Eastwood Report

Sheep production on buffel grass pasture. The 'Eastwood' grazing trial, 1967-1982.

Queensland Government

This publication has been compiled by Richard G. Silcock, Emeritus Researcher, Department of Agriculture and Fisheries.

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Forward

I congratulate Dr Richard Silcock and colleagues (all in retirement) for compiling a wealth of information on the Eastwood grazing trial some 40 years after the trial concluded. The Eastwood grazing trial ran for 15 years from 1967 to 1982 on 55 ha of buffel grass (*Cenchrus ciliaris L.*) pasture sown into cleared gidyea shrubland on the Gall family property south of Blackall. It sought to quantify the productivity and persistence of this relatively new form of improved pasture for the sheep industry in central-western Queensland. While parts of the Eastwood grazing trial have been reported previously in various reports and papers, this is the first time all the results and observations have been compiled in one document.

The scale and duration of the Eastwood grazing trial brought together a large team of specialists. Richard acknowledges the contribution from agrostologists, animal production researchers, chemists, biochemists, wool technologists, stock inspectors, biometricians and extension specialists. Eastwood, and other grazing trials that followed, provided an excellent platform to develop new staff, introducing them to new people, research skills and environments. Importantly, they also introduced staff to the complexity of livestock production systems characterised by landscape, seasonal and price variability.

Following Eastwood, the department established grazing trials in most of the major native pasture communities in Queensland (Arabella, Burenda, Toorak, Galloway Plains, Albilbah, Politic, Keilambete, Glentulloch, Wambiana, Pinnarendi). Each had different objectives, addressing questions ranging from impacts of stocking rate, improved grasses, legume oversowing, livestock supplements, burning and herbicide treatments on pasture yield, composition and plant dynamics, animal production, water quality, soil loss and economics.

A characteristic of these grazing trials is that most were conducted on privately owned properties in collaboration with willing property owners. The Gall family at Eastwood is a good example, where a rapport with local graziers was established, providing research and extension officers a close connection to the insights of experienced land managers.

Grazing trials also benefited from the long-term support from both the department and the various rural research development corporations of the day. While at times the treatments and research techniques were altered, the trial sites themselves provided a robust research base on which other studies were often layered. The Eastwood trial site and the other grazing trial sites were important for demonstrating sound grazing land management principles, with stark fenceline contrasts between treatments in certain seasons. The excellent colour slides from the 1960s and 1970s Richard has scanned and included on the cover page and pages 11 and 21, provide a clear visual story on Eastwood. These images are supported by the pasture and animal production results.

Over the last 30 years, the results from multiple long-term grazing trials have been re-examined in computer modelling studies (or “black boxes” as Richard describes) using the GRASP pasture growth model developed by Greg McKeon and colleagues. This work has drawn out the key relationships between climate, pasture production, animal production, landscape stability and financial performance across a range of production environments and seasonal conditions. This work has also reinforced the key principles underpinning sustainable grazing land management that continue to be applied across northern Australia today.

Thank you, Richard and colleagues for drawing together in one document the weather, pasture and animal production data from the Eastwood grazing trial so that it remains available for further analysis, complementing the published data from other long-term grazing trials and the long-term grazing trials that remain operating today.

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Abstract

This research project, coded Bkl P50 WR, ran for 15 years (1967-1982) to document the productivity and persistence of buffel grass (*Cenchrus ciliaris* L.) pasture sown into cleared gidyea shrubland in central-western Queensland. It was initiated when little objective data existed about the potential of such pasture on this newly developed country. Merino sheep were used as the grazing animal at stocking rates between 10 and 1.25 sheep/ha. Data collected concentrated on pasture yield and crown cover, pasture Nitrogen and Phosphorus content, sheep liveweight, wool growth and quality, fleece weight, faecal protein and phosphorus, and intestinal worm burden. Other data was collected on oestrus cycling in young ewes and the effect of differing grazing pressure on their conception rates. Seasonal conditions ranged from very dry to very wet at different stages and there were four distinct research phases which are reported separately.

Buffel grass proved highly productive and resilient under the grazing pressures applied and at least as productive as the highly regarded, local Mitchell grass country. However, sheep weight loss was common in winter after the grass was frosted. Optimal sustainable stocking rate was slightly greater than 2.5 Dry Sheep Equivalents (DSEs) /ha. The pasture lacked botanical diversity unless heavily overstocked when ephemeral herbs became common. No unexpected problems arose from the conversion of the gidyea scrub to open grassland. Woody regrowth was ever-present, particularly false sandalwood (*Eremophila mitchellii*), but did not seriously impinge on productivity in the pasture's first 20 years since clearing.

In light of the results, the use of buffel grass pastures in the region for cattle, goats and mixed species grazing is discussed. Potential long-term issues, both environmental and rural industry-related are discussed.

Prologue

This report, compiled decades after the research work ended, attempts to document publicly and extensively, a large sheep grazing trial that forms the basis of many computer decision packages that relate to the productivity of buffel grass pastures of central western Queensland. The data underpinning current modelling of that land type needs to be publicly available for future generations to use and to build upon at any time instead of being inside modelling ‘black boxes’.

Many people participated in this lengthy study and, as readers will see, that longevity brought with it complications that make publication of some data in modern scientific journals challenging. The study was instigated with the generous financial support of the Australian wool industry via the Wool Research Trust Fund and the backing of Dr George Moule, Dr Joe Ebersohn (Agriculture Branch) and Mr John Gibb (Sheep and Wool Branch). Onsite, the drive came from Blackall DPI staff led by Mr Graeme Payne (Senior Sheep Husbandry Officer, 1967-75) and Mr Graeme Lee (Senior Pasture Agronomist, 1967-69) with the generous support of Messrs W.C. and C.W. Gall of ‘Eastwood’ station, Blackall. ‘Eastwood’ provided the essentials – the pasture, the sheep, the shearing shed and the water supply at nominal cost to the project, with plenty of free labour as well.

Image 1 General impression of the 'Eastwood' trial's appearance and contrasts in June 1968. There is a similar mob of sheep in the distance in both paddocks, one in the heavily grazed paddock, the other adjacent but almost hidden in the tall, lightly grazed buffel grass pasture.

After the trial had been underway for a few years (Image 1), other DPI staff took over from the two Graeme's to keep the study going so that the real long-term productivity of the new buffel grass pastures on cleared gidyea country could be determined. Many technical assistants provided support and labour to the project leaders, particularly Charlie Nolan (Sheep and Wool technician) in the first 5-6 years. The other leaders of research discipline components were Agrostologists Richard Silcock (1969-70), Gavin Graham (1970-72) and David Orr (1972-82), and Sheep Husbandry Officer Noel O'Dempsey (1974-82). Other technical staff who provided onsite support were John E. Anderson (Stock inspector), David (Ed) Holmes (Sheep and Wool advisor), Gerry Roberts (Sheep and Wool officer) and Chris Evenson (Agrostology technician). Special acknowledgement must be given to numerous staff in the DPI Wool Biology Laboratory, Yeerongpilly, who tested hundreds of faecal samples for intestinal worms and assessed over 1000 fleece samples for their quality. The Biochemical Section at the Animal Research Institute, Yeerongpilly, analysed hundreds of faecal samples for crude protein and phosphorus content and the DPI Agricultural Chemical Laboratories were also asked to analyse numerous forage samples for nitrogen and phosphorus content and also some blood samples. DPI Biometricians Ms E.A. Goward, Ms J. Tommerup, Mr P.K. O'Rourke and Mr R.J. Mayer 'crunched the numbers' to confirm statistically important outcomes.

Thus, this report is prepared in 2020 with full acknowledgement of the immense effort and resources required to gather the results reported here and with thanks to many of the chief participants who have provided comments on draft versions. This report is structured around the four research phases of the work plus an opening section to explain the project's genesis and a summary that analyses the outcomes of the entire study and their implications more broadly to rural industry and the environment today in central western Queensland. Figures, tables and images are numbered sequentially.

Introduction

Enhancement of the value of animal production from pastoral land is a universal ambition. Traditionally this has been achieved by removing serious competition from woody vegetation and by planting pasture species that provide more nutritious fodder, if that is feasible. In the rangelands of the world, the option of sowing better forage species that persist has proven very elusive and the removal of dense woody vegetation is often uneconomic and sometimes seriously harmful to the landscape (Williams *et al.* 1997; An *et al.* 2008; Butler 2012). In much of Queensland, property improvement via land clearing was mandatory for many people granted leases over Crown lands in the 20th century up until the 1980s (Qld Times 1953). This often resulted in long term gains for pastoral businesses that survived but the range of forage species available to potentially replace the native species in lower rainfall districts has been quite limited, despite 150 years of endeavours. When the natural vegetation is a dense tall shrubland where very little herbage can grow beneath (Western Champion 1936), finding a sustainable pasture system to replace it after clearing is challenging because the changes involved are huge and potentially complex.

Image 2 Typical look of virgin gidyea scrub in the central west before development

That challenge arose in Queensland with the brigalow (*Acacia harpophylla*) and gidyea (*A. cambagei*) shrublands. The area of these acacia shrublands was huge, some 10% of the state (Qld Govt 2017), so the incentive to make them more productive was enormous. Before about 1940, the brigalow lands were regarded as too dense and subject to prolific regeneration from root suckers to warrant appreciable development. Prickly pear (*Opuntia stricta* (Haw.) Haw.) had also overrun many wetter areas until the *Cactoblastis* moth was introduced to largely control it by 1935. Gidyea scrubs had high potential (Everist 1951) and the advantage of not root-suckering and ringbarking resulted in good animal production afterwards in most areas (Western Champion 1936). However, ringbarking the densest gidyea scrubs was a slow, expensive exercise even in the early 20th century. After World War Two, large machinery became readily available that was capable of flattening the timber at a realistic cost. The Government sponsored Brigalow Land Scheme of the 1950s and '60s saw huge areas of brigalow country cleared and sown to 'promising' pasture species such as Rhodes grass

(*Chloris gayana*), green panic (*Panicum maximum,* now *Megathyrsus maximus*), blue panic (*P. antidotale*), sorghum almum (*Sorghum X almum*), sabi grass (*Urochloa mosambicensis*) and buffel grass (*Cenchrus ciliaris*) (Rockhampton Bulletin 1954). Phasey bean (*Phaseolus lathyroides*, now *Macroptilium lathyroides*) was about the only complementary legume that showed any promise initially as an option towards developing the sustainable, mixed pasture that was theoretically needed for these pastures.

Image 3 Typical barren understorey of a gidyea scrub on quite fertile clay soil

Less ambitious land development was envisaged for the drier gidyea lands but the general trend for closer settlement and excision of blocks from large holdings (Courier Mail 1934) saw much of the gidyea country burdened with mandatory requirements to clear big tracts of the scrub (Warwick Daily News 1950; Qld Times 1953). History shows that perennial pastures were developed for the brigalow lands after ways to control suckering and regrowth were developed and, thereafter, *Bos indicus* cattle performed satisfactorily. Buffel grass became the predominant pasture grass sown and it was productive on the ash-beds created after burning the pushed scrub (Hall 2000). The predominant underlying soil was a relatively fertile clay with high water-holding capacity and the appreciable salinity in the subsoil seemed not to present serious issues of dryland salinity. Experience has shown that buffel grass's salinity tolerance (Graham and Humphreys 1970) was a factor in its success in the 600-700 mm MAR zone where brigalow scrubs predominated. There were many smaller technical issues to be tackled to improve the profitability of those cattle enterprises that dealt with better species and cultivars of legumes, better animal genetics and better husbandry methods, but they were steadily addressed by industry and government research.

The question then was, could this success, particularly with buffel grass, be transposed further west into the gidyea scrubs that grew on similar soils, had very similar natural vegetation structure but were in a lower rainfall zone (450-550mm) and was in sheep-raising country (Images 2 and 3). Preliminary studies in the 1950s by Marriott (1954), Edye *et al.* (1964) and others indicated it could although searches for the most suitable buffel varieties and with alternative species such as sabi grass and blue panic continued apace (Project Bkl P13 WR, Purcell unpublished). CSIRO invested huge resources into tropical pasture science in Queensland during the era. Uptake of the technology by an economically buoyant wool industry was rapid and early successes were widely reported (Marriott and Anderssen 1953; Longreach Leader 1954; Humphreys 1957; Bisset 1963).

Image 4 The near-perfect goal of pasture development of gidyea country – verdant pasture.

By about 1965 some 300,000 hectares of gidyea scrubs in central western Queensland had been pulled with chains between bulldozers and sown, predominantly to buffel grass (Purcell 1965; Image 4). The major varieties available commercially then were West Australian, Gayndah and Biloela. At that time, it was unknown how productive the new buffel pastures would be and how persistent they would become (Qld Country Life 1951; Marriott 1955). The cost of creating them was high, the seasonal variability of rains and frosts was high but known (Image 5), and the comparison with the highly regarded Mitchell grass downs that adjoined much of the gidyea country and required no expensive timber clearing, was closely scrutinised.

Image 5 Similar healthy sown buffel pasture but in a dry time many months after the last rain

The Mitchell grass downs were proven lands for breeding merino sheep (Townsville Daily Bulletin 1936) and growing high quality wool (Skerman 1958) but there was an apprehension that the new buffel pastures lacked the diversity of herbaceous species that reputedly fostered higher lamb markings percentages and good wool growth from Mitchell grass pastures in average seasons (McMeniman *et al.* 1986; Orr *et al.* 1988). In response to that situation, the Australian beef and wool industries and the Queensland government decided to invest in some large, expensive grazing studies to provide objective data that would help determine the answers to those questions. Theories and anecdotal information had to be rigorously tested.

So, in late 1966 steps were taken to set up a scientific experiment to answer the following questions for the sheep and wool industry about buffel grass pastures sown into gidyea country:

1. What rate of liveweight change can be expected from sheep over a range of seasons?
2. How much wool growth occurs and of what quality?
3. How much pasture and of what quality do grazed buffel grass pastures provide under a range of stocking rates over the range of seasons expected?
4. How stable are the buffel pastures under a range of stocking rates?
5. What is an optimal stocking rate for the buffel pastures?
6. Are there unforeseen issues to be addressed that differ from those that routinely arise on Mitchell grass country, such as greater intestinal worm burdens, poorer reproductive performance, more wool contamination or poorer quality wool?

Image 6 Ewes in the 'Eastwood' trial in autumn 1968, 16 per paddock.

Results for beef cattle on brigalow lands were published (Walker *et al.* 1987; McLean and Ternouth 1994; Radford *et al.* 2007) but the results for sheep and wool production have largely remained in unpublished archives or in the 'black boxes' of computerised models of pasture growth and animal performance. The GRASP soil-water, pasture-growth simulation model (McKeon *et al.* 1982) is widely used in northern Australia and derives many of its animal production equations from such studies which are used to produce the output for widely used programs such as AussieGRASS (Carter *et al.* 2000).

At this time, Mitchell grass downs in the Blackall shire were rated to sustainably carry 1 sheep/ 3 acres (1.21 hectares) in the long term (Courier Mail 1937; Rockhampton Bulletin 1949) and for the sheep to cut an average of about 3.5 kg of greasy wool per year (Longreach Leader 1941). Those pastures were estimated to grow 1500 kg DM/ha/yr on average and for presentation yields to exceed 2000 kg/ha in good years (Davies *et al.* 1938; Orr 1975; Lorimer 1978).

