milang

RESEARCH CENTRE

FIELD DAY 1964

DEPARTMENT OF AGRICULTURE, SOUTH AUSTRALIA

MILANG IRRIGATION CENTRE FIELD DAY

THURSDAY, FEBRUARY 20TH, 1964

P R O G R A M M E

WELCOME	11.00 a.m. Mr. P. Judd, Officer-in-Charge
OFFICIAL OPENING	The Honourable, The Minister of Agriculture, Mr. D. N. Brookman.
	"Installing an efficient irrigation scheme" P. Judd
	"Results of Pasture Species Investigations" P. Judd
	"Results of Fodder Crop Investigations" A. Morris
	"Out of Season Fat Lamb Production" L. T. Hayward
LUNCHEON	
	1.30 p.m. "Methods used to determine irrigation frequency" A. Morris and P. Judd
	"Irrigation frequency and nitrogen trial" P. Judd
	"Results of Store Lamb Fattening Studies" L. T. Hayward
	"Worm and Fly Control in Sheep" J. Fearn
	"Using Irrigated pasture on the Dairy Farm" G. S. Pickhaver
AFTERNOON TEA	3.00 p.m.

MILANG IRRIGATION CENTRE

The Centre was established in 1953 to demonstrate the irrigation potential of the Lakes district. Out of 35 acres leased by the Department, 15 acres were developed under a border check system of flood irrigation and 15 acres were developed under spray irrigation.

Until 1957 lucerne and permanent pasture mixtures were grown under both systems of irrigation. The irrigated fodder was used to fatten northern store cattle.

In 1957 a programme was commenced to reorganize and equip Milang as a research centre and to investigate some of the basic problems of irrigated pasture management and production. By 1959 trials were in progress and by the end of 1961 the Centre was fully developed for experimental work.

SOILS

The grey, coarse sandy soil varies in depth from 6 in. to 30 in. The subsoil is a brown sandy clay loam which grades fairly quickly into a sandy limestone marl at a depth of 15 in. to 20 in.

In small areas the sandy clay loam has a high percentage of clay and restricts drainage. Travertine limestone occurs within 18 in. of the surface in isolated areas.

Soils are neutral to alkaline (pH 6.8 - 8.0) and in their dry land state are relatively low in nitrogen, phosphate and potash. Observations indicate that with the irrigation of pastures and the circulation of plant nutrients through the grazing of livestock the soil fertility is rapidly built up to a level suitable for most crops.

CLIMATE

The average rainfall at Milang is 14.8 in. a year. Average evaporation is about 56 in. a year. To maintain adequate pasture growth irrigation is necessary from September to May in a normal year. In a drought year this period can be extended from mid-August to mid-June.

Low temperatures and the occasional frost can limit pasture growth in June, July and August. However, the mean monthly temperature for this period does not fall below 50 deg. F.

The area is very exposed, and windy conditions throughout the year present difficulties with spray irrigation.

FERTILIZERS

All pastures receive a dressing of 2 bags of superphosphate per acre per year. One bag is applied in August and the other in January.

Marginal responses to potash have been obtained on permanent pasture. Copper and zinc have given no response on permanent pasture but there have been visual responses to these trace elements with Mount Barker and Bacchus Marsh subterranean clover oversown on the trial area.

As a result of these experiences all trial areas have been topdressed with 7 lb. copper and 7 lb. zinc per acre. Muriate of potash is applied to fertilizer trials to avoid potash becoming a limiting factor.

WATER SUPPLY

Irrigation water is pumped direct from Lake Alexandrina. The salt level of the lake water varies from 14 to 45 grains per gallon. The highest salt level met with to date was 60 grains per gallon in 1957, following the 1956 flood.

PUMPING AND IRRIGATION EQUIPMENT

Two 4 in. Harland SSB4 pumps driven by a 22 h.p. electric motor are used for pumping. The pumps are used in parallel for flood irrigation and deliver 40,000 galls. per hour at low pressure.

For spray irrigation the pumps are used in series and deliver 22,000 gall. per hour at 50 lb. p.s.i. pressure.

Four inch aluminium and galvanized fluming is used for spray irrigation. Both high output and low output sprinklers are used.

An 8 in. concrete main supplies water to the flood irrigated section. The main reduces to a 6 in. concrete pipe for the supply of spray irrigation water to the far end of the block.

