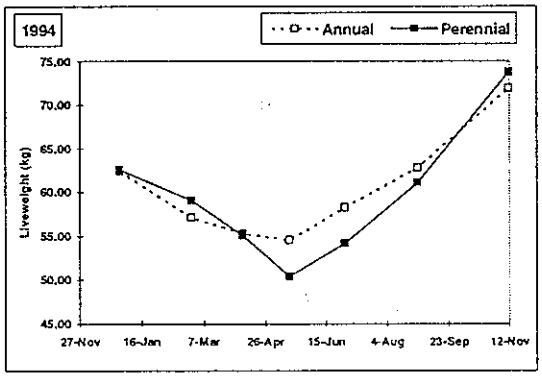
Year		kg/ha Hay	kg/ha Oats
1994	Perennial *	254	191
	Annual *	151	125
1995	Perennial **	180	102
	Annual**	138	60
1996	Perennial **	64	0
	Annual**	75	0

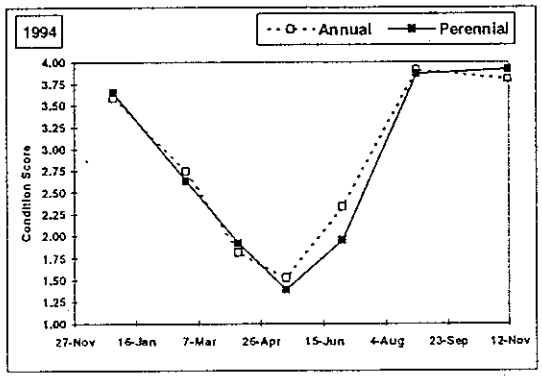
* Started feeding 20/3/94 ** Started feeding late March

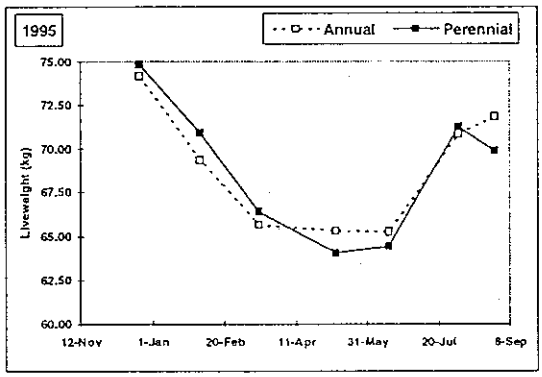
Sheep liveweights each year during the project

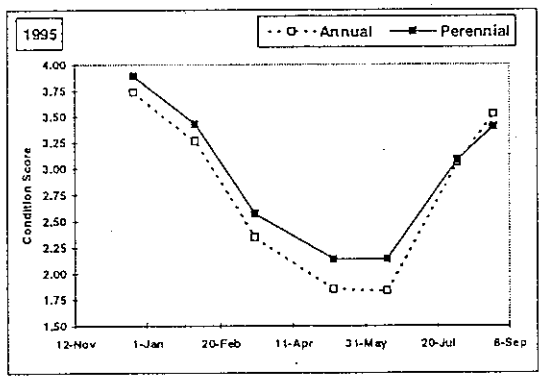












Appendix XV

Summary of wool data:

		1993		1993/94	1994/5
Greasy wool production (g/hd)	Annual		6373	6691	7106
	Perennial		6486	6398	7235
Yield (%)	Annual		75.3	75.9	78.6
	Perennial		76.6	76.9	79.3
		Pre Trial	Trial		
Staple length (mm)	Annual	62	51	111	113
	Perennial	63	53	110	117
Staple strength (N/Ktex)	Annual	na	na	26.5	36.7
	Perennial	na	na	24.2	35.6
Point of break (% from tip)	Annual	na	na	61	62
	Perennial	na	na	64	63
Date of break	Annual	na	na	12-Apr	10-Apr
	Perennial	na	na	23-Apr	14-Apr
Fibre Diameter (mean)	Annual	20.2	22.2	20.2	22.9
	Perennial	21.3	22.9	20.7	23.3
Hauteur (mm)	Annual	na	na	74	83
	Perennial	na	na	73	84
cV Hauteur	Annual	na	na	56.8	52
	Perennial	na	na	58.1	53
Clean wool production (kg/ha)	Annual	na	27.0	56.0	64.1
	Perennial	na	25.1	73.0	69.4
Sheep stocking rate (/ha)	Annual	na	13.5	10.6	12.1
	Perennial	na	12.0	15.4	12.4
Wool growth period (days)	Annual	na	161	357	361
	Perennial	na	161	357	361
Clean wool growth rate (g/hd/day)					
spring	Annual	na	na	22.8	24.9
	Perennial	na	na	23.9	26.6
summer	Annual	na	na	11.4	14.5
	Perennial	na	na	10.6	15.9
autumn	Annual	na	14.0	7.0	5.7
	Perennial	na	13.5	6.3	5.7
winter	Annual	na	11.4	14.8	16.0
	Perennial	na	12.6	13.7	15.3

Results:

1993

Rain: 621ml. Break of season occurred in the third week in March followed by a dry April and good rains in early and late May. Little rain was received after mid October. The perennial pasture was established in 1991 and we started our study on the site in March 1993. In 1993 **perennial grasses** (mainly ryegrass and cocksfoot) made up **25 to 30%** of the sward with a total of about **40 plants/sq m**. The clover component was good in both paddocks in winter at around 35% but was partly displaced by winter and barley grass in the annual paddock by spring. Weeds at around 20% in both paddocks in winter decreased by spring.

From late March the perennial pasture supported **10.4 DSE/ha** compared to **9.7 DSE/ha** on the annuals. Farmer observation prior to March was a significant improvement in carrying capacity on the perennial pasture. The early break ensured steady growth and improvement in condition of the **young sheep** on both paddocks without the need for supplements.

Over autumn and winter the annual pastures produced slightly more clean wool per ha than the perennial paddock (**27 c/f. 25.1 kg/ha**), related to the higher grazing pressure in the annual paddock over this period (**13.5 c/f. 12 DSE/ha**). Over the period of measurement (**161 days**) wool from the **annual and perennial** paddocks had similar characteristics. Respectively **staple length 51 and 53 mm** and **fibre diameter 22.2**

and 22.9 microns. Growth of wool in the annual paddock was 4% faster in autumn and 11% slower in winter than in the perennial paddock.

1994

Rain: 430ml. No rain was received before the break in mid-May and little after mid October. Perennial grasses(mainly cocksfoot) made up about 15 to 20% of the sward with total counts of about 30 per sq.m. The proportion of clover remained at around 30% in both paddocks through the growing season. In the annual paddock the proportions of annual grasses and weeds were similar to 1993 but annual grasses (mainly winter grass) increased from around 15% to around 35 % of the sward in the perennial paddock..

The higher average annual grazing pressure on the perennial paddock (**14.2 DSE/ha** c/f **10.6 DSE/ha**) was partly supported by extra supplements of **103 kg/ha hay** and **66kg/ha oats**. However this was not sufficient to hold sheep weights at the level of those in the annual paddock through late autumn/early winter.

Greasy wool produced per head was lower while clean wool production per hectare was greater on the perennial paddock than the annual paddock (respectively **6.4 vs 6.7 kg/hd** and **73 vs 56 kg per ha**), a consequence of the higher grazing pressure on the perennial paddock (**15.4 vs 10.6 DSE/ha**) over the wool growth period (**357 days**).

There was little differences in wool quality between the annual and perennial paddocks (**staple length, 111 and 110 mm**; **staple strength, 26.5 and 24.5 N/Ktex**; **fibre diameter 20.2 and 20.7 microns**; **hauteur 74 and 73 mm** and **weak point** in the wool around mid April.

The slightly weaker wool from the perennial paddock may well be a reflection of the sheeps' greater nutritional stress as indicated by lower body weights and condition scores in winter. Wool growth rate in autumn was about **half** that in winter and summer and a **third to a quarter** of that in spring.

1995

Rain: 524ml. Break of season was in mid May with little rain after late October except for 32ml. in late December. The perennial component declined to less than 5% of the sward with **25 to 30 plants per sq.m.** In both paddocks, during the growing season, the composition of the swards was similar, with clover 25%, annual grasses (mainly winter grass) 50% and weeds up to 30 %

The higher average annual grazing pressure on the perennial paddock (**11.6 DSE/ha** c/f **8.3 DSE/ha**) was partly supported by extra supplements of **42 kg/ha hay** and **42 kg/ha oats**. However this was not sufficient to hold sheep weights at the level of those in the annual paddock during autumn.

Greasy wool produced per head was similar while clean wool production per hectare was slightly greater on the perennial paddock (respectively **7.2 vs 7.1 kg/hd** and **69.4 vs 64.1 kg per ha**), again a consequence of the slightly higher grazing pressure on the perennial paddock (12.4 vs 12.1 DSE/ha) over the wool growth period (**361 days**).

There was little differences in wool quality between the annual and perennial paddocks (**staple length, 117 and 113 mm**; **staple strength, 36.7 and 35.6 N/Ktex**; **fibre diameter 22.9 and 23.3 microns**; **hauteur 83 and 84 mm** and **weak point** in the wool around mid April.

Wool growth rate in autumn was about a **third** that in winter and summer and a **fifth** that in spring.

1996

Rain: 587ml. Break of season was in mid May, after October, rain fell in mid November and mid December. The perennial component was less than 5% of the sward and counts of less than 5 plants per sq.m. In both paddocks there was a decline in the clover proportion to less than 10%, annual grasses increased to 65% and weeds to 25%.

SUMMARY

The perennial component of the pasture declined over the 4 years. The main reasons for this are considered to be:

- the relatively high grazing pressure maintained on the perennial paddock albeit with extra supplements but they were not fed at a level sufficient to prevent sheep weight losses greater than those on the adjoining annual paddock.
- the succession of late breaks and very dry summers (1994, 1995 and 1996).

The decline in clover in the swards may well have been exacerbated by the halving of the soil potassium content from about 100 ppm following no application of potash over the life of the project.

There was little difference in wool characteristics between paddocks within years, however wool was different between years. Comparing 1993/4 wool with 1994/5 wool; grazing pressures were higher, greasy yields per head were lower and the wool was finer, weaker and the hauteur was shorter. These differences would be associated with the increased stress on the sheep as illustrated by their lower 1993/4 autumn weights of 50 to 55 kg (CS about 1.5) compared with 63 to 66kg (CS 1.75 to 2.25) in 1994/5.

APPENDIX XVI Producer Demonstration Site

Fouracres Trial number: 93MA38

Map - reference: 424272 mE, 6212281 mN, zone 50

Area: *Annual* paddock 3.25 ha
Perennial paddock 3.25 ha

Background:
The 1993 establishment of pasture in the PDS at One Tree Bridge was not successful. After the field inspection in June 1994 it was decided to terminate this PDS immediately due to a very low perennial density of 7 plants/m².

Paddock topography: Gently sloping hill topography with the *annual* paddock in a valley position with some summer moisture.
Paddock history: The paddock was cleared in 1967, topdressed and sown to a mixture of perennial grasses with a satisfactory establishment. The persistence of the perennial species did decline to a significantly low level over a ten year period. The paddock has been topdressed annually and has been regularly cut for hay.

Soil Descriptions:

ANNUAL (two soil types)
Gn 2.12, Gn 3.12, Gn 4.12
Location: mid slopes

Depth (cm)	Description	pH	Gravel %
0-10	strong brown sandy loam	5.6	40
10-20	strong brownsandy clay loam	5.6	30
20-35	yellowish redclay loam	5.7	30

Uc 5.11
Location: footslopes and valley floor

Depth (cm)	Description	pH	Gravel %
0-15	dark brown loamy sand	5.5	0
15-50	brown to dark yellow brown loamy sand	-	-
50-80	yellow red to light yellow brown loamy sand	-	0-10

PERENNIAL (one soil type)
Gn 2.12, Gn 3.12, Gn 4.12
Location: upper and mid slopes

Depth(cm)	Description	pH	Gravel %
0-10	reddish brown to dark brown sandy loam	6.4	15-25
10-35	yellowish red to brown sandy loam	5.7	30-40
35-50	yellow red to brown sandy clay loam to light clay	-	0-50

Appendix XVI

Analysis of the top 10 cms. of soil in January 1994

		Annual	*Perennial*
Nitrate Nitrogen	ppm	7	12
Ammonium Nitrogen	ppm	20	20
Phosphorus	ppm	35	48
Potassium	ppm	82	123
Reactive Iron	ppm	880	1866
Organic Carbon	%	3.6	4.8
Salt	E.C. mS/m	9	9
pH (1:5 CaCl2)		4.6	4.6

Fertiliser application on both paddocks (kg/ha):

1993	Mar	200	3:2 super:potash
	Apr	150	3:2 super:potash
1994	Mar	200	3:2 super:potash
	Mar	0.2	colbalt sulphate

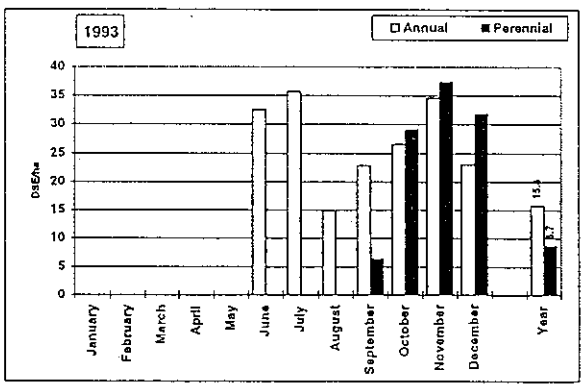
Perennial sward establishment:

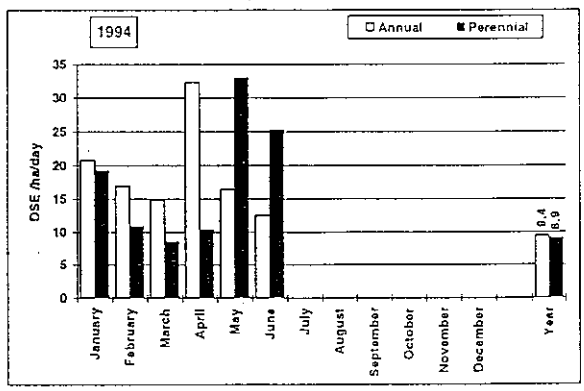
The farmer`s normal successful establishment technique is to start the year before seeding by cutting hay on the designated area. The area is then grazed hard over late spring and summer prior to an early autumn planting. Autumn weed control is not normally practised.
However the paddock selected for perennial establishment in this study was not preconditioned in this manner in the 1992 spring/summer for seeding in autumn 1993.
On April 14, two days prior to planting, the paddock was sprayed with sprayseed.
A mixture of Ellett (2.5 kg/ha) and Brumby(2 kg/ha) perennial ryegrasses, Concord annual ryegrass (4 kg/ha) and 5 kg/ha each of Karridale, Denmark and Larisa subclovers was sown with a cereal disc seeder, with seed falling onto the ground.
Insects (RLEM) were controlled 4 weeks after germination with an application of 85 ml/ha of Rogor through a mister.
A poor establishment of all species was the result.

Pasture composition (as % dry matter)

In August 1993 and October 1994 *both* pastures comprised approximately 40% subclover, 50% annual grasses and 10% weeds with only a trace of perennial grass in the *perennial* paddock.

Estimated Average Grazing Pressure each month during the project





Appendix XVI

Grazing management during the establishment year (1993) :
The *perennial* paddock was continually grazed from September 1993 through to June 1994. No hay was feed in the *perennial* paddock during 1993 while 75 kg/ha was fed to cattle in the *annual* paddock between June to December.

Subsequent grazing management in 1994:
Both paddocks received 1t/ha of hay during the first half of 1994 before the trial was terminated.

Pasture quantity and quality were monitored on a monthly basis throughout the trial period, but from October 1993 there was little difference between the two paddocks. No hay was produced from either paddock.
The marginally higher animal grazing rate in the *annual* paddock reflects the grazing capacity foregone during the perennial sowing operation.

Discussion:
With the transfer of key advisory staff from Manjimup to Busselton, communication with the farmer lapsed. This resulted in the paddock nominated for sowing to perennials not being preconditioned in the 1992 spring/summer for a 1993 autumn planting. The projects seeding operation was considered by the farmer to be too late. Other farm paddocks were successfully established (by the farmer using his normal technique) in mid March just prior to the first forecasted autumn cold front.
The seeding operation was difficult due to the large amounts of residual trash:

- preventing the seeding machine`s discs from effectively cutting grooves on the soil surface and
- preventing the trailing harrows covering the topdressed seed with soil.

The sown seed was not adequately covered and combined with infrequent light rainfall is likely to have desiccated, resulting in poor establishment.
The survival of the germinating perennial grass seedlings would also have been restricted by severe competition from the mixture of volunteer and sown annual grasses, and subclovers.
Competition from weeds were not considered to be an important factor in the first two months after sowing. However, weeds did dominate the sward from late winter onwards.

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APPENDIX XXII

PERENNIAL GRASS TRIAL AT MANYPEAKS

Final Report 1998

INTRODUCTION

Southwest Australia is characterised by a mediterranean climate and infertile sandy soils. The traditional annual pasture base is typically a mixture of subterranean clover (*Trifolium subterraneum* L.) and annual ryegrass (*Lolium rigidum* Gaudin), yet over time other plant species have invaded these pastures, the most common being capeweed (*Arctotheca calendula* L.), barley grass (*Hordeum leporinum* Link), silver grass (*Vulpia bromoides* (L.) S.F. Gray), flatweed (*Hypochaeris radicata* L. (Asteraceae)), sorrel (*Rumex acetosella* L.) and dock (*Rumex crispus* L.).
Annual pasture regenerates from a seed bank at the break of season in autumn/winter providing high quality green feed for stock until late spring. In summer and early autumn stock rely on dry pasture residues that were built up in the previous spring and conserved feed such as hay, silage or grain. Perennials grasses have the potential to provide a longer growing season and pasture production in summer which would raise stocking rate and/or reduce the amount of conserved feed fed out in summer. This investigation compares sheep production on an annual pasture to those containing perennial grasses.

MATERIALS and METHODS

Site characterisation

Site

The study was conducted on Mike and Robin Dovey's property at Manypeaks, Western Australia (34° 46′ S., 118° 14′ E.). The site for the trial was cleared and sown to annual pasture in 1986, the original native vegetation consisted of stunted Jarrah woodland. Kikuyu grass was sown in spring 1991, the temperate perennial mix in autumn 1992 and the annual pasture was resown to subterranean clover and annual ryegrass in winter 1992. The temperate perennial mix consisted of perennial ryegrass (cv Brumby), phalaris (cv Sirosa) and tall fescue (cv Au Triumph). The subclover population at the site consisted of the following cultivars in spring 1993, 60% Karridale, 5% Junee, 5 to 10% Denmark/Trikkala.

Climate

Rainfall, solar radiation and temperature for the experimental period are presented in Figures 1 and 2.

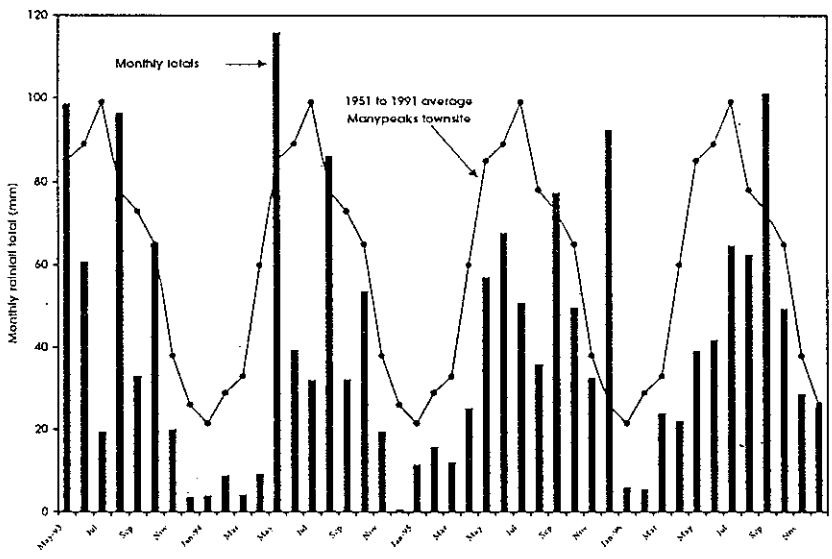


Figure 1. Rainfall at the Manypeaks trial site for the experimental period 1993 to 1996.

1996

A summer rainfall event (90 mm, Fig 1) in late December 1995 resulted in a failed annual germination and sufficient moisture for growth in both kikuyu and tall fescue well into early 1996. The amount of green feed available during this period on the perennial treatments was quite significant (450 to 1300 kgDM/ha) with the tropical grass kikuyu responding best (Fig 5). As a result of the summer rain the kikuyu swards recorded the highest amount of autumn green feed throughout the duration of the trial (1300 kgDM/ha). Tall fescue while not as active as kikuyu, still demonstrated good potential to provide green summer feed with amounts reaching 700 kgDM/ha in January. As you would expect dry residues in the annual pasture treatments held up poorly particularly on the higher stocking rates e.g. 16.5 dse/ha. By mid-autumn these residues had reached 1300, 300 and 80 kgDM/ha on 11.5, 14.5 and 16.5 dse/ha respectively (Fig 5). Feed on offer profiles following the break of season in April 1996 clearly demonstrate the effect of increased stocking rate on standing biomass (Fig. 5), with the highest rate on the annual and kikuyu treatments highlighting the ability of kikuyu to sustain higher rates of defoliation. During the growing season rotationally grazed tall fescue performed well with the amount of feed in spring exceeding that on all other treatments (Fig. 5).

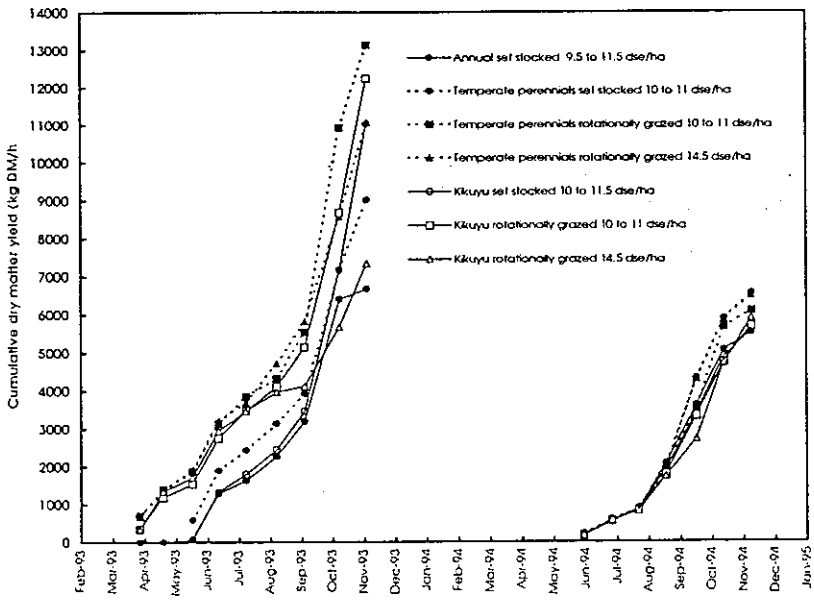


Figure 6. Cumulative dry matter yields for annual, kikuyu and temperate perennial pasture from 1993 to 1994 at the Manypeaks trial site.

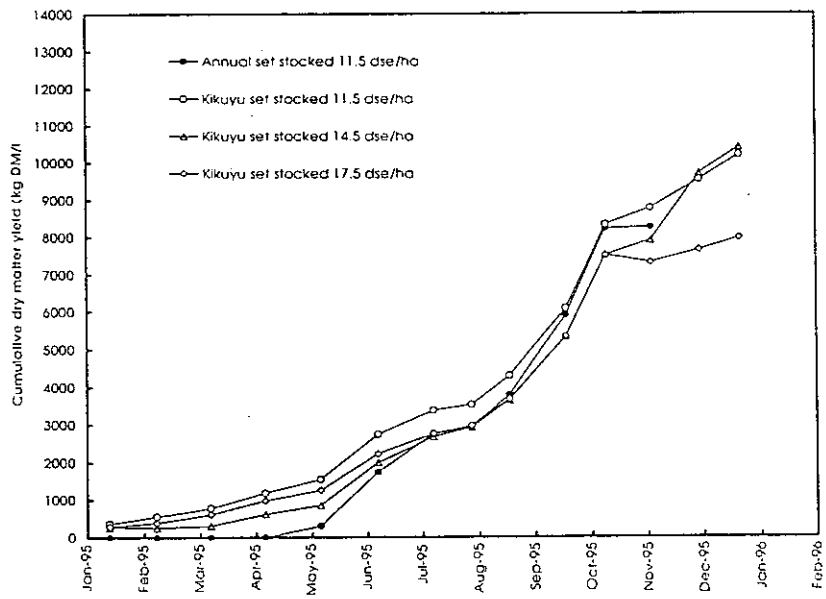


Figure 7. Cumulative dry matter yields for annual and kikuyu pasture during 1995 at the Manypeaks trial site.

summer. Interestingly, phalaris persisted well under rotational grazing, but poorly under set stocking while perennial ryegrass lacked persistence under both.

Tall fescue cv Au Triumph replaced the temperate perennial mix. Assessment began in 1996 following a good establishment in the autumn of 1995. Unfortunately, only one years worth of data was collected on this pasture type which prevented us exploring the full potential of this species. However, in that year tall fescue showed promise due to its ability to provide green feed in summer/autumn thereby filling the feed gap. While tall fescue cannot raise stocking rates as high as kikuyu, it can provide higher quality feed in summer for fattening stock out of season and a area for autumn deferment. As in the trial, if grazed by sheep it must only be grazed outside the growing season if there is sufficient green feed available otherwise plants will be removed and the pasture will revert to an annual only sward. The sheep on tall fescue did not perform as well as those on the annual treatments due to a particularly difficult autumn in which they were confined to the annual plot in the rotation with low amounts of feed. In addition, it appears that the sudden change in diet due to the rotation resulted in tender wool. In spite of these results tall fescue is a promising perennial grass if used strategically for out of season sheep meat production and/or autumn deferment.

The soil moisture data collected at the site is limited since the deepest moisture probe (35 cm) fell far short of the rooting depth of kikuyu which went below the laterite. The only preliminary conclusions that can be drawn from the data is that at 35cm there is consistently more soil moisture under the kikuyu pasture than the annual possibly as a result of variation in the soil profile across the site or kikuyu roots altering the moisture holding capacity of the soil. Also when the soil is wetted up in summer/autumn there is a tendency for the soil below kikuyu to be drier suggesting, that the perennial grass is using soil moisture during this period.

The success of the tropical grass kikuyu in a mediterranean environment is unexpected and opens up the possibility of other warm season perennial grasses being as equally or more successful given the required agronomic characteristics and suitability to southwest Australia. Other future directions include the possibility of developing a high input kikuyu system (e.g. tactical use of nitrogen, increasing annual ryegrass density) and finding a suitable companion perennial legume. Within the temperate perennial grasses the summer active types (e.g. tall fescue cv Au Triumph) will provide the largest benefit to animal production
The additional advantage of summer active perennials is they are likely to dry out soil profiles during the dry season thereby reducing groundwater recharge and subsequent salinisation.

Soil measurements

Soil moisture

Soil moisture data for 1994, 1995 and 1996 collected at 10 and 35 cm beneath each pasture type is presented in Figures 22, 23 and 24. This data provides useful information that can be used to gain a better understanding of pasture growth and water use. Unfortunately at the depths at which moisture was assessed the soil beneath the perennials wetted up and dried out in a similar fashion to the annual treatments. Exceptions to this, are examples of a drier profile below the kikuyu in the autumn of 1994 and 1996. In addition, kikuyu appeared to better facilitate the infiltration of water into the deeper part (35cm) of the soil profile.

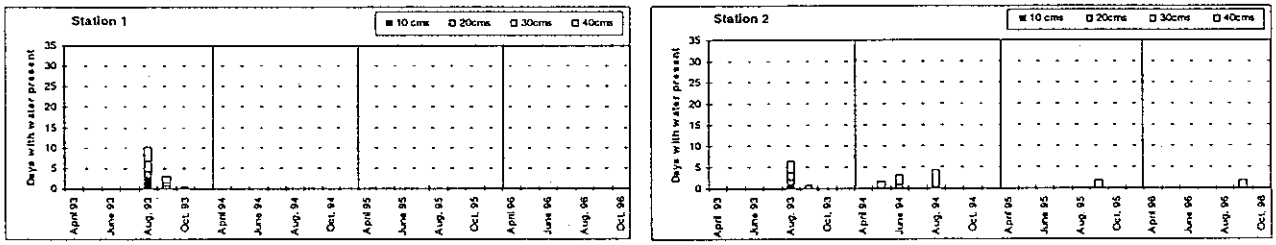


Figure 25. Groundwater levels from soil surface from 1993 till 1996 at the Manypeaks trial site.

Perched water

Perched water could have only affected pasture growth at the trial site in August 1993 for a relatively short period (Fig. 25). The site can therefore be considered free of waterlogging for the duration of the trial.

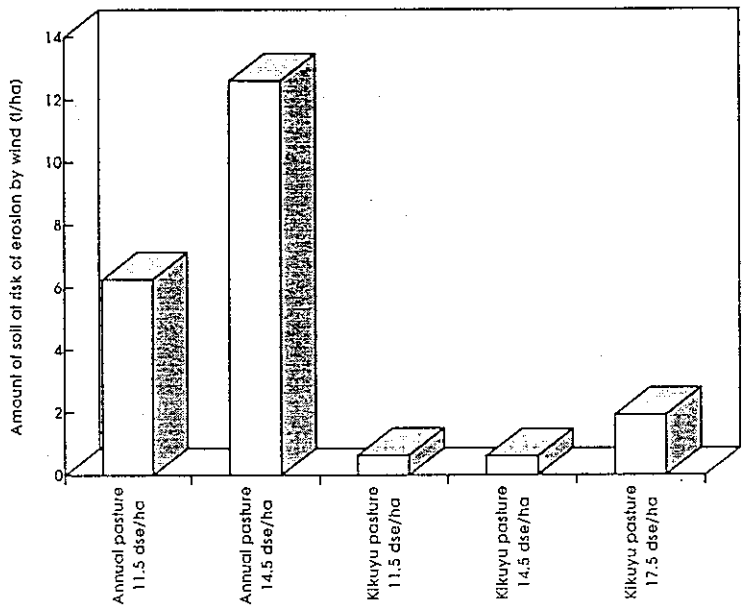


Figure 26. The amount of soil at risk of erosion by wind in autumn 1996 prior to the break of season at the Manypeaks trial site.

Soil erosion

The risk of soil erosion by the action of wind was assessed on the kikuyu and annual treatments in the autumn of 1996 prior to the break of season. The results clearly demonstrated the ability of kikuyu to prevent wind erosion in autumn by providing ground cover and soil binding by roots, stolons and rhizomes (Fig. 26). The biggest difference was recorded between kikuyu and annual swards grazed at 14.5 dse/ha, 13 tonnes of soil per ha was at risk from erosion on the annual compared to only 0.6 tonnes on the kikuyu (Fig. 26). Increased stocking rate increased the risk of soil erosion on the annual pasture far more than kikuyu (Fig. 26).

DISCUSSION

The experimental annual pasture was similar to those in paddocks on farms surrounding the trial. As such this treatment provided an excellent indicator as to the expected farm performance of the perennial grasses tested.
The introduction of the perennial grass kikuyu into a annual pasture consistently provided benefits to wool production - when compared to a annual only pasture - in both wet and dry summers. This increase in wool production on kikuyu resulted due to the pastures ability to sustain a higher stocking rate without damaging the pasture or soil.

This benefit arose as a result of the following characteristics of kikuyu;

- Summer activity and drought tolerance
- Good companion species to subclover and annual grass
- Tolerance to high rates of defoliation i.e. grazing
- Deep rooted nature
- Frost tolerance
- Stolon and rhizome structure which binds the soil together and allows the plant to spread
- Displaces broadleaf weeds such as capeweed
- Productive in infertile soils.

This study highlights the fact that to realise the full potential of kikuyu it is critical to maintain a strong annual component in the sward (particularly clover) which provides the pasture growth during late autumn, winter and early spring. Other benefits include biologically fixed N via an annual legume to provide N for grass production. The characteristics of a well managed and balanced kikuyu pasture is production equal to an annual only pasture in the growing season, high legume density and available green feed through summer and autumn. Maintenance of the annual component requires, insect control (e.g. red legged earth mite), adequate nutrients (i.e. fertiliser) and sward management via grazing. Of particular importance is the need to reduce dry residues prior to the break of season to enhance seed softening and allow seedlings access to light, water and nutrients.

Poorly managed kikuyu pastures have led to the belief amongst growers that kikuyu has no place in pastures in the region. This is not surprising since these swards are characterised by little or no annual component and rank kikuyu, which is unpalatable and low in digestibility. This investigation demonstrates to these growers that the key to the productive Kikuyu pastures is a strong annual component coupled with the appropriate grazing management.

The ability of kikuyu to fill the late summer/early autumn feed gap - which occurs annually in the mediterranean climate of southwest Australia - presents farmers with the opportunity to either raise stocking rates or reduce the amount of supplementary feed used at this time, providing increased returns per ha or reduced costs respectively. For the trial the approach of increasing stocking rates was adopted since there was no supplementary feed. In hindsight this is the best approach since it efficiently utilises the feed base and provides the correct grazing management for kikuyu i.e. continuous and at times heavy grazing pressure.