The original thinking behind the trial design was that breeder sheep should be studied to avoid the need to extrapolate from dry sheep or to have to conduct further research to provide that data. Thus, the trial was stocked with ewes (Image 6) but the methodology of how to do the reproduction studies was not fully worked out before the trial commenced.

This Report summarises the results from every component of the trial, including attempts made to measure the effect of stocking rate on lambing percentages.

Materials and methods

The trial was conducted on about 55 hectares in a well-established, gently sloping buffel grass pasture on a commercial sheep enterprise 'Eastwood' about 27km south of Blackall, 24.6706°S, 145.4522°E, at 340m elevation with mean annual rainfall of about 490 mm (SILO 2018).

Figure 1 Trial site outline and some remnant fencelines from 2006 satellite image (Google Earth)

The original gidyea scrub on this part of the property was described from remnant shade lines by J.R. Mills (Division of Land Utilisation 1979) as Linden Land System which is typically an *A. cambagei* low woodland 6-7 metres high with scattered shrubs, mainly *Eremophila mitchellii* (false sandalwood), growing on deep brown or grey cracking clay soils (Ug5.3, Northcote 1965) derived from Cretaceous sediments (shales). That land type, Regional Ecosystem 4.9.11 in the current statewide categorisation system, originally occupied about 830,000 hectares in the region of which about 60% was cleared and sown to buffel grass (Queensland Government 2018) by the late 1960s.

Soil

The soil would fit within that described in Mills' 1979 report as Carlow series, namely slight gilgai development, sparse gravel cover, alkaline reaction, lime throughout the profile and gypsum accumulation at depth. The surface soil was non-saline but the subsoil at 80-100cm was probably saline. A soil sample (0-15cm) from the trial site taken in 1975 was described as brown clay with strong alkaline surface pH of 8.5, fair acid extractable Phosphorus of 37ppm and high extractable Potassium of 0.7 m.equiv%. Data from surveys of such gidyea land systems (WARLUS 2 1977; Turner 1978) indicate that these soils were non-saline, non-sodic and should have had a high cation exchange capacity of about 40 me/100g, high soluble salt levels at depth (Electrical Conductivity of >10 mS/cm below 50cm), chloride levels of around 0.15% at depth and potential available water capacity of about 20% in the surface layers. An adjacent uncleared shadeline had identical pH and a very similar chemical composition *albeit* with a higher BSES acid extractable P level of 97 ppm and nitrate nitrogen assay of 9 ppm compared to 3 ppm under buffel grass on the trial site at that time. With increasing soil depth, clay content at 'Eastwood' increases and sand decreases slightly (Table 1). In its natural state, very little herbaceous growth occurs under such dense gidyea scrubs (see Image 3) and consists of small chenopods supplemented by annual grasses in exceptionally wet summers. If cleared and not established to buffel grass, the principal early grass is often *Sporobolus caroli* (fairy grass).

Table 1 Components of soil texture in the upper soil profile at 'Eastwood'

	Component (%)		
Depth	Sand	Silt	Clay
0-2 in (0-5 cm)	53	15	32
2-8 in (5-20 cm)	47	12	41

Climate

In general terms, the climate at the site is semi-arid with very hot summers and cool winters with many frosts. Rainfall averages about 500 mm with most rain in summer, but appreciable rain can occur at any time of year under the influence of a range of atmospheric cloud and wind patterns. As a general guide, average rainfall data for the Blackall township 27km to the north is provided in Table 2 for the years 1880 to 2017 (BOM 2018). Any month can receive no rain but, within a calendar year, at least 136 mm (Aug 1886) or more fell in one of the 12 months for the 138 years of records and the most was 395 mm (Jan 2004). On average 'Eastwood' would receive about 470 mm a year with a top monthly median of about 60 mm in February down to a median of only 7 mm in September.

Table 2. Long term monthly climate averages for Blackall from the Bureau of Meteorology (2018).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean maximum temperature (°C)	36	35.1	33.7	30.3	25.8	22.7	22.3	24.6	28.5	32.2	34.7	36	30.2	1957-2001
Mean minimum temperature (°C)	22.4	22	19.9	16.1	11.8	8	6.9	8.4	12.1	16.5	19.5	21.4	15.4	1957-2001
Mean rainfall (mm)	83.7	81	62.6	35.8	32.7	26.7	24.8	16.5	19	32.7	42.8	69	529	1880-2017
Decile 5 (median) rainfall (mm)	56.6	60.2	34.6	15	18.3	15.7	12	8.3	6.9	21.1	28.6	54.2	470	1880-2017
Mean number of days of rain ≥ 1 mm	5.7	5.2	4.3	2.4	2.5	2.2	2.1	1.7	1.9	3.3	4.1	5.1	40.5	1880-2017

A summer month without rain is rare (12 times in 1560 months) but such winter months commonly occur, 136 times since 1889. Table 3 provides decile annual rainfall values calculated for Blackall Post Office rather than 'Eastwood' to minimise the amount of smoothing that is inherent in the kriged data calculated for the 'Eastwood' location from surrounding places (see Appendix 3). 'Eastwood' annual values are commonly 70 mm less than the equivalent Blackall ones although their median value was very close (3.6 mm difference near 475 mm) and dry decile 1 and 2 values differ by only 20-25 mm.

Table 3 Annual and seasonal rainfall expectations for Blackall based on data from 1889 to 2018 inclusive, 130 years. 'Eastwood' kriged data for a calendar year is shown for comparison

	'Eastwood'	Blackall Post Office		Blackall		Seasons
Monthly Rain (mm)	Year calendar	Year calendar	Year July-June	Summer Nov-Mar	Winter July-Sep	Cooler mths Apr-Oct
Maximum	1373	1331	1313	807	246	563
Minimum	177	185	157	58	0	9
Mean	472	529	530	343	59	188
Median	401	475	494	318	47	165
decile 1	272	293	286	159	7	63
decile 2	322	354	381	217	13	91
decile 3	341	403	426	255	23	114
decile 4	370	438	458	278	35	143
decile 5	472	475	494	318	47	165
decile 6	473	540	545	342	57	184
decile 7	546	615	582	377	73	217
decile 8	612	694	673	479	92	256
decile 9	725	789	820	579	132	345
Max year	2010	2010	1890-91	1889-90	1921	1920
Min year	1926	1926	1901-02	1892-93	1932, 1941	1946

Actual rainfall received during the project will be presented and compared later for each trial phase. More climate data for Blackall is contained in Appendix 1. Values are rounded to whole millimetres.

Blackall has historically averaged 6 frosts per winter (July-September) but up to 29 have been recorded in a year between May and September (2011 – see Appendix 1 and 2). In June-July 1982 there were 14 frosts in an 18-day period and in 2002, 18 frosts in 27 consecutive days. A frost has been defined as a screen temperature of 2.2°C or less. Very low minimums are rare with -3.3°C being the lowest ever recorded in Blackall and 'Eastwood' probably experiences similar absolute lows, being further south. Occasionally a winter will pass without a frost, usually in a wet winter, such as in 1973. Historically (1890-2018) frosts have only been recorded at Blackall between May and September with July the frostiest month closely followed by June and August. Those 3 months account for 94% of probable frosts based on screen minimums (SILO 2018). Such temperatures will kill all green buffel leaf and most upper stems and exposed axillary buds, but not its crown or roots.

Pasture history

The gidyea scrub on the trial site had been pulled in September 1961, burnt in November and sown to Gayndah buffel in December 1961. The amount of unburnt timber still lying on the ground in the late 1960s (Images 6 and 8) would indicate that the burn was not a particularly hot one. Modest summer rainfall followed allowing a good buffel grass pasture to establish which was then grazed regularly by sheep from the next winter until our trial was established in mid-1967. Thus, the trial site was a typical buffel pasture for the region (Silcock 2020) that had experienced two good rainfall years initially (575 mm in 1962 and 786 mm in 1963) while the rest were below average between 275 and 402 mm in the 4 years immediately prior.

Paddocks and Stocking rates

Four stocking rates were instigated in September 1967, 0.5, 1, 2 and 4 sheep/acre with 16 sheep in each paddock and with 2 replicates. Thus, paddocks were 32, 16, 8 and 4 acres in area (12.95, 6.47, 3.24 and 1.62 hectares respectively) which equates to stocking rates, rounded up, of 1.25, 2.5, 5.0 and 10 sheep/hectare. The layout of the 8 paddocks is shown below (Figure 2).

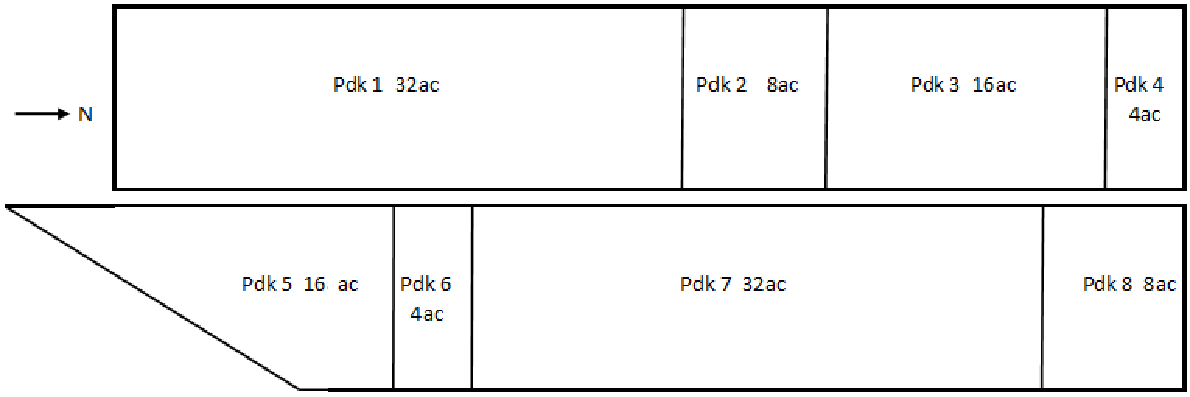


Figure 2 Paddock layout with replicate 1 west of the central access lane and replicate 2 to the east (below in this diagram).

These rounded values are used hereafter to cater for the change in Australian measurement systems from English to decimal units after the trail commenced. Those nominal stocking rates will be converted in some of the data presented to standardise them as Dry Sheep Equivalents (DSE) to accurately account for the variable liveweights over the years and amongst the different groups of sheep. A 2006 satellite image from Google Earth (see Figure 1) shows the area then, with some old fence lines still evident, particularly the 4 sub-paddocks of original paddock 1 that were created for the rotational grazing phase of the study in 1978.

Image 7 Shade structure constructed in each paddock.

The 8 paddocks were fenced with hinge joint and lay in a block between widely spaced shade lines (Figure 1) in a paddock of several thousand hectares. Each trial paddock had a leafy bow shade constructed near the water trough (Image 7).

The broad range of rates chosen was a deliberate attempt, based on recent local experience, to impose very heavy and very light stocking at the extremes and thus to generate good response surfaces in the data sets. Image 8 shows the contrasting forage available after 3 years between paddocks 3 and 4 which illustrates that the grazing pressures chosen were achieving the desired effect, *albeit* after a few low rainfall summers (Figure 5).

Image 8 Contrast in available forage and sandalwood foliage between Paddocks 3 (L) and 4 (R) in October 1970 after 3 years. Note the emergence of heavier grazing near the foreground water point and patchy grazing in Paddock 3 (2.5 sh/ha)

Grazing and stock management

The project ran through four phases between 1967 and 1982. Two core, relatively moderate, stocking rates continued throughout but the animals changed from ewes in Phase 1 to wethers in subsequent phases and the intensity of research was reduced over time. Ewes were used initially because treatment and pasture type effects on their reproductive capacity was an important focus. The highest of the four replicated stocking rates applied in Phase 1 soon proved excessive and was discontinued after 3 years but those paddocks were later restocked at a moderate rate for two more years early in Phase 2 to assess the recuperative capacity of these buffel grass pastures. In Phase 3 from 1977-79 after a series of exceptionally good summers, the other 6 paddocks were used to compare continuous versus rotational grazing at 2 stocking rates. After 10 years, it was clear that 1.25 sh/ha was grossly under-utilising these pastures, so those 2 paddocks were each subdivided into 4 smaller sub-paddocks and a system of rotational grazing imposed in them so that the overall stocking rate in each matched one of the ongoing 2 moderate stocking rates. Phase 4 saw only the four paddocks at the 2 intermediate, moderate stocking rates grazed with mature wethers to help confirm the persistence of buffel grass pastures on gidyea clays under such grazing pressure.

Stocking rate calculation and DSE conversion

The data will mostly be presented with stocking rates expressed as sheep/hectare but the weight of those sheep varied with mob and age and with time of year. Thus, the stocking rate will also be summarised at times using the convention of Dry Sheep Equivalents (DSE) that will allow the results to be interpreted better in terms that the sheep industry can use to compare with other sheep grazing data and enterprises. Stocking rate is a measure of the grazing demand placed on the pasture at a point in time. The grazing demand of an animal depends upon its weight, breeding status, its rate of weight gain, amount of walking and the breed of animal (Abaye *et al.* 1994; McLean and Blakeley 2014). Allowance has to be made for these factors, so that the differing intake of such animals from the pasture and thus a different grazing pressure can be properly accounted for. So, in places during this report, the results for each mob of sheep and the various stocking rates within a year have been converted to DSEs using the values provided by the RCS Australia organisation via the Farm Table website (Farm Table 2019). The standard used, 1 DSE, was the metabolic demand of a 50kg wether that was maintaining weight but RCS then recalculated that demand, as DSEs, for a range of weights at maintenance and then extrapolated further into a two-way table covering a range of daily growth rates, positive and negative, around each maintenance value.

We extended that table using the data provided by NSW Dept of Ag (2015) into the table shown in Appendix 11. That table was then used to convert our liveweight data and associated rates of gain into DSEs with mental extrapolation done to arrive at values interspersed within the tabulated DSE values shown. We used the weight of an animal at the start of a period and the net weight change between then and the next weighing to calculate the daily rate of change and from those two values determined a DSE grazing pressure for that period. No account was taken of the steadily increasing proportion of the liveweight contributed each year by wool growth because of calculation complexity but where a mob continued on immediately in the same paddocks after shearing, the fleece removed was subtracted before calculations were made of the rate of change in weight up to the next weighing. These calculations also made allowance for lost or dead animals between weighings and short periods between trial mobs after shearing when no animals were grazing the experimental paddocks.

The average DSE of each stocking rate during a year was calculated for each paddock of each mob and then expressed in terms of total DSEs per hectare for that period. The complete calculation sheets are in the Excel data files lodged in the project archives and an example of the nature of the data and the calculation flow for Mobs 1 and 2 is attached in Appendix 12. Those data illustrate how fluctuating the grazing pressure can be amongst the weighing periods for a single paddock within a year but also how the relative differences between paddocks are generally well maintained, even when an occasional animal is lost or changes in average liveweight seem unusually large in response to recent rainfall.