The total head against which water must be pumped when flooding approximates 45 ft. Total head when spray irrigating varies with the number and position of spray lines being used. However, the maximum head is between 110 ft. and 120 ft.

Before January, 1959, the pumps were powered by a Diesel engine. Although the electric motor is more costly in terms of power, it has reduced maintenance costs, increased convenience and overcome the long periods of inactivity due to mechanical failures. The latter is of extreme importance in experimental irrigation.

IRRIGATION PRACTICE

Flood irrigated lucerne is watered every three weeks and flood irrigated pasture watered every fortnight throughout the irrigation season. The average watering per flooding is 4 in. per acre, but this varies slightly, according to the amount of pasture cover on the bays.

Spray irrigated lucerne receives approximately 3 in. of water per acre every fortnight.

To maintain good growth of permanent pasture mixtures and fodder crops under spray irrigation a watering of 2 in. every 10 to 12 days is needed. In hot summers weather this needs to be increased to 1½ in. every 5 to 7 days. In all it takes 30 in. per acre per year to maintain adequate lucerne and pasture growth.

PASTURES

Lucerns is sown in autumn at 15 lb. per acre. Good stands have been established with 12 lb. seed per acre under ideal conditions.

Due to the prevalence of strong winds in autumn and spring and to the sandy nature of the soil, a cover crop of oats or barley is needed. Sown at 20 lb. to 25 lb. per acre two to three weeks before the lucerne is sown, this cover crop gives good protection against drift and "sand-blast". Good results can also be obtained with cereal rye.

Under good management lucerne will yield 7 to 9 tons of hay equivalent per acre per year.

Rhodes grass was sown with the lucerne in the early years at 4 lb. per acre. Although the first year production was good it did not persist under grazing, due to the crowns being exposed to frost in winter.

Cocksfoot and phalaris were also sown with lucerne at 4 lb. per acre, but did not improve the production of the lucerne or persist well.

Early pasture mixtures included phalaris, cocksfoot, timothy, Clunes perennial ryegrass, short-rotation ryegrass, Kentucky blue grass, red clover, New Zealand white clover and O'Connors strawberry clover.

After a short while under grazing the mixture was mainly perennial ryegrass, short-rotation ryegrass, cocksfoot phalaris and white clover.

As a result of this experience these are the species sown in pasture mixtures at present, with the addition of Palestine Strawberry Clover.

Paddock H is the only original pasture remaining and is worthy of inspection.

A 5 to 6 weekly grazing rotation on lucerne and a three weekly rotation on pasture mixtures have proved to be satisfactory in maintaining a productive sward. A maximum grazing period of 5 days (depending on growth and stocking rate) is suitable in the grazing of lucerne.

Experimental pastures are grazed on a 1 week on 3 weeks off rotation.

FLOOD V. SPRAY IRRIGATION

The actual irrigation costs at Milang are not of much interest commercially. The existing plant is peculiar, in that it is designed to handle both flood and spray irrigation and has a higher capacity than normal to enable it to handle experimental watering quickly.

However, the relative costs of flood and spray irrigation show interesting features:-

* With small bays and a large flow of water for flooding, labour costs are similar.

* Depreciation and interest on capital are higher for spray irrigation. However, this disadvantage is partly offset by the extra cost of maintaining check-banks and channels with flood irrigation.

* Pumping costs are cheaper for flood irrigation, but some of the extra efficiency is lost because more water must be used, i.e., 800,000 gall. as against 660,000 gall. per acre for spray irrigation.

Generally speaking, the Milang soils are better suited to spray irrigation. Bays must be kept small to avoid excessive water usage, check banks are difficult to maintain under grazing, and channels erode and get deeper each year.

WHAT'S BEHIND THE EXPERIMENTAL PROGRAMME?

I. FODDER PRODUCTION

The first phase of the experimental programme was designed to investigate methods to increase fodder production and reduce costs.

Where soils are suitable lucerne production presents few problems. Its summer production is good and its use of irrigation water fairly efficient.

Perennial pasture production presents many problems. The main problems are listed below:-

1. During the irrigation season permanent pastures produce only 2/3 the volume of fodder that lucerne will produce.
2. Peak production occurs in spring when feed supplies are already adequate in the higher rainfall areas.
3. Production tails off and pastures tend to be clover-dominant in mid-summer when most of the water is being applied and irrigation costs are high.

4. Production costs are higher than for lucerne due to the greater number of irrigations required to maintain reasonable growth.