The rotational grazing treatment applied to kikuyu swards as part of this trial failed since liveweight performance was poorer than that on the equivalent set stocked treatment. Rotational grazing was imposed in late spring with the objective of increasing the available green feed in summer, unfortunately the areas that were locked up in spring became rank and unpalatable, while the amount of feed on the area that was grazed limited intake. This situation arose since stocked were moved 6 weekly, not on the basis of pasture criteria e.g. amount of feed. The benefits of rotationally grazing kikuyu are restricted however, this tactic could be used to increase production if feed is limited and the leaf area index of the sward is below the optimum for growth.

The mixed temperate perennial pasture provided more feed in the year following establishment (1993) compared to the annual pasture. However, under a set stocking regime the animal liveweight performance was similar to the annual and under rotational grazing poorer, due to sheep being moved 6 weekly rather than on the basis of feed availability. In the second year there was no benefits with the temperate perennial pasture doing worse overall in terms of animal and pasture performance.

The mixed temperate perennial pasture failed to perform any better than a annual pasture because the perennials were only active during the growing season and dormant in summer/autumn. As a consequence overall the pasture possessed a green and dry feed profile similar to an annual sward. The only differences being green pick available in late spring/early summer and the potential to hold green feed on the paddock for summer feed if the pasture was locked up in late spring. Unfortunately, these benefits are unlikely to remain for long since the temperate perennials persist poorly under set stocking and only marginally better under the rotational treatments due to stock removing and killing plants in

Table 1. Soil measurements taken at Manypeaks summer of 1993 to 1996, 0 to 10 cm. Data is grouped on the basis of pasture type.

Measurement	Year	Annual Pasture	Temperate perennial pasture	Kikuyu pasture
pH ($CaCl_2$)	1993	4.2	4.5	4.4
	1994	4.3	4.5	4.4
	1995	4.3	4.4	4.4
	1996	4.4	4.3	4.4
Total nitrogen (%)	1993	0.11	0.12	0.12
	1994	0.12	0.12	0.11
	1995	0.12	0.12	0.13
	1996	0.14	0.13	0.14
Organic carbon (%)	1993	2.3	2.5	2.6
	1994	-	-	-
	1995	2.2	2.4	2.5
	1996	2.6	2.5	2.8
Available P (ppm)	1993	13.8	15.9	16.7
	1994	15.3	16.0	14.9
	1995	16.0	14.2	18.5
	1996	14.2	13.1	15.4
Available K (ppm)	1993	55.3	124.9	134.2
	1994	109.7	135.0	119.7
	1995	127.3	122.1	134.0
	1996	101.7	87.2	106.7

Fertiliser application

Table 2. Fertiliser applied in autumn to all trial plots at Manypeaks 1994 to 1996.

Year	Fertiliser type	Fertiliser rate (kg/ha)	P (kg/ha)	K (kg/ha)	S (kg/ha)	N (kg/ha)
1994	Mix containing 55 kg DAP, 22 TSP, 14 kg elemental S and 0.8 kg Zn	92	18.0	0.0	17.0	12.0
1995	3 - 2 Super Potash	110	5.8	20.0	6.9	0.0
1996	Summit Pasture + Potash	157	17.3	31.4	9.4	0.0

Insect control

From 1995 on plots were sprayed for red legged earth mite as required on the basis of insect numbers

Table 3. Details of insecticide applications at Manypeaks.

Year	Month	Insecticide	Rate
1993	-	not sprayed	-
1994	-	not sprayed	-
1995	May	LeMat	150 ml/ha
	August	Rogor	150 ml/ha
	October	Rogor	300 ml/ha
1996	September	Rogor	300 ml/ha
	October	Rogor	300 ml/ha

Treatments

Pasture

Pasture type and stocking rate treatments were changed throughout the life of the trial as either plant species failed or it became apparent that higher stocking rates were required to optimise production. Rotational grazing in 1993 and 1994 comprised of set stocking across the whole plot for autumn (from the break of season), winter and early spring, the plot was then split into 3 sections in late spring, which were, in turn, grazed for 6 weeks and locked up for 12 weeks. Rotational grazing of tall fescue in 1996 consisted of 3 plots, 2 tall fescue and 1 annual pasture. Stock were moved

from plot to plot in the growing season once feed on offer was reduced to 1500 kg DM/ha, in the dry season the tall fescue plots were only grazed if the fescue was active i.e. when the soil was moist, otherwise stock remained on the annual plot grazing dry residues. Treatments are detailed in Table 4.

Table 4. Experimental treatments imposed at Manypeaks from 1993 to 1996.

Year	Pasture type	Grazing management	Stocking rate (dse/ha)	No. of replicates
1993	Annual	Set stocked	8	2
			10	2
			12	2
	Kikuyu	Set stocked	10	3
		Rotationally grazed	10	3
			14.5	3
	Temperate perennial mix[1]	Set stocked	10	3
		Rotationally grazed	10	3
			14.5	3
1994	Annual	Set stocked	9.5	2
			11.5	2
			12	2
	Kikuyu	Set stocked	11.5	3
		Rotationally grazed	11	3
			14.5	3
	Temperate perennial mix	Set stocked	11	3
		Rotationally grazed	11	3
			14.5	3
Jan to June 1995	Annual	Set stocked	9.5	2
			11.5	2
			12	2
	Kikuyu	Set stocked	11.5	3
			14.5	3
			17.5	3
	Tall fescue	Establishment phase	-	9
Jul 1995 to Dec 1996	Annual	Set stocked	11.5	3
			14.5	3
			16.5	1
	Kikuyu	Set stocked	11.5	3
			14.5	3
			17.5	3
	Tall fescue (start Jan 1996)	Rotationally grazed	11.5	3

[1] Consisted of perennial ryegrass (cv Brumby), phalaris (cv Sirosa) and tall fescue (cv Au Triumph).

Animals

On the 15th of December 1992, 18-month merino wethers were allocated to the plots. These were then replaced with similar sheep on the 5th of January 1994, which remained on the trial until January 1997, due to the farmer being unable to supply replacement weaners. Sheep were stratified on a liveweight basis before being randomly allocated to plots. Sheep were shorn in January each year and at the same time drenched for worms and jetted for lice and fly.
No supplementary feed was given to stock in 1993, 1994 and 1995. In 1996 stock were fed lupins in summer/autumn if the plot mean liveweight fell at 100gm/head/day over a period 2 to 3 weeks, condition score was below 2.0 and pasture feed on offer was below 1500 kgDM/ha and of poor quality.

Measurements

Pasture composition was assessed visually in winter and spring. Pasture growth rates were estimated in autumn, winter spring and summer by measuring pasture accumulation in exclusion cages over 3 to 4 weeks, feed on offer (FOO) was assessed at the same time (60 quadrats per plot, each quadrat 0.1m^2). Pasture biomass was determined by the calibrated visual assessment technique, calibration quadrats (0.1m^2) were cut to ground level with a scalpel.
Subclover seed bank changes were assessed by collecting seed in spring at flowering and in summer when seeds were mature. Samples were dried prior to sieving, threshing and flotation, which separated the seed from most of the other material. Samples were then oven dried and sorted to remove contaminants prior to weighing the seed. Annual seed production was calculated from the difference between spring and summer seed bank estimates.

Table 5. Yield, characteristics and value of wool produced on Manypeaks trial 1993 to 1996

		Management	Stocking rate (wethers/ha)	Lupins fed (kg/ha)	Clean wool (kg/ha)	% yield	Micron	Staple strength (N/ktx)	Staple length (mm)	Hauteur (mm)	Net return per ha, indicator 900c/kg	Net return per ha, indicator 600c/kg
1993	Annual pasture	Set stocked	8	0	45.8	77	24	27.9	124	92	$138	$50
		Set stocked	*10*	0	61.2	81	24	28.1	128	94	$195	$83
		Set stocked	*12*	0	68.9	78	23	31.2	123	92	$250	$115
	Kikuyu pasture	Set stocked	*10*	0	57.5	81	23	41.0	121	95	$192	$81
		Rotational	*10*	0	56.7	78	24	38.4	123	96	$176	$70
		Rotational	*15*	0	80.3	78	22	33.8	117	89	$384	$195
	Temperate perennials	Set stocked	*10*	0	53.1	79	23	29.4	120	89.0	$163	$62
		Rotational	*10*	0	44.5	78	22.0	29.4	109	83	$167	$65
		Rotational	*15*	0	72.3	78.0	22	24.3	109	80	$320	$154
1994	Annual pasture	Set stocked	*9.5*	0	41.3	70	22	23.2	112	81	$173	$71
		Set stocked	*12*	0	49.8	73	21	19.8	110	78	$299	$150
		Set stocked	*12*	0	50.7	71	20.0	16.2	111	76	$469	$261
	Kikuyu pasture	Set stocked	*12*	0	51.7	76	21	26.4	109	82	$317	$161
		Rotational	*11.0*	0	47.8	76	20	26.4	111	81	$401	$219
		Rotational	*15*	0	53.8	75	20	24.0	107	76	$446	$240
	Temperate perennials	Set stocked	*11*	0	44.6	77	20	23.2	104	76	$358	$191
		Rotational	*11*	0	40.2	74	19	20.7	102	72	$330	$172
		Rotational	*15*	0	53.6	73	20	19.0	99	70.0	$467	$255
1995	Annual pasture	Set stocked	*12*	0	51.9	74	22	20.1	107	76.8	$217	$95
		Set stocked	*15*	0	60.1	75	21	18.0	105	74.9	$352	$177
		Set stocked	*17*	0	60.8	73	21	16.3	99	70.0	$365	$181
	Kikuyu pasture	Set stocked	*12*	0	56.5	80	22	34.2	110	84.0	$240	$110
		Set stocked	*15*	0	55.0	79	21	31.4	102	76.4	$320	$157
		Set stocked	*17.5*	0	64.6	79	20	23.4	100	72.3	$518	$295
1996	Annual pasture	Set stocked	*12*	78	55.3	77	22	30.6	105	82	$230	$97
		Set stocked	*15*	477	61.1	74	21	25.8	101	76	$302	$112
		Set stocked	*17*	1,301	62.8	76	20	25.9	95	71	$283	$39
	Kikuyu pasture	Set stocked	*12*	0	62.6	80	23	48.6	111	89	$214	$91
		Set stocked	*15*	50	62.8	78	22	37.6	105	81	$264	$115
		Set stocked	*17.5*	361	72.3	79	21	31.4	104	78	$370	$156
	Tall fescue	Rotational	*12*	177	48.2	74	21.0	15.0	100	69	$256	$109

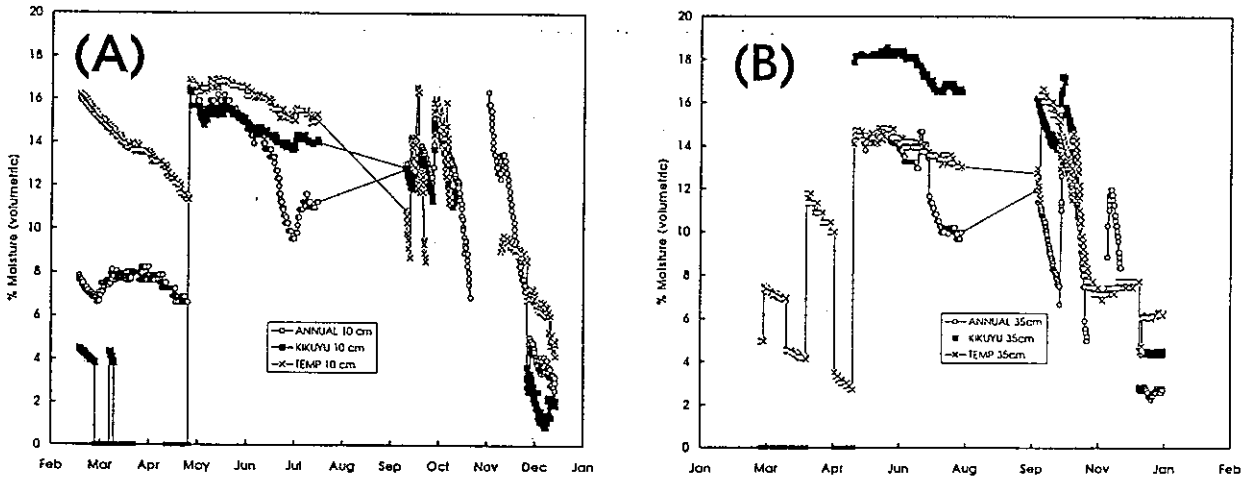


Figure 22. Soil moisture profile at (A) 10cm and (B) 35 cm below annual, kikuyu and temperate pasture in 1994.

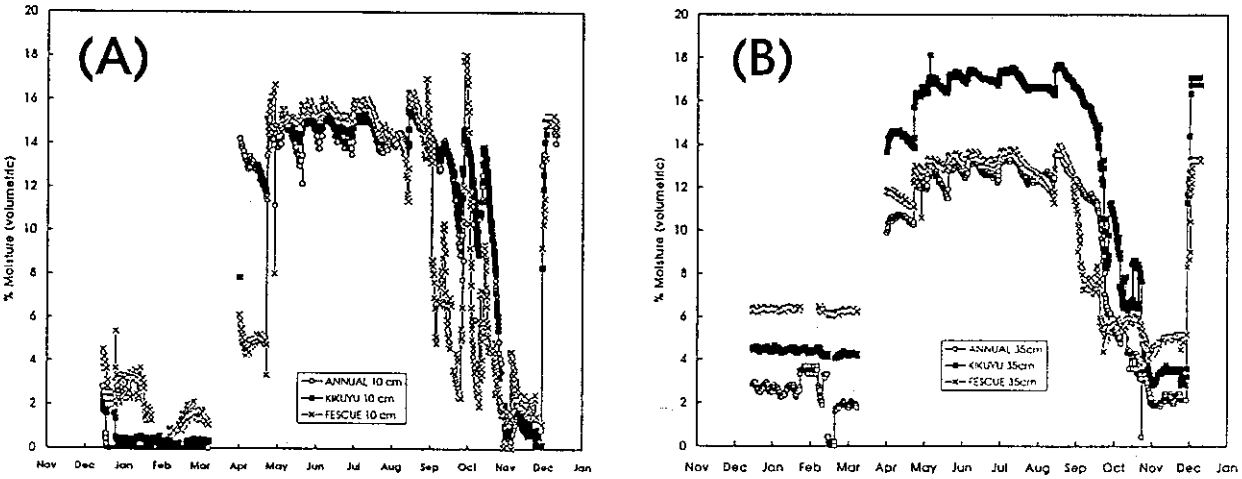


Figure 23. Soil moisture profile at (A) 10cm and (B) 35 cm below annual, kikuyu and temperate pasture in 1995.

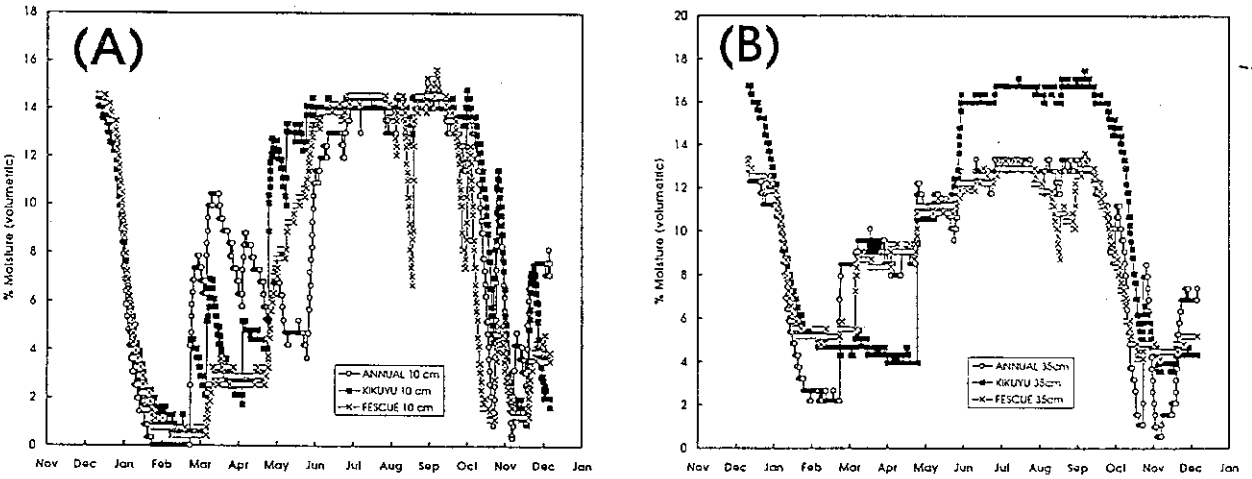


Figure 23. Soil moisture profile at (A) 10cm and (B) 35 cm below annual, kikuyu and temperate pasture in 1996.

grazing the kikuyu pasture at 11.5 dse/ha maintained their liveweight throughout this period without supplementary feed due to the availability of green feed (Fig. 18 and 5). Animal liveweights held up well on tall fescue early in the year however by late autumn/early winter this rotational treatment was doing poorly compared to the set stocked annual and kikuyu pastures at similar grazing pressures (Fig. 18).

In the growing season liveweight performance was largely determined by stocking rate and the amount of feed available through the autumn/winter period (Fig. 18 and 5). The liveweight data collected in 1996 demonstrates the ability of kikuyu to sustain higher stocking rates with better liveweight performance than annual swards e.g. compare kikuyu grazed at 17.5 dse/ha to annual pasture grazed at 16.5 dse/ha (Fig. 18 and Table 5).

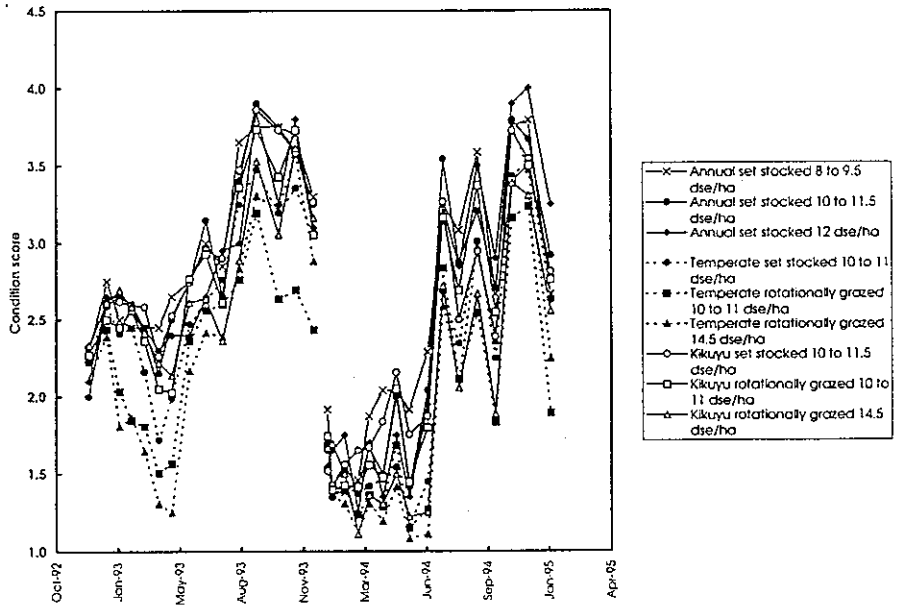


Figure 19. Sheep condition score for 1993 and 1994 at the Manypeaks trial site.

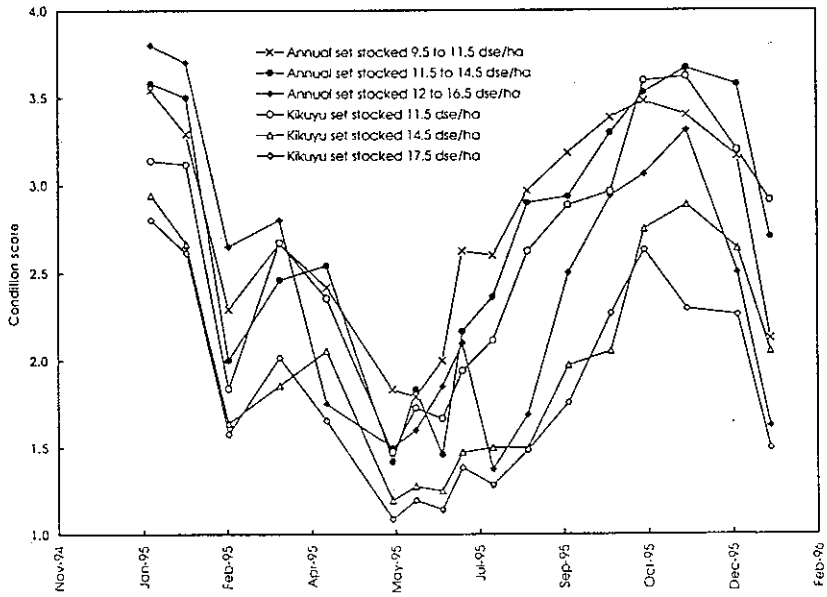


Figure 20. Sheep condition score for 1995 at the Manypeaks trial site.

Condition score

Condition scores are presented in Figures 19, 20 and 21 for the years 1993. 1994, 1995 and 1996. Changes in condition score closely followed that in liveweight change (see liveweight section). Overall pasture availability and quality determined condition score. Condition score was lowest in autumn for the rotationally grazed temperate perennials and highest for kikuyu and annuals grazed laxly at 11.5 dse/ha. The ability of kikuyu to maintain animal condition in

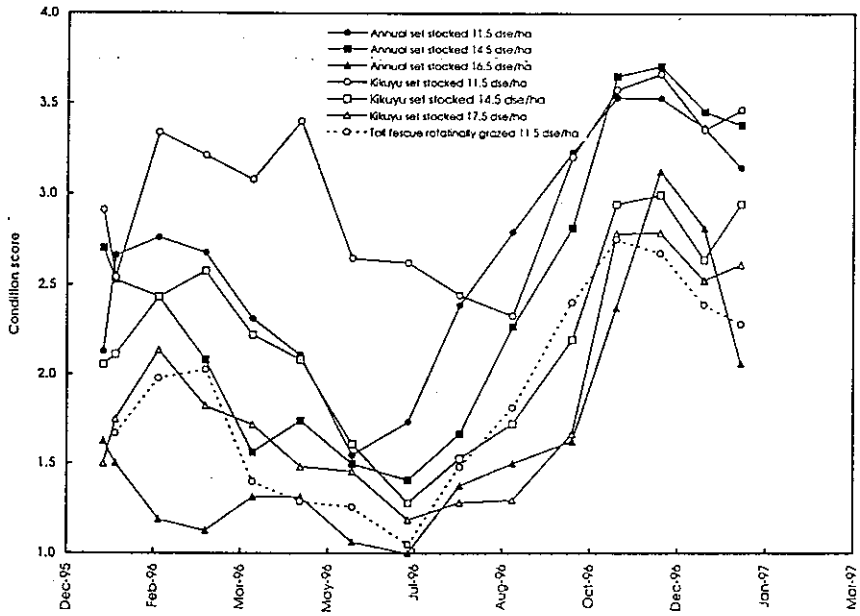


Figure 21. Sheep condition score for 1996 at the Manypeaks trial site.

autumn following summer rain is best illustrated by comparing kikuyu and annual treatments stocked at 11.5 dse/ha treatment in 1996.

Wool

Wool production data is presented in Table 5 In 60% of cases; more clean wool was produced on kikuyu than annual pastures at similar stocking rates due mostly to higher % yield e.g. 1995 at 11.5 wethers/ha. Statistically there were no differences in micron between kikuyu and annual pastures at similar stocking rates; however, increasing the stocking rate reduced micron. Each year, kikuyu produced stronger wool because of green feed in summer/autumn. Increased stocking rate reduced the staple strength. Overall there was little difference in staple length between kikuyu and annual pastures. Hauteur was consistently higher on kikuyu pastures. The difference in lupins fed out in autumn 1996 indicates the value of the kikuyu pasture at this time of year. Overall net returns per ha from wool production were higher on kikuyu, primarily because the pasture could sustain higher stocking rates. In any one year, the highest stocking rate on kikuyu was always more profitable than the highest stocking rate on annuals. Net returns from wool production for temperate perennials were generally less than or equal to the comparative kikuyu or annual treatment in 1993 and 1994. The tall fescue treatment in 1996 produced wool with a staple strength of only 15.0 N/ktx and therefore was discounted heavily. In summary, sheep grazing kikuyu pastures consistently produced more fine to medium wool which was sound. For example, compare a high stocking rate on annuals (14.4 wethers/ha) in 1996 to the potential on kikuyu at 17.5 wethers/ha. Kikuyu produced 11 kg/ha more wool which was finer and of similar strength.

Plant counts

Temperate perennials
Irrespective of grazing treatment the number of perennial ryegrass plants progressively declined from 1992 till 1994 (Fig. 12). By contrast, phalaris declined in a similar fashion under continuous grazing but maintained numbers in both rotationally grazed swards (Fig. 12). Tall fescue plant counts declined from 1992 to 1994 with the lowest rate of loss recorded in the rotationally grazed treatments (Fig. 12).

Kikuyu
The percentage of ground covered by kikuyu throughout the trial is presented in Figure 13. From 1992 until March 1997 percentage groundcover increased from just below 30% to on average 80%. Across grazing treatments there is a tendency for rotationally grazed swards to possess the most groundcover and the highest stocking rates to have the least.

Tall fescue
The average number of tall fescue plants per square meter from August 1995 until August 1996 is depicted in Figure 14. Plant numbers declined at relatively steady rate of 7 to 8 per month.

Seed bank

The changes that took place in the clover seed bank during the period of the trial are presented in Figure 15. Across all treatments and years, the total clover seed bank remained large, ranging from 500 kg/ha to 1500 kg/ha. Seed set for all treatments was highest in the spring of 1993 as a consequence of a productive season (Fig. 6) and lowest in 1994 due to a late break and subsequent poor pasture yield (Fig. 6). As a result season accounted for the changes in seed set from year to year. Within growing seasons, differences between grazing treatments imposed on the same pasture base were generally small. Across pasture types and seasons it appears that the seed set on perennial pastures was less influenced by season than that in annual pastures.

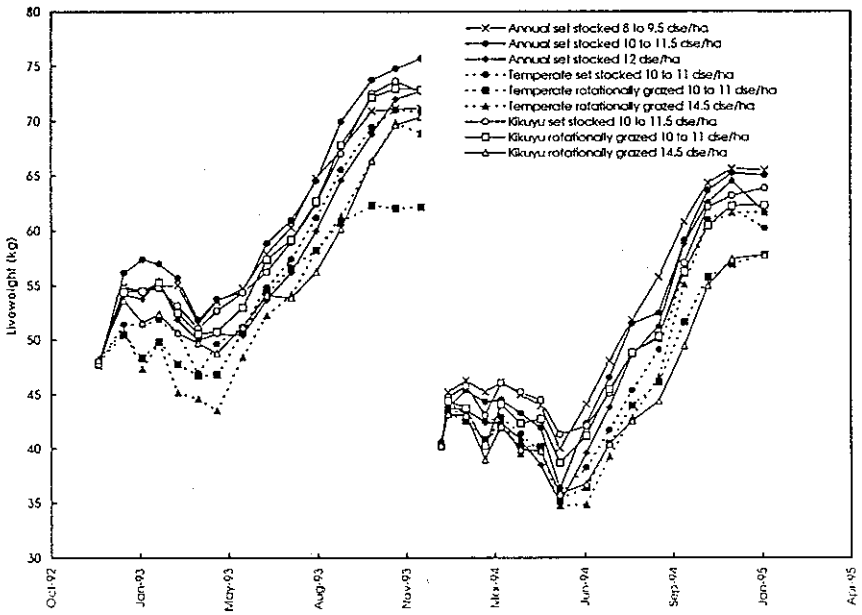


Figure 16. Sheep liveweights for 1993 and 1994 at the Manypeaks trial site.

Animal measurements

Liveweight

1993 and 1994
Changes in liveweight throughout 1993 on the set stocked kikuyu and annual treatments was similar, with the largest gains occurring once the pasture feed on offer reached 2000 kgDM/ha and above (Fig. 3 and 16). Stock grazing rotationally on the temperate perennial and kikuyu pastures possessed lower liveweights particularly in autumn and spring, as a result of remaining in plot sectors with low pasture availability while waiting to be moved on. Overall animal liveweight performance was superior on the kikuyu and annual treatments (Fig. 16).

While the differences in liveweight between treatments was not as marked in 1994 as 1993, similar trends emerged with the set stocked annual and kikuyu treatments performing best and the kikuyu and temperate perennials grazed rotationally worst (Fig. 16).

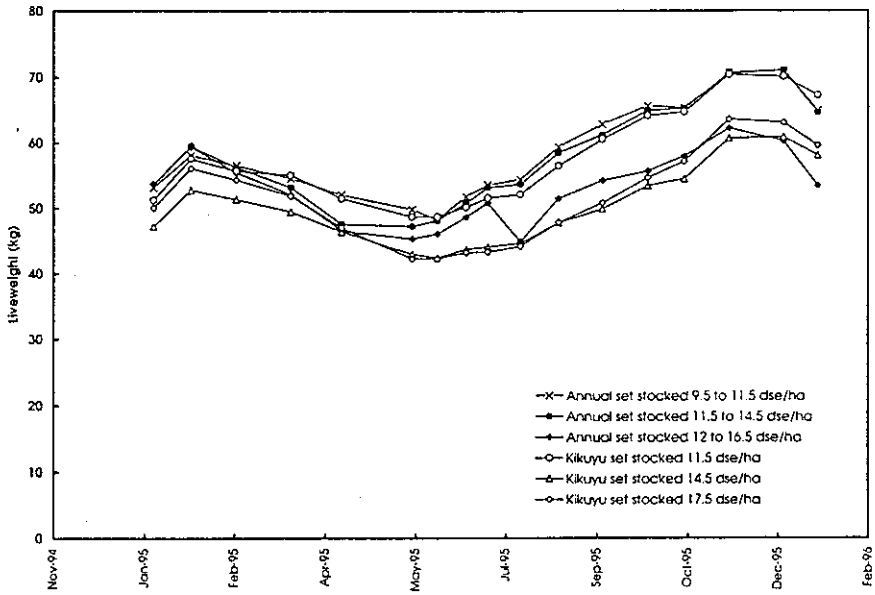


Figure 17. Sheep liveweights for 1995 at the Manypeaks trial site.

1995

At the end of 1994 the rotational grazing treatments were discontinued to be replaced by set stocking and the establishment of tall fescue in 1995. Throughout 1995 the liveweight performance of animals grazing different pasture bases at the same stocking rate was identical e.g. kikuyu vs annual at 11.5 dse/ha set stocked (Fig. 17). Across different stocking rates liveweights were heaviest at the lower stocking rates and lightest at the highest, therefore grazing pressure accounted for most of the variation in liveweight during 1995 (Fig. 17).

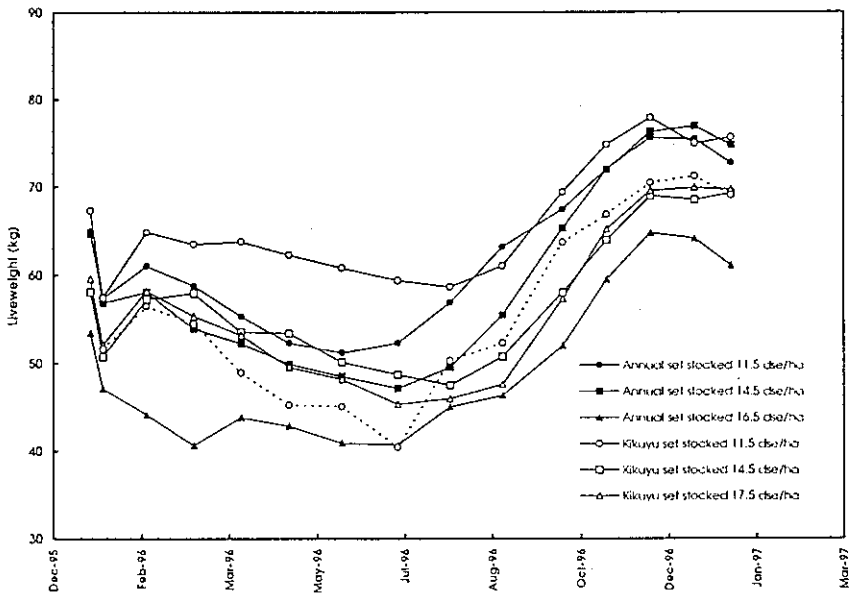


Figure 18. Sheep liveweights for 1996 at the Manypeaks trial site.

1996

Prior to the break of season in 1996 all treatments - except kikuyu set stocked at 11.5 dse/ha - were fed lupins (refer to Table 5 for the amounts per ha per treatment). The liveweight performance of stock receiving supplementary feed during this period was similar regardless of treatment (Fig. 18), with the exception of the highest stocking rate on the annual pasture which had little or no feed available and as result recorded the lowest liveweights (Fig. 18 and 5). Sheep on the annual pasture were consistently fed with more lupins than those on kikuyu at the same stocking rate (Table 5). Sheep

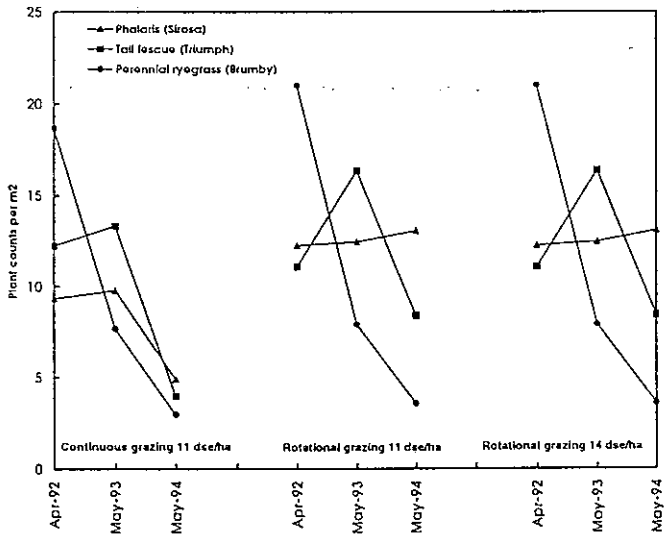


Figure 12. Plant counts for phalaris, tall fescue and perennial ryegrass from 1992 till 1994 at the Manypeaks trial site.