Stock management

Phase 1 (weaner ewes - 4 stocking rates, reproduction effects)

Prior to introducing sheep to the trial, the site was fenced in April 1967 and left unstocked during that winter. The initial period from September 1967 to August 1968 was to be regarded as a pilot run with slight modification of methods possible thereafter. Initially weaner ewes were used, selected on uniformity of body and fleece weights off-shears from 200-300 of the 'Eastwood' flock in August-September each year. Each September for the next 3 years they were replaced with a new, freshly-shorn weaner mob and the previous mob was assessed for the effect of the range of grazing pressure on lambing potential nearby. Sheep were allocated to paddocks by stratified randomization on body weight so that the mean liveweight and range was initially very similar in each paddock for that mob. Recording periods for the initial four years were September 28, 1967 to August 21, 1968 (Mob 1); October 14, 1968 to September 5, 1969 (Mob 2); September 25, 1969 to August 11, 1970 (Mob 3); and October 10, 1970 to August 8, 1971 (Mob 4). Between these recording periods after the annual 'Eastwood' shearing, stocking pressures were maintained using the current or other sheep until the weaner replacements became available. There was no dedicated group of 'spare' animals kept around the trial area. Replacements that would inevitably be needed were to be sourced from the remaining 'Eastwood' flock as required.

Grazing at 10 sheep/ha could not be maintained after the first year without supplementation because of constrained forage production which was exacerbated by poor rainfall (Table 6). In the second and third years these sheep continued to be fed regularly with a lucerne hay supplement (Image 9) before the treatment was abandoned in December 1970. Supplementation to maintain liveweight was commonly at the rate of 4 Food Units or 4.5kg hay/animal/week. The poor rainfall meant that sheep in the 5 sh/ha paddocks also required short periods of hay supplementation in July-August of 1969 and 1970. Between 29/9/70 and 9/11/70, 28 bales of hay were required, for example. However, pasture monitoring continued to see if the pastures would regenerate from an extremely bare state. Two good summer growing seasons over 14 months from December 1970 until March 1972 (Figure 5) saw the buffel pastures in those 2 paddocks regenerate very well, so they were then restocked at 2.5 sh/ha at the start of Phase 2.

Image 9 Lucerne hay supplement fed to ewes in a 10 sh/ha paddock in 1970. Note the healthy body condition being maintained on the animals in a paddock devoid of palatable feed.

During Phase 1, puberty and oestrus cycling of the young ewes in each paddock was monitored for Mobs 1, 2 and 3 during March-April using vasectomised rams called ‘teasers’ (see Reproductive Performance section below for details). In the next spring after being replaced in the trial paddocks, all ewes of a mob were joined over an 8-week period during September-October to entire rams in another paddock. Their pregnancy and lambing success was closely monitored thereafter to determine what effect widely differing grazing pressure during adolescence may have had on their fertility (details below).

Phase 2 (weaner wethers that were retained until 6 years old; 3 stocking rates)

In the second phase of the study which began on 8th February 1972, wethers were used and the core experimental design became a randomised block with two replications of three stocking rates: 5, 2.5 and 1.25 sheep/ha using the same paddocks for the same grazing pressure as before but stocked with 16 weaner wethers each. After shearing in late August 1971, the designated grazing pressure was maintained in all paddocks by similar 2-year old ewes until the wethers were introduced in February. These temporary sheep were weighed regularly as for the former mob. From February 1972, grazing resumed with similar wethers in the former 10 sh/ha paddocks that had recovered after being destocked in December 1970, but now at 2.5 sh/ha. The liveweights of those sheep were tracked along with that of those in the core experiment for two more years.

The wethers used (Mob 5) were weaners selected on uniformity of body weight (31-40 kg) from a commercial flock and allocated to paddocks by stratified randomization on body weight. Weighing intervals increased to 6-8 weeks but the same liveweight, wool and faecal sampling protocols continued. Unlike Phase 1, these wethers remained in their allotted trial paddocks until shearing in August 1977 when they were 6 years old. Between 1972 and 1977, it became necessary at times to use replacement wethers because of the loss of some of the original ones, sometimes due to fly-strike, at other times due to escape from their paddock, as well as unexplained causes. Wherever possible, replacement wethers were obtained from the original commercial flock as soon as practicable.

The animals in the former 10 sh/ha paddocks (paddocks 4 and 6) were removed from the recording schedule after 2 years in this phase grazing at 2.5 sh/ha (August 1974) because trends in pasture basal area, forage on offer and animal performance were similar by then to those in the other paddocks that had always been at that same grazing pressure. Thus, only six paddocks remained in the formal experiment after shearing in August 1974. From August 1976 ‘til August 1977 sheep liveweights were not recorded and no faecal samples collected but the 3 different grazing pressures and pasture basal area monitoring continued.

By August 1977, a series of very wet years (Figure 7) had produced a great bulk of pasture which was ungrazed in most parts of the lightest stocking rate paddocks (1 and 7). Such pasture became moribund and unpalatable and it was decided that those paddocks had outlived their scientific usefulness and should be used to test the pasture management option of rotational grazing as opposed to continuous grazing which was normally used. Thus, planning began for Phase 3.

Phase 3 (wethers; rotational v continuous; 2 stocking rates)

The aim was to determine if a rotational grazing system on the rank pasture would result in better animal performance and pasture utilisation. Each 12.95 ha paddock was subdivided by hingejoint fencing into 4 sub-sections of equal size and extra water points were installed (Figure 3), while paddocks 2 and 8 as well as 3 and 5 continued with their long-standing, fixed stocking rates of 5 and 2.5 sh/ha respectively.

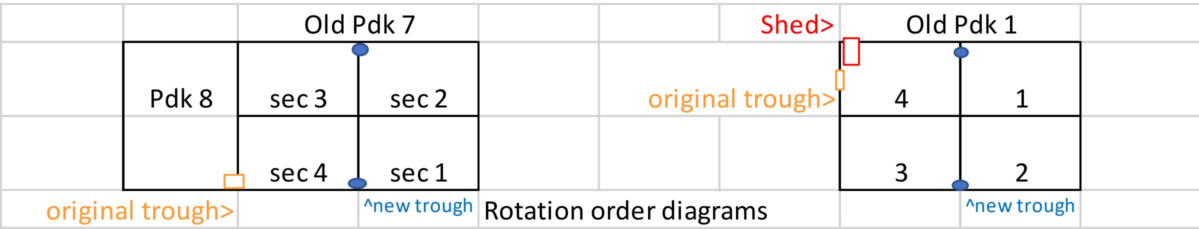


Figure 3 Sub-paddock arrangement for the paddocks that were subjected to a rotational grazing management scheme from Nov 1977 to Aug 1979

One set of smaller sections (derived from paddock 1) was to be stocked at 5 sheep/ha overall (64 wethers) and the other within paddock 7 at 2.5 sheep/ha (32 wethers) so that their stocking rates were directly comparable with the existing paddocks that were continuously grazed, namely 2 and 8 as well as 3 and 5 respectively. This meant that for a period, each section was grazed at four times the pressure that the overall stocking rate would indicate and that was expected to counteract the patch grazing that had become entrenched in those paddocks during the recent wet years. However, a reduced sheep growth rate was anticipated as each section was eaten out and that would be the trigger for moving the animals to the next section.

A new mob of weaner wethers (Mob 6) were acquired and allocated amongst all the trial paddocks following stratification based on liveweight (16-25 kg). The new treatments began on 7 November 1977 when 64 wethers were put into section 1 of paddock 1 and 32 into section 1 of paddock 7. They were subsequently moved to section 2 and then 3 and 4 and then back to 1 as shown in Table 4. A move to the next section occurred when their average liveweight at any weighing fell below 95% that of the mean of the sheep in the continuously grazed paddocks being grazed at the same nominal stocking rate. This was usually about every 2-4 months. Weighing occurred at intervals of 6-8 weeks with the same liveweight, wool and faecal sampling protocols continuing.

That comparison continued for nearly 2 years but the performance of the rotationally grazed sheep was consistently poorer and hence that peripheral experiment ended after shearing in August 1979 and this phase ceased. A water crisis in March 1979 caused the deaths of many sheep in section 2 of Paddock 7, bringing its involvement to a premature close. Similar problems saw many deaths and escapes in search of water for sheep in paddocks 3 and 8 which left them poorly stocked until new wethers were obtained in early 1980.

Table 4 Move dates during the rotation experiment between November 1977 and August 1979

	5 sheep/ha	2.5 sheep/ha
Section 1	7 Nov '77 – 24 Jan '78	7 Nov '77 – 7 Mar '78
Section 2	24 Jan '78 – 7 Mar '78	7 Mar '78 – 4 May '78
Section 3	7 Mar '78 – 4 May '78	4 May '78 – 9 Aug '78
Section 4	4 May '78 – 9 Aug '78	9 Aug '78 – 4 Oct '78
Section 1	9 Aug '78 – 4 Oct '78	4 Oct '78 – 4 Jan '79
Section 2	4 Oct '78 – 4 Jan '79	4 Jan '79 – 15 Apr '79 died
Section 3	4 Jan '79 – 24 Apr '79	
Section 4	24 Apr '79 – 8 Aug '79	

Phase 4 (wethers; 2 stocking rates, set stocked)

The final phase continued with only 4 paddocks and 2 stocking rates, 5 sheep/ha (paddocks 2 and 8) and 2.5 sheep/ha (paddocks 3 and 5). These paddocks had been maintained at those two moderate-to-high stocking rates for the entire trial, through bad, fair and good seasons. They should thus provide valuable wool industry data about the potential long-term productivity and stability of buffel grass pastures sown into cleared gidyea scrub country.

A new mob of wethers (Mob 7) weighing between 25 and 38 kg were sourced from 'Eastwood' and allocated on 3 February 1980 to paddocks to give an even distribution of liveweight across the 4 paddocks. Weighing continued at similar intervals with the same liveweight, wool and faecal sampling protocols retained but with greater emphasis on the control of intestinal worm burdens. Any sheep lost were quickly replaced with equivalent numbers acquired from the property owner.

Monitoring of pastures and sheep performance continued until shearing in August 1982 when this long-term grazing trial concluded due to inadequate resources for the safe management of the animals. The major problem was continuity of water supply during summer, especially as seasons turned dry again in early 1980.

Shearing

Each spring or late winter all sheep from that season were shorn at the 'Eastwood' shearing shed, including those from the grazing trial. Thus shearing time for the trial sheep was determined by the Eastwood schedule. Sheep were transported to the shed by trailer after weighing and held overnight before being shorn next morning. Dye-bands were clipped from the banded sheep at the trial site yards some days before shearing (see below). As they were shorn, the belly wool was collected separately and weighed because it was separated from the rest of the fleece by shearers following normal shearing protocols. Each fleece was weighed before being spread out on the classing table and a mid-side handful ('grab sample') taken and placed in an individual bag along with the animal's eartag number. Those samples went to the DPI Wool Research Laboratory in Brisbane for quality assessment – type, clean wool percentage and fibre diameter. All sheep were jetted for lice after shearing and often drenched for worms, if the season demanded it.

In Phase 1 the sheep of Mobs 1-3 did not return to their trial paddocks as a new weaner mob was prepared but those of Mob 4 did for several months while preparations were made to use wether weaners in future. During Phase 2 the shorn wethers returned immediately to their trial paddocks. In phases 3 and 4, the wethers were returned immediately to their respective paddocks except in 1979 when a new mob replaced Mob 6.

General animal management

Sheep were crutched annually in February, in the nearby property shearing shed. Intestinal worms were monitored by faecal sampling at each weighing and if counts rose too high (above 200 eggs/gm in any paddock) then all sheep were drenched with an approved chemical. Care was taken to change drenches reasonably regularly to avoid a build-up of resistance by the worms but changing commercially available standards also aided this intent. Flystrike was ever present and managed by spraying/jetting at appropriate times. Badly struck animals were given individual attention which would usually also involve clipping back wool in the affected area to discourage reinfestation to that susceptible location.

Feet were clipped during weighing events if they became an obvious problem on an individual sheep but that was not common.

This trial was planned and conducted in years before animal ethics committees oversaw research studies. Thus, animal welfare and management were under the judgement of qualified veterinarians and trained rural husbandry technicians who were present at every weighing and on call if required at other times.

Pasture monitoring

The pastures in each paddock were monitored by two methods, basal cover using pins in a frame and dry matter yield using calibrated cut quadrats. Observations were recorded of buffel grass seedling recruitment and prominent ephemeral herbs but no quantitative measurements of these were made. The paddocks contained a small and variable number of unpalatable false sandalwood shrubs (Images 6 and 8) that had negligible impact on pasture growth. They were nibbled by the sheep only when the pastures were very dry or badly frosted but became completely defoliated in the most heavily stocked paddocks once the sheep were experiencing severe feed shortages that required hay supplements (Images 8, 9 and 13).

Basal cover

Basal area of the pasture was measured annually in October/November using a point quadrat consisting of five points spaced 15 cm apart on a rigid frame. Four hundred positions of the quadrat (2000 points) were examined in an even grid of 8 transects across each paddock (10 in 1971) and basal area expressed as the percentage of points which made contact with a living plant crown at ground level. Almost all hits were on buffel grass but where that did not occur, the species hit was noted. Basal area measurements were made by Graeme Lee between 1967 and 1970 and by Gavin Graham in 1971 following standardization with Lee. After 1971, David Orr, with an assistant recording, did all the subsequent basal area measurements in order to maintain a standard assessment of a ‘hit’ by the pins.

Gavin Graham conducted a small trial in 1971 where he compared the results from recording 4000 points as well as 2000 but found no significant difference provided the paddock was adequately covered spatially. Basal area measurements were discontinued once a paddock had been dropped from the core trial.

Dry Matter Yield

Pasture dry matter (DMY) yield was recorded intermittently via estimation techniques for the first 7 years. The method used varied over time. Initially a combination of visual estimation of the fresh weight within forty well-distributed 5lk x 5lk (1 sqm) quadrats per paddock was used with ten of them clipped close to ground level and bagged. Those samples were taken to the office storage shed, weighed and sorted into green and dead components. After days of drying in brown paper bags in the sun, the air-dry weight was recorded and a calculation of the moisture loss made. The dry weight was correlated with the field estimates of those samples and an average weight per acre calculated from the 40 estimates per paddock. A drying oven was acquired in 1968 and the air-dried cut samples were dried at 80° C for 24 hours which showed that they still contained, on average, 10% moisture. All earlier estimates were then recalculated using that assumed moisture percentage. Once the drying oven was available, the cut samples were dried directly from the field after sorting and the moisture content of the component green and dead material was assessed independently.

From 1970, a method called the ranked-set method (Halls and Dell 1966) was used as it was judged to provide a more reliable estimation system. Forty randomly selected locations were still used in each paddock but locations were determined in the office beforehand within a defined paddock grid of 100 possible locations along each of 10 fixed transects that were based on fencepost positions. Sets of three closely-grouped 0.5 sqm quadrats at each predetermined location were visually ranked as encompassing relatively High, Medium and Low biomass and the yield of one was estimated in the sequence of high, medium or low as the operators moved from one location to the next. The quadrat estimated at every eighth set (by 2 operators) was clipped to ground level and the harvested material weighed and subsampled for later drying. Yield in the remaining 35 estimated quadrats was estimated visually by the two independent operators and these yield estimates were then correlated with actual yields from the five clipped quadrats.