5. No reliable date is available in Southern Australia on the most desirable irrigation frequency, the effects of fertility level on water economy, methods of predicting irrigation requirements and the general economics of pasture production.

6. Much of the States fodder irrigation area is devoted to perennial pastures, and much of the potential irrigation area is unsuitable for lucerne production.

Because of these problems the experimental programme at Milang has been designed along the following lines:-

1. Species Studies

Investigations to determine which perennial grasses could replace perennial ryegrass as the main grass component of an irrigated pasture mixture, to boost summer production.

A range of new white clovers and lucerne strains have also been tested to determine if any are superior to the strains that we are now using.

2. Fodder Crops

A wide range of fodder crops are being tested to observe their seasonal production, and to determine their usefulness as a supplementary fodder to pastures to boost green feed production in lean periods.

3. Irrigation frequency and nitrogen fertiliser studies

An experiment was designed to give information on the following:-

(a) To determine the irrigation frequency that will give the most economic level of pasture production.

(b) To determine the effect of nitrogen fertilisers on -

(i) Total pasture production
(ii) Production per unit of water applied
(iii) Pasture Composition

(c) Assessment of the different types of pasture produced using the live weight gain of store lambs as a yardstick.

(d) Methods of measuring moisture stress, water usage and predicting irrigation requirements.

II PASTURE UTILISATION

Once a fodder is grown the next and most important phase is to turn it into hard cash. Efficient utilisation and economic success are dependent upon good stock husbandry, and pasture management.

An understanding of problems such as the best stocking rate, parasite control, quality, the feed and the seasonal growth of fodders play a leading role in determining success or failure.

The Milang block is not large enough to run comprehensive experiments in this field, and no dryland run off is available. However where possible small plot trials have been conducted to throw some light on a few of the utilisation problems.

Examples are as follows:-

(a) The possibilities and profitability of producing out of season fat lambs on irrigated pasture and lucerne.

(b) The effect of stocking rate and rotation on the productivity of lucerne and the liveweight gain of both store lambs and suckers.

(c) Comparison of rotational grazing, crop grazing and set stocking of lambs on pastures.

(d) Seasonal production and protein content of lucerne.

SPECIES INVESTIGATIONS

PERENNIAL GRASS EXPERIMENTS

Background

The ryegrasses are the main grass components used in perennial pasture mixtures in Southern Australia.

Their main feature is an autumn-winter-spring growth pattern. Peak production occurs in spring. Flowering takes place in the November-December period. This gives rise to a post flowering dormancy period in late December-January resulting in poor growth. High summer temperatures also suppress growth during the December-February period.

This growth pattern causes total pasture production to reach a peak in spring. In mid-summer production is relatively poor and pastures become clover dominant.

In an endeavour to find a more suitable perennial summer growing grass 30 grasses were tested in a pilot trial in 1957-58. This trial made it possible to discard some species and enabled the limited resources available to be concentrated on the more promising ones.

Consequently a new experiment was sown in spring 1960.

Objective of Experiment

To find a palatable summer producing grass that would:-

1. Replace perennial ryegrass as the main grass component in pasture mixtures.
2. Boost summer production and assist to overcome clover dominance.

Design of Experiment

Balanced lattice square. 16 treatments x 5 replicates. Plot size 9' x 9' = $\frac{1}{537}$ acre

Treatments

The following grasses were sown with New Zealand White Clover.

1. N. Z. Perennial Ryegrass
2. N. Z. H. I. Ryegrass
3. Kangaroo Valley Ryegrass
4. 526 Cocksfoot
5. Currie Cocksfoot
6. Phalaris tuberosa
7. Phalaris davesii
8. Ronpha grass (Phalaris tuberosa x arundinacea)
9. Alta fescue 5170
10. Bromus inermis 17588
11. " " 7073
12. Phalaris arundinacea (commercial)
13. " " 24306
14. Rhodes grass (comm.)
15. Rhodes grass (NZOIA strain)
16. Rhodes grass (Katambora strain)

Plots were harvested with the autoscythe.

At each harvest a sub sample was taken for dry matter determination and separation into sown grass and clover.

Four harvests were taken in the 1961-62 season and nine harvests at approximately five weekly intervals during the 1962-63 season.