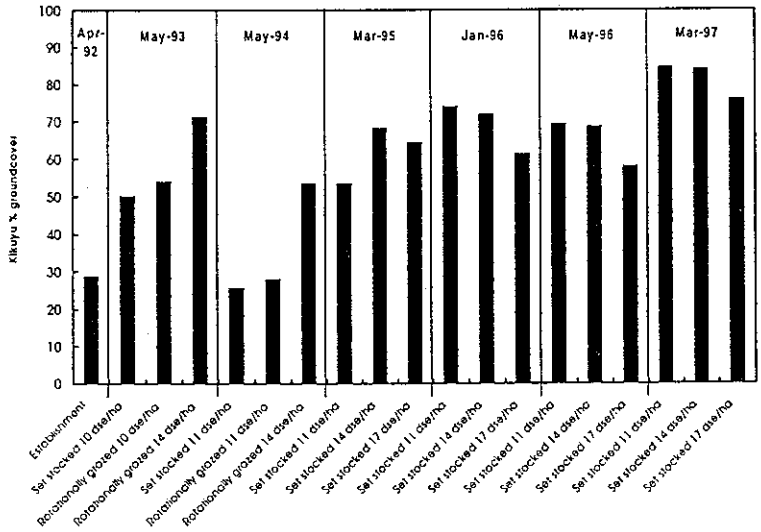


Figure 13. Percentage of ground covered by kikuyu between 1992 and 1997 at the Manypeaks trial site.

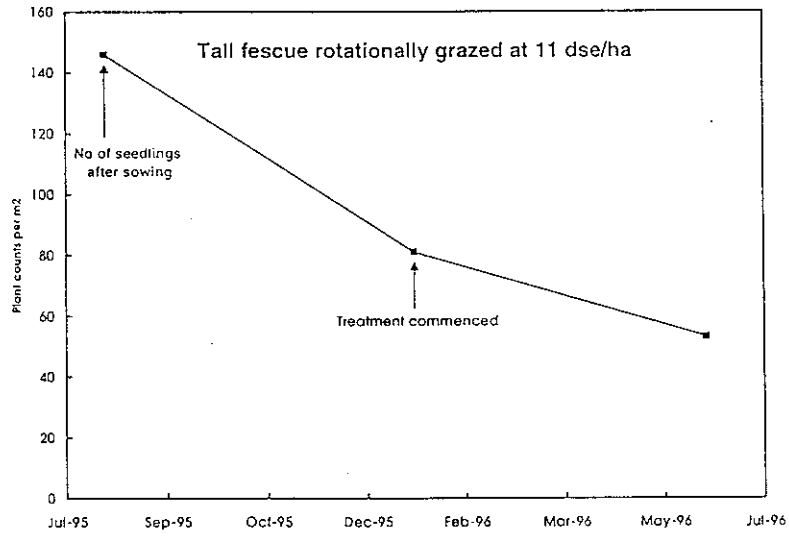


Figure 14. Tall fescue plant counts for 1995 and 1996 at the Manypeaks trial site.

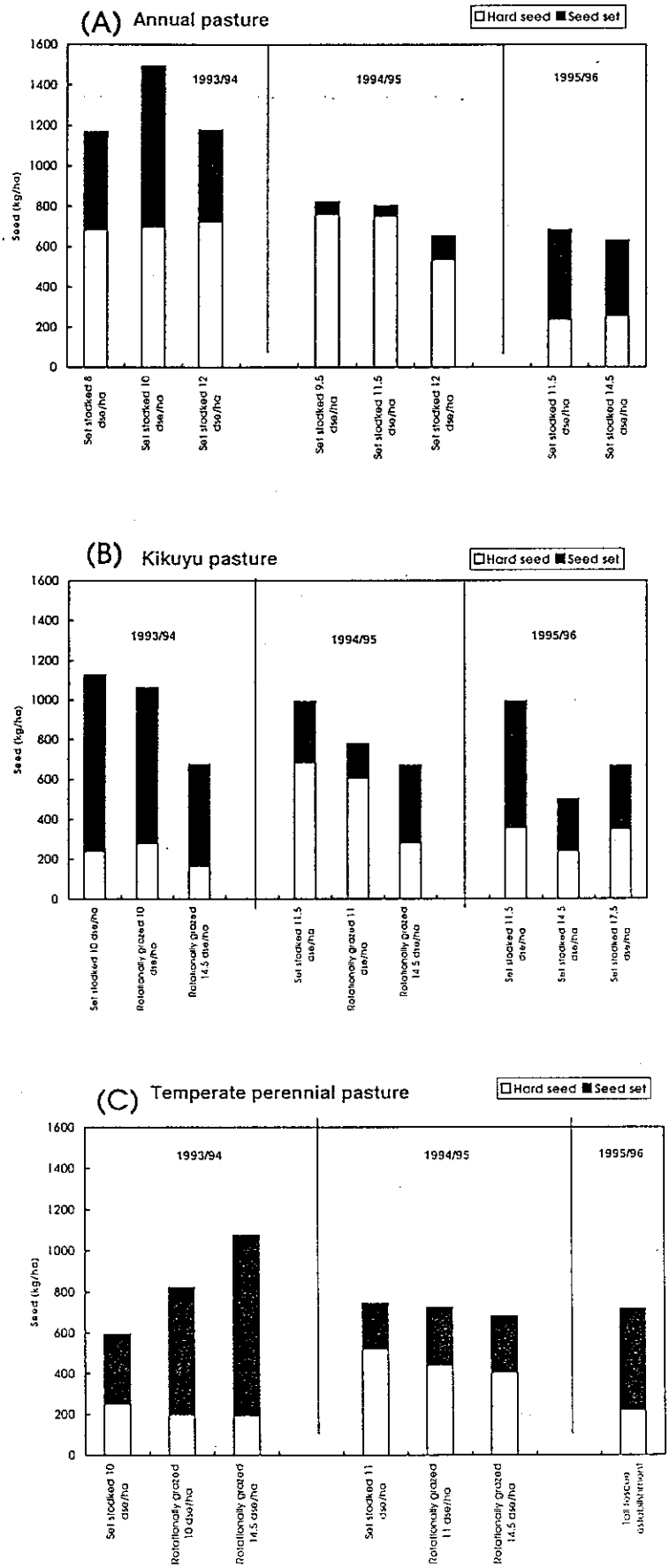


Figure 15. Subclover seed bank for (A) annual, (B) kikuyu and (C) temperate perennial pasture for the experimental period of the Manypeaks trial.

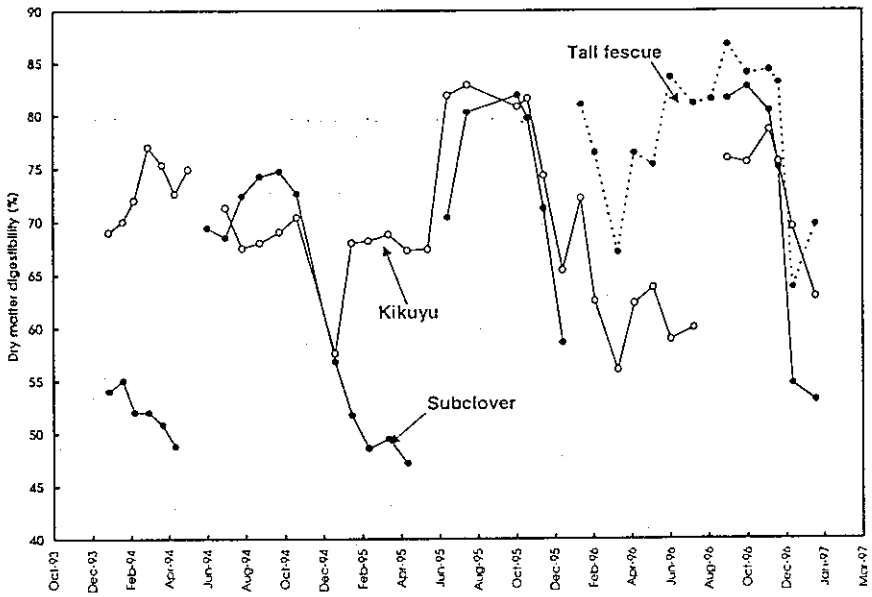


Figure 9. Dry matter digestibility of subclover, kikuyu and tall fescue for the experimental period 1994 till 1996 at the Manypeaks trial site.

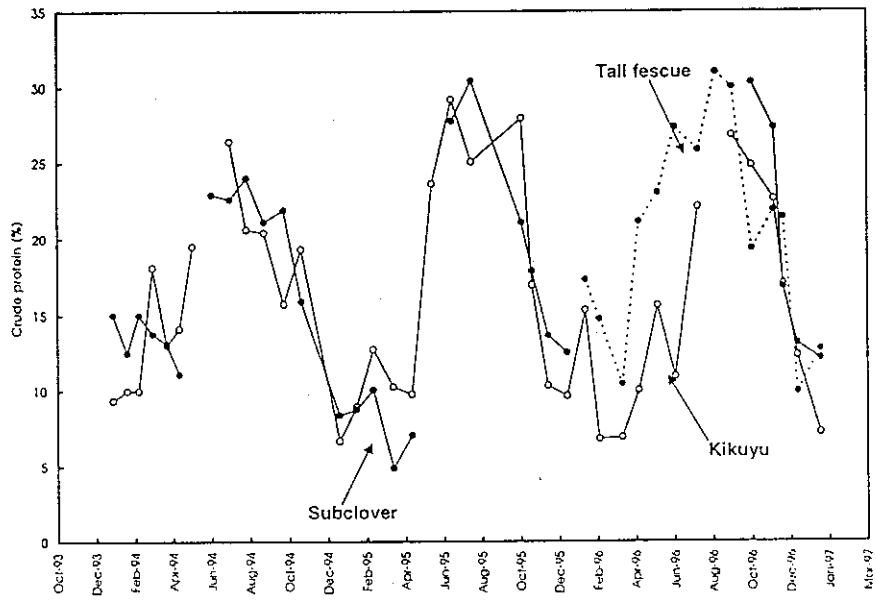


Figure 10. Percentage protein for subclover, kikuyu and tall fescue dry matter for the experimental period 1994 till 1996 at the Manypeaks trial site.

Botanical composition

Changes throughout the trial in spring botanical composition are presented in Figure 11. The annual pastures comprised of a mixture of subclover, capeweed, flatweed, barley grass, ryegrass and silver grass. While the ratio of these components changed during the trial (e.g. clover dominated in 1993, Fig. 11(b)) the botanical composition was similar in any given year and across treatments.

Kikuyu pastures initially (see Fig. 11(a)) were similar to the annual pasture with the addition of kikuyu however, as the trial progressed kikuyu displaced the broadleaf weeds from the sward (Fig. 11, compare 1992 to subsequent years).

The temperate perennial pastures contained the same annual species as the annual treatments with the addition of perennial ryegrass, phalaris and tall fescue. From 1992 until 1994 the density of perennial grasses declined in proportion to that of subclover and annual grasses in all treatments (Fig. 11(a)(b)(c)). By the spring of 1994 the swards were dominated by annual species. The temperate perennials also displaced the broadleaf weed component in the sward.

The temperate perennial treatments were replaced by tall fescue in the autumn of 1995, while this treatment only ran for a short period the density of tall fescue did record a modest increase between 1995 and 1996 under rotational grazing (Fig. 11(d)(e))

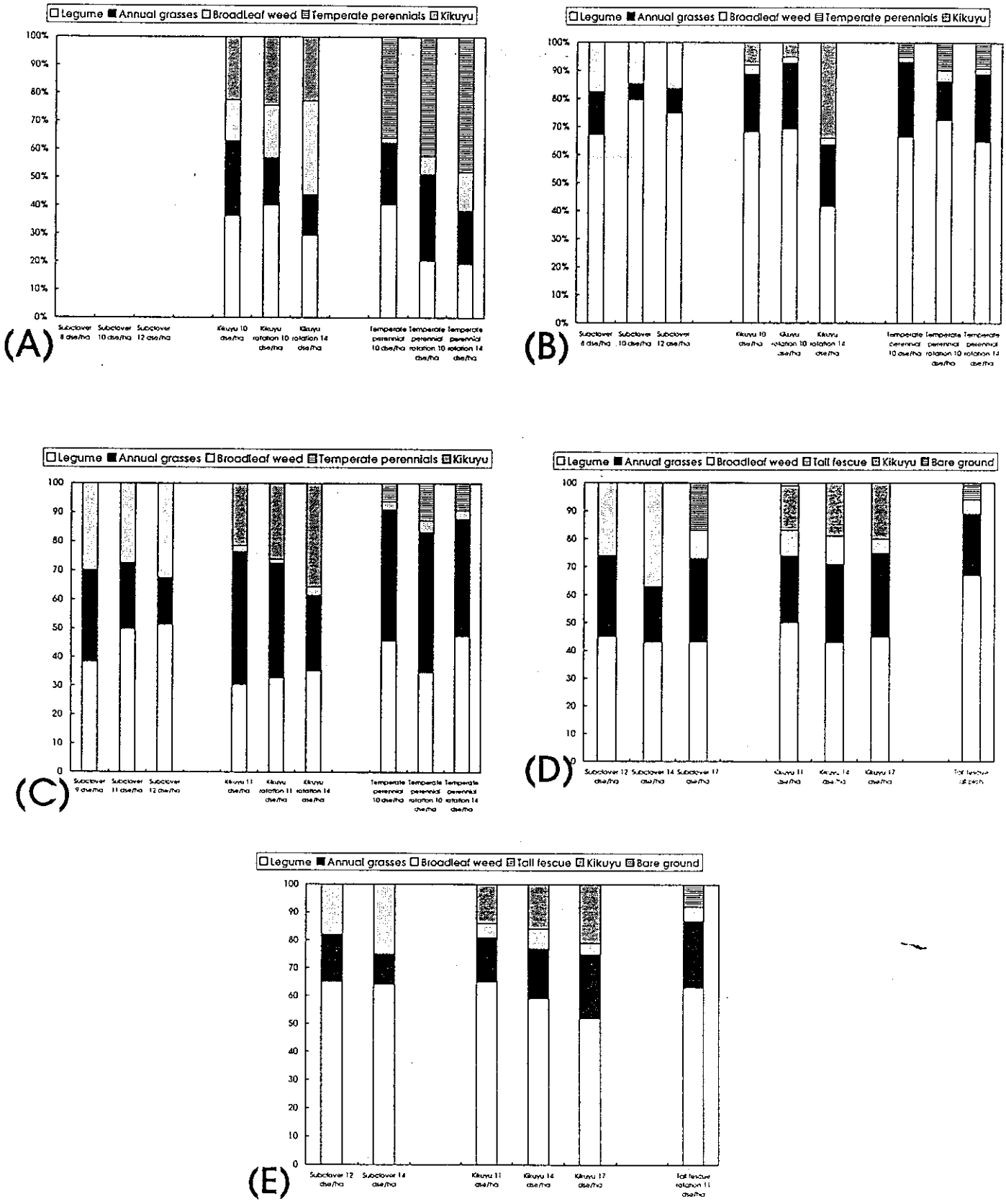


Figure 11. Spring time botanical composition of annual, temperate perennial, kikuyu and tall fescue pasture in (A) 1992, (B) 1993, (C) 1994, (D) 1995, and (E) 1996 at the Manypeaks trial site.

1996

A summer rainfall event (90 mm, Fig 1) in late December 1995 resulted in a failed annual germination and sufficient moisture for growth in both kikuyu and tall fescue well into early 1996. The amount of green feed available during this period on the perennial treatments was quite significant (450 to 1300 kgDM/ha) with the tropical grass kikuyu responding best (Fig 5). As a result of the summer rain the kikuyu swards recorded the highest amount of autumn green feed throughout the duration of the trial (1300 kgDM/ha). Tall fescue while not as active as kikuyu, still demonstrated good potential to provide green summer feed with amounts reaching 700 kgDM/ha in January. As you would expect dry residues in the annual pasture treatments held up poorly particularly on the higher stocking rates e.g. 16.5 dse/ha. By mid-autumn these residues had reached 1300, 300 and 80 kgDM/ha on 11.5, 14.5 and 16.5 dse/ha respectively (Fig 5). Feed on offer profiles following the break of season in April 1996 clearly demonstrate the effect of increased stocking rate on standing biomass (Fig. 5), with the highest rate on the annual and kikuyu treatments highlighting the ability of kikuyu to sustain higher rates of defoliation. During the growing season rotationally grazed tall fescue performed well with the amount of feed in spring exceeding that on all other treatments (Fig. 5).

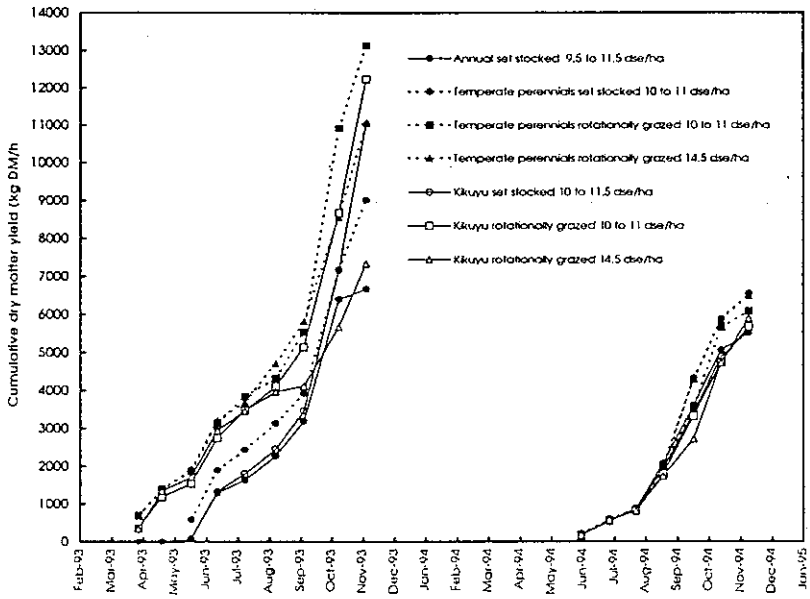


Figure 6. Cumulative dry matter yields for annual, kikuyu and temperate perennial pasture from 1993 to 1994 at the Manypeaks trial site.

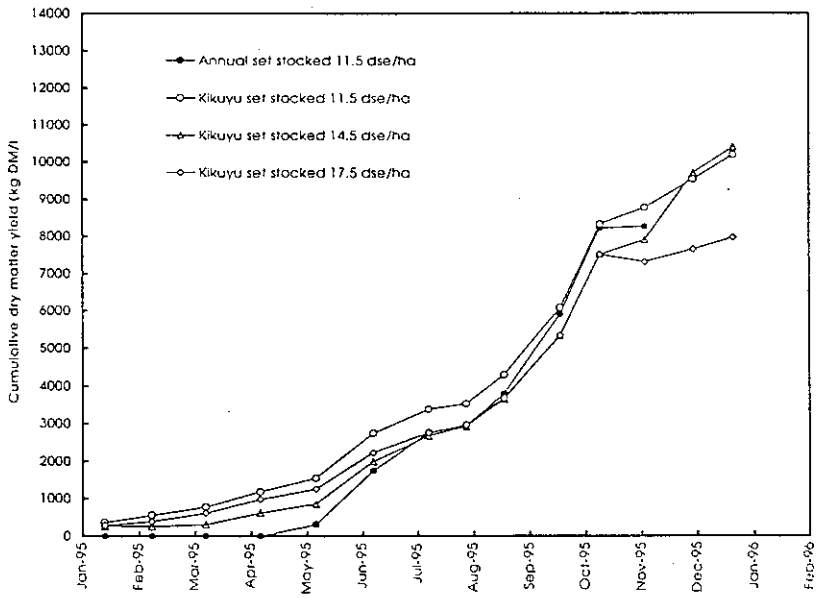


Figure 7. Cumulative dry matter yields for annual and kikuyu pasture during 1995 at the Manypeaks trial site.

Pasture yield

1993 and 1994

Pasture yields in 1993 varied considerably between treatments. In autumn and winter growth was delayed in set stocked treatments as opposed to the rotationally grazed (Fig. 6). At similar stocking rates and management the temperate perennials performed best during this period (Fig. 6). The largest yields for the season were recorded in the rotational treatments (highest; 13300 kgDM/ha temperate perennial rotationally grazed at 10 dse/ha), with the annual set stocked at 9.5 dse/ha and kikuyu rotationally grazed at 14.5 dse/ha recording the lowest yields at 6600 kgDM/ha and 7200 kgDM/ha respectively (Fig. 6).

As a result of the late break and lower rainfall in 1994 pasture yields were lower than in 1995, with an average yield of 6000 kg DM/ha (Fig. 6). Pasture yields were similar across treatments.

1995

Moderate growth was recorded in all kikuyu treatments prior to the break of season in 1995 (Fig. 7). Once the season got underway in April the annual pasture grew rapidly to eventually record a similar yield to that of kikuyu set stocked at 11.5 and 14.5 dse/ha of 8000 kgDM/ha (Fig. 7). Growth ceased on the annual pasture at the end of the season in November, all kikuyu treatments however continued to grow well into December as a result of soil moisture and late rain (Fig. 1). The best regime, kikuyu stocked at 14.5 dse/ha, accumulated 2300 kgDM/ha during this early summer period (Fig. 7).

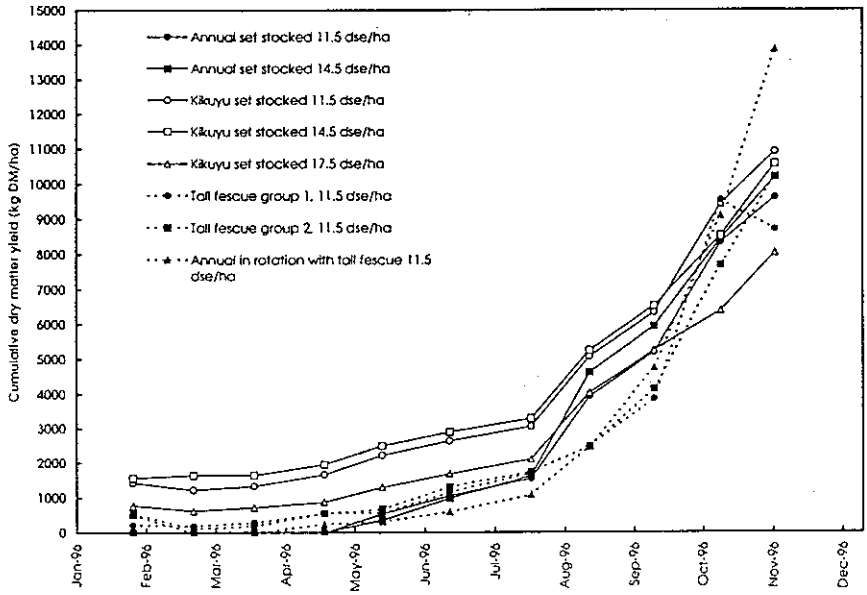


Figure 8. Cumulative dry matter yields for annual, kikuyu and temperate perennial pasture during 1996 at the Manypeaks trial site.

1996

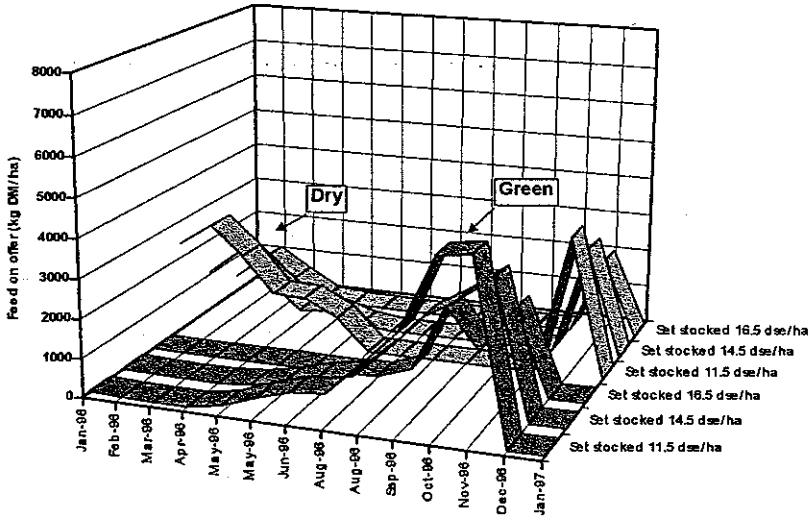
All treatments recorded little or no growth during February and March 1996. Following the opening rains in April, growth commenced earlier in the kikuyu and tall fescue pastures (Fig. 8). Growth was similar across all treatments in autumn and winter; however, once temperatures rose in late winter/early spring the annual pastures recorded the highest growth rates. Yields across treatments were similar in late spring averaging about 10000 kgDM/ha, except for the highest stocking rate on kikuyu (8000 kgDM/ha) and the annual in rotation with tall fescue (13800 kgDM/ha) which was ungrazed during spring.

Digestibility and crude protein

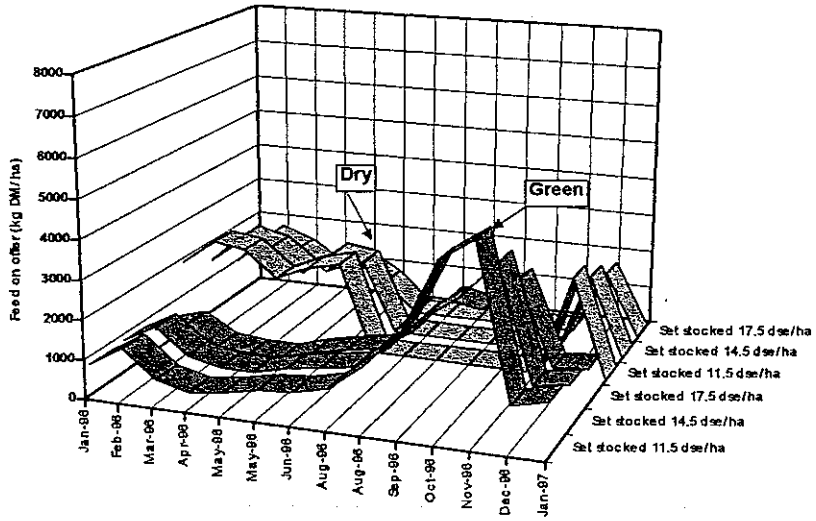
Digestibility and crude protein is presented in Figure 9 and 10 for individual pasture species. Overall subclover and tall fescue had the highest digestibility within the growing season between 75 to 85%. Kikuyu was typically 70 to 80% digestible at this time of the year. During summer and autumn both perennial species possessed far better dry matter digestibility than subclover with values ranging between 60 to 75% - depending on management and moisture availability - compared to only 45 to 55% for subclover dry residues.

Crude protein was similar throughout the trial for kikuyu and subclover. In summer/autumn tall fescue recorded higher protein levels than kikuyu.

Annual pasture



Kikuyu pasture



Tall fescue grazed rotationally at 11.5 dse/ha

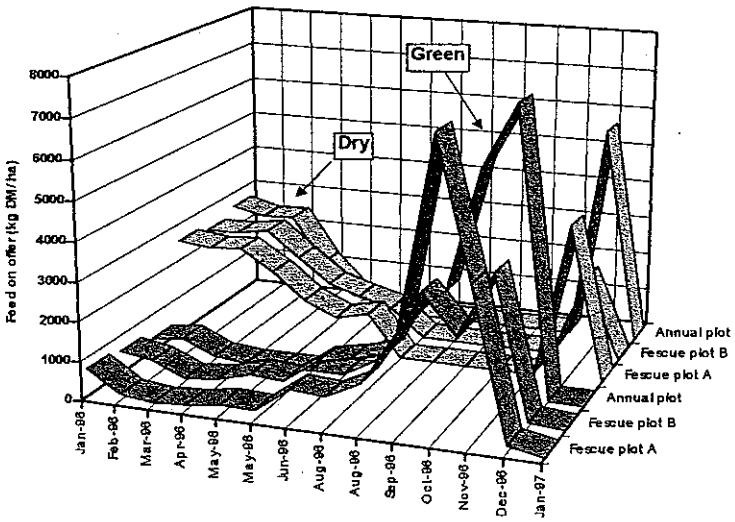


Figure 5. Green and dry feed on offer profiles for annual, kikuyu and temperate perennial pasture for 1993 and 1994 at the Manypeaks trial site.

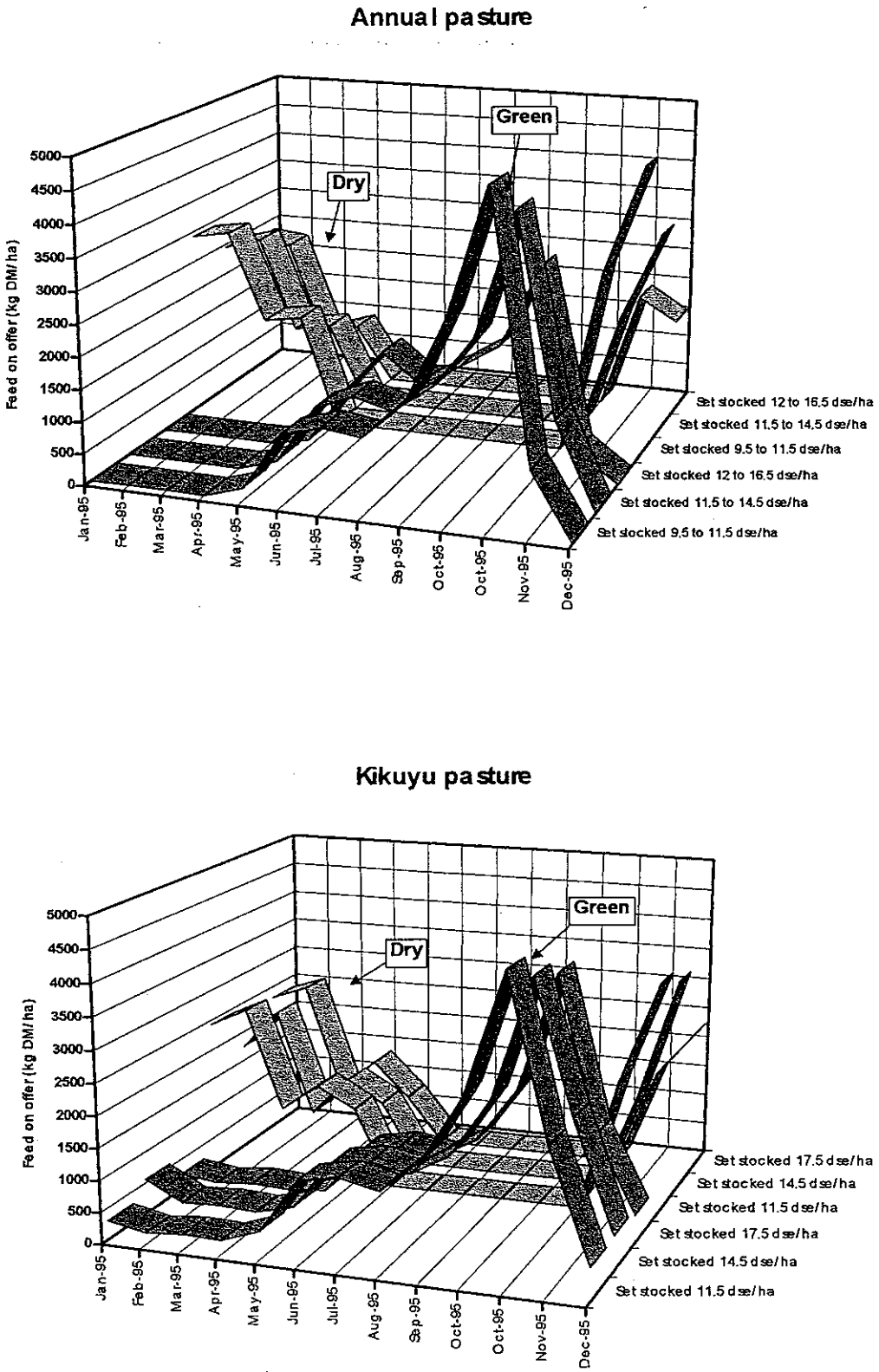


Figure 4. Green and dry feed on offer profiles for annual and kikuyu pasture for 1995 at the Manypeaks trial site.