Many sub-sampled lots were separated into green and dead buffel and then oven-dried, thus allowing the percentage of green matter to be calculated for the whole pasture at the time. Green leaf and their sheathing leaf bases plus moist green and yellow stem were regarded as green material. Sometimes leaf was also separated from stem with leaf being defined as leaf blade and sheathing leaf base. Data presented in Table 8 have the early air-dry values converted to oven dry by assuming a 10% moisture content in the air-dry material.

Pasture quality

Samples of the whole, dead and green segments were sent away regularly from every paddock during Phase 1 to the DPI Agricultural Chemical Laboratory for chemical analysis for nitrogen and phosphorus content (Kjeldahl digestion then autoanalyzer). Further samples from most paddocks were analysed up until October 1974 when the last sampling of standing pasture dry matter was conducted. The nitrogen results are reported as Crude Protein percentage (%N x 6.25).

Pasture quality was also assessed indirectly up until June 1980 via the crude protein and phosphorus content of faecal samples collected at each weighing time.

The quality of 3 different loads of hay was tested during 1969 and showed the following results –

Lot A 3.05% N and 0.38% P;   Lot B 2.75% N and 0.35% P;   Lot C 3.00 %N and 0.38% P

Other pasture features

Browsing of sandalwood trees and invasion of paddocks by weeds were recorded when apparent. The main ephemeral ‘weeds’ were soft roly-poly (*Salsola kali*) and speedy weed (*Flaveria australasica*).

Sheep measurements

For the first four years (Phase 1), weaner ewes were selected from a large flock on the basis of body weight and fleece weight. The 128 needed for the core paddocks in the first year came from amongst 300. Difficulty in getting enough ewes of the same age required some sheep in September 1969 to begin as unshorn animals that were subsequently shorn on 23rd October 1969 and their fleece weight recorded. Initial liveweights that year ranged from 18 to 27 kg and woolled animals were evenly distributed around the 8 groups. In Phase 2, 2-tooth wethers (32-40kg) were chosen in early 1972 and they remained as the trial sheep until August 1977, survivors remaining in the same paddock all that time. They were medium wool, Peppin merinos based on local “Terrick Terrick” bloodlines which are very common in commercial flocks in central western Queensland.

Losses due to various causes required extra sheep to be brought in as replacements at various times. To do that quickly so as to maintain grazing pressure, dry ewes of similar size were occasionally used. In Phase 3 when rotational grazing was tested in the two biggest paddocks, a new mob of weaner wethers (16 to 24 kg) was acquired, including for the ongoing continuously grazed paddocks. Finally, a new mob of 2-tooth wethers (25 to 37 kg) was acquired in February 1980 to stock the four paddocks that remained in the experiment at the two intermediate stocking rates during Phase 4.

Liveweight

Sheep were weighed individually each month during Phase 1 in a portable metal cradle following overnight fasting in the small yards constructed at the site (Image 10). After 1973, weighings occurred less frequently, commonly every second month.

Image 10 Sheep being held for weighing, dye-banding and faecal sampling at the onsite yards.

Wool growth

Greasy fleece weights of individual sheep were obtained at the end of each grazing year at shearing time as described earlier in the 'Shearing' section. Linear wool production rates were also measured during Phases 1 and 2 using a wool dye-banding technique (Chapman and Wheeler 1963) on 8 sheep in each paddock. That involved placing a sheep on its left side on a pivoted table, parting the midside wool dorso-ventrally and applying a few millilitres of a Durafur Black R dye solution with a fine pipette at skin level in a line about 12cm long. The procedure was repeated at the same location every second weighing time (8-weekly intervals) with each application producing a black band of exposed wool separated by white wool that grew between each application (Image 11). Just prior to shearing and sometimes at February crutching time these bands were clipped from the animals along with a measured area of about 12 x 5 cm of mid-side wool – 3 lengths and 3 widths measured to the nearest mm using vernier calipers. Removal earlier in the cycle at crutching time was instigated because the older bands would fade beyond clear delineation under prolonged exposure to strong sunlight and other ambient elements. The clipped sample was placed flat in a small cardboard box labelled with the animal's eartag and despatched to the Qld Wool Biology Laboratory, Yeerongpilly in Brisbane (Moule and Miller 1956).

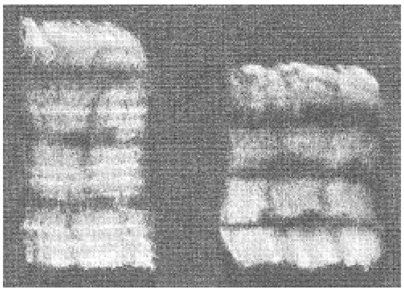


Image 11 Dye-bands on merino wool (Chapman and Wheeler 1963)

Clean wool production rate (mg cm^{-2} d^{-1}) was sometimes calculated from the clipped dye-band mid-side samples after picking out any large vegetation contaminants and washing the patches in detergent, drying in a desiccator and weighing. Rates over each measured interval could be calculated based on the sample area and the weight of wool grown during each interval. This was possible because the clipped dye-band samples were carefully laid between sheets of thin cardboard in individual cardboard boxes immediately they were collected and thus kept their integrity during transport to the wool laboratory.

Wool quality

For the 4 shearings in Phase 1, a grab sample from each fleece was graded by a qualified wool classer using the Bradford wool quality system (Bradford 2019) that relied on visual assessment of the tightness of crimping, colour and feel. There is a close relationship between the Bradford quality number (60s, 64s etc.) and mean fibre diameter/micron count (Table 5, Lang and Campbell 1965). Thereafter, fibre diameter replaced the Bradford system as a major wool quality measure at each shearing. Observations were also made of fibre tenderness, colour and style.

Clean fleece weight, percentage yield (after grease, dust and vegetable fault removal) and fleece abnormalities were also determined for many years by the Wool Biology Laboratory from the same grab samples. This was done by picking out vegetable fault with tweezers from a weighed subsample and then washing the grease and dust out with detergent-laced warm water and drying the clean sample in a desiccator rather than to a standardised moisture content of 16% as used by the Australian Wool Testing Authority (AWTA 2019). Then wool quality was also characterised by mean fibre diameter using the projection microscope technique (Textile Learner 2012). The fibre diameter was determined for each growth interval delineated by the stained bands. Thus, the pattern of wool fibre thickness change during each year was recorded as well as the average fibre diameter grown.

No details are available about the precision of the reported results but the paper by Kritzinger *et al.* (1964) discusses how reliable the method was in general. A number of different laboratory technicians were involved in carrying out these assessments over the years.

Phase 4 fleeces were quality assessed by the AWTA following their protocols which involve expressing clean fleece on a standardised 16% moisture and also by cutting the staple into tiny pieces and using a scanner to calculate the mean fibre diameter of those pieces (AWTA 2019).

Table 5 The relationship between the Bradford wool quality number and mean wool fibre diameter in microns of Australian merino wool.

Bradford quality number	Mean wool fineness (micron)	Standard deviation
70's	20.36	2.31
66's	20.88	2.34
64's	21.33	2.50
60's	22.32	2.70
58's	24.24	2.93

Faecal sampling -worms and Nitrogen and Phosphorus

At most sheep weighings in all phases, faecal samples were taken from half of each paddock group and bulked. Those samples were then split usually into halves. One half was oven-dried at 70°C for 2 days and sent to the Agricultural Chemical Laboratories at Indooroopilly for analysis for N and P content via Kjeldahl digestion and autoanalyzer assaying to monitor the variation in the quality of the diet being consumed. In early years the nitrogen content was usually reported as crude protein which is N% * 6.25. The other half was tested for intestinal worm egg numbers at the Animal Research Institute at Yeerongpilly using a modified McMaster technique (Gordon and Whitlock 1939). Most times the whole sub-sample was immersed in a small bottle of ortho-dichloro benzene for despatch. When high worm burdens were suspected, this sample was often split again and half was placed in cold storage and despatched expeditiously under refrigeration to the Brisbane laboratories for culturing in order to identify the worm species. The other part was immersed as usual in ortho-dichloro benzene liquid to be used for egg counts.

Reproductive performance

Oestrus cycling

The potential reproduction performance of the ewes of Phase 1 was recorded each year via checks for puberty and oestrus cycling which is a crucial stage in determining ultimate lambing rates in rangeland sheep. One of 8 vasectomised 'teaser' ram with Siresign raddle harness (Radford *et al.* 1960) was placed in each of the 8 paddocks for a week and then mustered and moved sequentially to another paddock. This continued for 2 months and the ewes were assessed weekly for evidence of service by the ram as an indication that they had reached puberty. Service on successive weeks was regarded as evidence of oestrus cycling and thus the potential to becoming pregnant. No ram worked in a paddock of 16 maiden ewes more than once so each lot of ewes had similar exposure to each ram. At fortnightly intervals the crayons in the harnesses were changed.

The number of ewes served each week was recorded when the rams were swapped and linked to the ram in the paddock at the time. The ewes were also given a condition score between 1 and 5 during this period, where 1 was Poor, 2 was Store, 3 was Forward Store etc. Some ewes were served more than once during the 8 weeks. Records were kept of the numbers of ewes served in each paddock each week and also of the service counts by each ram in each week.

The first run of this assessment began on 8 February 1968 and concluded on 4 April 1968. Similar assessments were done on the next 3 mobs in late summer, 12 Feb – 10 Apr 1969, 24 Feb – 21 Apr 1970, and 8 Apr – 4 Jun 1971.

Pregnancy and Lambing

Each year in the following spring, all ewes from a mob were then run together in a completely separate paddock and joined to entire rams over a 2-month period, 28 Oct – 23 Dec 1968, Sep-Oct 1969, 28 Oct – 21 Dec 1970 and 16 Sep – 11 Nov 1971. The grazing pressure in that lambing paddock was moderate at about 2.5 sheep/ha. Siresign harnesses on the rams allowed counts to be made of which ewes were served when they were periodically weighed. Pregnancy was assessed afterwards in the January-February period using an ultrasound device called Sonicaid that detected foetal heartbeat, while initial lambing success was assessed by 'wet 'n dry' udder palpitation in April-May. Final lambing percentages were calculated from lamb numbers present at lamb-marking time, about 6 weeks after the lambs were born. Because these lambing ewes were run as a mob, assignment of final lambing success to a paddock or treatment was not rigorous because of the inability to link every lamb with a specific mother.

The slow-maturing ewes from the most heavily stocked paddocks that did not conceive at the first joining were joined again in the succeeding spring to see if they fell pregnant that time. Thus in September 1969, 29 sheep from the heaviest stocking rate treatment of Mob 1 that had not conceived the previous year were compared against 30 from other Mob 1 treatments that had, to see if the fertility of the former group had improved. The same system of joining to entire rams and monitoring pregnancy was followed in conjunction with the ewes from Mob 2 that were joined at the same time after their grazing at the different grazing pressures had ended in August 1969. This assessment was repeated each spring in 1970 and 1971 with similar numbers of non-conceiving sheep each time. It must be kept in mind that the sheep of Mobs 2 and 3 in the heavily stocked paddocks received regular hay supplementation to help them maintain poor condition which did not happen with Mob 1 that had far more pasture available to them for much of the first year.

On one occasion the joined ewes were run as a group on the Blackall town common. On other occasions they were agisted in open paddocks on adjoining properties that had a spare grassy paddock. It is unclear from available records if these were buffel grass or Mitchell grass country. Those ewes that were not pregnant after a Sonicaid test were removed and the rest followed for their success in raising the lamb or lambs to weaning, sometimes including the weight of the lambs.

Ancillary experimentation

Other information was collected during Phase 1 to supplement understanding of the results being recorded.

Condition score, skin wrinkliness and facial covering.

The ewes were scored for their body condition, facial cover and skin wrinkliness because published research indicated that there was sometimes a correlation between them and lambing success (Dun 1964; Mullaney 1966). The evidence at the time for appreciable lambing benefits due to good body condition prior to, during and after lambing was compelling (Kenyon *et al*. 2014) but not so much for the other two factors mentioned. Two trained assessors independently assigned the relevant score to each sheep in the trial to provide an average score. Wrinkliness (1-5, where 5 means dense wrinkle folds in an area) was scored independently for the neck, side and breech of each ewe from Mobs 1, 2 and 4. Facial cover (1 to 5, where 5 meant extensive wool cover on that region) was scored separately for the face and the jowl of all ewes from Mobs 3 and 4. Such scores followed the categories used by Sheep Genetics (2013).

The body condition scoring (1 to 5, where 5 is very fat; Lifetime Wool 2011) was sometimes done several times from the initial oestrus cycling test to joining time to pregnancy testing time while the animals were mustered in the yards.

Diet selection.

Some greater knowledge of the diet being selected by the sheep under different grazing pressure was also desirable, so a few oesophageal fistulated sheep were acquired in 1973. Those sheep were introduced to the trial area and allowed to become accustomed to the pastures. Animals were then held in the yards overnight and released in the early morning to graze for a short period of time with the throat bungs removed. Extrusa was collected in plastic bags fitted over the stoma but the method used to estimate the *invitro* digestibility of the consumed pasture was a failure.

An attempt was also made to determine how much time sheep in the different treatments spent grazing each day. One animal in each paddock was fitted with a motion-sensitive clock that recorded neck movement in a similar way to that reported for dairy cattle by Stobbs (1970). Unfortunately, the devices fell off too readily and no useable data was collected.

Sentinel herd.

Animals in the trial were also used to test for blue-tongue disease as part of a national programme to check for the existence of that dangerous disease that Australia was free of but had potential insect vectors present.

Statistical testing

All data were subjected to analysis of variance and treatment means were compared by the protected LSD procedure at the 5% level of significance. The statistical model used stocking rate and year as main effects and inter-animal variation was constrained as a separate error layer when analysing animal-based parameters such as liveweight and fleece weight. However, our biometricians determined that the ‘animal to animal’ variation should be used as the error term in such analyses as there were more degrees of freedom to work with and the overall trend in results was often clear. Also, the significance test when paddock variation was used as the error term often gave the same order of probability.

Pasture parameters such as dry matter yield, nitrogen percentage and basal area were analysed using the mean paddock values only and did not incorporate individual sample or quadrat values as a separate measure. This is because spatial variability in rangeland pasture is always high and sampling protocols are designed to encompass that variability. In contrast, the sheep were selected to initially exhibit constrained variability amongst them and their subsequent growth and wool production integrated the spatial variability of the pasture via their selective grazing.

Regression analysis was used to derive a relationship between average daily weight gain and faecal nitrogen and phosphorus concentrations.

Loss of individual sheep at times often required the calculation of missing values during these analyses and, even with 16 sheep per paddock, the losses were sometimes sufficient to greatly reduce the power of those statistical tests. One option was to ignore the data from replacement sheep within any one mob or year; another was only to exclude their data from the first weighing or sampling after being added to the paddock group. To test the likelihood that such an approach would statistically affect results if they were included after initial exclusion, a comparison was made of greasy fleece weights of the original and replacements for 1973, 1974, 1975 and 1976 fleeces. The comparison test was restricted to Paddock 3 because only it had sufficient replacements each year to allow a credible statistical test to be done. Similar comparisons were done on liveweight from 13 weighings of Paddock 3 sheep between 13/4/1973 and 7/8/1974.

Both tests found no significant effect of having between 50 and 69% of sheep replaced during a year on the power of the ANOVA to report significant effects of stocking rate on animal production. Therefore, data from replacement animals that usually came from the same flock, were the same age and had been grazing primarily on buffel grass pastures, were included in the calculation of the paddock means upon which the significance of treatment effects was calculated.