SUMMARY OF

RESULTS 1961-62

TABLE I GRASS PRODUCTION - lb d.m. per acre

	1st Harvest 3/1/1962		2nd Harvest 21/3/62		3rd Harvest 9/5/62		
Grass	lb/acre d.m.	% increase	lb/acre d.m.	% increase	lb/acre d.m.	% increase	Total lb/ac
Perennial Ryegrass	670	-	510	-	490	-	1670
H.I. Ryegrass	460	-	560	9.8	350	-	1370
Alta Fescue	990	47.8	780	52.9	580	18.4	2350
S26 Cocksfoot	1190	77.6	850	66.6	380	-	2420
Phalaris arundinacea	1220	82.1	820	60.8	420	-	2460
Rhodes commercial	1490	122.4	2730	435.3	910	85.7	5130
Rhodes NZOIA	920	37.3	2380	366.7	630	28.6	3930

RESULTS 1962-63

TABLE II GRASS PRODUCTION - lb d.m. per acre

Date	15/1/63		26/2/63		26/3/63		
Grass	lb/acre d.m.	% increase	lb/acre d.m.	% increase	lb/acre d.m.	% increase	Total lb/ac
Perennial ryegrass	320	-	627	-	221	-	1168
H.I. Rye-grass	370	15.6	876	40.0	246	11.3	1492
Acta Fescue	427	33.4	1108	76.7	423	91.4	1958
S26 Cocks-foot	440	37.5	882	40.6	160	-	1482
Phalaris arundinacea	665	108.0	692	12.0	102	-	1459
Rhodes commercial	510	59.4	1022	63.0	372	68.3	1904
Rhodes NZOIA	423	32.2	863	37.6	357	61.5	1643

The main features of the results are as follows:-

1. Rhodes Grasses

The production of commercial Rhodes grass was outstanding in both 1961-62 and 1962-63 over the period mid December-April. The NZOIA strain also performed particularly well during the same period. While its production was lower than the commercial strain the results are of particular value as NZOIA is a more leafy plant and is likely to be more palatable.

Phalaris arundinacea

This grass was 60-100% better than perennial ryegrass in the December-February period.

Its autumn-winter-spring production however is poorer. Its main value appears to be in extending the spring flush well into January. However Phalaris arundinacea may not be as palatable as one would like.

Commercial seed supplies are available.

S26 Cocksfoot

Cocksfoot produced 38-80% more feed than perennial ryegrass in the January-February period. Its production was better under the infrequent cutting management used in the 1961-62 season.

While not spectacular it is still a useful summer growing grass.

Alta fescue S170

Alta fescue produced well throughout the experiment. Its winter-spring production was not quite as good as perennial ryegrass - but throughout the summer especially in the January to March period production was good.

It is interesting to note that five grasses listed in the tables outproduced perennial ryegrass in terms of total summer production in both years.

PERENNIAL CLOVER EXPERIMENT

Background

The legume investigational programme was stimulated by favourable reports of Ladino clover growth on the Riverina and by the availability of new lucerne and white clover strains from the Plant Introduction Section of C.S.I.R.O. Canberra.

A small plot experiment was sown in the spring of 1960.

Objectives of experiment

To test new varieties and strains of white clover and lucerne to establish if any of the new material available was superior to plants at present in use.

Design of Experiment

Randomised block = 15 treatments x 3 replicates.

Treatments

White Clovers

1. CPI 13818 Lebanon
2. " 19433 Algeria
3. " 19434 "
4. " 19438 Portugal
5. " 18738 Kersey
6. " 24266 Pilgrim
7. New Zealand
8. Victorian Irrigation
9. Commercial Ladino
10. Californian Ladino

Various

11. Palestine Strawberry Clover
12. Siratro
13. Hunter River Lucerne
14. African Lucerne
15. Hairy Peruvian Lucerne

All legumes were sown as pure stands.

Seven harvests were taken during the 1961-62 season and 10 harvests at approximately 5 creek intervals during the 1962-63 season.

SUMMARY OF RESULTS

White Clovers showing promise of improved summer production

Harvest Date	10/1/62	28/2/62	10/4/62	Total
Clover	Lb. d.m./ac.	Lb. d.m./ac	Lb dm/ac	Three harvests
N.Z. White	1880	2440	1970	6290
Victorian Irrigation	2220	2180	1890	6290
Commercial Ladino	2630(1)*	2980(2)*	1940	7550
Pilgrim Ladino	2220	3070* (1)	2240* (1)	7530

The standard white clover, New Zealand white and Victorian irrigation clover, while varying slightly in seasonal production showed no differences in total production.