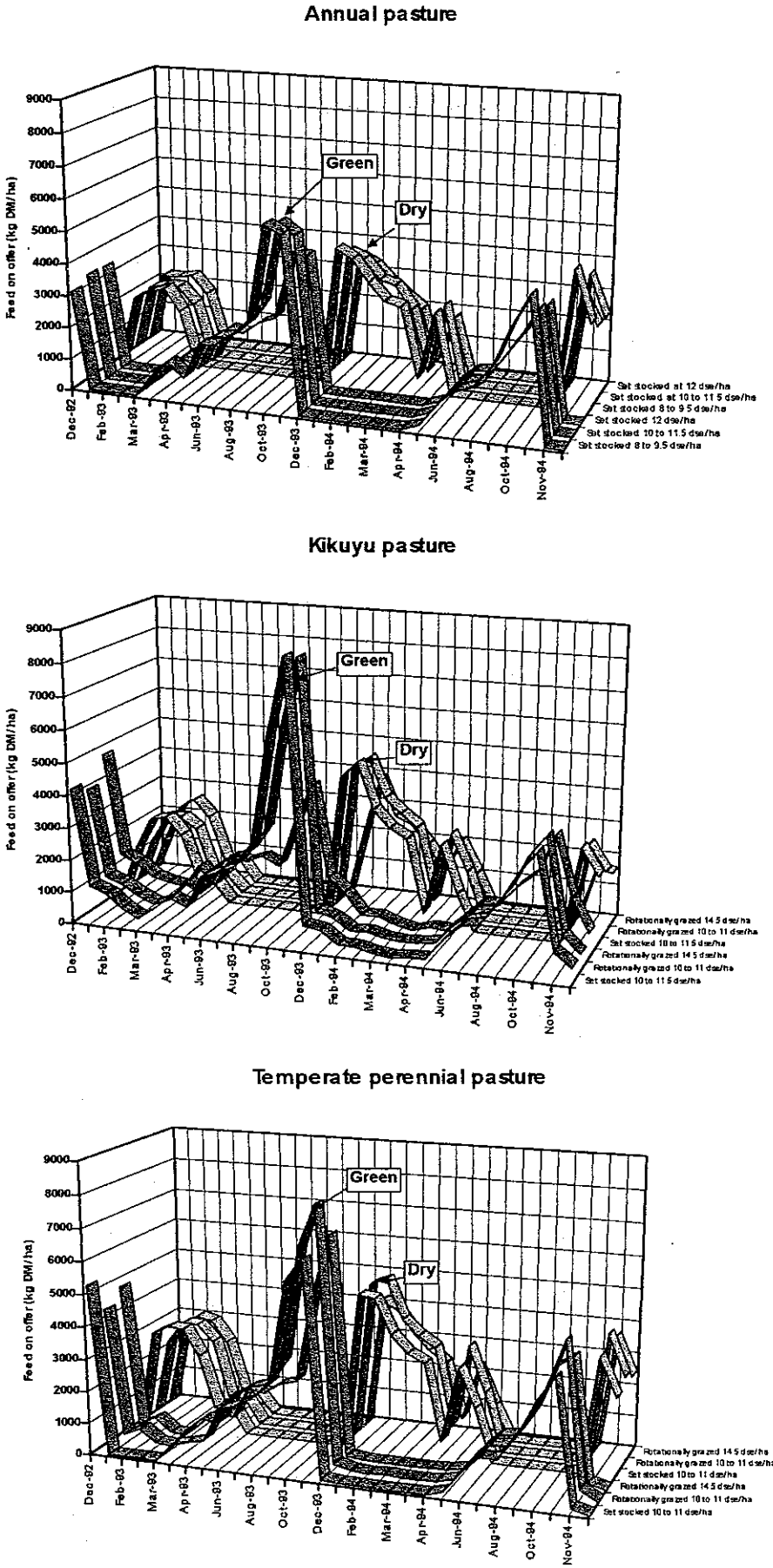


Figure 3. Green and dry feed on offer profiles for annual, kikuyu and temperate perennial pasture for 1993 and 1994 at the Manypeaks trial site.

Dry Matter Solubility (DMS) of pasture was measured using the pepsin-cellulase technique. DMS was regressed against the dry matter digestibility (DMD) of standard feeds, calculated from total faecal collections from wethers fed the standard materials at a maintenance level. Crude protein was determined using Kjeldahl digestion with the resulting digest analysed using the colorimetric reaction of soduim salicylate/sodium nitroprusside in a sodium hydroxide solution of sodium dichloroisocyanurate.

Sheep were weighed every 3 to 4 weeks using electronic scales; condition was assessed at the same time. Wool yield was determined by greasy fleece weight and converted to clean on the basis of a yield assessment of a midside sample. Staple length and strength was measured on staples taken from midside samples, which was then tested for yield and mean fibre diameter.

Soil moisture (% volume) was assessed using DRW Microlink solid state probes. Probes were deployed at a depth of 10 and 35 cm at 3 locations in a kikuyu and temperate pasture plot and 2 locations in an annual plot; measurements were taken twice daily. Calibration was done by assessing the gravametic soil moisture of soil in close proximity of the probe. Perched water was determined by measuring the height of water in a borehole lined with a PVC tube at two locations at the site (holes 77 and 41 cm deep), water height was assessed daily by an electronic logger.

RESULTS

Pasture measurements

Feed on offer

1993 and 1994

In 1992 the growing season finished late in December as illustrated by the amount of green feed still available on all treatments including the annual pasture (Fig. 3). Early 1993 (January and February) was dry with stock relying on residues for feed on both the annual and set stocked temperate perennial pastures. The kikuyu treatments all had moderate amounts of green feed available, ranging from between 300 to 1000 kg DM/ha (Fig 3). The rotational grazing management imposed upon the temperate perennial swards also provided a small amount of green feed of up to 500 kgDM/ha.

The opening rains for season 1993 fell in March, resulting in the breakdown of autumn dry residues and an annual germination. During this period in which feed on offer is typically below that required for maximum intake for stock (> 2000 kgDM/ha) the kikuyu pastures provided the largest quantity of feed (300 to 600 kgDM/ha green vs zero green on the annual treatments, Fig. 3) This advantage however was short lived as the annual and temperate perennials grew rapidly with the favorable temperatures at this time of year (Fig. 2).

The feed on offer profile throughout the 1993 growing season was similar across all pastures with only the spring peak differing between treatments and pasture type (Fig 3). As expected for all pasture bases as stocking rate increases pasture feed on offer decreases. Peak biomass in spring 1993 for the set stocked treatment at 10 to 11 dse/ha was 5500 kgDM/ha, 8500 kgDM/ha and 6500 kgDM/ha for the annual, kikuyu and temperate perennial pastures respectively (Fig 3). Rotational grazing resulted in higher levels of feed on offer compared to set stocking at similar stocking rates (Fig 3).

The 1993 growing season finished in November, followed by a dry summer/autumn and a late break in May 1994 (Fig 1). The quantity of dry residues held up well during the summer/autumn across all treatments due to the lack of rain. Only the kikuyu treatments provided substantial amounts of green feed during this period with between 500 to 2000 kgDM/ha available in December/January 1993 depending on treatment (Fig 3) which to 200 to 800 kgDM/ha in late autumn.

Treatment effects in season 1994 were small for any given pasture base, with spring peak biomass being the highest for the temperate perennial swards (4600 kgDM/ha rotationally grazed at 14.5 dse/ha) and lowest for kikuyu (3600 kgDM/ha rotationally grazed at 14.5 dse/ha) (Fig 3). Overall pasture standing biomass was lower in 1994 than 1993 due to the late break, below average rainfall in October 1993 (Fig 1) and increased stocking rate on most treatments. The season finished in November.

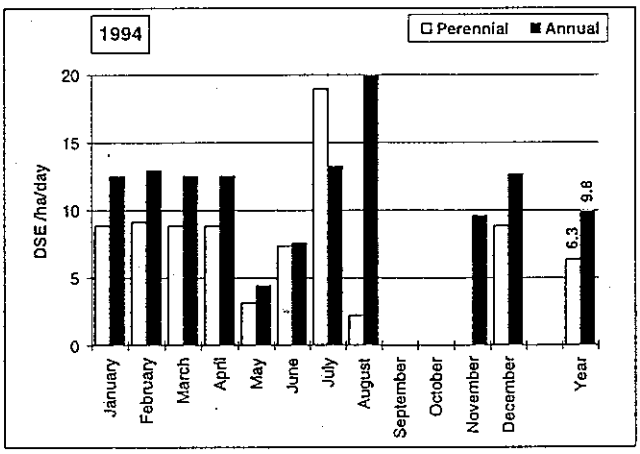
1995

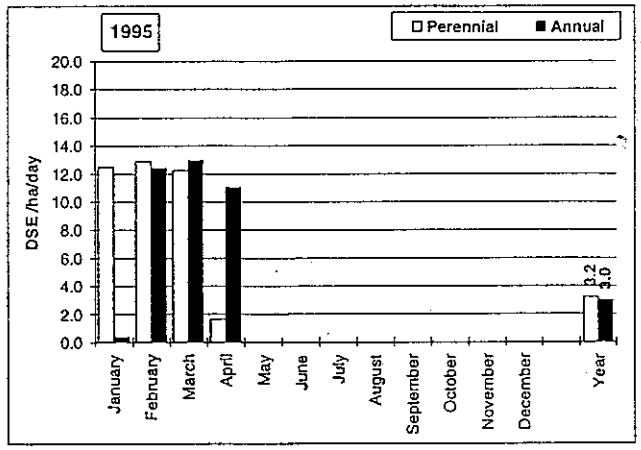
The opening rains for season 1995 fell in April. The preceding dry summer/autumn period reinforced the ability of the perennial kikuyu to provide stock with a small amount (200 to 500 kgDM/ha) of green pick during this time of year (Fig 4). At the lowest stocking rate of 11.5 dse/ha the annual pasture had a similar or better-feed profile to that of the corresponding kikuyu treatment (Fig 4). However, as stocking rate increases the quantity of feed on the annual pasture is less than that available on the kikuyu. This treatment difference becomes most apparent when you compare the standing biomass in spring on the kikuyu stocked at 17.5 dse/ha (4000 kgDM/ha) to that of the annual pasture at 16.5 dse/ha (3200 kgDM/ha) (Fig 4).

As a result of below average rainfall throughout the season 1995 (Fig 1) the amount of feed available on all treatments was below that expected in a normal year. Season 1995 finished in late November.

Appendix XVII

Estimated Average Grazing Pressure each month during the project





Perennial sward establishment:

No weed control was possible during the spring prior to sowing due to late hay making in November 1992. However in May 1993, germinating seedlings were controlled using 1 l/ha of Roundup and 75 ml/ha of Goal herbicide.
In May a mixture of 6 kg/ha Embassy perennial. ryegrass, 3.5 kg/ha Tetila annual ryegrass, 2.5 kg/ha Trikkala subclover and 2.5 kg/ha Paradana balansa clover were sown using minimum tillage methods.
Insects (RLEM) were controlled 4 weeks after germination with 75 ml/ha of Lemat applied with a mister.
Establishment of all sown species was satisfactory at 8 weeks after sowing despite a high density of volunteer silver grass and erodium.

Grazing management during the establishment year (1993)

The *perennial* paddock was only lightly grazed during winter (due to lack of pasture biomass). In contrast, the *annual* paddock was rotational grazed with surrounding paddocks from January. Both paddocks were closed up for hay production in late August and cut in October. The most significant pasture grazing management difference between the two paddocks was the early commencement (in December) of grazing the regrowth of the *perennial* pasture sward after hay cutting.

Subsequent grazing management in 1994.

After calving started in April/May (*perennial*) and April/June (*annual*), 5 t/ha of hay was fed to cows in both paddocks. Both paddocks were grazed and closed up for hay production in late August and cut in October.

Results:

The establishment and subsequent persistence of perennial ryegrass in the PDS at Donnybrook was sufficiently low after 3 years to warrant termination of this trial. see Table 1.

Table 1. Perennial ryegrass plant density (plants/m²)

Oct	1993	50
May	1994	20
May	1995	1

There was little difference between the *annual* and *perennial* paddocks in pasture quantity (feed on offer) and quality monitored monthly throughout the study. In 1993 and 1994 more hay was harvested from the annual paddock (5.1 and 4.4 t/ha) than from the perennial paddock (3.6 and 3.2 t/ha).
The marginally higher animal grazing rate in the *annual* treatment reflects the grazing capacity foregone during the perennial sowing operation. see attached graph 1.

Discussion:
Reasons for the lack of persistence of perennial ryegrass into the second and third years include:

- No weed control in the spring prior to sowing and poor control in autumn 1993 coupled with strong competition from the sown annual ryegrass (cv Tetila). Both factors would have significantly limited the establishment, tillering and growth potential of the sown perennial ryegrass.
- The choice of perennial grass species was inappropriate as it is not tolerant of either summer drought (low soil moisture/high evapo-transpiration) or soil acidity (paddock pH was 4.1 in CaCl2). A more appropriate choice would have been Cocksfoot, Phalaris or Tall fescue. However the farmer favoured perennial ryegrass as he required the potential for a reasonably high hay yield in the planting year (and also in subsequent years).
- Inappropriate choice of the Embassy perennial ryegrass cultivar (only cv Embassy was available at the time of planting !). A more appropriate choice would have been cv Roper or Brumby, both of which have some drought tolerance.
- Hay was cut in the *perennial* paddock after hay cutting in the adjacent *annual* control paddock, both of which were considered to be late (in order to maximise yield). It is possible that the high leaf area at this time may have depleted soil water reserves for summer.
- Grazing the new (and still green) perennial ryegrass regrowth in late December and through the summer until mid May 1994
- The record long dry summer period (1993-94) in the establishment year. The only rainfall recorded was 19 and 2 mm on the 9th and 11th November 1993 respectively, together with a further 13 mm total up to mid May 1994. This was followed by another very dry summer (1994-95) when rain for November 1994 was 12 mm with only a further 14mm up to May 1995.
- The area was continuously grazed through the summer of 1994 -95 with no hay fed.
- The need for the farmer to cut hay each year from as much of his farm as possible and to graze paddocks as soon as possible thereafter.

APPENDIX XVII Producer Demonstration Site

John Fry Trial number: 91BY11

Map - reference: 389486 mE, 6275274 mN Zone 50

Area: *Annual* paddock 17 ha
Perennial paddock 31 ha

Topography: Undulating hilly country with both paddocks extending across lower slopes, midslopes and hill tops.

Soil Description:

ANNUAL (two soil types)
Dn 2.62.
Location: mid and lower slope

Depth (cm)	Description	pH	Gravel (%)
0 - 5	dark brown **silty loam**	5	0 - 10
5 - 15	dark grey brown **sandy clay loam**	5.5	0 - 20
15 - 25	strong brown **light clay**	6.0-	0 - 30
25 - 50	yellow brown light/medium clay	6.0	0 - 40
>50	yellow brown medium clay with brown,grey, olive mottles	6.5	

Uc 5.11
Location: drainage depressions

Depth (cm)	Description	pH	Gravel (%)
0 - 10	dark grey brown **loamy sand**		0 - 5
10 - 30	brown yellow **loamy sand**		0 - 5
>30	yellow brown **sand to loamy sand**		0 - 40

PERENNIAL
Gn 2.12
Location: .upper slope

Depth (cm)	Description	pH	Gravel %
0 - 15	red brown **loam**		15
15 - 50	red brown clay loam		20
50+	red light clay		-

Gn 2.42, Gn 2.82, Gn 4.82
Location: upper and mid slope

Depth (cm)	Description	pH	Gravel %
0 - 10	dark brown **sandy loam**	5.0.	25
10 - 30	dark brown **sandy clay loam**	5.0	10 - 25
30 - 50	strong brown sandy light clay	5.5	10 - 30
50+	brown mottled sandy **medium clay**	5.5	5

Appendix XVII

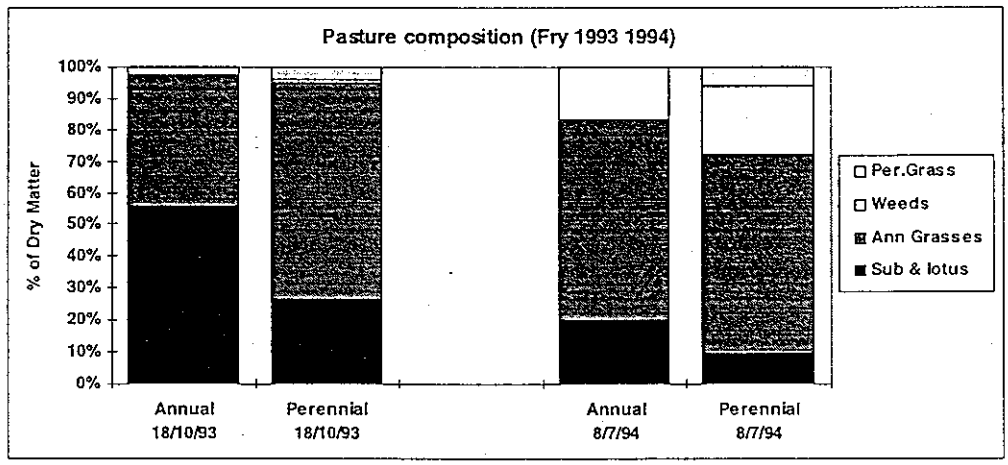
Analysis of the top 10 cms. of soil in January 1994

		Annual	*Perennial*
Nitrate Nitrogen	ppm	9	5
Ammonium Nitrogen	ppm	20	20
Phosphorus	ppm	34	58
Potassium	ppm	86	137
Reactive Iron	ppm	1786	2614
Organic Carbon	%	3.0	3.6
Salt	E.C. mS/m	8	8
pH (1:5 CaCl2)		4.4	4.4

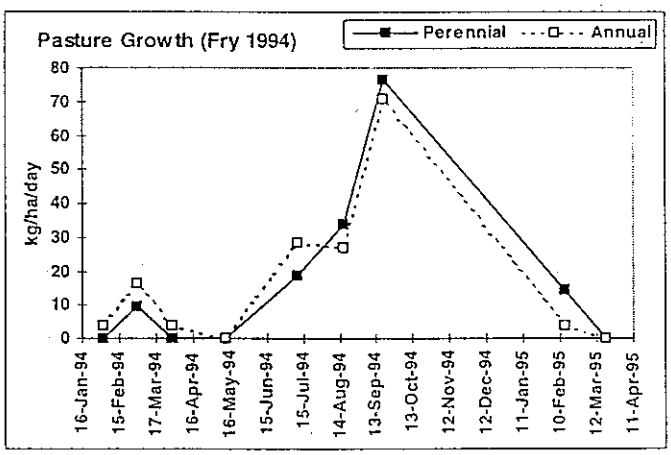
Fertiliser application on both paddocks:

1993	Mar	200	superphosphate
	Sep	140	sulphate of ammonia
	Sep	100	DAP and muriate
1994	Mar	200	superphosphate
	Sep	100	urea
	Sep	80	3:2 super:potash
1995	Jan	200	superphosphate

Pasture composition (as % dry matter)



Pasture Growth on the two paddocks



Paddock history: During the last 10 years both paddocks have been cut for hay.

APPENDIX XVIII — Producer Demonstration Site

Tom Muir Trial number: 92Ma24

Map Reference: 44711mE, 6197178mN

Manjimup **Area:** Annual Paddock 23 ha. (57 acres)
Perennial Paddock 15 ha. (37.2 acres)

This property was originally selected as a demonstration site, however in 1996 the farmer decided to renovate the annual paddock. The perennial pasture was continued as a monitoring site.
Base Pasture: Two adjoining paddocks were used for this demonstration site. The uncleared native timber areas included in these paddocks (25% of the annual area and 6% of the perennial area) have not been included in the grazed areas for all the calculations even though stock had access to them.

Annual Paddock: This paddock (31 ha with 8 ha uncleared trees) started with approximately a third each of subclover, annual grasses and weeds. Commencing in the last week in March 1996 the area was grazed by 300 sheep and a small herd of cattle until the first week in May when it was ploughed. In the last week of May oats (cv Saia, 50 kg/ha) plus 20 kg/ha of superphosphate was drilled into the paddock. Using a super spreader the paddock was then top dressed with annual ryegrass (cv Surrey and Progrow) at 2 kg/ha, as well as annual ryegrass (cv Richmond) and sub clover (cv Trikkala and Denmark) at 2.5 kg/ha. mixed with 40 kg/ha of super. The area was then lightly harrowed. Fifty cattle grazed the paddock for two weeks in July and then again for two weeks at the end of August. The paddock was then closed for hay.

Perennial Paddock: This is a 16 ha paddock with 15 ha of pasture. In 1992 the area was ploughed, scarified for weed control and sowed to perennial grasses in May. A mixture of equal weights of Currie cocksfoot, Cajun tall fescue and Roper perennial rye grass was sown at 9 kg/ha. Germination and establishment of the perennial grasses was successful and half the sward was cut for hay in spring. Grazing commenced on this paddock in January 1993.

Animals: Both paddocks were continuously grazed with mixed sex weaner cattle during 1993 and 1994. Both paddocks were not grazed for the first two months of 1995 and grazing was withheld from the annual paddock from December 1995 to February 1996 and from the perennial paddock during February, March and July 1996.

Soil Description: Dy 5.12, Dy5.52

ANNUAL (two soil types)
Location: upper slope

Depth (cm)	Description	pH	Gravel (%)
0 - 5	brown sandy loam	6.3	10
5 - 25	light yellowish brown sandy loam	6.5	20-30
+ 25	yellow brown medium clay	-	-

Location: upper, mid and lower slopes

Depth (cm)	Description	pH	Gravel (%)
0 - 10	dark brown loamy sand	6.0	30-50
10 - 40	brownish yellow loamy sand	6.2	60-70
+ 40	yellow brown medium clay	-	-

Appendix XVIII

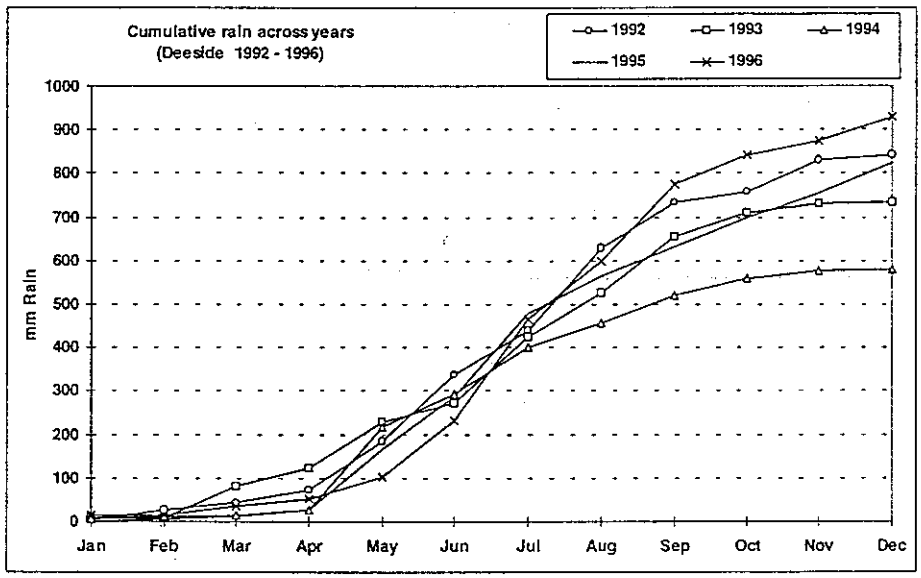
Soil Description: **Dy 5.12, Dy5.52**

PERENNIAL

Location: flat crest and mid slope

Depth (cm)	Description	pH	Gravel %
0 - 10	dark greyish brown **sandy loam**	6.3	15-40
10 - 40	yellowish brown **sandy loam**	6.4	25-50
40 - 50+	yellowish brown to reddish yellow **medium clay**	6.4	-

Cumulative rainfall patterns over 4 years at this site



Analysis of the top 10 cms. of soil at the start and end of the study

Soil test		Ann. paddock		Per. paddock	
		1994	1996	1994	1996
Nitrogen. Nitrate	ppm	13		4	
Ammonium	ppm	20		20	
Phosphorus	ppm	44		31	
Potassium	ppm	228		221	
Reactive iron	ppm	1626		2053	
Organic Carbon	%	6.2		5.5	
Salt	E.C. mS/m	11		9	
pH	1:5 CaCl2	5.0		5.2	

Fertiliser applied.

Date	Fertiliser	Amount (kg/ha)	Comments
1973	Superphosphate, copper, zinc	175	
1974 - 1993	Superphosphate	175	January each year
1994	Superphosphate	175	March
1995	Superphosphate	175	January
1996	Superphosphate	175	January

Quantity and Quality of fodder conserved.

	Date cut	Roll No:	Ave wt (kg)	t/ha	%DMD	Mj/kg	%CP
1992 half the perennial paddock	Oct - Nov	62	450	3.9	56.0	7.8	6.2

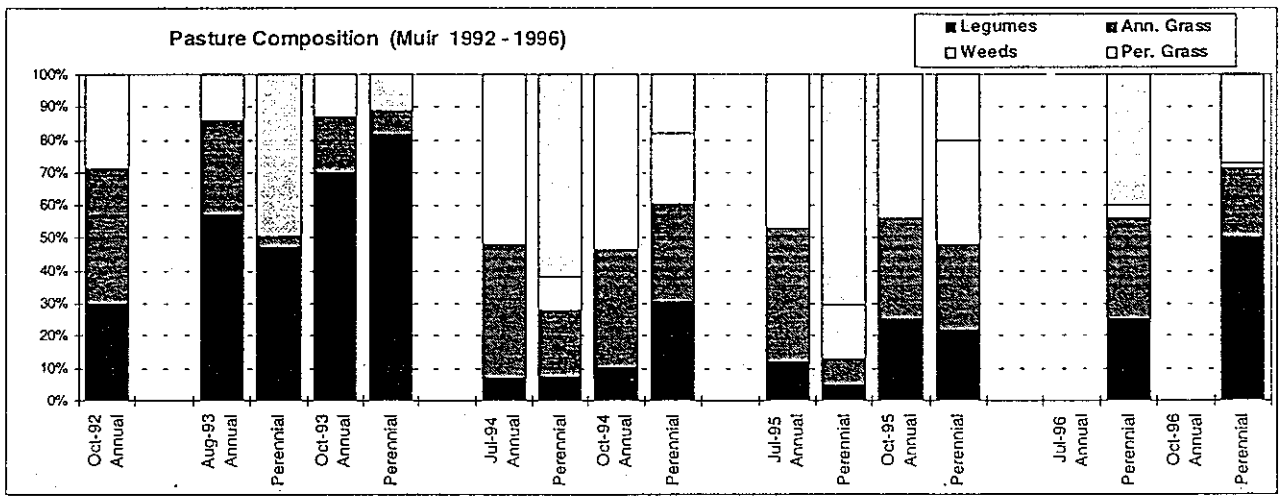
Quantity of hay fed..

		Start date	End date	Total kg	kg/ha
Annual	1994	Feb	June	12000	522
Perennial		Feb	June	12000	800
Annual	1995	Feb	July	4560	198
Perennial		Feb	July	3540	236
Annual	1996	Feb	Feb	2000	87
Perennial		Mar	July	10000	667

Counts of perennial plants (plant/sq.m.) and percent of different species in May of each year:

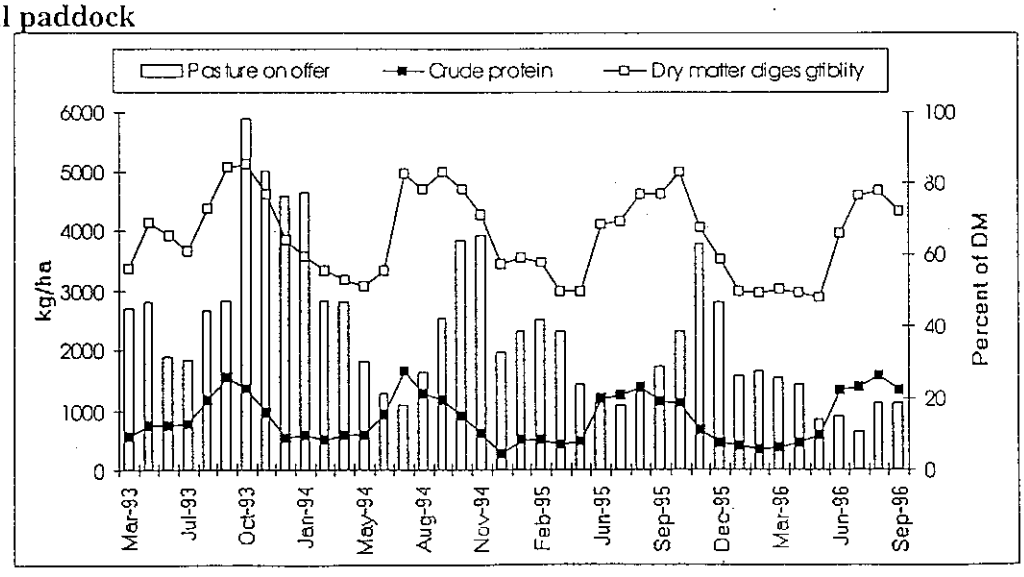
	1993		1994		1995		1996	
	Count	%	Count	%	Count	%	Count	%
Cajun tall fescue	2	3	3	7	2	5	1	2
Currie cocksfoot	26	46	29	63	29	71	40	78
Roper perennial rye	29	51	14	30	10	14	10	20
Total	57	100	46	100	41	100	51	100

Pasture composition (as % dry matter)



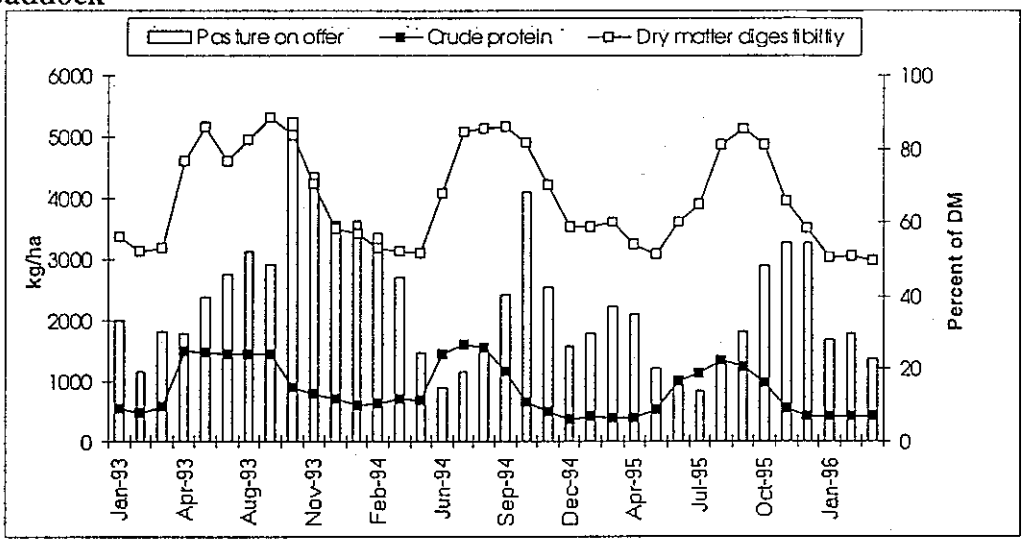
Feed on offer (FOO), dry matter digestibility (%) and crude protein (%) of pasture on the two paddocks during the study were:

Perennial paddock

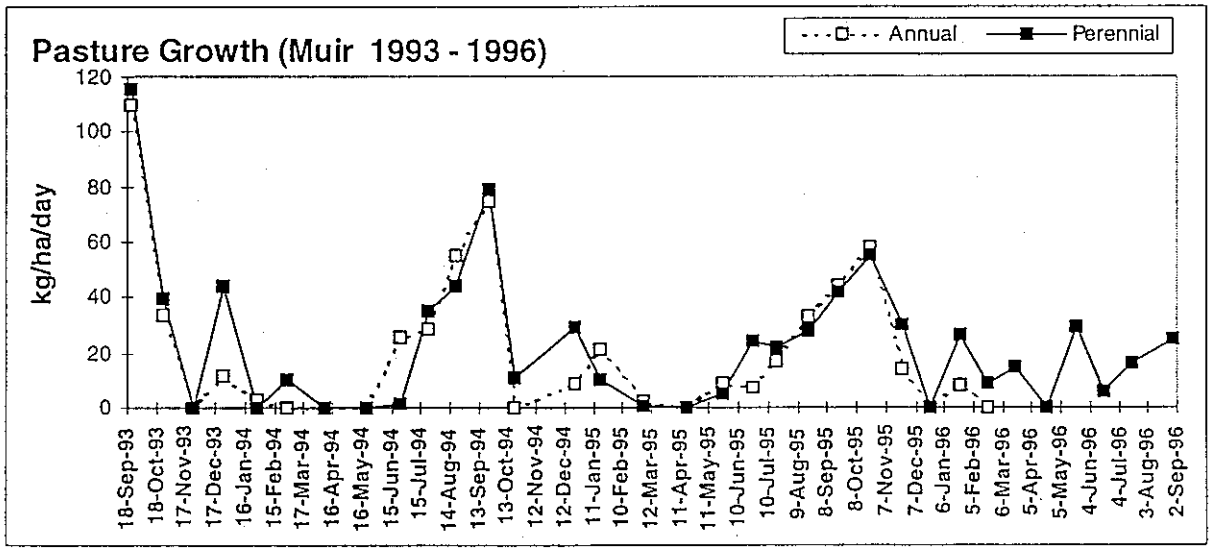


Appendix XVIII

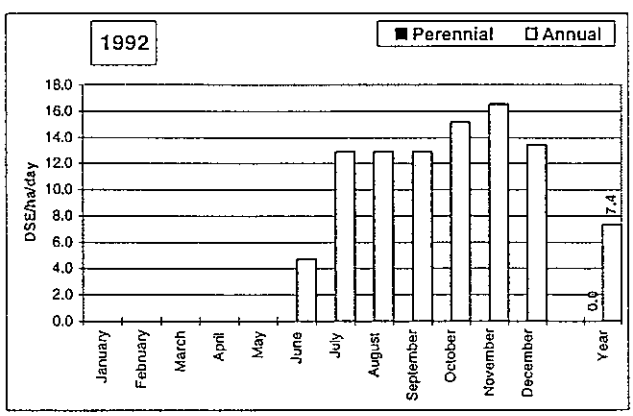
Annual paddock

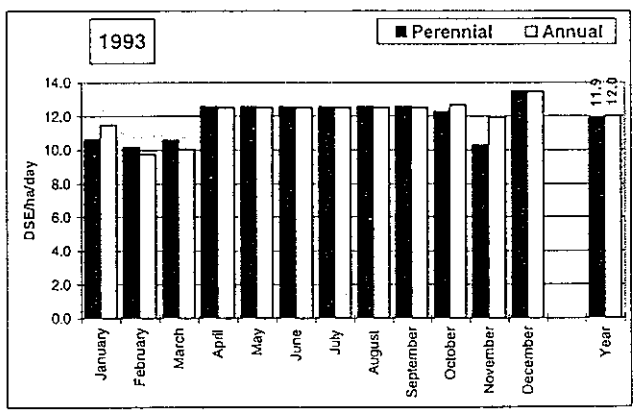


Pasture Growth on the two paddocks



Estimated Average Grazing Pressure each month during the project





Appendix XX

In *1995* despite the weight gain benefits from feeding grain through the autumn/early winter period, the steers were not sufficiently fat to market at the end of grain feeding. Compensatory gain in weight by steers only fed hay for their welfare had matched the gains made by grain fed steers by the time they had achieved a condition suitable for market in October/November.
In *1996* compensatory gain was not as complete as 1995 due to the severity of the feed restriction of the steers through winter. In this year grain fed animals could have been marketed approximately a month before those on pasture and hay only.