Results

Rainfall

Rainfall records for the site were kept for the first few years when regular visits were made but later were obtained from the 'Eastwood' homestead which lay about 4.5km to the south-west, or from the Blackall township records. Today there is access to detailed records from the whole region from which interpolated data for any location can be obtained via a data drill on the SILO website (SILO 2018) which sources its raw data from the Australian Bureau of Meteorology (BOM). Appendix 3 has synthetic, kriged monthly rainfall for 24.65°S, 145.45°E during the whole trial period as well as seasonal and annual values plus corresponding decile values based on the entire rainfall record of 136 years. Appendix 4 has the 'Eastwood' homestead and trial site daily records for the first 4 years compared to Blackall recordings and SILO kriged values for the same dates. Daily records over the entire trial period from SILO are in project files. Note how the kriging protocol produces many more rainy days than occur at both the Blackall Post Office and the 'Eastwood' house and that big events generally have lower daily synthetic values than those from a single gauge as Beesley *et al.* (2009) would predict.

The nearest official rainfall stations to the site are 30-40km away at Blackall, Gillespie, Terrick Terrick and Malvern Hills and were presumably used to create the synthetic rainfall values. The synthetic data purports to represent rainfall at the centre of a 0.05 degree pixel which is about 2.3 km north of the trial site. Appendix 4 data from the gauge at the trial site yards is in some cases aggregated falls over several days because access was impossible over black-soil clay roads until they dried out. More reliance may be put on the homestead records rather than at the site because reading the site gauge after small falls was not done on some visits. Even then, those homestead recordings were not strictly done at 9 am like the BOM ones but rather after the main event had ended each day, or after dawn or at dusk.

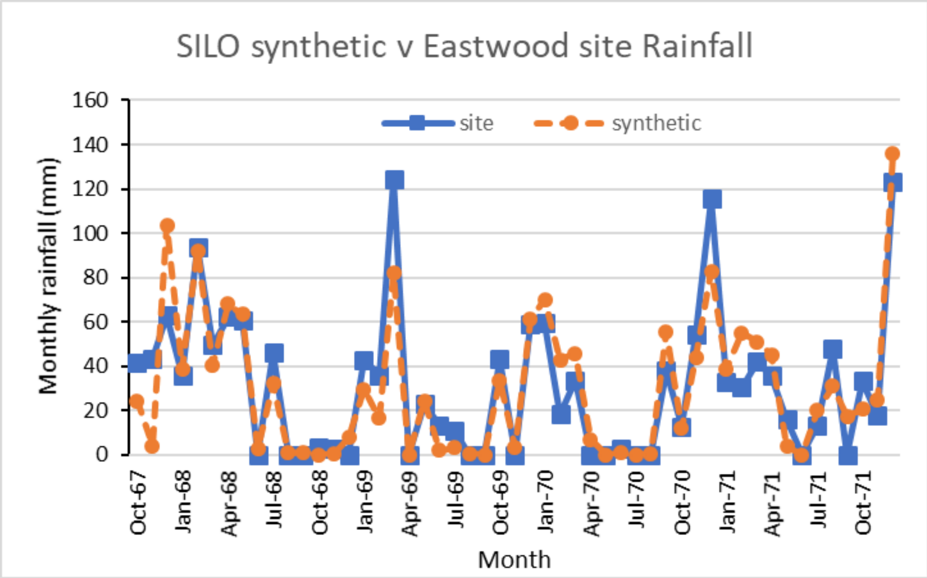


Figure 4 Correlation between monthly site rainfall and synthetic calculated rain at -24.65°, 145.45°E from nearest official stations.

Figure 4 shows the correlation between that synthetic data and the site data available for the first few years, plotted using monthly totals. The correlation is best during the winter months and worst during the summer storm season when high intensity storm rains commonly fall over quite restricted areas on any particular day. Generally, site records were more extreme than the district-averaged data drill calculations. Comparing 'Eastwood' synthetic with Blackall daily rainfall from 1960 to 1984 resulted in a correlation coefficient of 0.84.

Figures 5 to 7 display the data drill synthetic rainfall data for the 4 core winter and summer months each year and the annual calendar year totals for the nearby pixel during the whole period of the trial. As actual site rainfall was only sporadically recorded after 1971, the synthetic data provide the most consistent picture of the contrasting seasons experienced over the whole trial period. Archived project files hold the complete 1889 to 2018 climatic data for Blackall but the kriged monthly values for 'Eastwood' were used to calculate median, decile 2 and decile 8 values shown in the Figures for the various seasonal components.

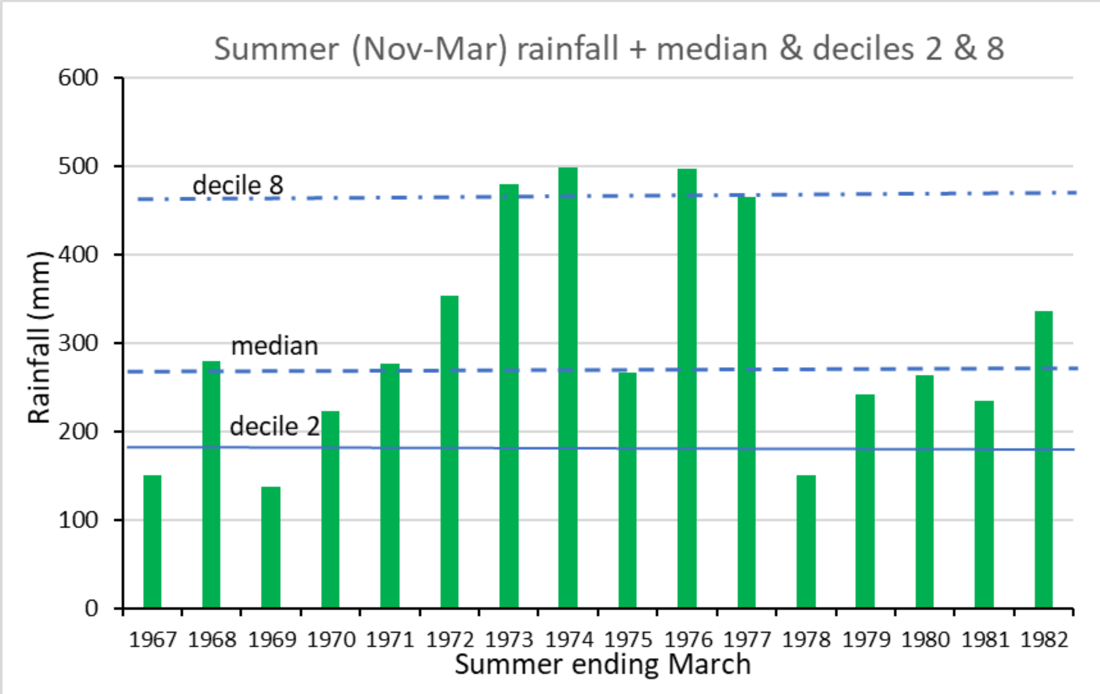


Figure 5 Synthetic core summer (November to March inclusive) rain for the 'Eastwood' location. Long term (139 years) values for decile 2 (20% of years received less), decile 5 (50% of years, median) and decile 8 (80% of years less) are shown by horizontal blue lines across the figure.

Phase 1 of the trial with ewes began in a run of fair to very poor seasons with the 1969 summer being particularly bad (Figure 5). Only calendar year 1971 achieved rainfall totalling about average (Figure 7) although the summers of 1967-68 and 1970-71 received slightly more than the median rainfall that historically fell (Figure 5). Reasonable to excellent seasons prevailed from1972 until 1977 during the second phase when wethers were used, initially at 4 grazing pressures and then 3 after 1974. During the rotational grazing comparison (1977-79), the seasons deteriorated from very good to below average summers (145-257 mm) although the 1978 winter was exceptionally wet (237 mm, Figure 6) and the 1979-year poor (Figure 7). Rainfall during the final phase when only 2 grazing pressures continued to be used was of mixed quality with excellent rain in May 1981, but the final winter was exceptionally dry (Figure 6).

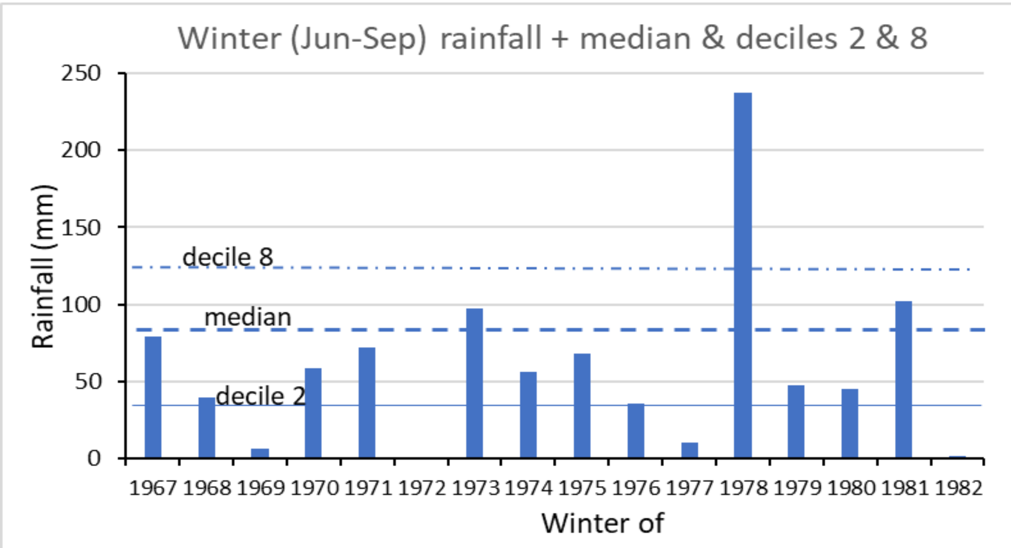


Figure 6 Synthetic core winter (June to September) rainfall for 'Eastwood' location. Horizontal lines indicate the long-term decile 2, 5 and 8 values recorded.

Rainfall relative to district long term records

Calendar year data (Figure 7) shows that, in terms of historical values recorded between 1889 and 2018, there were 3 extremely poor years (<decile 2) and 2 very good years (= decile 8). Really poor winters occurred on 4 occasions (1969, 1972, 1977 and 1982) but winter rainfall is not a major driver of productivity except when extremely good winter rains fall, like in 1978 (Figure 6). In contrast low summer rain is extremely detrimental to rural productivity in this region. Hence the 1966-67, 1968-69 and 1977-78 summers (Figure 5) had a big potential impact on pasture growth and animal performance and will be discussed in detail later. So too did the excellent 1972-73, 1973-74, 1975-76 and 1976-77 summers.

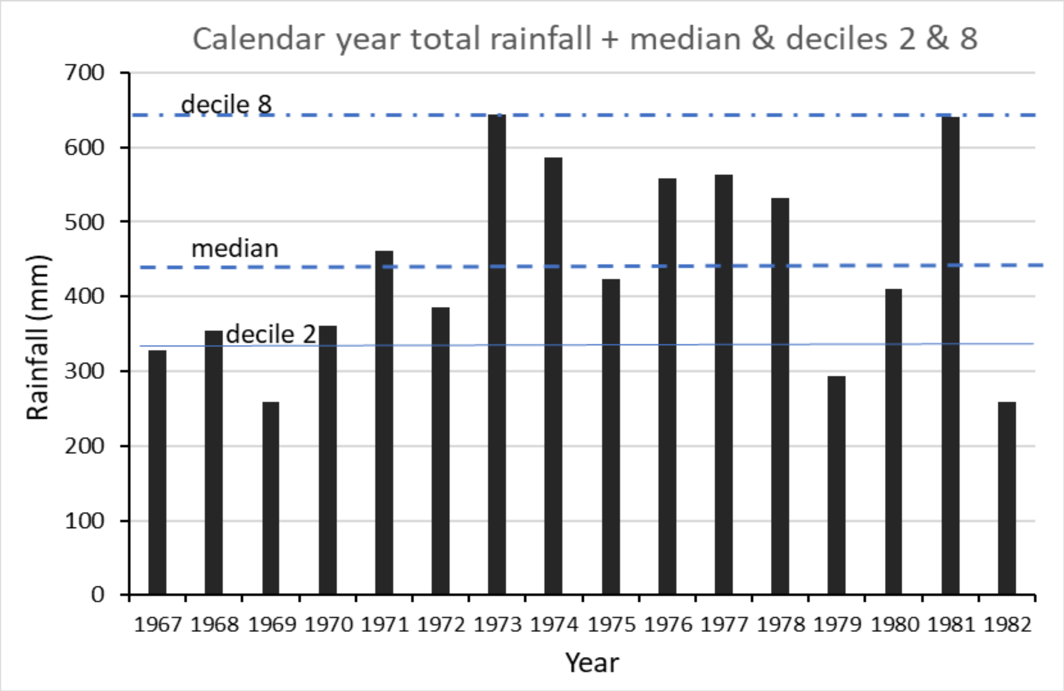


Figure 7 Synthetic calendar year rainfall for the 'Eastwood' location, generated by SILO algorithms. Horizontal lines indicate the long-term decile 2, 5 and 8 values recorded.

Phase 1 results (September 1967 – February 1972; ewes, 4 stocking rates)

Rainfall

Prior to the sheep entering their paddocks, rainfall had been limited since March 1967 and the last summer ranked as a poor decile 2 one (Figure 5). Two reasonable rain events in June (47 and 23 mm) put a small, temporary green shoot into the buffel grass and germinated some annual 'herbage' but that grew little in the following dry winter (Table 6). The green shoot in the buffel grass after the June 1967 rain was completely lost due to frosts in the subsequent 3 months.

No grazing had occurred between April 1967 when the fences were erected and late September when the experimental ewes commenced grazing yet standing pasture yield in early September was visually rated as fairly low.

Table 6 Monthly 'Eastwood' trial location rainfall (mm) during Phase 1 compared to Blackall long term data

Month	Long term	1967	1968	1969	1970	1971
January	84	*18*	36	43	59	33
February	81	*79*	94	36	18	31
March	63	*40*	50	125	34	42
April	36	*0*	**62**	0	0	**36**
May	33	*0*	**61**	23	0	16
June	27	***72***	0	14	3	0
July	25	*0*	**46**	11	0	14
August	17	*2*	0	0	0	**48**
September	19	0	0	0	38	0
October	33	41	3	**43**	13	33
November	43	43	3	0	55	18
December	69	63	0	59	116	123
Year	529	358	355	353	335	392
Cool months	188	122	169	90	54	146
Warm months	343	172	285	206	170	276
Warm mth decile		2	5	2	2	4

Long term values are for Blackall P.O. Warm month deciles include the prior November and December falls.
Warm months are taken as November to March inclusive; Cool months are April to October inclusive
Values in italics in 1967 are for the nearby 'Eastwood' homestead prior to the project's start
Bold values indicate cool season rain effective enough to stimulate some buffel grass regrowth

Rainfall in summer (Nov-Mar) was below average (303 mm SILO synthetic, 343 mm Blackall) every summer, very poorly distributed in the 1968-69 summer and very low in 1969-70. However, the long-term median summer rainfall there is about 266 mm which 1968 and 1971 achieved (Table 6). The comparatively good early cool season rainfall in 1968 (Table 6) produced only a short-term benefit to pasture yield and quality (Table 8).