Both Commercial Ladino and Pilgrim gave a higher total yield during the summer.

Commercial Ladino was superior in the December-January period and Pilgrim showed promise in the February to April period.

White Clovers showing promise for autumn-winter early spring production

Harvest Date	16/8/61	29/5/62	31/7/62	28/5/63	
Clover	lb dm acre	lb dm acre	lb dm acre	lb dm acre	Total
Victorian Irrigation	2120	940	1040	960	5060
Algerian 19433	2720	1200	1010	1160	6090
Portugal	2160	1190	1360	1111	5821
Palestine Strawberry	1840	830	1180	880	4730

Algerian 19433 showed up to advantage throughout the trial during the autumn and mid winter months.

The Portugal strain had a similar growth pattern and both clovers outyielded Victorian Irrigation and Palestine Strawberry Clover on most occasions during the autumn - winter periods of the trial. Results are promising enough with these new mediterranean clovers to warrant further testing under grazing.

FODDER CROP INVESTIGATIONS

Background

The permanent pasture production curve has pronounced troughs. Production is very low in the May-July period and is lower than it should be in mid-summer.

Lucerne overcomes the mid-summer drop in production in areas where it can be grown. However where soils are unsuitable the farmer must rely on annual fodder crops or conservation to overcome feed shortage.

Objective of Experiments

To determine the potential production of a range of fodder crops during the autumn-winter and in the late spring-summer period.

Design and Methods

Small replicated drill strip trials are sown in a randomised block layout.

Cuts are taken at strategic intervals to determine dry matter production.

Experiments commenced in 1959. To date three summer fodder crops and one autumn-winter fodder crop experiments have been completed.

SUMMARY OF RESULTS

AUTUMN-WINTER FODDERS

TABLE I

Crop	1st Harvest 21/5/63		2nd Harvest 17/7/63	
	Lbs d.m. per acre	d.m. /acre per day 70 days growth	Lbs d.m. per acre 127 days growth	d.m. /acre per day
N.Z. Rape	2120	30.3	4390	34.6
Yarloop	1080	15.4	2040	16.1
Chou	1300	18.6	4300	33.9
Noyep	3800	54.3	3740	29.5
Clare	1370	19.6	1930	15.2
Berseem	1020	14.6	2230	17.6
Turnips	3590	51.3	7350	57.9
Oats	2930	41.9	6180	48.7
Italian Rye	1880	26.9	3020	23.8
Rape	2630	37.6	5160	40.7

L.S.D. 5% 740 lb/acre L.S.D. 5% = 1660 lb/acre

1st Harvest

Turnips, Oats and Rape were the outstanding fodders. As a comparison mixed pasture during May was producing 25 lb. d.m. per acre per day. The yield of Noyep barley is high - but it was worthless as a fodder as it came into head.

2nd Harvest

Turnips, Oats and Rape were again the best fodders and Chou also was beginning to show up. Pasture production in June-July period was 16-20 lb d.m. per acre per day.

The 1963 autumn was unusually wet and cold and further data is required before recommendations can be made.

SUMMER FODDER CROP TRIAL 1962/63 - Sown 6/12/62

TABLE II

Crop	1st Harvest 22/1/63 47 days growth		Final Harvest 19/2/63 75 days growth	
	lbs d.m. per acre	d.m./acre per day since 6/12/62	lbs d.m. per acre	d.m./acre per day since 6/12/62
Sudax	5490	117	13581	181
Millet	5437	115	12620	168
S. almum	4588	98	10375	138
Turnips	4365	93	10780	143
N.Z. Rape	3718	80	9413	125
Essex Rape	3411	72	8524	113
Sudan Grass	2590	55	9416	125
Chou	1957	41	5931	80
Pasture	-	60	Pasture	50

L.S.D. 5% = 850 lb/acre

L.S.D. 5% = 226 lb/acre

SUMMER FODDER CROP TRIAL 1963/64
Sown 27/11/63

TABLE III

Crop	1st Harvest 29/1/64	
	lbs d.m. per acre	d.m. per acre per day 63 days growth
Maize	4314	68.5
Millet	4245	67.4
Turnips	3755	59.6
Rape	2397	38.0
S. almum	1750	27.8
E. Orange	1403	22.3
Saccaline	1128	17.9
Chou	936	14.9
Sudax	828	13.1

In the 1962/63 trial, Sudax, Millet, Sorghum Almum, Turnips, and Rape produced particularly well throughout the December - late February period. Some crops produced at double the rate of pastures.