Aims: To study the persistence and compare the productuctivity of perennial grasses with that of annual pastures when grazed by cattle.

Design: 5 treatments x 3 replicatess x 3 steers/plot (2/ha)

Treatments: **1987 to Dec 1991** The site was used in a grazing management experiment, with 12 of the 15 plots sown to annuals and the other 3 sown to a perennial grass mixture which resulted in a strong stand of *Currie cocksfoot.*

Plot conditioning prior to the **autumn 1992** sowing of the current perennial grass pastures commenced in Dec 1991.

1987 - 1991 OLD EXPERIMENT

	All 15 plots sown in autumn 1987 using a combine following 2 cereal crops.
Currie mix.....	Retained in new experiment
Annual pastures:	
Continuous.....	Retained in new experiment
Spring deferred, heavy summer	*(Sown in autumn 1992 to perennial grasses, new expmt*
Summer deferred, heavy spring	(" " " " " " " " "
Autumn deferred	(" " " " " " " " "

1992 - 1996 NEW EXPERIMENT

	Sown autumn 1987
Currie mix.....	**Retained**
Annual.....	**Retained**
	Sown autumn 1992
Brumby ryegrass..	(***Summer 1992*** *variable grazing. Germination, 15/5 1L/ha Roundup*
Triumph fescue.....	(*CT,* (***19/5*** *sown with 6.2kg/ha subterranean clover and either 5.8kg/ha*
Sirosa phalaris.....	(*Brumby or 7.6kg/ha Triumph or 5.4kg/ha Sirosa using a* ***combine.***
	(*29/5 350 ml/ha Imidan.*
	((*Each grass was sown into 1 of each of the old annual grazing system*
	(*treatment plots.)*
	(*Grazing commenced when FOO reached* ***1100 kg/ha***

1993 and 1994

Currie mix	**3 plots**	**Continuously grazed**
Annual	**3 plots**	**Continuously grazed**
Brumby ryegrass	**2 plots**.....	(1993 Perennials sown into the three spring
Triumph fescue	**2 plots**.....	(deferred, heavy summer grazing treatment plots of
Sirosa phalaris	**2 plots**.....	(the **old** experiment failed to establish densely
		(enough to be included in the **new** experiment, but
		(were grazed continuously in line with the
		(treatments

Appendix XX

Mt Barker Research Station

K D Greathead (Research Officer) and **John Boultwood** (Technical Officer).

Summary: The successive, extremely dry summers have helped halve the counts of *Brumby ryegrass* and *Triumph fescue* at this site. However *Sirosa phalaris* and the long established *Currie cocksfoot* stands were still strong at the end of the study.
High levels of subterranean clover seed (>600 kg/ha) were available for germination each year, a decline in total seed from 1992/93 to 1995/96 is associated with the succession of late breaks and subsequent poor pasture growth. There was no obvious difference between treatments in the levels of clover seed in summer prior to any germination.
Over the years *Capeweed* has been an important component of the *annual* swards but not in the *perennial grass* pastures
In all years the *annual* pastures had the lowest levels of dry residues through summer and were the slowest to emerge. In 1993, , green FOO reached around 2000 kg/ha in all pastures by May, however subsequently this level of FOO was not reached until July in 1994 and August in 1995 and 1996.
The growth estimates were based on total FOO and not growth of the individual grass species within a treatment, resulting in little obvious difference between treatments.
Green FOO through the summer/autumn months was absent in the *annual* pasture except in 1993 following the early opening rains. In the *perennial* pastures green FOO was present, generally most in the *cocksfoot* pastures and least in the *perennial rye* swards.
The inclusion of perennial grass in the pastures reduced the hay requirement of steers to 20% - 67% of that of steers grazing the *annual* pastures.
On average the extra live gain and carcase gain over the *annual control* treatment were respectively 97 and 54kg/ha for *phalaris*, 46 and 20 kg/ha for *tall fescue* and 39 and 20 kg/ha for *cocksfoot*.
The pattern of growth of steers grazing the different pastures varied, with those grazing *cocksfoot* and *tall fescue* performing slightly better in late summer/autumn while those grazing *phalaris* growing faster in winter/spring.
Those grazing *perennial rye* consistently lost more weight than other treatments in autumn and were unable to make up the loss in the winter and spring.

Dollar value of differences in hay fed and carcase gained: On average over the 4 years, the steers grazing the *cocksfoot, tall fescue* and *phalaris* pastures provided dollar benefits over the annual *control*, however the *perennial rye grass* treatment was less economic than the *control*.

1993 to1996	hay cost $/ha @ $60/t	carcase benefit $/ha @ $2.00/kg carcase	outcome $/ha compared with the control
Annual control	- 28	0	---
Cocksfoot	- 6	40	62
Perennial rye	- 19	- 92	- 83
Tall fescue	- 7	40	61
Phalaris	- 9	108	127

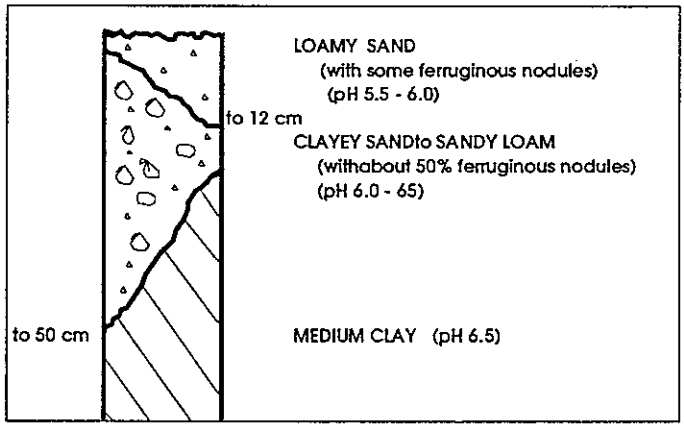
Green FOO and steer growth: combining data for all treatments, when there are low levels dry FOO and before October when green feed quality can start declining, indicates that *2000 kg/ha* is a critical level when steer live gains start to exceed one kg/day, a rate sufficiently high for steers to improve in condition.

Appendix XX

Soil type and history

Soil Description :... Dy 2.2 (also Dy 2.1 and Dy 2.12)

A Typical Profile:.....



Soil Test : 1987 (range of values across the blocks)

Phosphorus	ppm	34	to	39
Potassium	ppm	148	to	173
Organic carbon	%	2.71 (good)	to	3.33 (good)
Reactive Iron	ppm	1033 (high)	to	1242 (high)
Salt		V.Low		V.Low
pH	in water	5.5	to	5.7

Fertiliser applied in autumn and annual rainfall:

	Fertiliser	(kg/ha)	Rain Total
1987	Superphosphate	133	485
1988	Superphosphate	200	773
1989	Superphosphate	150	676
1990	Superphosphate	150	673
1991	Superphosphate	83	603
1992	Superphosphate	110	728
1993	Superphosphate	105	654
1994	Superphosphate	100	468
1995	Superphosphate	100	557
1996	Superphosphate	200	612

Plant counts: By the last counts taken late April (1996) the perennial plant numbers had all decreased compared with the 1993 levels (Table 1). Counts are low in the perennial rye grass plots and one of the tall fescue plots (the one that had more competition at the start resulting in fewer, smaller plants in 1993). The cocksfoot and phalaris stands comprise large strong plants and appear to be quite stable and I would expect them to persist for a number of years under this grazing system (this is the 9th year for the cocksfoot plots and 4th for the phalaris).

Appendix XX

1995 and 1996

Currie mix	3 plots	)
Annual	3 plots	)
Brumby ryegrass	2 plots	) **All continuously grazed with + or - hay.**
Triumph fescue	2 plots	)
Sirosa phalaris	2 plots	)
Continuous + Grain	*3 plots*	(***Barley*** *supplement of* ***4kg/hd/d*** *was fed over (autumn to steers grazing the 3 plots where we (****failed*** *to establish the perennial grasses (see (above)*

Based on predetermined weight/condition welfare criteria hay was fed to steers on the plots as necessary and was recorded as a dependant variable.

Measurements:
soil parameters; rainfall; pasture growth (in one year), feed on offer and nutritional quality of FOO (monthly); botanical composition (twice a year); perennial plant counts; liveweight, condition scores (monthly), ultrasonic P8 fat measurements (live at start,finish and monthly from winter), carcase weights and P8 fat (slaughter); perched water table (during winter and spring); quantity and quality of supplements fed; clover seed yields (spring and early summer) and soil phosphorus and potassuim levels in summer.

Results

Rainfall The Mt Barker received less than normal rain over the summers of 1993/94,1994/95 and 1995/96 with no appreciable falls until mid May in any of these years (Fig1). This has provided a severe test for the persistence of perennial grasses with consequent losses of plants from most swards

Figure 1

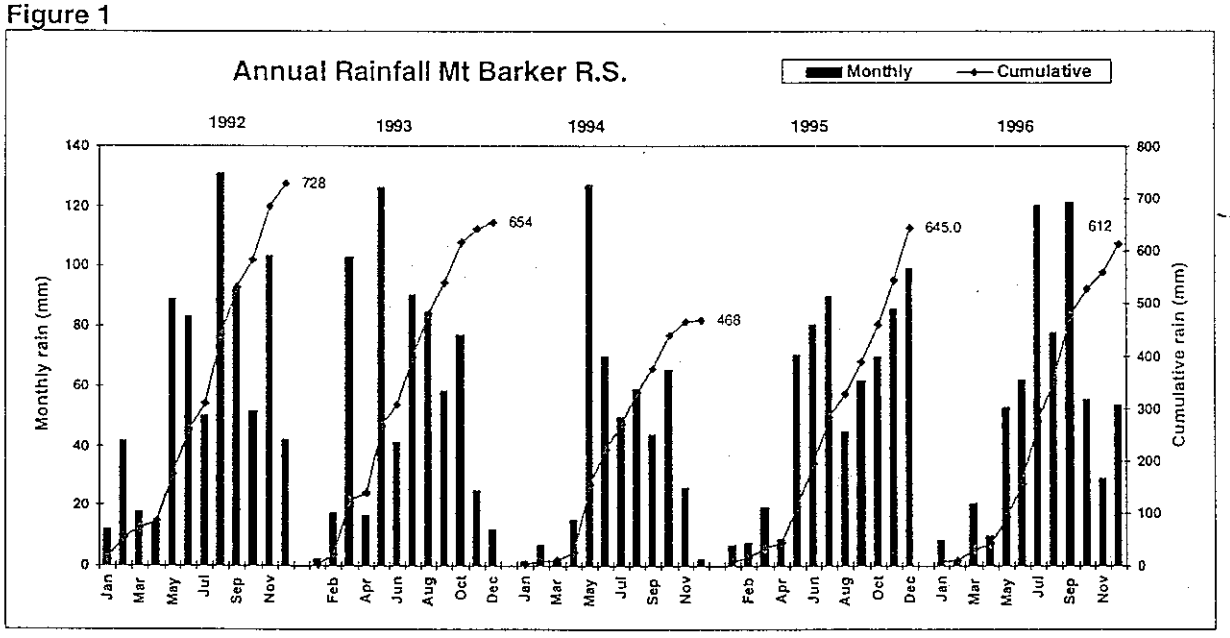
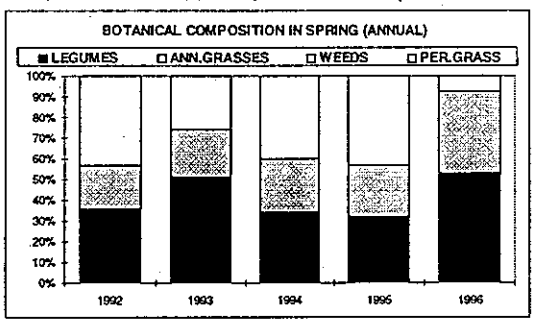
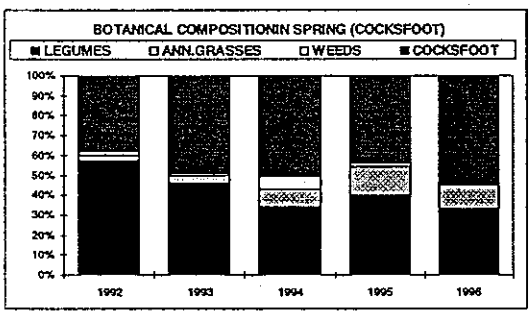
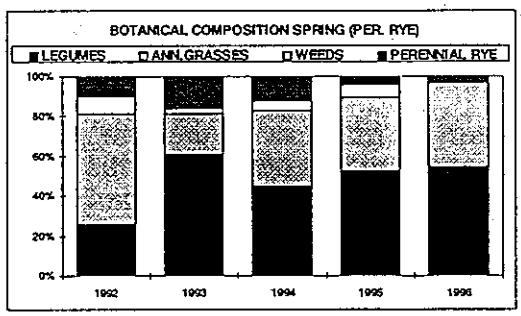
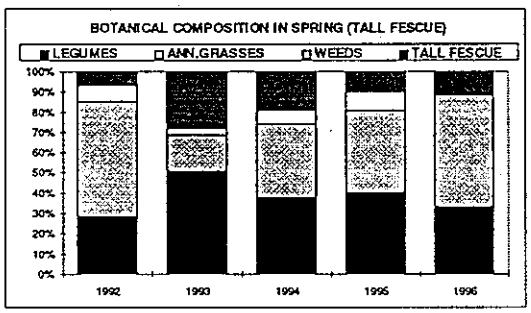


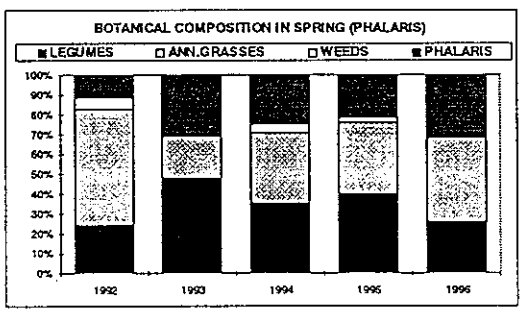
Figure 3 The five stacked histograms depict the botanical composition of each of the 5 treatments over the life of this experiment.











Feed on Offer (FOO): Profiles of green and dry feed on offer (FOO) in figure 4 show the effect of the sequence of late starts to the growing seasons 1994 to 1996. Normally the opening rains are expected by late April. In 1993 it occurred in late March, in 1994 and 1995 in mid-May but in 1996 not until early June. This affected the levels of FOO with a peak in 1993 to a low in 1996.

Other than in the *annual* and *cocksfoot* treatments the FOO levels in 1992 were confounded as it was the year the other perennial pastures were being established. Green FOO through the summer/autumn months was absent in the annual pasture except in 1993 following the early opening rains. In the perennial pastures green FOO was present, generally most in the *cocksfoot* pastures and least in the *perennial rye* swards.

In all years the annual pastures had the lowest levels of dry residues through summer and were the slowest to emerge. In 1993, , green FOO reached around 2000 kg/ha in all pastures by May, however subsequent to that this level of FOO was not reached until July in 1994 and August in 1995 and 1996. *Phalaris* appears to be the fastest to emerge in terms of FOO and animal gains.

Appendix XX

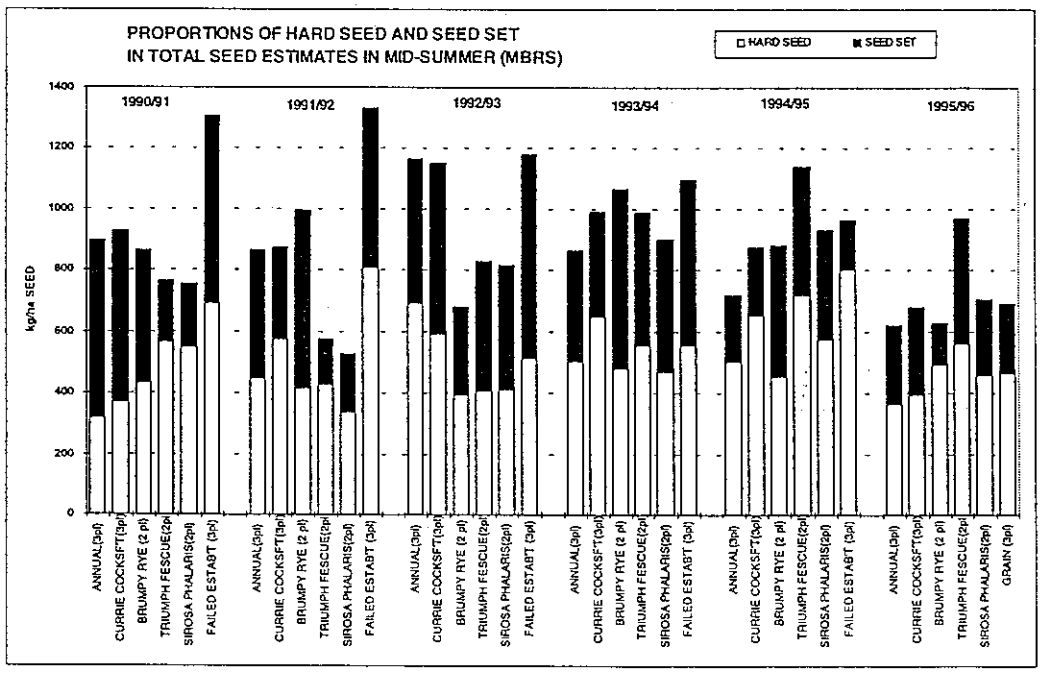
Table 1 1993 to 1996 Plant counts/m^2

Treatments	30/3/93 Rep 1	Rep 2	Rep 3	3 plots		17/5/94 3 plots	17/3/95 3 plots	25/5/95 3 plots	22/4/96 3 plots
Currie cocksfoot	38	35	46	40	—	34	27	34	29
Sirolan phalaris	4	5	3	4	—	5	4	5	4
Demeter fescue	1	1	1	1	—	0	1	—	—
Currie	43	41	51	45	—	39	32	39	33
					2 plots	2 plots	2 plots	2 plots	2 plots
Brumby ryegrass	38	4	49	30	43	32	14	16	6 &23
Triumph fescue	7	31	61	33	46	38	21	17	8 & 33
Sirosa phalaris	39	44	15	33	41	37	25	34	23 &27
All Mean	32	30	44	35	43	36	23	27	23

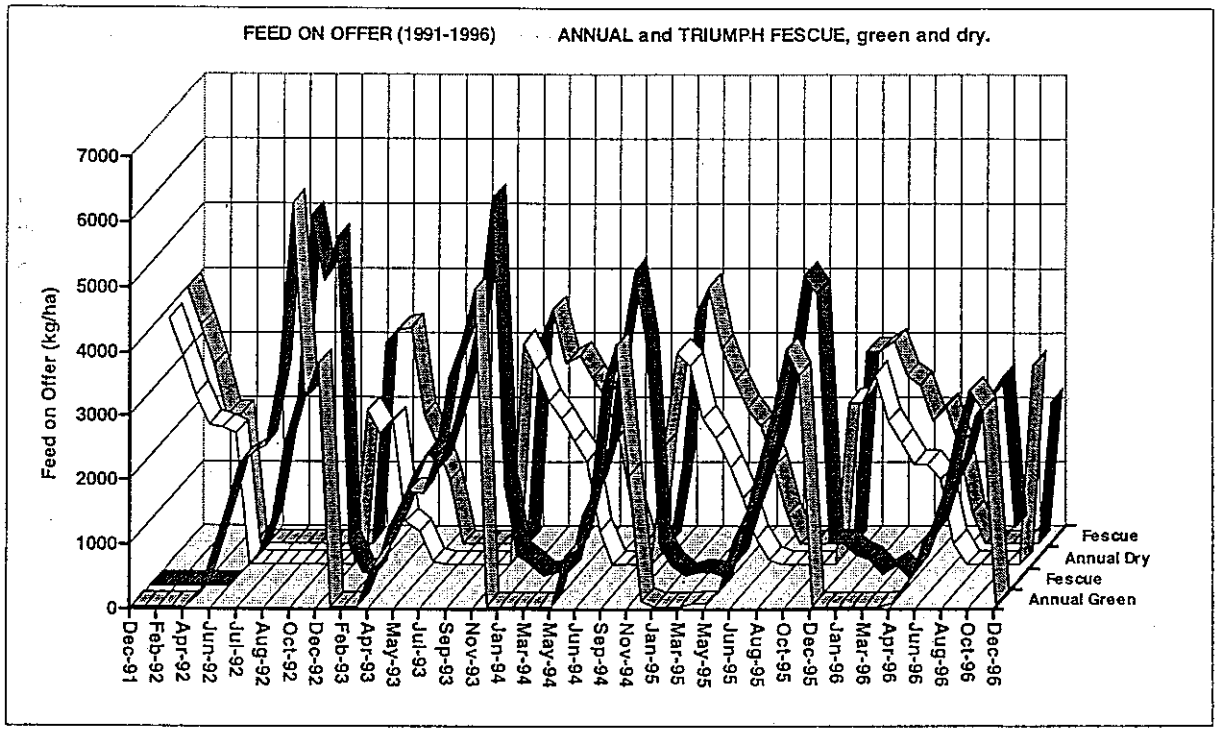
Clover seed yields: Levels of clover seed in the soil in mid summer are shown in Fig 2. for the years of this project and the two summers prior to establishment of the perennial treatments. Estimates of *hard seed* carry over from year to year and *seed set* each year are identified from samplings done in spring and mid summer High levels of seed (>600 kg/ha) were available for germination each year, an apparent decline in total seed from 1992/93 to 1995/96 is likely to be related to the succession of late breaks and subsequent poor pasture growth.
There is no obvious difference between treatments in the levels of hard clover seed, clover seed set or total clover seed in summer prior to any germination.

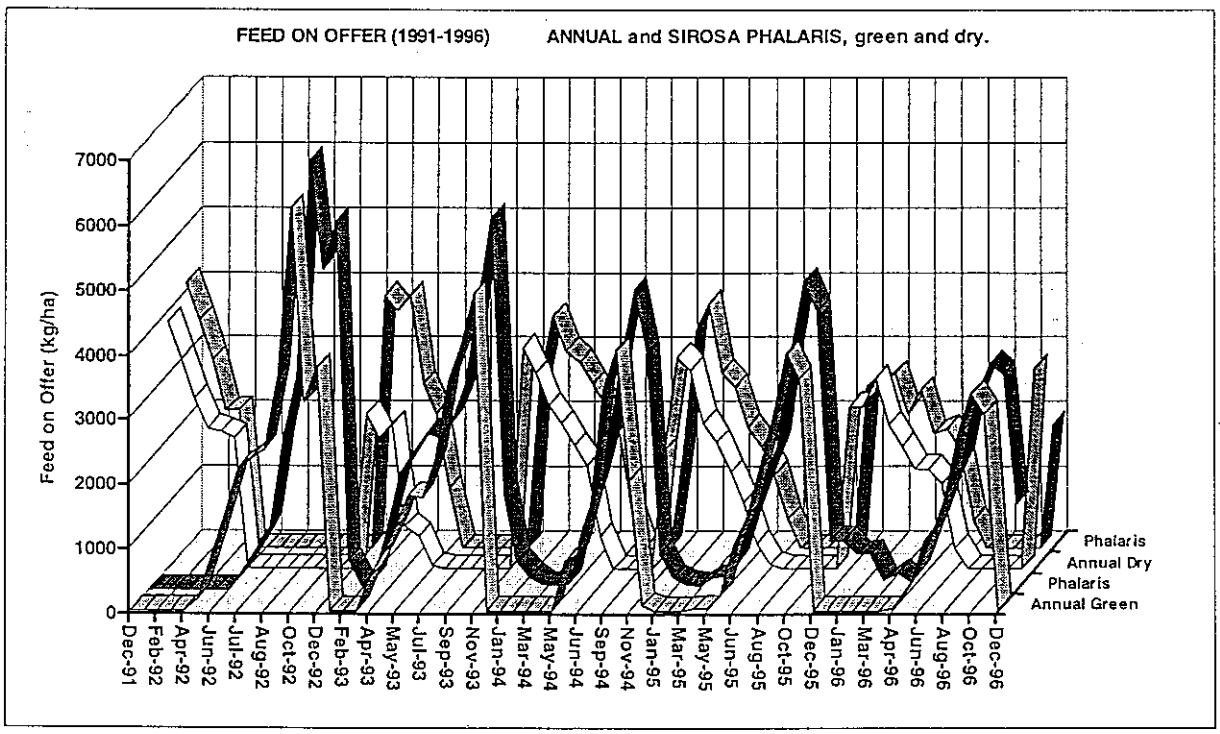
Botanical composition: Over the years Capeweed has been an important component of the *annual* swards but not in the *perennial grass* pastures (Fig 3). Sub clover made up around 30% and 40% of all swards. By 1996 cocksfoot (55%) and (31%) were strongly represented in their respective swards while the perennial rye (3%) and tall fescue (11%), though represented have declined following the series of very dry summers (Fig 1).

Figure 2 Total clover seed and the proportion of hard seed and seed set.



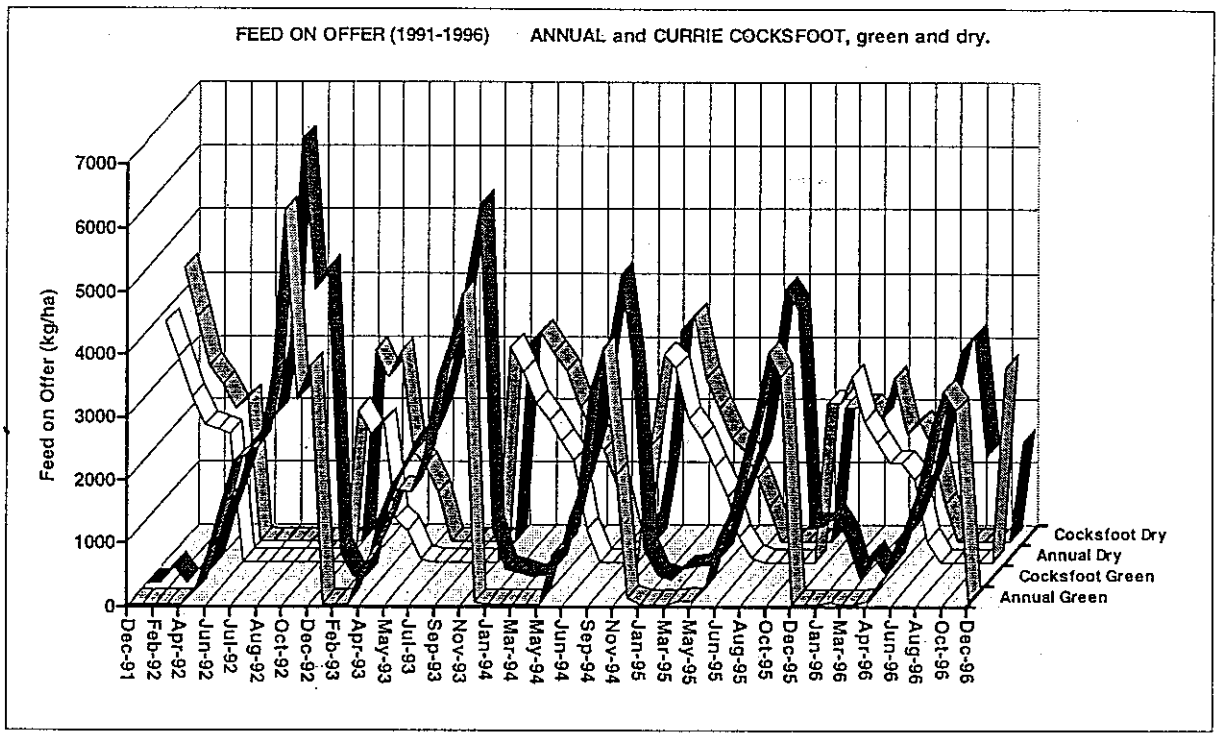
Appendix XX

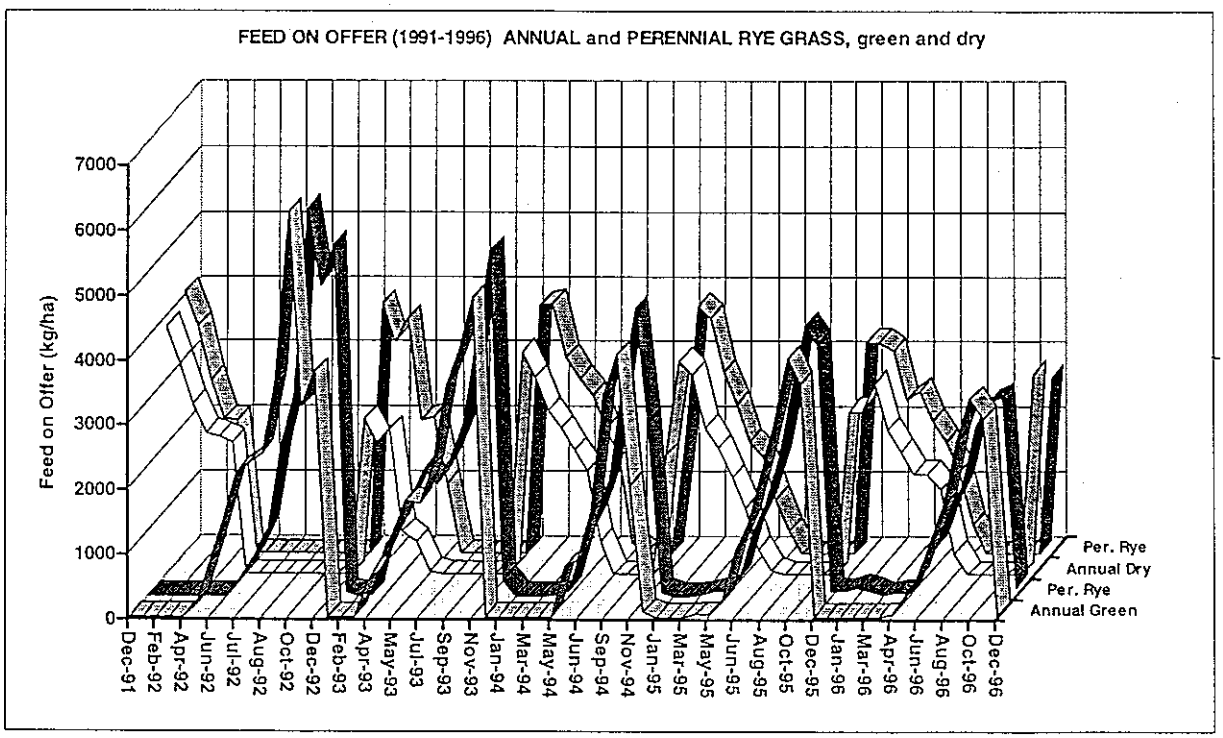

FEED ON OFFER (1991-1996)
ANNUAL and TRIUMPH FESCUE, green and dry.
Feed on Offer (kg/ha)
7000
6000
5000
4000
3000
2000
1000
0
Dec-91
Feb-92
Apr-92
Jun-92
Jul-92
Aug-92
Oct-92
Dec-92
Feb-93
Apr-93
May-93
Jul-93
Sep-93
Nov-93
Jan-94
Mar-94
May-94
Jun-94
Sep-94
Nov-94
Jan-95
Mar-95
May-95
Jun-95
Aug-95
Oct-95
Dec-95
Jan-96
Mar-96
Apr-96
Jun-96
Aug-96
Oct-96
Dec-96
Fescue
Annual Dry
Fescue
Annual Green


FEED ON OFFER (1991-1996)
ANNUAL and SIROSA PHALARIS, green and dry.
Feed on Offer (kg/ha)
7000
6000
5000
4000
3000
2000
1000
0
Dec-91
Feb-92
Apr-92
Jun-92
Jul-92
Aug-92
Oct-92
Dec-92
Feb-93
Apr-93
May-93
Jul-93
Sep-93
Nov-93
Jan-94
Mar-94
May-94
Jun-94
Sep-94
Nov-94
Jan-95
Mar-95
May-95
Jun-95
Aug-95
Oct-95
Dec-95
Jan-96
Mar-96
Apr-96
Jun-96
Aug-96
Oct-96
Dec-96
Phalaris
Annual Dry
Phalaris
Annual Green

Appendix XX

Figure 4 Levels of dry matter of green and dry feed on offer in 1991 and 1996





Appendix XX

Across the 4 years and 5 treatments live weight and carcase weight gained each year averaged 413 and 199 kg/ha ranging from 210 to 590 kg/ha and 79 to 312 kg/ha respectively.
Only the *perennial rye grass* treatment consistently gained less than the *annual control* treatment each year. Other than *cocksfoot* in 1996, the other pastures incorporating perennial species consistently gained more than the *control* (table 3). On average the extra live gain and carcase gain over the *control* were respectively 97 and 54kg/ha for *phalaris*, 46 and 20 kg/ha for *tall fescue* and 39 and 20 kg/ha for *cocksfoot*.
The pattern of growth of steers grazing the different pastures varied, with those grazing *cocksfoot* and *tall fescue* performing slightly better in late summer/autumn while those grazing *phalaris* growing faster in winter/spring. Those grazing *perennial rye* consistently lost more weight than other treatments in autumn and were unable to make up the loss in the winter and spring.