Environmental extremes

No extreme climatic or environmental events of note were recorded during Phase 1. Heavy frosts were common in mid-winter in most years (Appendix 2) and there were summer storms but none that produced hail so violent that it stripped foliage from trees. There were no wildfires to alter the amount or quality of the forage on offer to the sheep nor any severe locust plagues.

Pasture data

Pasture basal cover

The basal area of the crowns of living plants fell appreciably in the more heavily stocked paddocks and held or increased slightly in the lightly stocked paddocks (Table 7) after 4 well-below average rainfall years (Table 6). At the lightest stocking rate there was a hint of grass tussock death after 3 years probably due to the recent poor, decile 2 summers but may also have been the result of difficulties in identifying live grass crowns in tall, dense, mostly ungrazed buffel grass. Patch grazing quickly became entrenched in such paddocks. Despite the intense grazing at the highest stocking rate, some gidyea seedlings survived in the bare pasture for many years as small plants that never grew away much in later years (Image12).

Table 7 Basal area (%) of buffel grass pastures at four stocking rates on four occasions between November 1967 and October 1971

		Sample date			
Shp/ha	Pdk	15/11/1967	1/11/1969	1/10/1970	29/10/1971
1.25	1	6.1	6.2	5.3	7.5
	7	8.3	9.8	7.0	7.0
	Mean	**7.2**	**8.0**	**6.1**	**7.2**
2.5	3	5.6	6.8	6.6	6.9
	5	6.2	6.0	5.4	5.9
	Mean	**5.9**	**6.4**	**6.0**	**6.4**
5	2	6.0	6.2	5.2	3.9
	8	7.3	6.3	7.2	4.3
	Mean	**6.7**	**6.2**	**6.2**	**4.1**
10*	4	5.6	4.1	5.1	6.2
	6	6.2	3.9	3.4	0.9
	Mean	**5.9**	**4.0**	**4.3**	**3.5**
Std error of	mean	0.38	0.99	0.96	1.26

F values were not significant between treatments. * Destocked from August 1970

Image 12 Resprouting small gidyea plants in the most heavily grazed paddocks in Nov 1970.

Variability in basal cover between replicates was quite large at times and prevented any statistically significant difference amongst stocking rates being recorded. The extreme was at 10 sh/ha where the replicate values in October 1971 were 6.15% and 0.90%. The replicate difference of 5.3% at this point is considerably higher than the mean replicate difference over all treatments for all years of 1.45%. This may be because identifying an early reshooting crown from a mass of small seedlings via the point method was difficult for observers. Signs of crown improvement in 1971 in the lightly stocked paddocks after a reasonable summer were not repeated at 5 sh/ha nor in Paddock 6.

The basal cover did not rapidly recover under relatively dry summer conditions after the 10 sh/ha paddocks were destocked in December 1970 (Table 7). The lack of reduction in basal area in Paddock 4 by October 1970 was unexpected, possibly due to different assessors in different years and because the animals were supplemented with lucerne hay after 1968 – about 10kg/wk/sheep.

Pasture standing dry matter

Available forage was quite low as the trial began in September 1967 (491-847kg/ha) and did not rise to well over 1000kg/ha until after good rain (94 mm) fell in mid-February 1968 (Table 6). Thereafter, the effect of the widely differing stocking rates became entrenched (Figure 8). Good autumn rain in April and May 1968 maintained that abundance of pasture and its greenness into June (Table 8, Figure 9) except at the heaviest stocking rate (10 sh/ha). Meaningful yield sampling of the 10sh/ha paddocks with the techniques then available became impossible after winter 1968 when only hard, coarse old stem bases under 2.5cm high remained (see Image 8). At 1.25 sh/ha, the animals only needed to graze part of the paddock, mostly around the periphery and near the water trough, to meet their needs. This resulted in new green shoot being available in most months while our sampling covered the whole paddock evenly, including parts that were virtually ungrazed after a few years and lacking much obvious green leaf in winter.

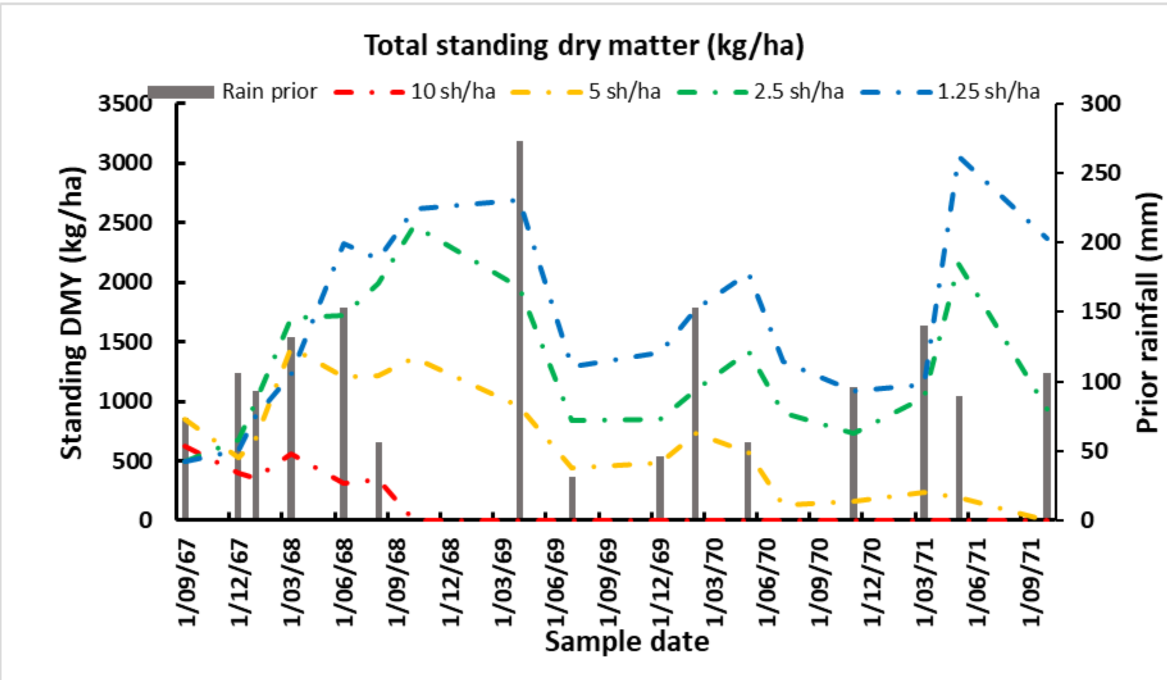


Figure 8 Variation in standing pasture dry matter over time at the different stocking rates (dashed lines) and the rainfall (mm, bars) in the period between consecutive samplings

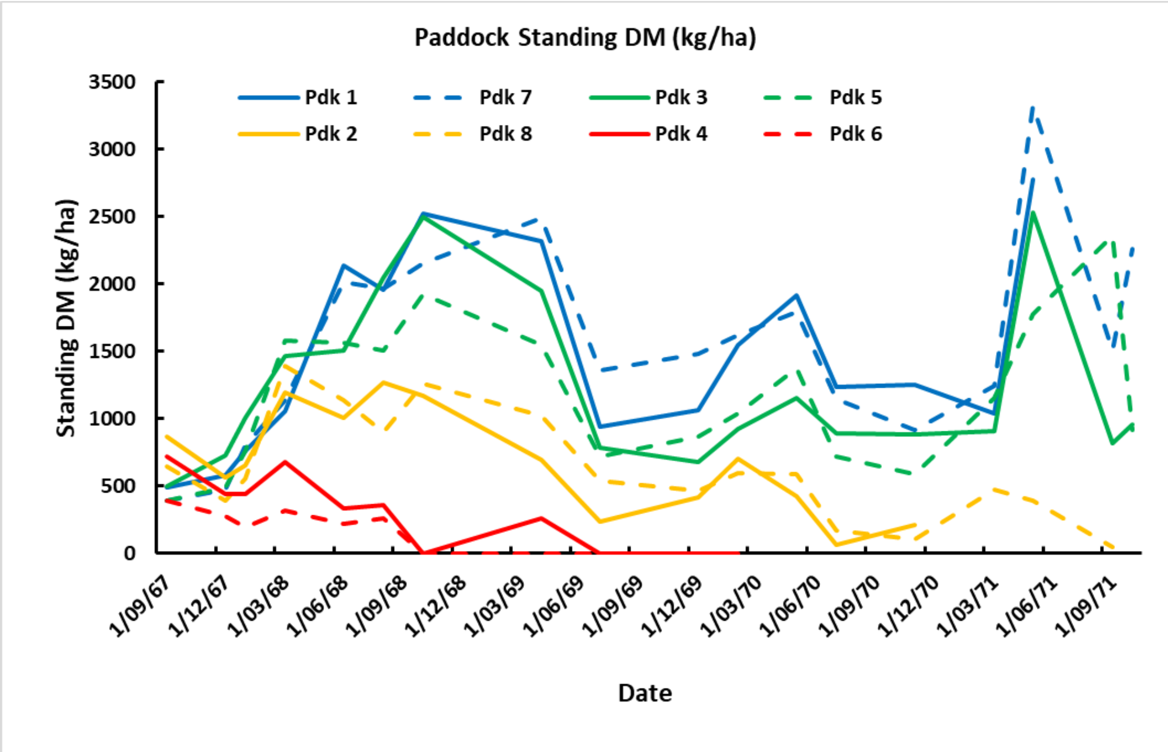


Figure 9 Variation between individual paddocks in recorded standing pasture during Phase 1

The general difference in forage availability shown in Figure 8 partly disguises the differences that existed between the replicate paddocks at certain times (Figure 9). That is partly a sampling error effect (due to relatively small sample numbers in the largest paddocks -40), partly due to patch grazing in the most lightly grazed paddocks; but also a real difference between paddocks due to their location in the landscape. The typical distribution of pasture dry matter assessment categories in individual quadrats due to very different grazing pressures is shown in Figure 10.

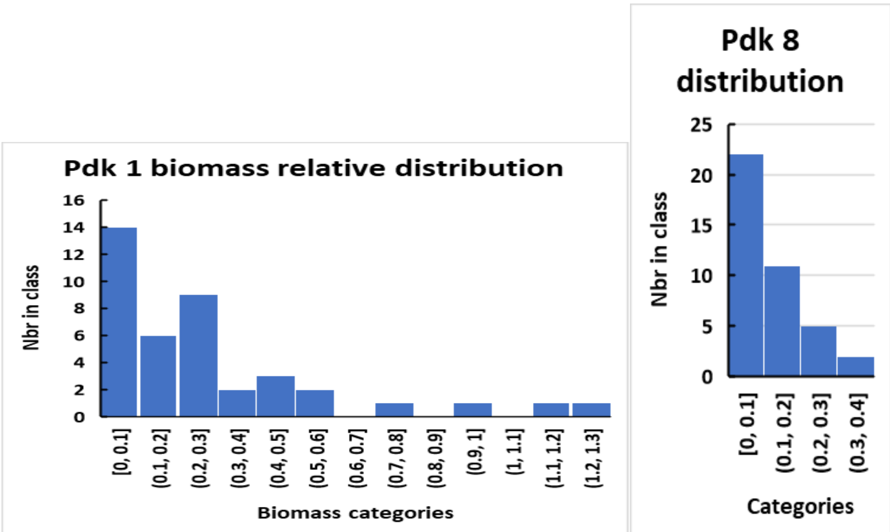


Figure 10 Differences in the distribution of biomass classes in paddocks under very different grazing pressure in December 1969. Paddock 1 was lightly grazed while Paddock 8 was quite heavily grazed.

Paddock 8 seemed to receive extra runoff water from paddock 4 which was often very bare and upslope from it which allowed it to retain more pasture than Paddock 2 at the same stocking rate. There are some gaps in the data because labour resources available at certain times did not allow a full sampling to be done but the probable result can be mentally interpolated because any observed major change due to the treatments would have been sampled for, eg. in paddocks 1 and 2 in 1971.

Table 8 Standing pasture Total Dry Matter and Green pasture DM (kg/ha) during Phase 1

Harvest date	Stocking rate (sheep/ha)									
	10		**5**		**2.5**		**1.25**		LSD	P=0.05
	Total	Green	Total	Green	Total	Green	Total	Green	Total	Green
21/09/1967	625		847		495		491		269	
6/12/1967	400		531		680		589		139	
31/01/1968	353	89	675	325	989	401	870	353	350	240
7/03/1968	558	178	1447	1119	1705	1344	1227	890	636	595
13/06/1968	307	#	1200	1081	1723	1548	2323	2091	311	389
15/08/1968	345		1215		1993		2198		634	
31/10/1968			1361	29	2477	293	2619	418	1159	320
20/04/1969			962	654	1961	1030	2692	1661	1306	840
3/07/1969			436		841		1288		NS	
10/12/1969			488	20	852	237	1408	205	651	132
25/02/1970			728	197	1101	563	1776	896	406	45
7/05/70			567	78	1416	452	2078	714	601	230
9/07/1970			130		899		1334		501	
24/11/1970			158		733	129	1081	350	371	NA
2/03/1971			238	119	1029	508	1141	580	446	NA
25/05/1971			196		2154	281	3052	653	NA	NA
20/10/1971			Nil#		939	94	2367	246	NA	NA

NS = non-significant (P>0.05) NA = Not Analysed # sample too small to process

At least one rep of each grazing pressure was sampled on almost every date or a note made that there was insufficient harvestable material to allow a realistic sample to be cut, eg. paddock 2 (5 sh/ha) in 1971. This data shows how available pasture was always adequate at the two lowest stocking rates (Figure 8) but became limiting at 5 sh/ha after the dry 1969 year. In 1971, even the lowest stocking rate paddock had very little green pasture available at any time, possibly because they were consuming all the limited new green growth as rapidly as it formed (Figure 11). The pasture response to early summer rains was quite marked but less so as the trial progressed through this phase. The greatest amount of green pasture was recorded in June 1968 after 73 mm in late May and a prolonged period of effective rain each month between December 1967 and May 1968 totalling 400 mm. The other high green yield in April 1969 was the result of over 160 mm in mid-March (Appendix 4).

Pasture quality

Pasture quality varied greatly throughout most years with low levels during prolonged dry periods and in most winters after the first frost. The general stemmy nature of vigorous buffel grass pasture further constrained the forage available to the sheep.

Comments from Annual Reports summarise the forage available to the sheep.

- ❖ *1967-68 report*

"Useful June rain produced a rapid green pasture response but that was short-lived due to subsequent frosts. The pasture responded well to Dec-Jan rain."