However in the current trial overall production has been poor. Millet and Turnips have produced quite well but Sorghum Almum and Sudax have been disappointing.

Poor establishment and cool weather were the main factors affecting the yield of Sorghums in the current trial.

Millet, Turnips and Rape have given the most consistent results for the December-January period to date. Further work is needed especially on the feed value and utilisation of summer fodders.

IRRIGATION FREQUENCY X NITROGEN EXPERIMENT ON A PERMANENT PASTURE MIXTURE

Objectives of Experiment

1. To obtain basic information on the effect of irrigation frequency, and nitrogen application on:-

   (a) Total pasture production
   (b) Pasture composition
   (c) Protein content and nitrogen recovery in the pasture
   (d) Root distribution and water extraction from the soil
   (e) Water usage or water economy
   (f) Changes in soil fertility

2. To establish as closely as possible from the data obtained the level of irrigation that will give the most pasture production at the lowest cost.

3. To assess various methods of predicting irrigation requirement, e.g. Tensiometers, estimates based on climatic data.

4. To assess the value of the various experimental pastures produced in terms of the performance of store lambs.

Design of Experiment

Randomised Factorial.

3 levels irrigation x 3 levels N application x 4 replicates = 36 plots

Plot size $^{1}/_{6}$th acre

Treatments

Irrigation	Nitrogen
W1 Low Watering Frequency (Approx. 180 pts loss from soil)	No Nitrogen
W2 Medium Watering Frequency (Approx. 120 pts loss from soil)	X 440 lb Ca. Amm. Nit. /acre (98 lb. N) per irrigation season
W3 High Watering Frequency (Approx. 60 pts loss from soil)	1440 lb. Ca. Amm. Nit. /acre (295 lb. N) per irrigation season

Methods

(i) Irrigation treatments are based on moisture stress as measured with tensiometers installed at 3", 6", 9", 12", 21" and 28" under each pasture plot in Block I.

(ii) Fertiliser Calcium Ammonium nitrate is applied at fortnightly intervals from late October-April. Adequate Super and Potash are applied to all plots to ensure P and K are non-limiting.

(iii) Grazing The plots are rotationally grazed on a 1 week on 3 weeks off basis.

Stocking rate is adjusted to feed availability on each treatment in an attempt to get even grazing pressure over all treatments.

(iv) Stock Two groups of store lambs are fattened per irrigation season. 1st group October-January. 2nd group January-April.

From April-October young ewes are carried and sold as breeders in October.

Liveweight gain, carcass weight and grade are recorded on all lambs - fattened.

(v) Herbage production. Pasture cuts are taken from the caged areas after the sheep have grazed the plot. Samples are taken for dryweight determination. Nitrogen analysis and separation into grass and clover.

SUMMARY OF RESULTS

The experiment does not reach completion until the end of this season and all data is not yet available. However interim results are as follows:-

Total production

1. Over 12 months in 1961/62 the worst plot yielded 16,000 lb d.m./acre and the best 19,000 lb d.m./acre. In 1962/63 the figures were 14,000 lb and 17,000 lb d.m. per acre respectively.

Yield figures on pastures in the Hills indicate a production of 11,000 lb d.m./acre and on the Murray Swamps 13,000 lb d.m./acre.

It is apparent that many irrigated pastures in the State are producing well below their potential.

2. Pasture production rises with increasing irrigation frequency. During the 1961/62 and 1962/63 season the W_2 treatments showed a 14% increase and the W_3 treatment a 20% increase in production over W_1.

These increases are larger when N is applied.

3. A nitrogen response was achieved at all watering frequencies. However nitrogen response varies with watering frequency. The best response to 440 lb C.A.N. was obtained at the medium watering frequency whereas the best response to the heavier application was obtained at the W_3 level of irrigation. Overall N responses were poor as one would expect in the absence of a vigorous summer growing grass.

4. The application of nitrogen compensates for less frequent irrigation (or moisture stress). In practice this means there could be a choice between applying nitrogen or paying labour to move spraylines more often.

Pasture Composition

1. Where no nitrogen is applied increased watering frequency increases the clover percentage of the pasture.

2. Increasing nitrogen application reduces the percentage of clover in the pasture at all levels of irrigation.

3. Nitrogen application improves the efficiency of water usage.

Water Extraction Patterns

The way in which pastures extract moisture from the soil appears to vary with the weather.