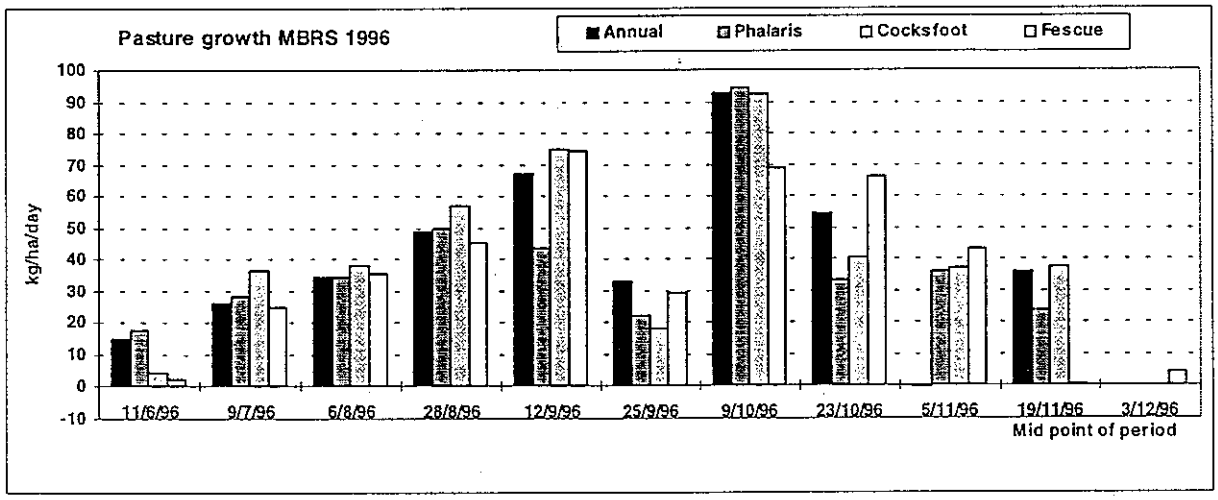
Table 3. Live and carcase weight and weight gain of steers on the different treatment from 1993 to 1996

		Start			End				Gain/yr		GAIN c/f. ANNUAL	
	n	full wt kg/hd	CS.	HCW kg/hd	full wt kg/hd	CS.	SHCW kg/hd	P8 mm	full wt kg/ha	HCW kg/ha	**full wt kg/ha**	**HCW kg/ha**
1993												
Annual	9	293	2.2	145	537	3.5	276	10	489	261	0	0
Currie	9	295	2.3	147	578	3.8	298	11	566	303	77	42
Brumby	6	298	2.3	148	516	3.6	255	11	436	215	-53	-46
Triumph	6	295	2.4	145	581	3.6	293	11	573	295	84	34
Sirosa	6	293	2.2	146	586	3.9	302	12	587	312	98	51
1994												
Annual	9	298	2.9	153	487	3.1	234	10	377	162	0	0
Currie	9	299	2.6	153	508	3.2	246	10	419	185	41	23
Brumby	6	302	2.7	154	470	3.1	221	8	337	133	-41	-29
Triumph	6	301	2.9	154	514	3.5	244	12	426	181	49	18
Sirosa	6	309	2.9	157	553	3.7	269	14	488	223	111	61
1995												
Annual	9	295	2.4	146	483	3.2	238	9	377	184	0	0
Currie	9	288	2.2	143	494	3.3	244	9	411	202	35	18
Brumby	6	299	2.3	148	458	2.9	220	7	318	145	-59	-40
Triumph	6	289	2.5	143	490	3.2	242	9	402	197	25	13
Sirosa	6	295	2.2	146	538	3.6	269	11	486	245	109	61
Grain	9	281	2.4	140	502	3.4	247	9	441	214	65	30
1996												
Annual	9	310	2.7	155	468	3.1	230	8	317	149	0	0
Currie	9	303	2.5	151	463	3.0	224	8	320	146	3	-4
Brumby	6	308	2.5	154	414	2.5	193	5	211	79	-105	-71
Triumph	6	310	2.4	155	482	3.2	237	9	343	164	27	15
Sirosa	6	302	2.6	151	495	3.5	246	10	387	191	70	42
Grain	9	307	2.7	153	521	3.8	263	10	428	221	111	72
Average across years												
Annual		299	2.5	150	494	3 2	244	9	390	189	0	0
Currie		296	2 4	149	511	3 3	253	9	429	209	39	20
Brumby		302	2 4	151	464	3.0	222	8	326	143	-64	-46
Triumph		299	2.5	149	517	3 4	254	10	436	209	46	20
Sirosa		300	2 5	150	543	4 7	272	12	487	243	97	54

Pasture growth : caged pasture growth was only measured in 1996 in one paddock of each of four of the pasture treatments, the annual growth pattern is shown in Fig 5. The growth estimates were based on total FOO and not growth of the individual grass species within a treatment, resulting in little obvious difference between treatments.

Hay fed: Hay was fed to steers in some treatments in all years except 1994 (Table 2). The inclusion of perennial grass in the pastures reduced the hay requirement of steers to 20% - 67% of that of steers grazing the *annual* pastures. The extremely late season in 1996, with cold conditions slowing early pasture growth, resulted in the most hay of any year being fed to steers in all treatments of this experiment. It was also the most fed to the control plots in the 9 years they have been running.

Figure 5 Growth of pasture (kg/ha/day)



***Grain feeding*:** In 1995 and 1996 a barley supplement was fed to steers on the 3 plots where we failed to establish perennial grasses in 1992. This side project was added to study the compensatory gain occurring in the pasture only plots.

Table 2 Hay and grain fed to the treatments over the 4 years of the experiment

		hay and grain fed (kg per ha)					
Treatment	Plots	1993	1994	1995	1996	4 year total	4 year average
Annual	3	343	0	329	1195	1867 (100%)	467
Cocksfoot	3	0	0	137	249	386 (21%)	97
Per. Rye	2	0	0	400	859	1259 (67%)	315
Fescue	2	0	0	168	299	367 (20%)	117
Phalaris	2	0	0	18	597	615 (33%)	154
Grain ..hay	3	-----	-----	0	0	0	
...grain				870	870	1740	

***Cumulative live weight gain (kg/ha)*:** A summary of the steer performance data is given in table 3, the means of the *annual* and *cocksfoot* treatments include data from 9 animals (3 animals/plot x 3 blocks) while those for the other treatments include data from only 6 animals (3 animals/plot x 2 blocks).

Appendix XX

The pattern of live gain and outcome of the *grain* feeding treatment compared with the *control* and the *phalaris* treatments is summarised in figure 4 and table 6.

In 1995 despite the weight gain benefits from feeding grain through the autumn/early winter period, the steers were not sufficiently fat to market at the end of grain feeding. At this time green FOO in all the paddocks was around one tonne per hectare and increased steadily to more than 2 tonnes per hectare by mid August. Compensatory gain in weight by steers only fed hay for their welfare had matched the gains made by grain fed steers by the time they had achieved a condition suitable for market in October/November (shaded area table 6). This was achieved in the pasture system at considerably lower cost. (table 6)

In 1996 compensatory gain was not as complete as 1995 due to the severity of the feed restriction of the steers through winter (figure 4). In this year grain fed animals could have been marketed approximately a month before those on pasture and hay only. (table 4). The severity of the season is illustrated by:

- levels of FOO at the end of grain feeding in late June being 0.6 to 0.7 t/ha and not exceeding 2 t/ha until mid September.
- the steers gaining 40 to 50 kg less liveweight by September than in 1995 and about 100 kg less than by September 1993.

Pasture fed steers in 1996 were only ready for market at the end of the year (shaded area table 6).

Table 6

1995	Supplement		Mar 8 (start grain)		Jun 27 (end grain)		Sept 19	
	kg/hd	$/hd	Wt G	CS	Wt G	CS	Wt G	CS
Annual	hay 165	12	26	1.8	-2	1.4	96	1.9
Sirosa phalaris	hay 9	1	28	1.8	1	1.2	134	2.4
Annual + grain	grain 435	70	24	1.7	60	1.8	124	2.3
			Oct 17		Nov 15		Dec 13	
Annual			142	2.4	168	2.9	188	3.3
Sirosa phalaris			187	3.3	207	3.4	243	3.6
Annual + grain			173	2.7	196	3.1	221	3.4

1996	Supplement		Mar 6 (start grain)		Jun 25 (end grain)		Sept 17	
	kg/hd	$/hd	Wt G	CS	Wt G	CS	Wt G	CS
Annual	hay 597	42	-14	1.9	-33	1.2	43	1.6
Sirosa phalaris	hay 299	21	-12	2.0	-19	1.3	93	2.0
Annual + grain	grain 420	67	-10	1.9	42	2.0	121	2.1
			Oct 15		Nov 12		Dec 9	
Annual			89	2.1	133	2.7	158	3.1
Sirosa phalaris			124	2.2	167	2.9	193	3.5
Annual + grain			162	2.7	196	3.6	214	3.8

(CS = condition score, **Wt G.** = weight gained since allocation in December....weaning)

Green FOO and steer growth: combining data for all treatments and years (figure 5) when there are low levels dry FOO and before October when green feed quality can start declining indicates that **2000 kg/ha** is a critical level when steer live gains start to exceed one kg/day, a rate sufficiently high for steers to improve in condition.

Appendix XX

Year effect on animal performance: Average overall liveweight and carcase weight gains for the last 4 years from the same genotype of cattle starting at similar weights in early December each year are given in Table 4. The early season resulting in superior pasture growth in 1993 is well illustrated with greater gains per ha and the slightly better proportion of carcase in the gain of that year compared with 1994,1995 and 1996.

Table 4 Average production/ha data for the 4 years.

	1993	1994	1995	1996
Average live gain (kg/ha)	530	409	399	342
Estimated SHC* gain (kg/ha)	272	200	198	164
Carcase gain as % of live gain	51.3%	48.8%	49.6%	47.9%

* SHC Standard Hot Carcase

Dollar value of differences in hay fed and carcase gained: On average over the 4 years, the steers grazing the *cocksfoot, tall fescue* and *phalaris* pastures provided dollar benefits over the annual control (table 5), however the *perennial rye grass* treatment was less economic than the *control.*

Table 5

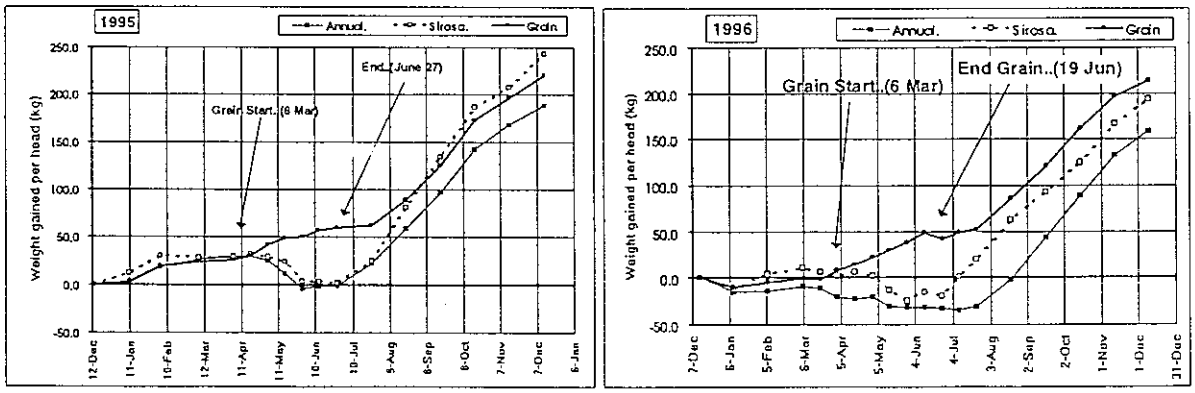
1993 to1996	hay cost $/ha @ $60/t	carcase benefit $/ha @ $2.00/kg carcase	outcome $/ha compared with the control
Annual control	- 28	0	---
Cocksfoot	- 6	40	62
Perennial rye	- 19	- 92	- 83
Tall fescue	- 7	40	61
Phalaris	- 9	108	127

Compensatory gain study 1995 and 1996: In the plots where we failed to establish perennial grasses in 1992 we decided to look at the effect of grain supplementation on animal gains. By preventing weight loss in the steers during autumn and winter through feeding grain, we wanted to determine whether compensatory gain would be complete in those not fed grain, and if so by when.

Supplemented steers were fed 4 kg a day of a ration made up of barley with 1% urea. The fermentation modifier, *Virginiamycin* was supplied in the mix at 40 ppm in the first week and 20 ppm thereafter. Steers were fed their total ration once a week (ie 28 kg/head) throughout the feeding period from March 8 to June 27 (1995) and March 6 to June 19 (1996).

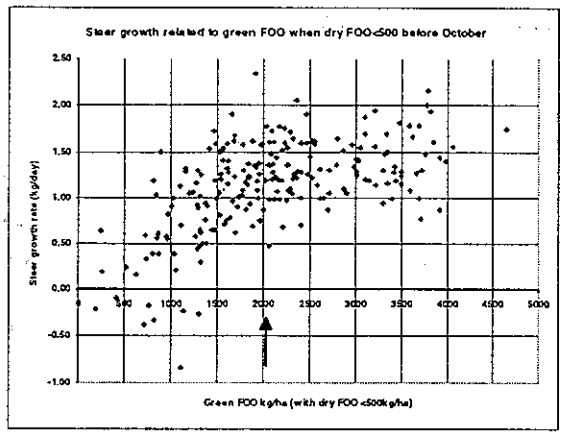
Grain feeding was commenced in March to ensure nutritional adequacy over any pattern of rainfall at the break of season.

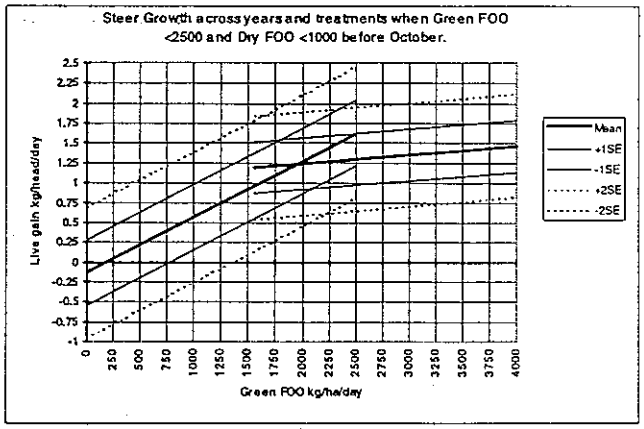
Figure 4 Cumulative live gain (kg/head) of steers grazing the *annual control*, the *phalaris* pasture and the *grain supplemented* annual pasture at MBRS



Appendix XX

Figure 5 Data pooled across years, treatments and plots.





Appendix XXI

Pardelup Prison Farm

K D Greathead (Research Officer) and **John Boultwood** (Technical Officer).

Summary: At this site *Triumph fescue* has maintained its superiority in terms of animal production, with all *fescue* plots still supporting very strong stands. All the temperate perennials plant counts decreased by 15% to 30% over 1994/95 but did not change 1995/96. *Kikuyu* grass has established well in one (sandy surfaced) plot. The successive, extremely dry summers has slowed its spread on the other plots but plants persist and have the capacity to spread in the future
High levels of seed (>600 kg/ha) were available for germination each year. There is no obvious, consistent difference between treatments in the levels of clover seed in summer prior to any germination.
Subclover levels in all the swards over the years have been high and the *broadleaf weed* component negligible. The *kikuyu grass* is expected to increase steadily and would be more obvious in a summer sampling while the proportion of the other perennial grasses has remained fairly stable with *tall fescue* being the most strongly represented.
Blocks within this experiment are associated with soil type and suitability of the perennial species used to the soils of this site are:

	Description	Cocksfoot	Kikuyu	Phalaris	Fescue
Block1	Sandy surface	√	√√	√	√√
Block2	Ironstone at surface(ridge)	√	x√ ?	x	√
Block 3	Lower lying, prone to water logging	x	√	√	√√

(x = not suited, √√ = most suited)

No hay was fed to steers on the plots in this project. Howevr when necessary animals were removed from plots on welfare criteria and grazed elsewhere. Use of fescue (1994, 1995 and 1996) and kikuyu grass (1996) at this site reduced the need for alternative grazing over the autumn/early winter months. Over the 4 years
Over the past 4 years the *fescue* treatment has been grazed the longest, between 10 and 15 percentage units more than the other treatments anbd this benefit has come when feed is short. *Fescue* has shown to be a valuable source of feed through our seasonal feed 'gap', and in years with more summer rain it is likely to be even more beneficial. In the spring months (1995) performance of steers grazing phalaris was superior, the same effect has occurred in the Mt Barker experiment (see earlier).
Dollar value of differences in agistment *and carcase gained:* On average over the 4 years, the steers grazing all the *perennial* pastures at this site provided dollar benefits over the annual pasture (control) of up to $88/ha.

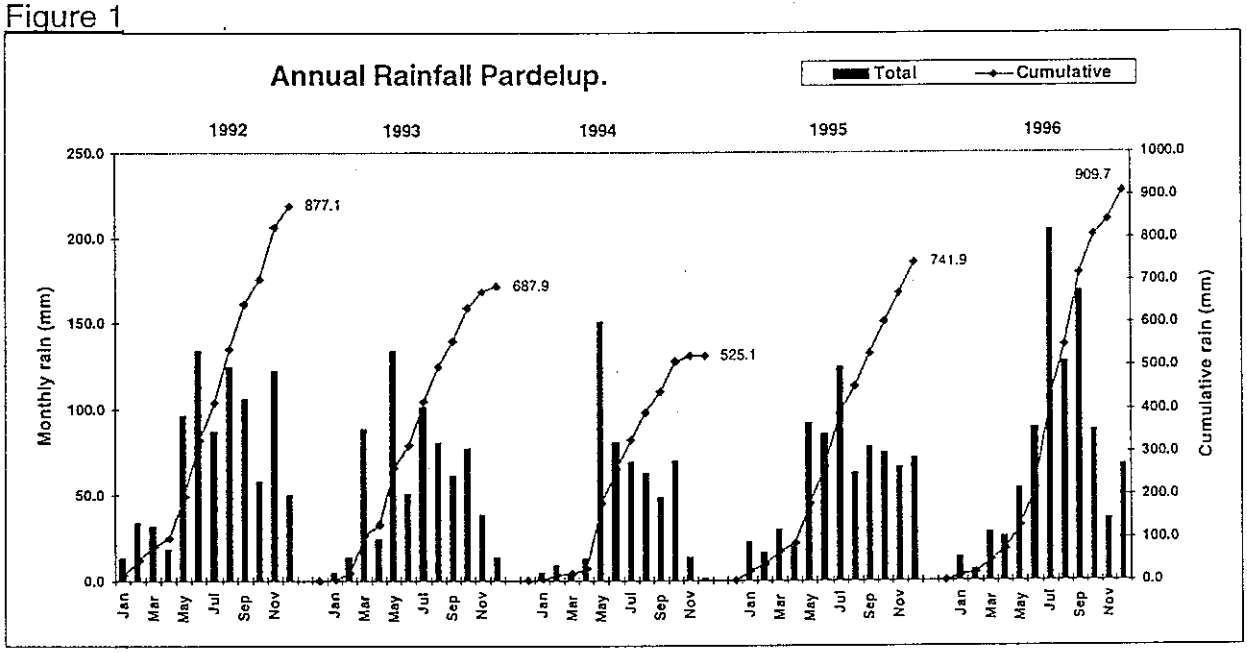
Green FOO and steer growth:. The level of 2000 kg/ha and its effect on steer growth is not as clear cut as in the Mt Barker data. It appears that the 1993 data does not fit the pattern and its removal restores the pattern of steer growth in relation to green FOO reported for Mt Barker. This may well be associated with animal condition as in 1993 the steers grew faster earlier following an early break and their average body condition in June, July and August were higher steers in subsequent years.

Aims: To study the persistence and compare the productuctivity of perennial grasses with that of annual pastures when grazed by cattle.

Design: 5 treatments x 3 replicates x 3 steers/plot (2/ha)

Results: Rainfall Pardelup received less than normal rain over the summers of 1993/94 and 1994/95 with no appreciable falls until mid May in either of these years (Fig 1). This has provided a severe test for the persistence of perennial grasses with consequent losses of plants from most swards. Annual rainfall at Pardelup, 10 km west of Mt Barker RS has been on average 25% higher than at Mt Barker RS over the 5 years (range 5 to 50%).

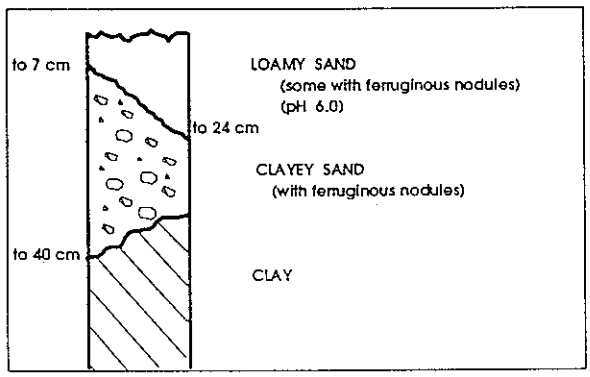
Figure 1



Soil type and history

Soil Description :... Dy 3.12

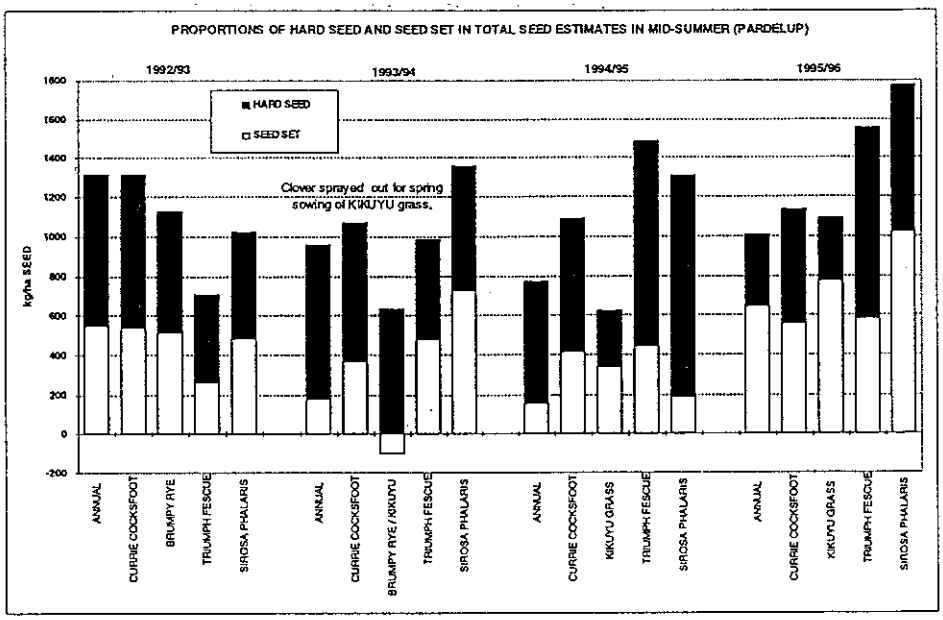
A Typical Profile:.....



Soil Test: April 1989 (range of values across the blocks)

Phosphorus	ppm	18	to	26
Potassium	ppm	93	to	190
Organic carbon	%	1.98 (good)	to	2.64 (good)
Reactive Iron	ppm	364 (norm.)	to	652 (medium)
Salt		V.Low		V.Low
pH	(water)	5.9	to	6.1

Figure 2 Total clover seed and the proportion of hard seed and seed set.



Botanical composition: The composition in spring of all the treatments across the years are shown in Fig 3. *Wimmera ryegrass* sown into the annual swards that had been about 90% sub clover to reduce the incidence of bloat, established well, however there is now a strong representation of *barley grass* in these swards, probably introduced with the *wimmera rye.*

Clover levels in all the swards over the years have been high and the broadleaf weed component negligible.

The *kikuyu grass* is expected to increase steadily and would be more obvious in a summer sampling.

The proportion of the other perennial grasses in their respective treatments has remained fairly stable with *tall fescue* being the most strongly represented.

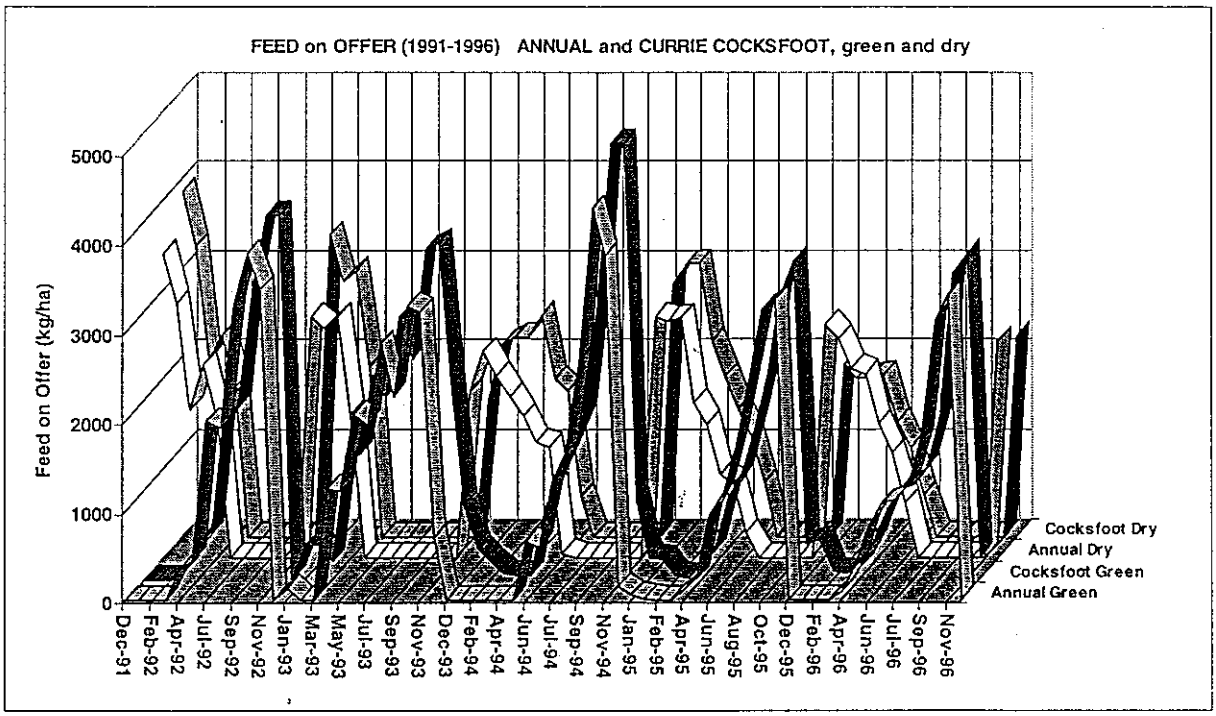
Feed on offer (FOO): The decline in dry residues over summer in 1995 and 1996 were similar (Fig 4). The *fescue* provided higher levels of green and of total FOO over the summer, autumn and early winter periods.

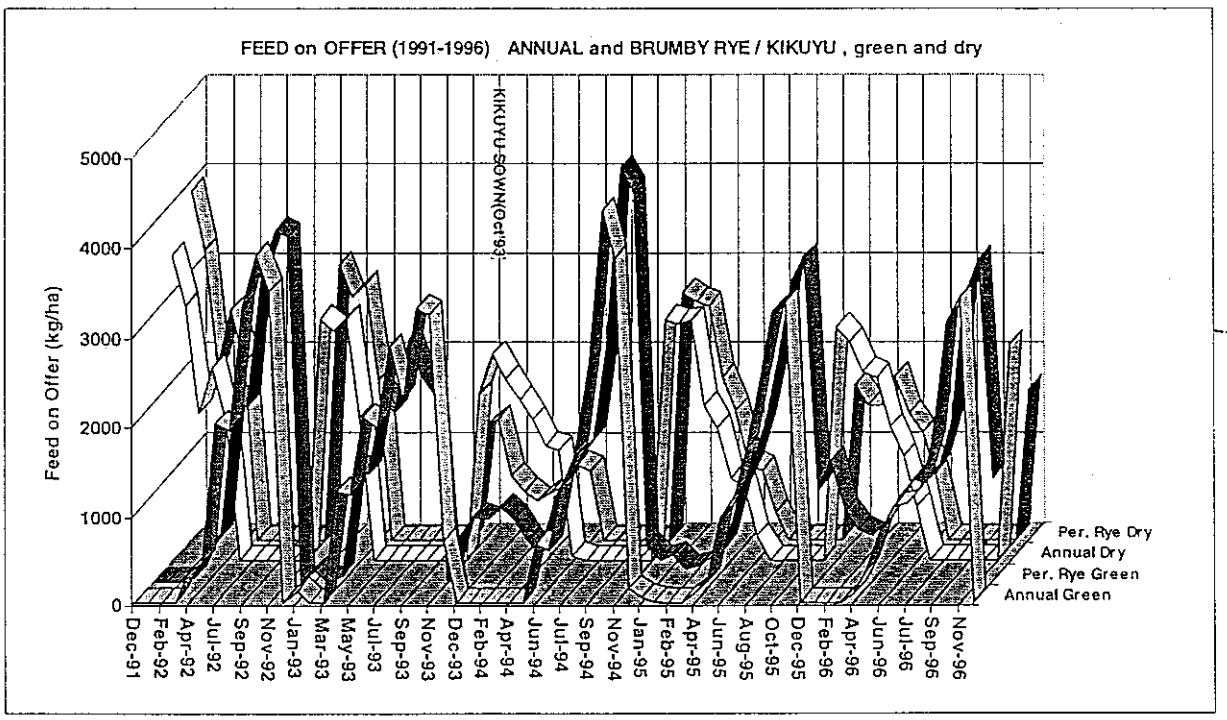
One plot of *kikuyu grass* in 1996 produced good levels of FOO through out the summer/autumn, it is now sufficiently well established to preclude serious damage by grazing, One of the *phalaris* plots (on the gravelly soil type) was poorer than the annual plots and has needed destocking for longer. This is a good indication of the sensitivity of these perennial species to the variation of soil type, even within the same paddock. Blocks within this experiment are associated with soil type and generalised outcomes of suitability of the perennial species used to the soils of this site are:

	Description	Cocksfoot	Kikuyu	Phalaris	Fescue
Block1	Sandy surface	√	√√	√	√√
Block2	Ironstone at surface(ridge)	√	x√ ?	x	√
Block 3	Lower lying, prone to water logging	x	√	√	√√

(x = not suited, √√ = most suited)

Figure 4 Levels of feed on offer FROM 1991 to 1996.





Hay feeding: No hay was fed to steers on the plots in this project. Though this was the preferred method to overcome feed shortage in autumn winter, the station management did not want to introduce weeds to the site through this practice. Consequently when necessary animals were removed from plots on welfare criteria and grazed elsewhere. This entailed the following removals:

Table 2 Dates and number of days steers were not grazed on the plots and the weight change that occurred while they were elsewhere.

	1993					1994				
Treatment	Plots	Out	Back	Days out	Wt ch'ge while out (kg/head)	Plots	Out	Back	Days out	Wt ch'ge while out (kg/head)
Annual	---	---	---	---	---	2, 6, 8	28/3	20/6	84	-37
Per Rye	---	---	---	---	---	---	---	---	---	---
Sirosa	---	---	---	---	---	15	10/5	30/5	20	-23
Cocksfoot	---	---	---	---	---	3	10/5	30/5	20	-13
Fescue	---	---	---	---	---	---	---	---	---	---

	1995					1996				
Treatment	Plots	Out	Back	Days out	Wt ch'ge while out (kg/head)	Plots	Out	Back	Days out	Wt ch'ge while out (kg/head)
Annual	2, 6, 8	5/5	20/6	46	24.4	2, 6, 8	22/5	2/7	41	-16
Kikuyu	1, 5, 7	5/5	20/6	46	4.5	5	22/5	2/7	41	-6
Sirosa	15	5/5	20/6	46	13.3	15	10/4	2/7	83	-27
Sirosa	11, 13	15/5	20/6	36	9.7	11, 13	22/5	2/7	41	-9
Cocksfoot	3, 4, 9	15/5	20/6	36	9.2	3, 4, 9	22/5	2/7	41	-10
Fescue	10,12,14	---	---	0	---	10,12,14	---	---	0	---

Over the 4 years, on average, animals were removed from their plots for the following number of days

Treatment:	Total	per year
Annual	171	43
Cocksfoot	84	21
Per Rye/Kikuyu	60	15
Fescue	0	0
Sirosa	101	25

In all years steers remained grazing the *tall fescue* plots right through the year, from allocation to slaughter. While in all years excepting 1993 steers grazing all the *annual* pasture plots had to be removed. Steers were also removed from most of the other pasture treatments for differing periods in different years, especially in 1995 and 1996.