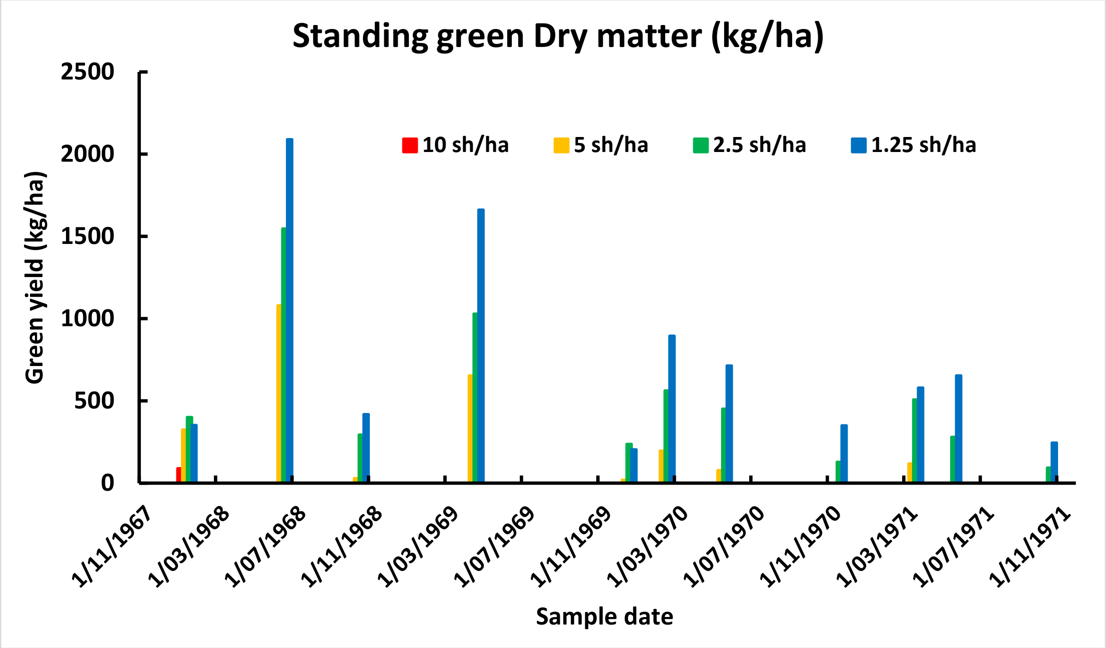


Figure 11 Standing green pasture yield at different times in relation to stocking rate in Phase 1.

❖ *1968-69 report*

"Good green feed until late March despite some very hot days. Feed available at 10 sh/ha reached a critical level by April with sandalwood being browsed (Image 13). The other 3 treatments had feed in excess of requirements."

Image 13 Paddock 6 (10 sh/ha) 22 Nov 1968 after 14 months grazing. Note heavy browsing of false sandalwood shrubs which are very unpalatable.

❖ *1969-70 report*

"Towards the end of June 1970 paddocks 1 and 7 (1.25 sh/ha) carried a good body of "hayed off" material with some green shoot present in the closely grazed tussocks near the watering points. Similar amounts of dry feed were available in paddocks 3 and 5 (2.5 sh/ha) though no green shoot was evident. In paddocks 2 and 8 (5 sh/ha) only dry stem material remained. Even less dry stemmy material remained in paddocks 4 and 6 (10 sh/ha)."

❖ *1970-71 report*

“The buffel grass under the two lightest stocked treatments (1.25 sh/ha and 2.5 sh/ha) responded well to the November rains. The pasture in paddocks 2 and 8 (5 sh/ha) was mostly dry standing material with the green pick being closely grazed. Following destocking, paddocks 4 and 6 (10 sh/ha) grew mainly speedy weed (*Flaveria australasica*) though quite a lot of buffel grass seedlings germinated in the gilgais in paddock 4.

By autumn, most of the feed had hayed off and the seed fallen. Even in the lightest stock treatments bare areas were evident, however, there was also evidence of seedling regeneration. In paddocks 3 and 5 (2.5 sh/ha) no seedlings were observed and any green growth remaining was confined to the gilgais. Paddock 2 was severely depleted of feed with only scattered tussocks of dry stem material remaining. Paddock 8 appeared to have more plant cover than paddock 2.” Image 14 shows this paddock at that time.

Image 14 Bare patches and heavily defoliated sandalwood regrowth in Paddock 8 in October 1971.

❖ *Moisture content and proportion of green foliage*

The moisture content of the bulk buffel grass ranged from 15-17% in dry seasons and winter to 46% in mid-summer after good rain. This range correlated well with the percentage green material in the bulk pasture which ranged from an average 12% up to 64% in pasture that had a good, freshly-grown biomass. However, the relationship was more complex in heavily stocked paddocks where there was negligible pasture and no green foliage visible sometimes while at other times the resprouting crowns after good rain could provide almost 100% green pasture of high moisture content. There was almost always a large proportion of stem in the standing biomass.

❖ *Crude protein (as nitrogen) and phosphorus*

The effect of stocking rate on nitrogen concentration in bulked buffel grass was significant ($P< 0.05$) only in December 1967 but phosphorus concentrations did differ significantly in December 1967, August 1968 and July 1969. On some occasions, very low levels of both N (<0.6%) and P (<0.06%) were recorded from the remaining buffel grass in the 10 and 5 sh/ha paddocks. At other times, N ranged from 0.68% to 1.88% and P from 0.07% to 0.17%, with the highest levels being recorded in the February to April period in the more heavily stocked paddocks where only short green shoot was available. In the green buffel sub-samples, N varied from 0.8% in July 1969 to 2.5% in April 1969 (Table 9) and P from 0.1% (July 1969) to 0.24% (November 1970) (Table 10). Again, the highest values were from the heavily grazed paddocks where a small amount of green shoots was all the pasture available for harvesting. However, there was no consistent trend in the assays on the basis of grazing pressure. Dead buffel grass contained on average 0.67% N and 0.05% P. Differences between replicate paddocks were generally small but that was affected sometimes by appreciable differences in the percentage of green herbage in the pasture. Thus, green buffel grass was providing adequate protein (>7%, equivalent to 1.12% N) and phosphorus to allow animal growth whenever it was available. However, as a general guide, bulked samples of buffel grass pasture in that district could be expected to assay between 0.8% N in winter and dry times and 1.2% in mid-summer when rainfall had been satisfactory. Phosphorus levels would be expected to range between 0.09 and 0.14%.

Table 9 Nitrogen percentage of bulk pasture samples and the green component at various dates in pastures under four different sheep grazing pressures over 4 years.

Values followed by a different letter indicate a significant difference (P<0.05) at that time.

	Whole standing pasture Stocking rate (sh/ha)				Green component Stocking rate (sh/ha)			
Date	10	5	2.5	1.25	10	5	2.5	1.25
27/09/1967	0.80	1.15	0.85	1.20				
6/12/1967	0.45a	0.65b	0.68b	0.88c				
30/01/1968	0.78	1.18	1.08	0.95	1.50	1.70	1.70	1.75
7/03/1968	1.18	1.33	1.18	1.20	1.40	1.70	1.75	2.40
13/06/1968	0.83	0.90	1.03	1.15				
15/08/1968	0.58	0.88	0.80	0.90				
31/10/1968		0.75	0.75	0.83				
22/04/1969	1.88	1.10	1.10	1.00	2.50	1.55	1.33	1.30
3/07/1969		0.53	0.73	0.78		1.00	1.03	0.80
10/12/1969		0.68	0.77	0.85		1.62	1.24	1.42
25/02/1970		0.99	1.20	1.31				
7/05/1970		0.64	0.72	0.86				
24/11/1970			0.79	0.88		2.34	1.74	1.37
2/03/1971			0.88	0.95			1.13	1.18
25/05/1971		0.66	0.83	0.81			1.36	1.41

Table 10 Phosphorus percentage in standing bulk buffel pasture and its green component in pastures under four different sheep grazing pressures at different dates over 4 years.

Values followed by a different letter indicate a significant difference (P<0.05) at that time.

	Whole standing pasture Stocking rate (sh/ha)				Green component Stocking rate (sh/ha)			
Date	10	5	2.5	1.25	10	5	2.5	1.25
27/09/1967	0.09	0.10	0.07	0.10				
6/12/1967	0.05a	0.08b	0.10b	0.11b				
30/01/1968	0.07	0.11	0.10	0.13	0.21	0.19	0.15	0.16
7/03/1968	0.11	0.17	0.10	0.14	0.17	0.15	0.21	0.21
13/06/1968	0.05	0.14	0.14	0.11				
15/08/1968	0.04a	0.10b	0.13b	0.15b				
31/10/1968		0.09	0.11	0.12				
22/04/1969	0.15	0.14	0.12	0.11	0.19	0.18	0.18	0.17

3/07/1969	0.04a	0.07b	0.08b	0.12	0.10	0.10
10/12/1969	0.05	0.09	0.08	0.18	0.15	0.19
25/02/1970	0.10	0.10	0.11			
7/05/1970	0.06	0.09	0.09			
24/11/1970		0.06	0.08	0.24	0.17	0.16
2/03/1971		0.09	0.10		0.15	0.15
25/05/1971	0.07	0.09	0.09		0.19	0.20

*Image 15 Speedy weed (*Flavaria australasica*) abundance in Paddock 6 in October 1970.*

Other vegetation shifts

A browse line to approximately 1.5 m high was prominent by March 1968 on sandalwood trees and regrowth in paddocks stocked at 10 sh/ha, with shorter regrowth being completely defoliated. During summer and autumn 1968 this treatment was invaded by speedy weed which was grazed very sparingly by the sheep (Image 15). This contrasted with the other treatments where no obvious browsing of sandalwood or invasion by speedy weed occurred (Image 8). However, during 1970 and 1971 a similar situation also developed at 5 sh/ha as forage supplies diminished. In February 1971 hungry sheep uprooted young speedy weed plants (15 to 20 cm high) and consumed the entire plant.

Animal data

General – deaths, escapes,

Very few losses occurred during this phase either by escape from their paddock or from disease or flystrike. The property is in an area that was protected by the dingo barrier fence.

Sheep liveweight

The complete, raw, individual ewe liveweight data for the first two years of the trial have not been retrieved from archival DPI files. However, there is a complete record over time of the mean treatment results (Figures 12, 13 and 14) and almost complete records for paddocks 2 and 8 throughout. Weights for individual sheep have been recovered for the initial and final weighings of Mobs 1 and 2 and averaged in Table 11. The means for the replicate paddocks track closely for most dates and the differences due to stocking intensity become manifest after the first few months. The data for paddocks 4 and 6 (10 sh/ha) are fragmented after 1968 because these animals were regularly fed hay after the first year to allow the grazing pressure on the pasture to be maintained but interest in their growth waned. Sometimes they were not weighed for expediency and universally low worm burdens in the other paddocks removed any need to monitor faecal samples from them.

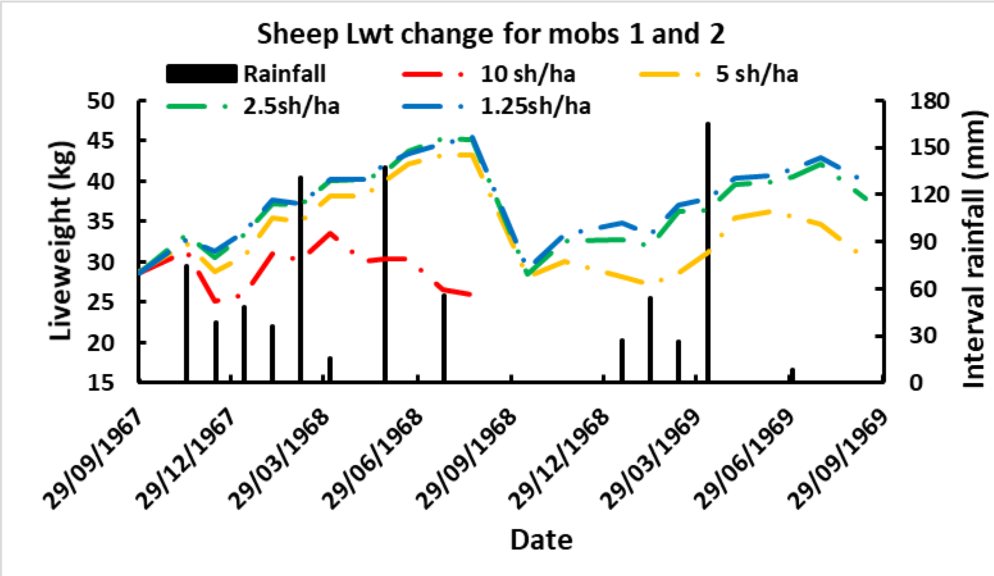


Figure 12 Liveweight changes under different grazing pressure for the first 2 mobs of ewes on buffel grass pastures at 'Eastwood'. Rainfall bars show cumulative rain between weighings.

The liveweight changes of sheep at 1.25 and 2.5 sh/ha exhibited a similar pattern throughout the four periods, although total liveweight gains were significantly greater at 1.25 sh/ha in 1969/70 and 1970/71 ($P<0.05$; Figures 13 and 14). In the graphs, Block 1 paddocks are shown as a solid line and Block 2 lines are dashed, using a different colour for each stocking rate.

Table 11 Mean sheep liveweight (kg) for each paddock for Mobs 1 and 2 extracted from surviving records. Means are mostly from 16 animals. The data is almost complete for the 5 sh/ha treatment (Paddocks 2 and 8).

	1.25 sh/ha				Paddock		10 sh/ha	
Date	1	7	3	5	2	8	4	6
29/09/1967	29.4	27.9	28.7	28.6	29.5	28.1	28.5	28.7
15/11/1967	31.5	34	33.6	33.2	31.9	32.7	31.6	31.0
13/12/1967					29.3	28.2		
10/01/1968					30.6	30.7		
7/02/1968	38.7	39.1	38.1	38.1	36.5	36.8	30.8	27.6
6/03/1968					35.1	34.9		
4/04/1968					38.1	38.2		
7/05/1968					38.4	38.0		
28/05/1968					40.1	39.9		
19/06/1968					42.6	41.6		
24/07/1968					44.0	42.6		
21/08/1968	46.9	43.8	45.5	45.1	43.5	43.0	26.9	25.1
14/10/1968*	28.3	30	29.1	27.9	28.1	28.3		
20/11/1968					27.0	27.6		
15/01/1969					28.2	29.0		
12/02/1969	31.9	34.8	32.7	31.2	30.6	32.0	24.8	24.1
12/03/1969					34.7	36.1		

	1.25 sh/ha				Paddock		10 sh/ha	
Date	1	7	3	5	2	8	4	6
10/04/1969	36.3	39.6	36.7	36.2	35.0	37.4	29.9	27.0
6/05/1969					34.2	37.1		
11/06/1969					33.3	35.9		
2/07/1969								
30/07/1969								
11/09/1969	39.4	40.4	39.6	36.2	28.9	33.5		

* Mob 2 replaces Mob 1

In 1967/68, sheep at 5 sh/ha performed similarly to those at 2.5 and 1.25 sh/ha although their overall weight gain was approximately 2 kg/head less. At 10 sh/ha weight losses commenced in April 1968 and at the end of the grazing period these sheep were 5.7 kg (free of wool) lighter than at commencement in September 1967 (Figure 12). Sheep in paddock 8 generally grew better than those in the other replicate at the same stocking rate (Figures 13 and 14, Table 11). Note how feeding a hay supplement to sheep run at 10 sh/ha in 1969-70 kept their weight slightly above their starting weight but removed the normal seasonal fluctuation seen at other stocking rates (Figure 13). Despite an abundance of pasture biomass, the Mob 2 sheep grazing at 1.25 and 2.5 sh/ha did not grow nearly as well as their counterparts from Mob 1 due to the much drier seasonal conditions (Figure 12).

In all four Phase 1 years, once summer growth occurred, paddock 8 sheep gained more weight than those in paddock 2, the other replicate at the same stocking rate. They then maintained that advantage until removed at shearing, despite losing a lot of condition during the winter (Figures 12, 13, 14, Table 11).