Live and carcase weight gain:(kg/ha) Overall summary of steer weights and weight change each year are summarised in table 3. In 1995 and 1996 Steers grazing the annual pastures lost most weight over summer/autumn followed by those grazing phalaris pastures and then the cocksfoot mixture. Use of fescue (1994, 1995 and 1996) and kikuyu grass (1996) at this site has reduced the need for extra feed over the autumn/early winter months when animals were retained on the pastures.

Table 4 Grazing days (2 steers/ha) available and practiced on the different pastures during the experiment.

	STEER GRAZING DAYS per ha					
	1993	1994	1995	1996	Total	% of max.
Maximum	730	730	730	730	2920	100
Annual	612	460	552	560	2184	75
Cocksfoot	640	612	587	560	2399	82
Brum/Kike	535	378	596	614	2123	73
Fescue	679	628	711	642	2660	91
Phalaris	640	612	565	532	2349	80
TOTAL(%)	643 (88)	578 (79)	604 (83)	582 (80)		

Year effect on animal performance: Average overall liveweight and carcase weight gains for the last 4 years from the same genotype of cattle starting at similar weights in early December each year are given in Table 5. The early season resulting in superior pasture growth in 1993 is again well illustrated with greater animal gains per ha with a higher proportion of carcase in the gain than in 1995 which was in turn higher than 1994 and 1996.

Table 5 Average production/ha data for the 4 years.

	1993	1994	1995	1996
Average live gain (kg/ha)	461	305	352	251
Estimated SHC* gain (kg/ha)	232	133	166	107
Carcase gain as % of live gain	50.2%	43.6%	47.2%	42.8%

* SHC Standard Hot Carcase

Dollar value of differences in **agistment** ***and carcase gained:*** On average over the 4 years, the steers grazing all the *perennial* pastures at this site provided dollar benefits over the annual control (table 6), however benefits of the *perennial rye grass/kikuyu* treatment was compromised by the sowing of kikuyu in late 1993 and the results are likely to be an under estimate of the benefits of *kikuyu grass.*

Table 6

1993 to1996	agistment cost $/ha @ $2.80/hd	carcase benefit $/ha @ $2.00/kg carcase	outcome $/ha compared with the control
Annual control	-34.00	0	---
Cocksfoot	-16.80	38.00	21.20
Perennial rye	-12.00	18.00	6.00
Tall fescue	0.00	88.00	88.00
Phalaris	-20.00	52.00	32.00

Green FOO and steer growth: all data for all treatments where there were low levels of dry FOO (<500kg/ha) and before October when green feed quality is likely to start declining have been combined in figure 9. The level of **2000 kg/ha** is not as clear cut as in the Mt Barker data above. It appears that the 1993 data does not fit the pattern and its removal (see other graphs in figure 5) restores the pattern of steer growth in relation to green FOO reported for Mt Barker. This may well be associated with animal condition as they grew faster earlier following an early break and their

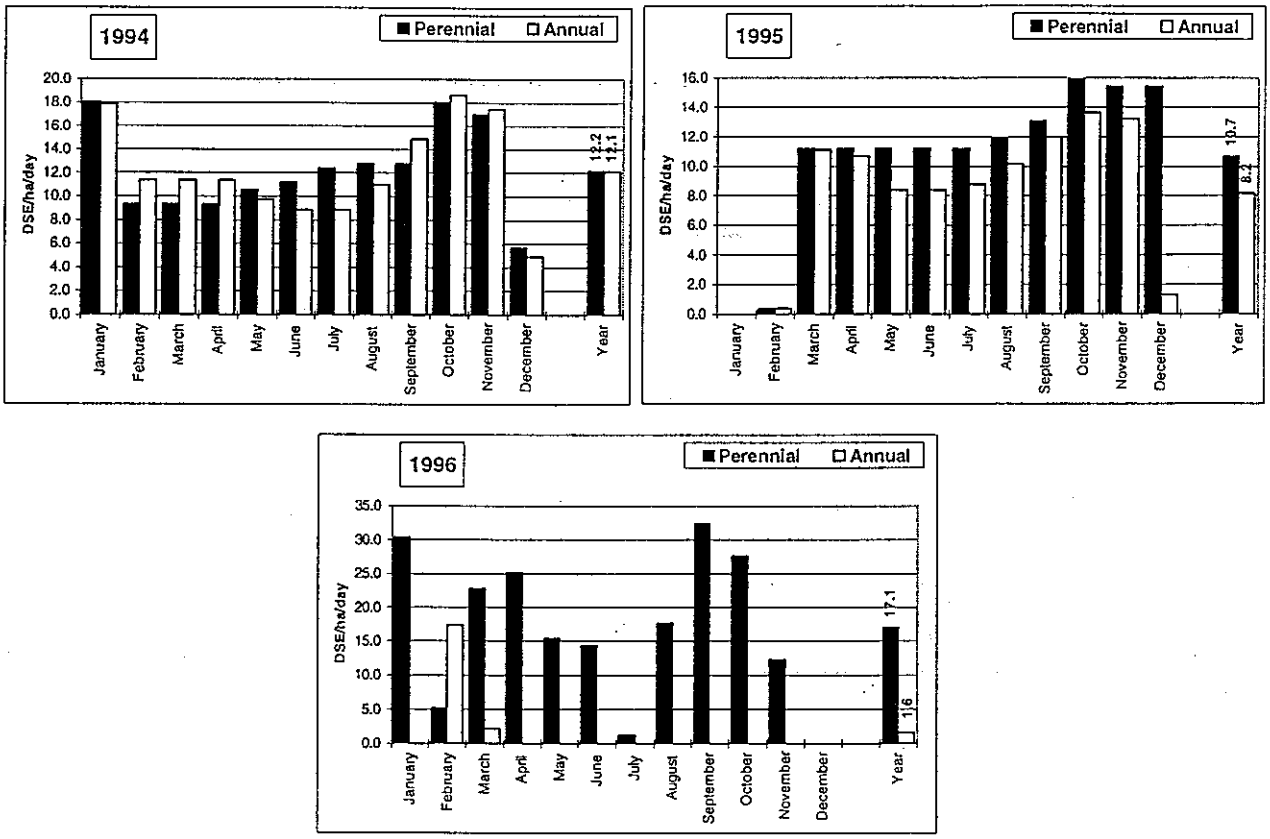
and establishment of the perennial pasture. However since then it made up around 50% of the annual sward and up to 30% of the perennial sward though in 1996 levels were negligible in the perennial pasture. Annual grasses made up 30 to 40% of the annual pasture over the years and up to a maximum of 30% in the perennial pasture.
The perennial grass comprised between 40 and 70% of the sward in winter and 10 and 30% in spring. Of the perennial fraction, the proportion of Roper perennial ryegrass declined from 50% to 20% and the Currie cocksfoot increased from 45% to 80%over the period of the study. By 1996 the perennial pasture plant count was strong at 50 plants/sq m.
A summary of the productivity of the study area is provide below:

		Live weight gained (kg/ha)	DSE/ha	Hay fed kg/ha	Hay made t/ha
1992	Annual	254 (from June)	7.4		
	Perennial	4 (from Dec.)	-----		3.9
1993	Annual	276	12.0		
	Perennial	267	11.9		
1994	Annual	213	12.1	522	
	Perennial	233	12.2	800	
1995	Annual	147	8.2	198	
	Perennial	228	10.7	236	
1996	Annual	0 (being renovated)	1.6	87	
	Perennial	401	17.1	667	

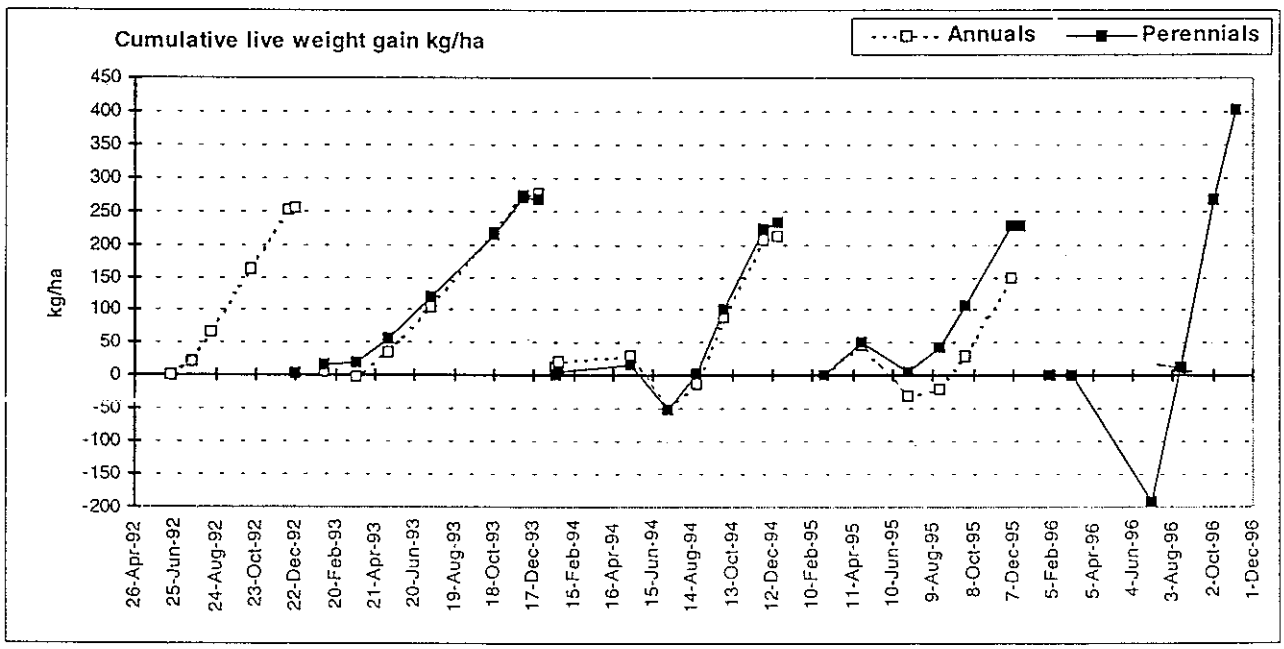
In the year of establishing the perennial pasture, grazing pressures and production per hectare on the two paddocks was similar. In the following year the grazing pressures of the annual and perennial paddock were again similar but 9% more live gain was achieved on the perennial pasture though 53% more hay was fed.
In 1995 the year round grazing pressure on the perennial paddock was 30% higher than on the annual pasture, generating 55% more live gain but with the added cost of 20% more hay fed.
The annual pasture was only grazed for a short period in 1996 before it was renovated, but the perennial paddock carried a higher grazing pressure and produced more live gain per hectare than in other years though 670 kg/ha of hay was also fed.

A general conclusion is difficult because of the range of variables involved. However considering animals grazing the annual pasture had access to 25% more area albeit non pasture, by the second year after establishment the perennial pasture proved to be more productive than the annual pasture. It is also likely to persist considering the strong 50 perennial grass plants/sq m. remaining at the end of the study.

It is interesting to note that the establishment of this perennial sward incurred little to no cost in terms of production foregone in the year of establishment.



Cumulative live gain (kg/ha) by the groups of cattle in the two paddocks over the life of the project:



SUMMARY

The summer autumn period has been very dry since 1993, with the break of season in June in 1996 and May in the intervening years.
As expected there was a consistent variation of subclover within each year, spring proportions being higher than winter. There has been a steady decline in subclover since 1993 which coincides with the late breaks. Levels of soil phosphorus and potassium are good and not likely to have limited legume content. The weed component of the pastures has comprised mainly capeweed, levels were comparatively low in 1993 following the early break

Appendix XIX

ESTABLISHMENT DEMONSTRATIONS 1995

By winter 1994 it was obvious, for various reasons outlined under the specific projects, that it would be a waste of time persisting with three of the west coast sites. Continued recording at these sites was subsequently terminated.
The sites included one *Monitoring site*: McCormack's at Pinjarra(appendix vii) and two *Producer Demonstration sites*: Fouracres at Manjimup (appendix xvi) and Fry's at Donnybrook (appendix xvii).

As an adjunct to the project it was then decided to to develop three perennial pasture sites on farms to demonstrate establishment techniques.

In May 1994 three small paddocks were located. Two of these were on farms where we already had perennial paddocks being monitored.

The sites were:

	Location	Area (ha)	Topography	Soil type
D & A Weightman	Margaret River *	2.0	Flat to slightly undulating	Sandy loam
K & Z Smith	Treeton *	3.0	Gentle slope	Gravely loamy clay
S Coombes	Donnybrook	0.9	Hill side	Sandy gravel

(* Farms with a paddock already being monitored).

Weed control

The Margaret River and Treeton sites were sprayed with glyphosate at 1.5l/ha and Brushoff at 3gm/ha, to prevent the seed set of annual grasses and broad leaf spp on 21/10/94 and 7/11/94 respectively. At the Donnybrook site no spring weed control was necessary following the removal of an oat silage crop.
All sites were grazed over summer down to 700-800kg/ha of dry matter by April 1995.
The Treeton site was top dressed with lime at 2.0t/ha which was cultivation into the top soil in May 1995.
All sites were sprayed with 2.0l/ha of sprayseed on 25/5/95, approximately two weeks after the opening rains of 90mm.

Sowing (Autumn 1995)

All sites were divided into three equal areas each of which was sown to a different perennial grass species. The areas were sown between May 29 and 31 with an Agroplough direct drill fitted with tines and Baker boots. All sites were then rolled with rubber tyres
Seeding rates of each of the perennial species was as follows:

Species	Sowing rate (kg/ha)
Sirolan phalaris	3
Au Triumph tall fescue	7
Wana Cocksfoot	3

Establishment

Satisfactory establishment was achieved with *all species* at Treeton and with *phalaris* at Margaret River, with plant densities (plants/m^2) in September 1995 of:

	Phalaris	Tall fescue	Cocksfoot
Margaret River	43	3*	1*
Treeton	91	56	63
Donnybrook	1*	3*	<1*

* These areas were reseeded in spring.

Reasons for the poor establishment included:
- low viable seed (cocksfoot tested after seeding: 45% normal, 7% abnormal, 43% dead seed).
- cold temperature during germination (late seeding due to the late break)
- failure to adequately control insects (red legged earth mite and lucerne flea).

As a result it was decided to **reseed** *tall fescue* and *cocksfoot* at Margaret River and all *three species* at Donnybrook in spring.

Spring seeding
Due to a particularly wet July in 1995 weed control of the 2 sites was not possible until August 8.
Margaret River. The areas to be sown were sprayed with 2.0 l/ha of glyphosate and 50 ml/ha of Lemat and were sown on August 14 with the Agroplough direct drill fitted with tines and Baker boots followed by light harrows.
Donnybrook. This site was sown on August 18 using the Agroplough direct drill fitted with tines and Baker boots then rolled with rubber tyres. As this site was still wet it was not possible to sow the whole area. The site was inspected for insect damage as the seedlings were emerging and the presence of lucerne flea warranted an application of Lemat at 50 ml/ha on August 31.
Seed used at both sites had a satisfactory level of germination and was sown at the same rates as in autumn (table above).

All spring sowings were satisfactory with the following plant densities(plants/m^2) recorded in December 1995:.

	Phalaris	Tall fescue	Cocksfoot
Margaret River		64	67
Donnybrook	48	58	79

Pasture management.
Margaret River. The area sown to phalaris was fenced from the tall fescue and cocksfoot areas and was grazed in January 1996. The area sown in spring was left ungrazed until late summer.
Treeton. The whole area was strip grazed with poddy calves from early September to the end of November 1995 and was block grazed by cows from early April to mid May 1996.
Donnybrook. Sheep have continually come though fences during January and February 1996, no time or numbers have been recorded.

At the final sampling in autumn 1996 the relevant plant densities were as follows:

	Phalaris		Tall fescue		Cocksfoot	
	plants/m^2	Sown	plants/m^2	Sown	plants/m^2	Sown
Margaret River	38	Aut	47	Spr	62	Spr
Treeton	45	Aut	<1	Aut	<1	Aut
Donnybrook	26	Spr	6	Spr	16	Spr

During 1995 and 1996 these sites were used as focal points for extension on pasture establishment with discussion topics including:
- project DAW.046
- species selection
- time of seeding
- establishment techniques (seed quality, insects)
- proposed management
- survival and response to summer rain

RESULTS:

SECTION 1 Management of Established Perennial Grasses.

Comments on Specific Perennial Grasses:

Kikuyu:

Suitability Generally kikuyu was most favoured along the South Coast being particularly useful on the sandier soils. It was however being increasingly used further inland and on a greater range of soil types.

Many comments were received on kikuyu being used to stabilise sandy soils and also to give production on otherwise unproductive deep sandy areas. Several people commented on areas where they had been unable to sustain an annual clover pasture becoming productive and also supporting substantial clover growth subsequent to kikuyu being established.

Once established, particularly the seeding cultivar (*Whittet*), kikuyu was reported to be spreading over the farm in many cases. This was used as a deliberate strategy in some cases, grazing seeding areas with cattle then immediately turning the cattle into the target area.

Grazing The general consensus was that kikuyu required hard grazing in all seasons, and in fact needed heavier grazing pressure than other pastures. Most farmers commented it needed to be grazed back hard at least once per year, particularly in autumn/early winter and especially after a frost. The major strategy was to remove any rank growth of kikuyu to allow the annual clovers and grasses a chance to get away in the winter period when kikuyu is mostly dormant.

Kikuyu pastures were grazed rotationally and by set stocking with both cattle and sheep.

Comments generally indicated that kikuyu based pastures had a greater carrying capacity than other annual based pastures on the farm.

Hay Production Most of the hay production off the kikuyu based pastures was acquired from the annual components of the pasture. Severe grazing pressure during autumn/winter allowed the annual clover and grasses to dominate kikuyu during early spring. This was then cut for hay, allowing the kikuyu to get away later.

Problems Virtually no problems were reported once kikuyu was established, the major one being keeping enough grazing pressure to allow the annual clover component to express itself.

A few commented on poor winter production from kikuyu but most regarded this positively as it enabled the annual clovers and grasses to grow in winter/spring, giving good production through most of the year.

Some reported on the very small size of kikuyu seedlings in their first year, often causing concern, but they almost invariably showed a strong presence the following year.

There were several comments that kikuyu provided a good reservoir for red legged earth mite.

reports varied from seeing it once to a regular problem with stock losses. Most, however, regarded it as a minor problem.

Phalaris:

Suitability The persisting phalaris based pastures were mostly of the older P. *tuberosa* variety. It was generally considered to survive and do well on heavier country although a few commented on its ability to stabilise fragile soils.

Grazing It was usually commented that once it was established phalaris could stand and needed hard grazing, especially in spring, to prevent it getting rank.

Two growers commented on very high production from phalaris in agro-forestry situations.

It was grazed by both sheep and cattle with set stocking and rotational grazing being carried out. Several growers commented that set stocking with cattle was very successful but there was a need to control or rotationally graze with sheep.

Hay Production Generally phalaris was not cut for hay, several commented on its poor quality when conserved as hay. Two growers who had cut hay had planted the variety *Sirosa*.

Problems A specific problem with phalaris based pasture was phalaris toxicity. This was reported by 8 growers out of 12 having phalaris based pastures plus 14 having phalaris in mixed pasture. It was reported in sheep and cattle and was mostly of a mild sporadic nature with only one case of stock losses, in weaner cattle, being noted.

Another problem was the poor palatability of phalaris if it was allowed to get rank, especially the older *tuberosa* variety.

Several growers noted serious damage to phalaris pastures caused by wingless grasshoppers.

Cocksfoot:

Suitability and Grazing It was generally considered not to persist, particularly when sown in mixtures. Where it had persisted was in better gravelly soils with one grower commenting that it did well near trees in the shade. However one grower had an established stand of cocksfoot when he took over the farm, cropped the area in his first year and the cocksfoot came back and has persisted for 10 years. This grower also noted that it was grazed heavily all year round whereas one other grower commented on poor winter production.

Hay Production Only one grower used cocksfoot for hay and commented on very high production and palatability.

Problems These were mostly related to poor persistence under sheep grazing. One grower commented that other grasses did not survive in areas where cocksfoot was growing but clovers did.

Fescue:

Suitability and Grazing This was generally considered not to persist under grazing especially when sown in mixtures. *Demeter* was the variety generally used but favourable comments were made by several growers about the new variety *Triumph*.

However, three growers commented on *Demeter* doing well in wetter areas where it was increasing. One grower with a winter wet area which could not be grazed through winter reported that *Demeter* fescue had taken over and was out competing all the other pasture plants.

Veldt Grass:

Suitability and Grazing Was specifically targeted to deep sandy areas in conjunction with serradella. Was not grazed in spring to allow seed set then grazed, usually by cattle over summer.

Mixtures:

Suitability A wide range of mixtures were recorded as being sown, but there was no detailed assessment of pastures to isolate persistent species. Farmer observations and comments on the value of different species in mixes were noted.

The mixtures sown varied from 2 to 6 varieties together with annual clovers, occasionally annual grasses and very occasionally perennial clovers. Of the 21 growers sowing mixtures 20 had ryegrass in the mix, 14 phalaris, 12 fescue and 10 cocksfoot. Ten growers had sown only a mix of ryegrasses and phalaris plus annual clovers.

Generally the comments were made on poor persistence of cocksfoot, only 1 out 10 reporting any persistence, and fescue with 3 out 12 growers reporting persistence. Several growers reported poor persistence of the newer varieties of phalaris (*Sirosa* and *Sirolan*) particularly *Sirolan*.

Grazing Generally growers reported a better carrying capacity on the perennial mixtures than annual pastures. Most deferred grazing after summer rain to allow plants to get away and many observed the need to control grazing by sheep to prevent the crowns being eaten out.

Opinions were divided on the need to allow the grasses to set seed in spring.

General Comments on Perennial Grasses:

Several strong points were made on the virtues of perennial pastures.

Erosion A very important role reported by many growers was in stabilising fragile soils and reducing run-off, also in making best use of available water and nutrients. Many had targeted specific areas such as deep sands and paddocks close to sheep handling facilities to minimise water and wind erosion risks. One grower reported a reduction in the rate of acidification of soils under perennials.

Production Most farmers reported increased carrying capacity on perennial pastures compared with annuals, a range of 30% increase to doubling being claimed. This was reported to be achieved by extending the growing season at both ends, providing autumn feed and also making good use of summer rain.

Hay Production With regard to hay many reported improved production and quality whilst a significant number claimed a great reduction in the need to make hay.

Costs and Returns There were some comments on the high cost of establishing perennials but others considered they were economically worth while.

Many of the growers reported they would like to increase the area under perennial pastures and were actively pursuing this aim, a few said they would not like the whole farm under perennials, particularly cropping paddocks.

Species In terms of species many of the growers on the south coast considered a kikuyu based pasture to be most productive, but some commented on the need for improved cultivars and establishment techniques. Several commented on the need for more persistent ryegrass that did not cause staggers. Favourable comments were made on some of the newer varieties that had not been present long enough to be considered in this survey. Notably, *tall wheatgrass* was reported to be performing well in wet, salty conditions. *Triumph* fescue and *Yatsyn* ryegrass were both reported to be performing well.

All the growers commented on the need for perennial grasses to be in a balance with annual clovers for optimum production.

When asked for a definition of a perennial pasture the mix of perennial grass with annual clover ranged from 70:30 to 30:70 with the majority preferring a 50:50 mix. The great majority required a capability to respond positively to summer rain. Some considered perennial pastures should be self sustaining.

Fertilisers Most of the growers commented on the need to feed perennials well to get optimum production.

Many of the farmers reported fertilising according to soil tests. Those that did not soil test favoured super-phosphate/potash mixtures.

Only a few farmers used nitrogen and then only occasionally, either in autumn to get early feed or in spring in conjunction with potash for hay production. Many of the farmers commented on the need for a significant component of clover, mostly annual clovers, in a perennial pasture to supply nitrogen to the grasses.

It was generally reported that potash fertilisers were used when the pasture was used for hay production.

Insecticides Many of the farmers used insecticides to control red legged earth mite, mainly to protect the annual clover component, and claimed a marked improvement in production. However a few farmers commented on considerable damage to grass seedlings and early growth of grasses by red legged earth mite.

Some of the farmers used insecticides routinely up to twice per season while others only used them if a significant problem was seen. Some never used insecticides, a frequent comment being, once you start you have to keep going as you kill all the predators of the mite.

Several farmers claimed to minimise red legged earth mite problems by their grazing management, keeping the pastures short in winter.

Problems A non-pasture issue that was raised by several growers was the problem of increasing *endo-parasitism*, mainly in sheep, with greater areas under perennials. Some growers had already experienced problems but several others were concerned and had adjusted their management to avoid, or minimise, any potential problem.

Species Summary

A summary of the essential management techniques used by farmers to maintain specific perennial grasses is given below in the order of the declining number of grower comments received.

Kikuyu:
1. Graze it hard all year especially in autumn and winter.
2. Fertilise well.
3. Good establishment.

Probably summed up by the two comments "Try and kill it with teeth" and "It survives despite my management".

Rye-grasses:
1. Good establishment.
2. Controlled grazing to avoid winter, autumn and summer overgrazing;
3. Allow it to set seed in late spring;
4. Re-seed every 5-6 years;
5. Nothing special.

Phalaris:
1. Good establishment;
2. Graze hard especially in spring;
3. Fertilise well;
4. Allow to reseed if gets too thin;
5. Controlled grazing with sheep in summer.

Cocksfoot:
1. Good establishment;
2. Fertilise well.

Fescue:
1. Good establishment - may need to protect for 2-3 years;
2. Fertilise well.

Veldt Grass:
1. Good establishment;
2. Allow to set seed;
3. Controlled grazing.

Mixtures:
1. Controlled grazing especially after summer rains;
2. Good establishment;
3. Fertilise well;
4. Control competition by cutting hay or spray topping;
5. Allow to re-seed;
6. Nothing special.

Appendix XXIII

Could I now get some information on the management of your perennial grasses in the years after establishment.

20. Fertiliser strategy?
Amount (kg/ha)..... Type..... Frequency.....

21. Have you used any insecticide treatments? Yes..... No.....
If Yes, for what reason?.....

22. Compared with the rest of the farm do you graze it:
Heavily, similarly or lightly in

Autumn	Winter	Spring	Summer

23. Stock type used?.....

24. Do you cut hay off the area? Yes..... No.....
If **Yes** ,how often?.....

25. Are there any seasonal factors such as drought or waterlogging that affect your grazing management?.....
.....

26. Have you had any specific problems such as phalaris toxicity or ryegrass staggers with the perennial species you have?.....

27. Are there any general problems you have had in maintaining perennial pasture species?.....
.....
.....

28. What do you consider are the essential management techniques that have enabled you to maintain your perennial pasture?.....
.....
.....
.....
.....

29. Do you have any other comments on perennial pastures?
.....
.....
.....
.....

30. How would you define a perennial pasture?
.....

That concludes my questions. Thank you for your co-operation.

Appendix XXIV

SPREADSHEET MODEL:

WHAT IS THE COST OF ESTABLISHING A PERENNIAL PASTURE?

INTRODUCTION:

One of the objectives of the project "Perennial pastures for animal production in the high rainfall areas of Western Australia" was to determine the economic feasibility of establishing perennial grass pastures using gross margins, pay back period and cash flow budget analyses and other economic analyses including *Grazplan* when it becomes available.

This initially appeared to be a fairly straight forward task, however it developed to be quite complex. The economics of establishing perennial grasses is mainly determined by three factors:

the recent history of the paddock to be sown (eg this may be crop stubble, a well established annual pasture or a run down annual pasture) because this is related to the amount and hence value of production foregone in the establishment phase.

the type, class, production level and grazing pressure of the grazing animals before, during and after the establishment period.

the processes and costs (eg operations and consumables) of the establishment phase.

To draw these issues together we developed an interactive EXCEL spread sheet which accomodated a wide range of inputs and provided upto four concurrent outputs for estimated costs and returns for a 10 year period.

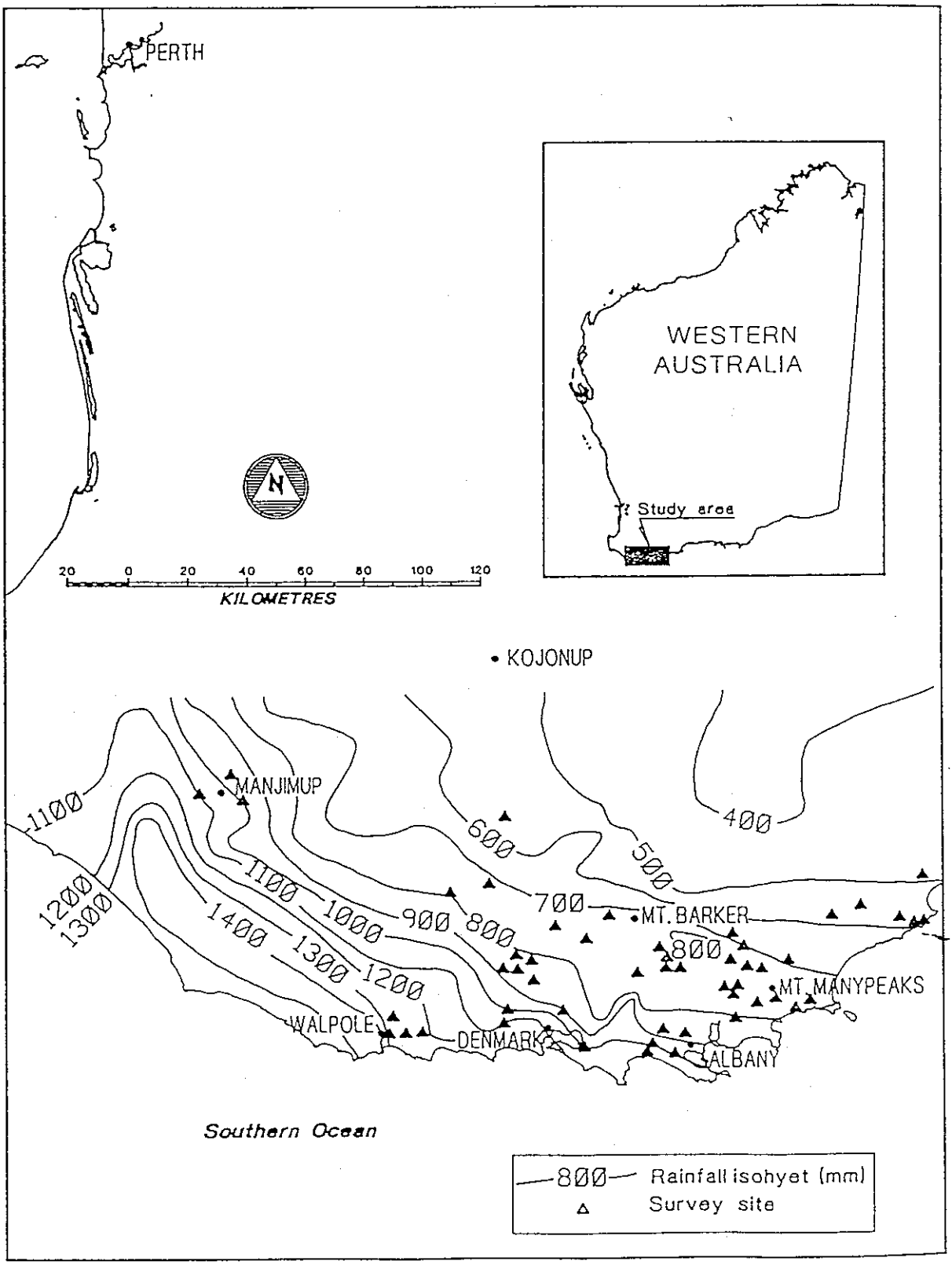
This is not a biological model, but we have attempted to include the important biological variables so that the user can make adjustments for economic comparisons between and within pasture systems.

BRIEF OUTLINE OF MODEL

Use: The model was developed to determine the cost and break even period by calculating the costs of pasture establishment and maintenance as well as animal returns over a 10 year period. Four concurrent pasture systems comparisons can be run, one of the four being used as a base or "control" system.

As we do not have the answers to all the combinations and interactions of perennial pasture establishment and management systems, all biological variables in the model have to be supplied by the operator. However sensitivity to different components of the pasture systems can be compared.

Distribution of surveyed properties.



Animal gross margin budgets: The opening page offers a selection of four grazing enterprises

COWS AND VEALERS

COWS AND STEERS

STEERS ONLY

EWES AND LAMBS

Clicking on the appropriate enterprise button displays a gross margin spreadsheet.
The four gross margin spreadsheets have basically the same structure. They allow the operator to vary a range of the inputs which are highlighted in **red text.** The **base grazing pressure** at the top of the page has a factor of '1' and is the reference grazing pressure for the paddock. When estimating grazing pressure in the different year tables (see later) it is expressed as a factor which is higher, equal to or lower than '1' eg 1.2 or 1 or 0.7 etc. expressing respectively 20% higher, the same or 30% lower grazing pressure than the paddock base or reference level.
Once the enterprise has been chosen and values entered, the ACCEPT button invokes the appropriate calculations and returns the operator back to the "**Page 1**". Pressing the RETURN button, only takes the operator back to the "**Page 1**".

NEXT

Moves the operator to **PAGE 2 (Pasture Outcomes)** where they can select the current paddock uses and intended pasture management (maintenance of the current or establishment of annuals or perennials).

PAGE 2 (Pasture Outcomes)

The two drop down tables on this page provide:

a) on the left, an opportunity to select in turn 4 of 8 crop to pasture, annual pasture to annual pasture or annual pasture to perennial pasture options, and these are headed ***"current state to intended state"***. The first of the four selected by you is used as the ***base*** system and later in the calculations the other systems are compared with the base system.

b) Within each of the four selections made in (a) above there is a different range of pathways to achieve the ***intended state*** and these appear

Type: The model has been generated using Microsoft Excel application software. It consists of a series of spreadsheets, dialogue boxes, dropdown boxes, toggle boxes and input cells drawn together using the Visual Basic language for applications (VBA).

Operation: The main components of the model are:

1) a choice of **animal gross margin budgets** which are driven by grazing pressure. A selection has to be made from these and appropriate adjustments can be made to variables in the budget of choice.
2) a selection of **paddock states** (in drop down tables) plus associated **pasture management systems and expected outcomes** (in a second drop down table). This provides the opportunity to select up to four pasture management programes with the first recognised as, and referred to as the **base system** to which the other systems are later compared.
3) **pasture costs** are then entered for each of the years for each of the systems on individual tables, the sum of which are automatically transferred to a summary sheet.
4) **expected grazing pressures** for each year is entered on the summary table.
5) **results tables** of summarised costs and returns and estimated break even periods as well as **graphs** for 10 years estimates are presented.

MORE DETAILED NOTES

PAGE 1

SPREDSHEET INFORMATION

Invoking this option takes you to this documentation for assistance. An overall **diagram** of the interelationship of the spreadsheets is provided plus these notes.

VIEW PREVIOUS RESULTS

This allows the operator to revisit the last range of analyses calculated.

EXIT

Provides an opportunity to quit the programm at this stage. This takes the operator into EXCEL from which normal close down procedures are necessary. **Saving** the spreadsheet at this point will retain the last 'runs' for future reference.

NEXT PAGE (An outline of the specific management system selected)

This page (which is different for each of the grazing ***management systems*** selected) outlines the whole system for 10 years.
The entries to be made at this stage are:

a) the annual pasture treatment variables such as costs of fertiliser, seed, cultural practices, herbicides ,insecticides and supplements. To enter these, press the button located on the specific year, which will display the entry sheet for that year, once complete (see further details below) press the RESULTS button which returns you to the selected ***management sytem*** sheet. The total from each annual costs entry sheet is autumatically carried forward to the ***management sytem*** sheet. This procedure needs to be repeated for the costs of each year in turn until the *'year in year out'* management system is reached.

b) the relative grazing pressure values for each year. The grazing pressure of a standard pasture on the property is taken as 100% or a factor of 1, any variation expected or predicted from this is recorded as a factor. eg in the establishment of a perennial it might be expected that only 60% of 'normal' grazing can be achieved, as a factor this would be entered as 0.6; alternatively once established the perennial might be considered to have a 20% benefit over the standard pasture, a factor of 1.2.

Once all entries have been made for a specific management system pressing the return button displays **PAGE 3 (Pathway Selection)**. Another management system is selected and the above procedures ('a' and 'b') are repeated until you are satisfied with entries for each of them. At this point you use the RESULTS button on **PAGE 3** to proceed with calculations and display them on the **Final Page**.

Once comparitive systems have been run, changes can be made to test the sensitivity of a system to the different variables eg grazing pressure.

FINAL PAGE..... Results

The results are presented in a number of formats on this spreadsheet. From the opening position a ***Results Summary*** is provided for the base system and each of the 3 alternatives with 3,5 and 10 year outcomes and provides an estimate of the number of years for costs and returns to ***break even.***
From this position using the VIEW GRAGHS button will scroll directly to the graphs (see below).
Scrolling to the left will display a blue table headed ***"Present value of annual costs and returns of a base pasture and 3 alternatives"*** Scrolling down from this presents the data used in the graphs and then the graphs themselves.

on the drop down table on the right of the screen and are headed ***"Method of arrival".***

Once these are selected the operator can move to the next stage by pressing NEXT

SPREDSHEET INFORMATION

Invoking this option takes you to this documentation for assistance.

PREVIOUS

This button provides the option to go back to PAGE 1

NEXT

Moves the operator to **PAGE 3 (Pathway Selection)** where they can select the current paddock uses and intended pasture management (maintenance of the current or establishment of annuals or perennials).

PAGE 3 (Pathway Selections)

The right hand side of this page provides the opportunity to check the scenarios and pathways selected on PAGE 2

Once satisfied the ***Pasture Cost Buttons*** on the left of each of the selections are used to move to the next phase where there is an outline of the specific management system selected, and each of these needs to be followed through in turn **(see below)**

The ***discount rate*** used in the calculations can be altered as necessary on this page.

PREVIOUS

This button provides the option to go back to PAGE 2

RESULTS

Once you have completed and are satisfied with all the details in each of the management systems, having entered all the costsetc and the relative grazing pressures, pressing this button will sort and calculate the outcomes of each of your four options. This process can take a little while. You are then taken to the **final page** where the results are displayed, in detail and in summary.

summed to provide a total cost, which is linked to cells in the pathways spreadsheet.
Results are calculated using the value for grazing pressure from the pathways spreadsheet to Vlookup a figure in the gross margin database which is discounted to 'today's values. The present values are summed to give a total cost for establishing and maintaining the selected perennial pasture system. This calculation is performed for animal costs excluding and including capital, land capital and gross returns. Cumulative returns and break evens are included to demonstrate profitability of the investment over ten years.

Acknowledgements:
Liz Peterson and Murray Gillespie, for their invaluable computing skills, and Jason Kelly for his help and comments on the approach.
The animal budgets have been adapted from those prepared by the Marketing and Economics staff of Ag WA.

Scrolling further left from the blue table provides a multi-coloured table of the outlines of the specific management systems selected, a copy of those previously displayed when entering the pasture costs and relative grazing pressures.

PREVIOUS

This button provides the option to go back to **PAGE 3**

START AGAIN

This button provides the option to go back to **PAGE 1** to start looking at another range of systems.

VIEW GRAPHS

Invoking this button moves the screen output to on of two graphs. Scrolling down allows the viewing af the second graph. To retreive the ***Results Summary*** view scroll up and to the right.

GENERAL NOTES

Annual costs entry sheet. These sheets are made up for each years costs in each management system. Entries in the sheet are activated through toggle boxes, with the cross showing the entry is made. The spreadsheet is made up to accept either your specific values (purple columns) or if there is no entry in these columns the default values (grey columns) will be used. Initially your default values as well alternative values will have to be entered. Other costs than those listed can either be added, if there is space, or substituted for other unwanted entries.

The **graphs** depict;

- The estimated present value of the cumulative returns per hectare of the four selected management systems over a 10 year period
- The estimated present value of the cumulative margin per hectare of each of the three alternative options over the **base** option for a ten year period.

Calculations: Values entered into the gross margin spreadsheet are used to calculate returns per ha including and excluding capital and gross returns per ha.
A key parameter in the spreadsheet is grazing pressure, which generates a sensitivity table, this database is then copied onto the results sheet.
Costs of pasture establishment and maintenance are calculated from the options spreadsheets. Activation of toggle boxes identifies inputs which are

Appendix XXV

VALIDATION OF '*GRASSGRO*'

This is a separate document supplied to MRC with this report.

Appendix XXIII

A SURVEY OF GROWER EXPERIENCES IN MAINTAINING PERENNIAL PASTURES

INTRODUCTION

The persistence of perennial grasses is of major concern to farmers, and represents a significant block to increased adoption. We have attempted to identify successful management strategies for the major species within the region by interviewing farmers known to have persistent perennial pastures. This report is a compilation of that information, which although often anecdotal, suggests useful farmer perceptions and possible guidelines for maintenance of perennial pastures.

Having a perennial pasture to maintain is obviously dependent on successful establishment. Whilst establishment is not the key issue in this survey, it is considered an integral component of perennial pasture management. Information on farmers experiences in establishing pastures has been collected as part of this survey, and compiled in a separate section within the report.

Finally, our concept of the term "perennial pasture" should be conveyed. A perennial pasture does not mean the total pasture is comprised of perennials. Ideally, in this environment where we have highly successful annual legumes, a perennial pasture should combine an annual legume with the perennial grass. The proportion of each is dependent on edaphic and environmental conditions. For example, in the high rainfall/high soil moisture reserve situations, the density of perennials able to be maintained permanently is greater than in drier areas. A range of proportions have been found in the survey paddocks. Proportions will also vary seasonally. In terms of temperate perennial grasses, we have set a rough base density of 25 plants/m^2, below which we would not consider the perennial component comprising a significant fraction of total pasture. In terms of kikuyu, a base level of 30% ground cover over summer has been set as a guide.

BACKGROUND INFORMATION:

The survey was conducted by interview using a questionnaire, a copy of which is at the end of this survey report. The majority of farmers were interviewed on farm but due to time and distance constraints some were interviewed by telephone.

In all, 52 farmers were interviewed whose farms had areas under pasture ranging form 57 to 4200 hectares.

The main enterprises carried out on the farms were:

Beef.....24 farms.....15 were sole enterprises, 9 mixed.
Wool.....22 farms.....2 were sole enterprises, 20 mixed.
Prime Lamb.....3 farms.....all had mixed enterprise.
Cropping.....2 farms.....both had mixed enterprises.
Dairy.....1 farm.....also had mixed enterprise.

Soil Moisture Measurements at Mt Barker.

DRW Microlink System equipment was purchased in the project to investigate the effect of different perennials on the change in soil moisture, with the aim of determining the magnitude of the benefit of the different perennials compared with an annual pasture in their use of soil water.
If temperate perennial grasses use more water than annuals at the ends of the growing season a buffer (reservoir) should be developed which should accommodate more rain and reduce the amount of excess water escaping to deep drainage.

Method

Two *Microlink* field units were set up to service 2 plots each. Each unit supported 8 moisture probes. These probes were arranged in 2 sets of pairs in each plot, the pairs were about 10 metres apart, and the individual probes of each pair were set in the soil one above the other, at 10 cm and at 35 cm from the ground surface.
As the areas being monitored were being grazed by cattle all wiring had to be carefully buried. Exposure of wiring at one point lead to its uprooting and chewing of the cable and destruction of the probe.
Though these probes were supplied to us with calibration data for our soil, these calibrations were wrong and we needed to calibrate them individually in the field. To do this we periodically collected samples of soil in the vicinity of each probe for gravimetric moisture assessment. The gravimetric values (w/w) were converted to volumetric (v/v) values and regressed with the moisture readings and all previous measurements were recalculated. Considerable data was lost in this process because any moisture values recorded from the early incorrect calibration which resulted in negative values were lost. The only data recorded in the *Microlink* system was that which had been converted to soil moisture, the whole process would have been considerably easier if the direct electronic output from the probes had been accessible.
Each *Microlink* unit was fitted with a *Datalink* data logger to collect data over a prolonged period, these were periodically down-loaded to a portable computer. Solar panels were used to power each field unit.

Results and Discussion

Our final calibration data for each probe is given in the following table. Two regressions (probes 3 and 7) included extreme outlying points that were excluded from the final regressions. These points may well have been associated with a change in soil type, as at 35 cm most probes were close to the B horizon (clay layer) and high levels of clay in calibration samples may have confounded the results. The slope of one regression (probe 8) was not significant (P~0.1) but it was still used.

	Treatment		n	Coefficients y=a+bx							
				a	P-value	Sign	b	P-value	Sign	R^2	SE
1	Phalaris	10 E	7	0.3331	0.0006	***	0.1625	0.0078	**	0.7859	0.0430
2	Phalaris	10 W	9	0.3916	0.0011	**	0.2557	0.0100	*	0.6360	0.0759
3	Phalaris	35 E	6	0.2438	0.0003	***	0.0871	0.0110	*	0.8334	0.0299
4	Phalaris	35 W	8	0.5219	0.0009	***	0.3846	0.0102	*	0.6944	0.0757
5	Annual	10 E	6	0.2103	0.0004	***	0.1015	0.0041	**	0.8971	0.0164
6	Annual	10 W	9	0.1948	0.0020	**	0.1236	0.0255	*	0.5331	0.0446
7	Annual	35 E	7	0.2424	0.0008	***	0.0702	0.0151	*	0.7244	0.0451
8	Annual	35 W	9	0.3780	0.0065	**	0.1655	0.1044	ns	0.3321	0.1374
9	Cocksfoot	10 E	7	0.2270	0.0002	***	0.1173	0.0048	**	0.8226	0.0289
10	Cocksfoot	10 W	9	0.1963	0.0002	***	0.0776	0.0058	**	0.7059	0.0274
11	Cocksfoot	35 E	9	0.3017	0.0040	**	0.1750	0.0366	*	0.4868	0.0911
12	Cocksfoot	35 W	8	0.3482	0.0033	**	0.3427	0.0140	*	0.6619	0.0602
13	Fescue	10 E	6	0.3002	0.0006	***	0.1910	0.0054	**	0.8822	0.0254
14	Fescue	10 W	6	0.3053	0.0007	***	0.1569	0.0061	**	0.8757	0.0350
15	Fescue	35 E	6	0.4111	0.0020	**	0.2543	0.0138	*	0.8147	0.0506
16	Fescue	35 W	6	0.3989	0.0024	**	0.3453	0.0122	*	0.8254	0.0484

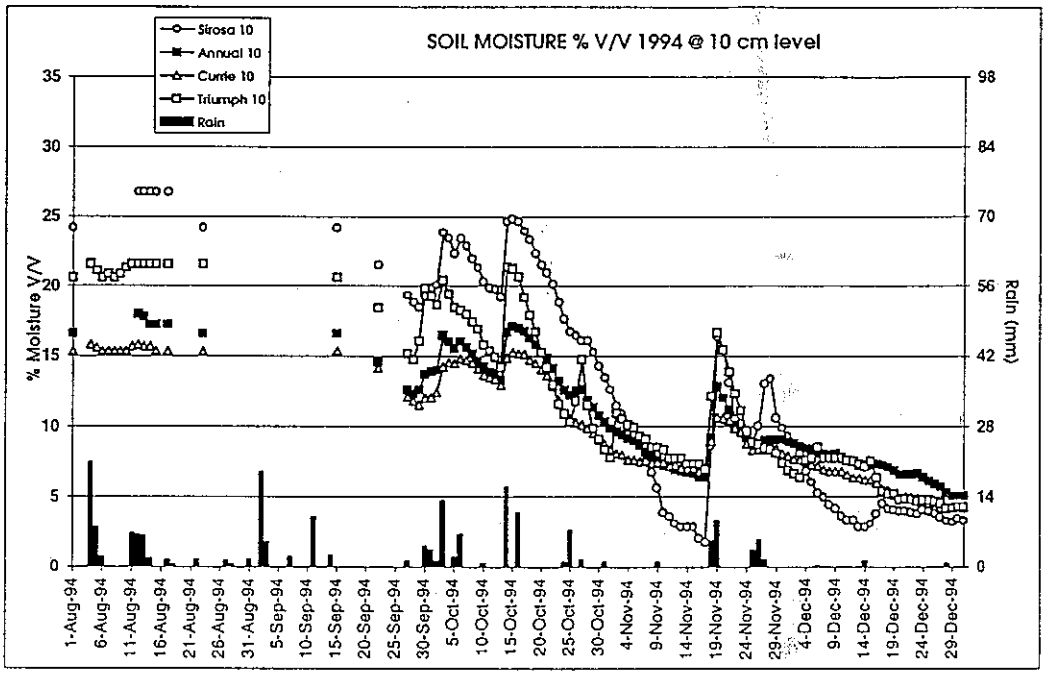
Extreme outlying points removed from these regressions

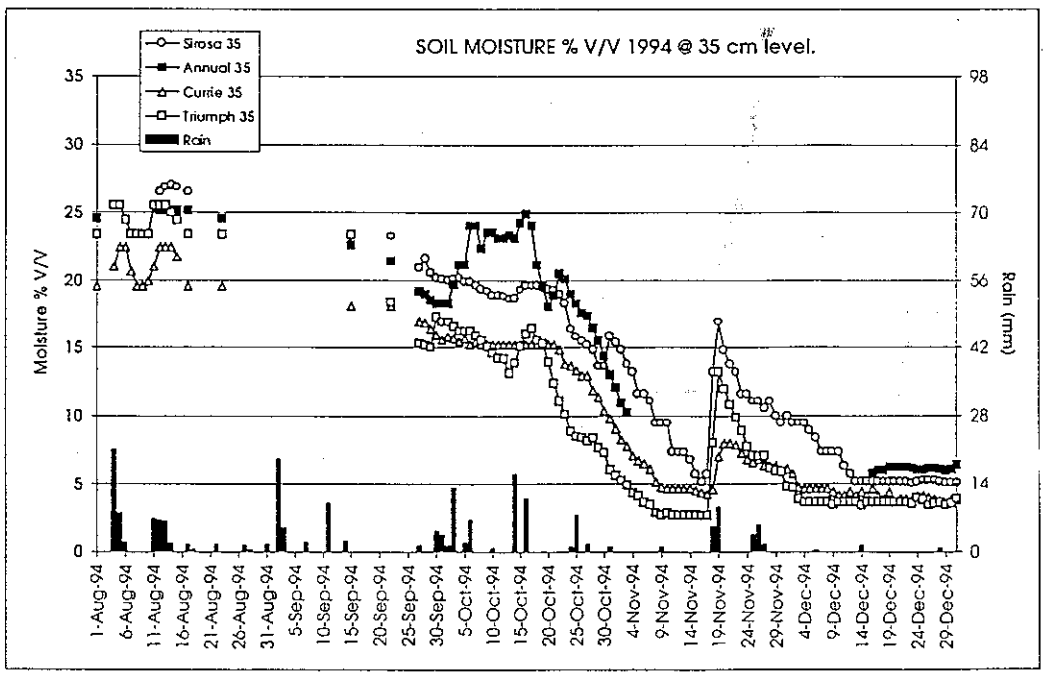
The following graphs outline the estimated soil moisture levels at the two depths for each of four pasture types. Each point represents the average of two probe readings.

1994: The equipment was set up before August but early data was lost through wrong initial calibrations. Continuous data commenced after the soils were well wet up.

10cm probes: The annual and long established cocksfoot (7 years) pastures appeared to maintain drier profiles through spring than the phalaris and fescue pastures (only 2 years old). However the phalaris appeared to dry out more quickly than the others in late spring/early summer. Soil moistures at the driest period in summer (December) were around 4% v/v and during winter ranged from 16 to 26%

35 cm probes: Through spring and early summer the annual pasture generally maintained higher levels of moisture than the perennial grass pastures. Soil moistures at the driest period in summer (December) were around 4 to 6% v/v and during winter ranged from 23 to 27% v/v.

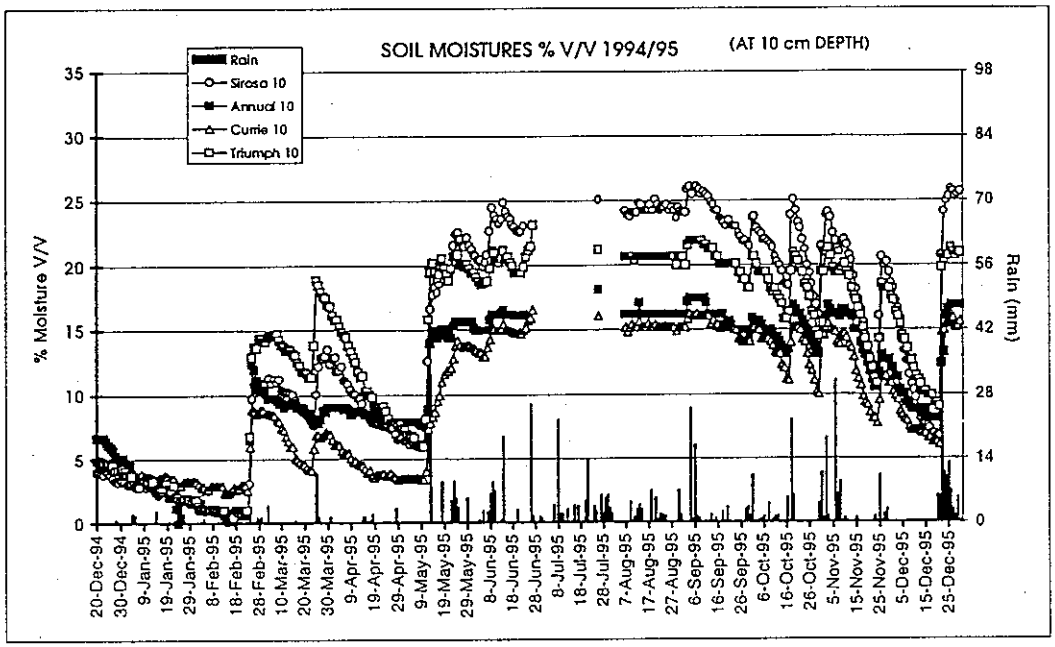


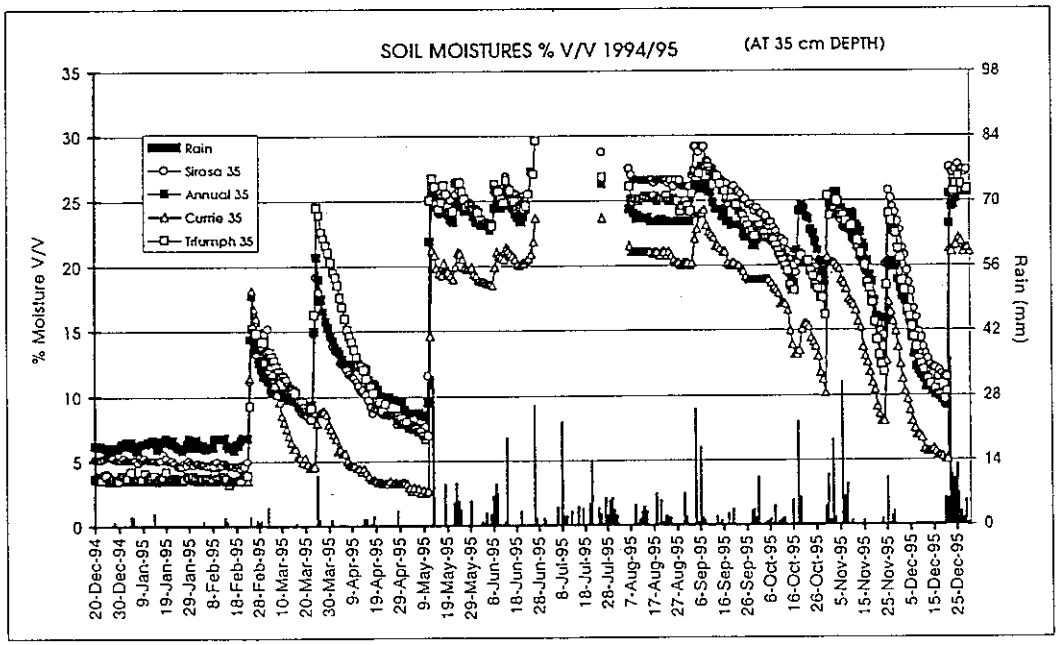


1995:

10cm probes Again the annual and cocksfoot pastures were drier at the surface than the other two perennial pastures and cocksfoot maintained a lower level of soil moisture throughout the year. Soil moistures at the driest period in summer (February) were around 2% v/v and during winter ranged from 16 to 26%.

35cm probes Soils under cocksfoot were the driest though the year. All soils responding similarly to rain and drying out, though they were at different levels of soil moisture. Soil moisture under the annuals, before rain in summer, were higher than under the perennials. Moistures in this period (December) were around 4 to 6 % v/v and during winter they ranged from 24 to 28% v/v.

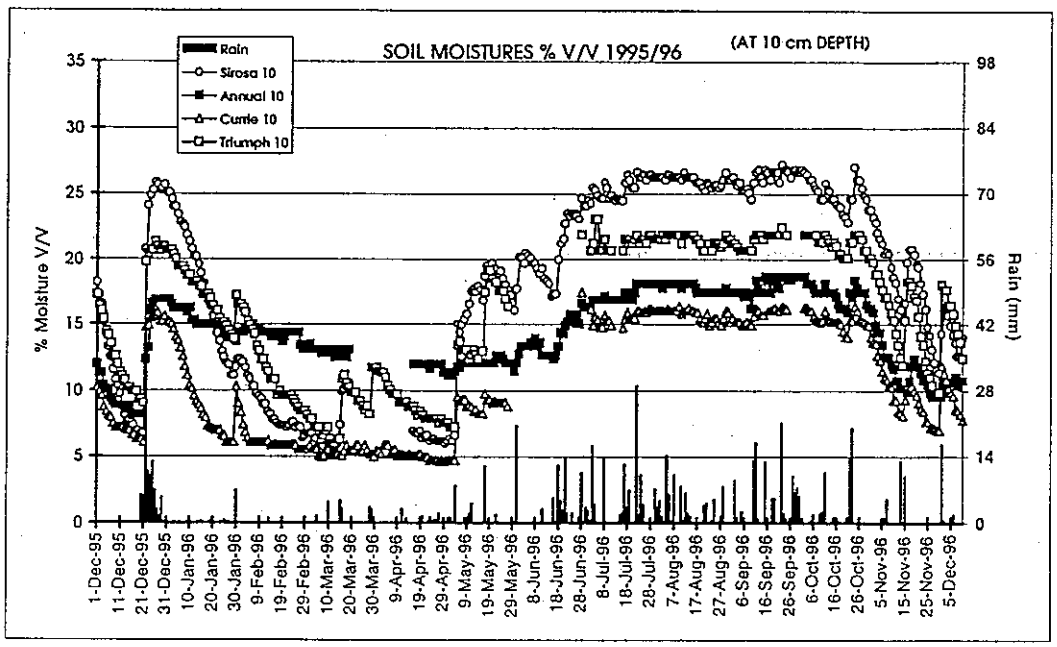


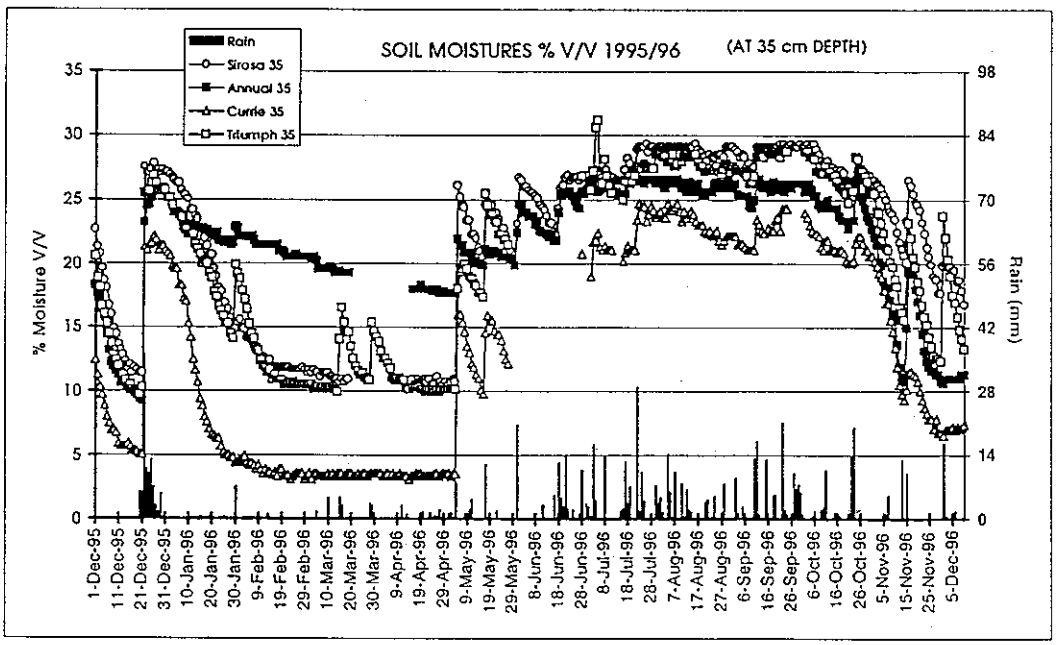


1996: Soil moisture in summer of 1996 were strongly influenced by the heavy out of season rains received in late December 1995. At this time soil moistures surged to between 15 and 25% at 10 cm and 21 and 28% at 35 cm.

10cm probes Soil under the cocksfoot pasture was the driest throughout the year. Following the heavy December rains the soil under the annual pasture, which in 1994/5 summer was as dry as that under the cocksfoot, did not dry out through summer as did that under the cocksfoot (to ~5 %), maintaining moisture levels at between 11 and 15%. Soil moistures during winter ranged from 17 to 27%, again the soils under the annual and cocksfoot pastures were drier the those under the phalaris and fescue.

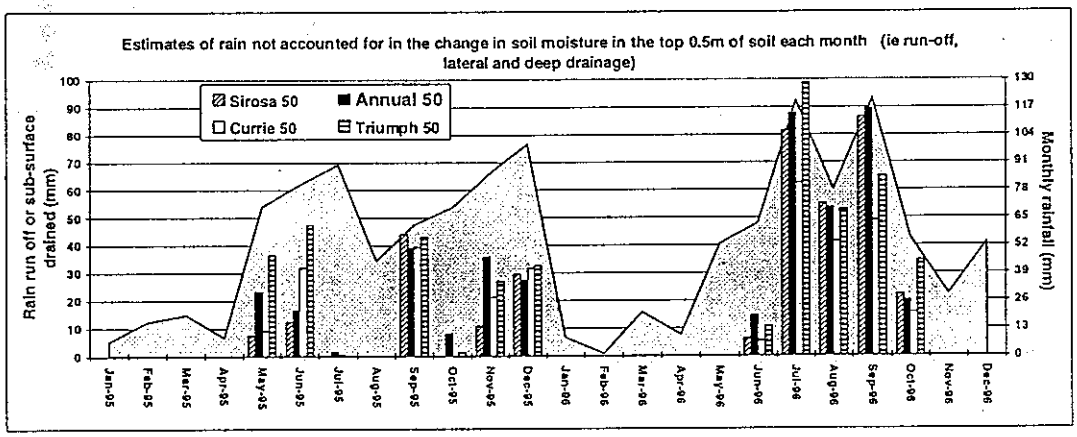
35cm probes A similar effect occurred at this level as at the 10 cm level, with soil under the cocksfoot pasture being the driest throughout the year. That under the annual pasture maintaining moisture levels at around 19% while under cocksfoot swards the moisture was at around 4% and under the other perennials around 11 %. Soil moistures during winter ranged

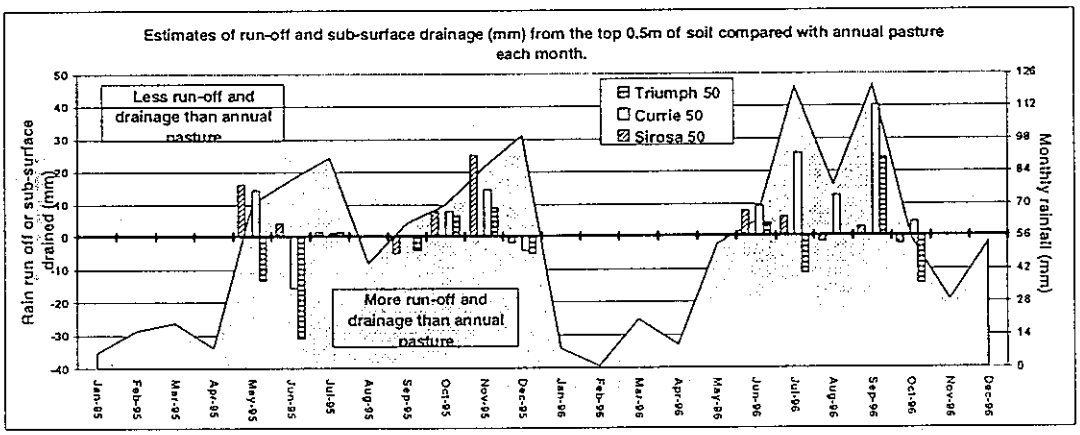




from 24 to 29%, the soils under the annual and cocksfoot pastures were drier than those under the phalaris and fescue.

Moisture levels in the top 0.5m of soil under each pasture were calculated using the 10 cm probe measurement as being representative of the top 0.2m of soil and the 35cm probe as being representative of the next 0.3m of soil. Field capacity for the soils at each depth below each pasture was determined from the high plateaus on the above graphs. It was assumed that any rain event that exceeded the available water space in the top 0.5m of soil on any day was lost to surface or sub-surface drainage. These calculations are depicted on the following graphs.





Over the two years more rain drained from the annual pasture than the phalaris and cocksfoot pastures. However more drained from the fescue pastures than the annual pasture. The values for each year and pasture type are given in the table below.

Estimated surface and sub-surface drainage, ie rain not accounted for in the soil moisture changes in the top 0.5m of soil and the difference between the annual and perennial pastures:

	Annual	Phalaris	Cocksfoot	Fescue
	mm	mm	mm	mm
1995	152	104	133	188
Better than Annual	--------	48	18	-36
1996	265	252	173	262
Better than Annual	--------	13	92	3
Two year mean	--------	30	55	-17

Overall the perennials reduced the estimated surface and sub-surface drainage, (ie rain not accounted for in the soil moisture changes in the top 0.5m of soil) by **23mm per year.** At