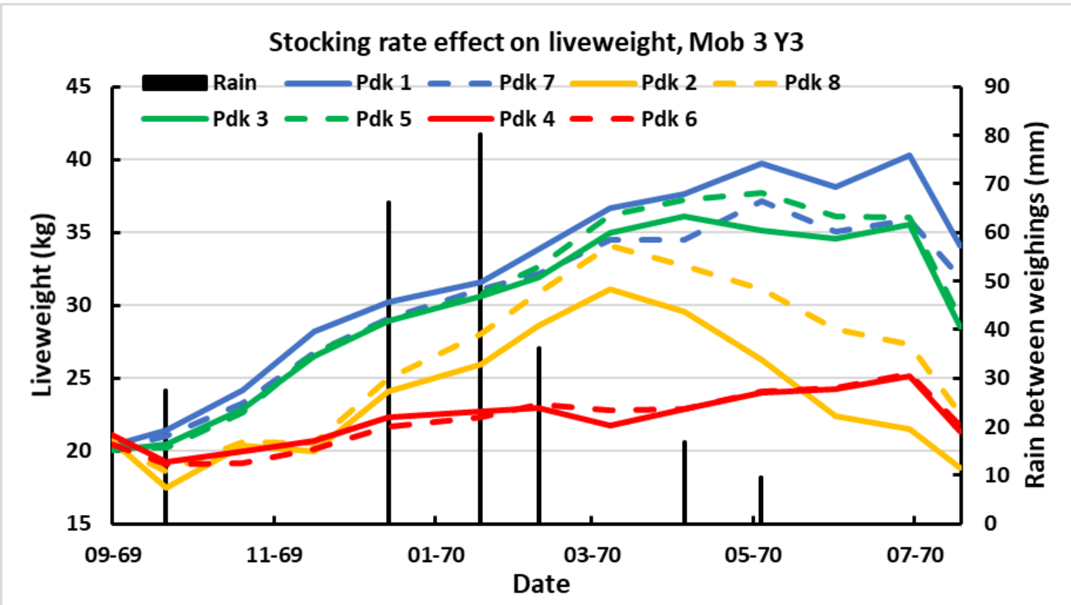


Figure 13 Liveweight changes during the year for Mob 3 ewes grazing buffel grass pastures at 4 different stocking rates.

Rainfall bars show cumulative rain since the previous weighing. Block 1 paddocks are shown as solid lines and block 2 dashed.

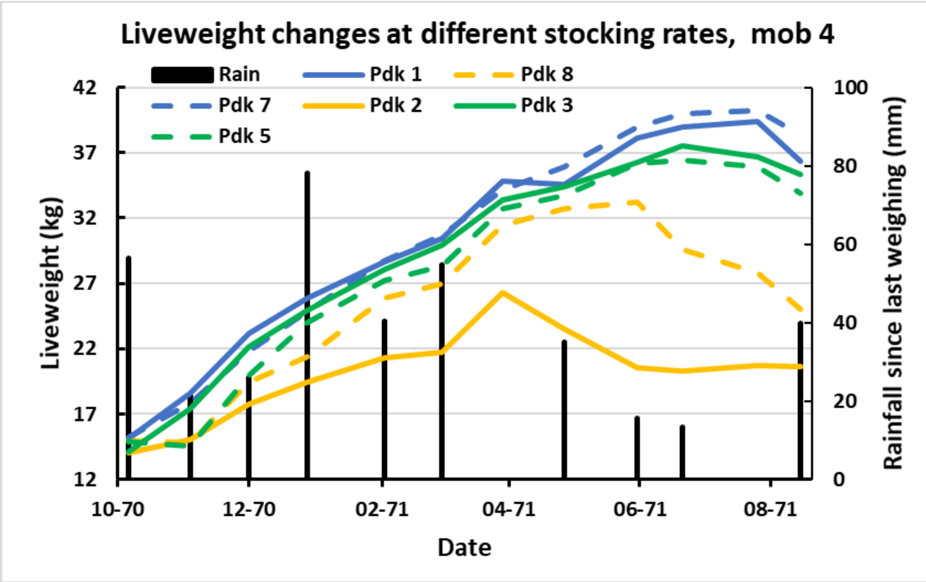


Figure 14 Mean paddock liveweight changes for Mob 4 ewes under the 3 lightest grazing pressures. Rainfall bars show cumulative rain since the previous weighing.

Average daily gains were approximately 0.08 kg/head/day following effective summer and autumn rains. At 1.25 and 2.5 sh/ha, gains of this magnitude were maintained to June/July each year whereas at 5 sh/ha weight losses commenced in autumn/early winter in each of the last three grazing periods (Figures 12, 13, 14). In the dry spring of 1969, forage quality and/or quantity were insufficient to allow weaners to gain weight when stocked at 5 sh/ha but such was still possible at 2.5 sh/ha (Figure 13; Table 12). There was a significant effect of stocking rate on weight gain on almost all occasions (Table 12).

Table 12 Rate of liveweight gain (kg/hd/d) between various dates for sheep in Mobs 1-4, the rain received over that time and the net liveweight change (kg) of weaner ewes up until shearing.

	Rain received	Stocking rates Sheep/ha				
Date interval	(mm)	10	5	2.5	1.25	L.S.D. P =0.05
28.9.67 - 13.12.67	114	-0.035	0.0078	0.033	0.041	0.0069
13.12.67 - 4.4.68	211	0.07	0.082	0.082	0.080	n.s.
4.4.68 - 24.7.68	181	-0.054	0.051	0.052	0.044	0.0099
28.9.67 - 21.8.68	**506**	**-5.74**	**10.05**	**11.96**	**12.14**	**1.11**
14.10.68 - 20.11.68	6		0.051	0.109	0.115	0.03
20.11.68 - 12.2.69	61		-0.033	-0.006	0.002	0.01
12.2.69 - 11.6.69	162		0.084	0.065	0.062	0.01
11.6.69 - 30.7.69	24		-0.033	0.045	0.042	0.01
14.10.68 - 5.9.69	**253**		**-0.190**	**5.505**	**6.342**	**1.36**
25.9.69 - 15.10.69	25		-0.130	0.130	0.050	0.04
15.10.69 - 1.4.70	217		0.085	0.084	0.083	0.01
1.4.70 - 22.7.70	10		-0.080	0.003	0.019	0.01
25.9.69 - 11.8.70	**252**		**-0.08**	**8.65**	**12.75**	**1.55**
15.10.70 - 7.4.71	266		0.082	0.107	0.106	0.01
7.4.71 - 24.8.71	104		-0.043	0.016	0.035	0.01
15.10.70 - 24.8.71	**370**		**5.34**	**15.95**	**18.17**	**1.19**

Rainfall received during any long growth interval was not a good predictor of eventual weight gain - over 500 mm in 1967-68 produced similar annual gains as 250 mm in 1969-70 (Table 12). However, rate of gain over shorter time periods was quite well correlated with rainfall received once the rain exceeded about 50 mm (Figure 15), particularly if the grazing pressure was moderate.

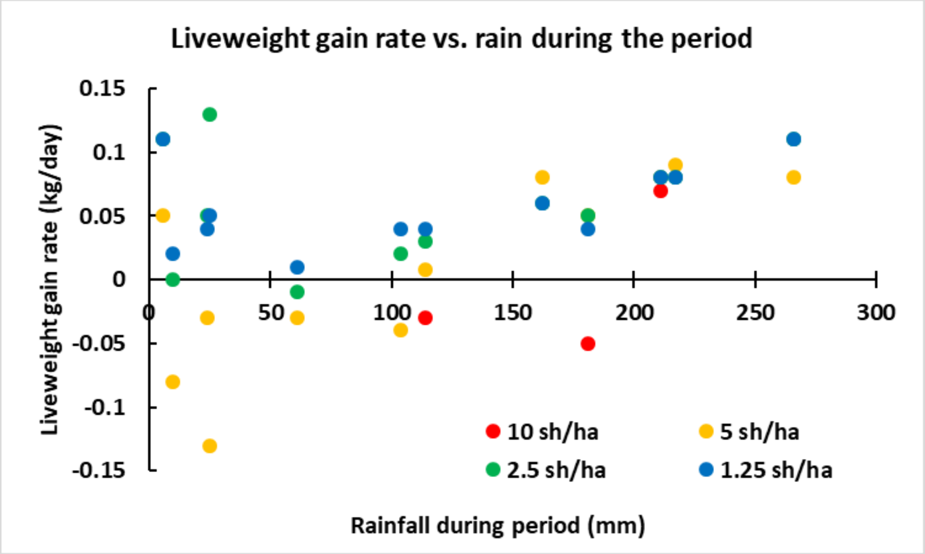


Figure 15 Relationship between rate of liveweight gain (kg/day) over a short period and rainfall received (mm) during that period, using data from all 4 mobs.

An optimum stocking rate for these pastures was calculated based on average liveweight gains over the four years for the three lightest stocking rates (after Jones and Sandland 1974). It was about 3.4 sh/ha (1.4 sh/ac) but this is for small paddocks and would be an overestimate if extrapolated to a commercial property scale. How great such an overestimate might be would depend mostly on distance between watering points, pasture biomass (and thus rainfall) and shade availability (Bailey 2005).

Table 13 Contrasting liveweight changes in mid-summer 1968 associated with pasture availability and nutritional stress during and after cool rainy weather from 11 to 18 February.

Stocking rate	Paddock	7/02/1968	22/02/1968	change	29/02/1968	change
1.25 sh/ha	1	38.7	39.8	1.1	39.9	0.1
	7	39.1	40.3	1.2	39.8	-0.5
2.5 sh/ha	3	38.1	38.9	0.8	39.3	0.4
	5	38.1	39.1	1	39.5	0.4
5 sh/ha	2	36.5	37.5	1	37.3	-0.2
	8	36.8	38.2	1.4	37.5	-0.7
10 sh/ha	4	30.8	29.7	-1.1	33	3.3
	6	27.6	25.1	-2.5	30.4	5.3

In February 1968, there was an extended period of cool wet days and the sheep in the very heavily stocked paddocks lost a considerable amount of weight while those in the more lightly grazed paddocks did not (Table 13). The weather was bleak enough that, despite the rain to boost new pasture growth, weight gain was curtailed for several weeks. Fortunately, the distress of those sheep running at 10 sh/ha was short-lived and they rapidly regained weight, possibly partly because they achieved gut fill from new pasture growth which was not possible beforehand (Table 13).

Image 16 New buffel regrowth in Sept 1970 which was difficult for sheep to reach in amongst the long, stiff, thick stems surviving from the prior growing season under very light grazing pressure.

It is intriguing that the sheep in the lightly grazed paddocks did not get a rapid boost of growth from the same rain and illustrates well the complex dynamics of animal performance on pastures in rangeland environments. It may have been due to an inability to reach early buffel regrowth within the thick, stiff, dead stems remaining from the bulky growth of the prior two summers (Image 16).

More detailed liveweight data is presented in Appendix 5.1 to 5.3 but only as paddock averages for Mobs 1 and 2 because the original data sheets are missing.

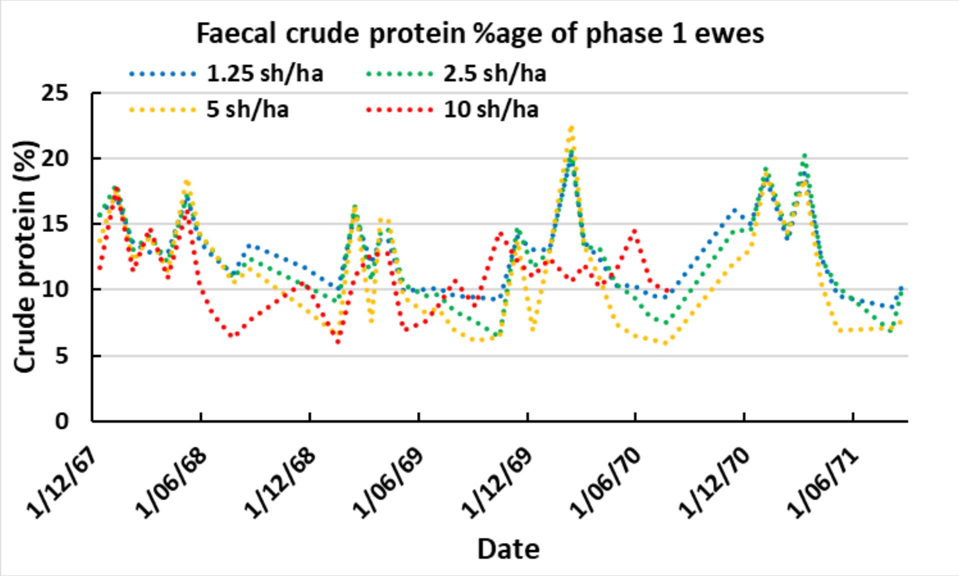
Faecal protein and phosphorus

Faecal nitrogen/crude protein and phosphorus concentrations were significantly correlated (r = 0.85, P<0.05) over time. Greatest levels were recorded in late summer to early autumn. See Appendix 6.

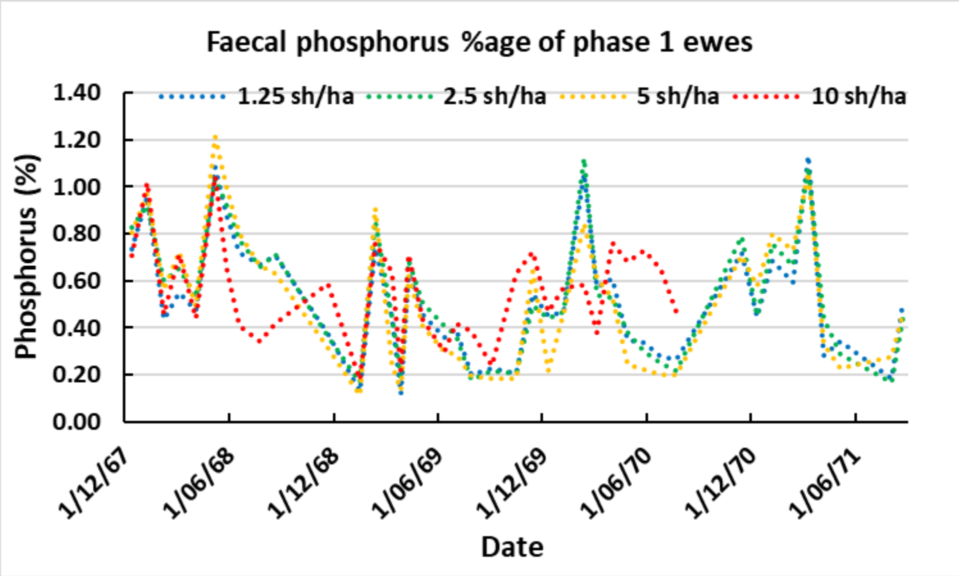
Stocking rate effects on faecal crude protein levels (faecal N% x 6.25) were significant (P< 0.05) at only eight of the 42 sampling times during Phase 1. On seven of these occasions lowest nitrogen concentrations were in the most heavily stocked treatments (10 sh/ha in 1967/68 and 5 sh/ha in the remaining periods). The highest recorded level of faecal crude protein was 22.7% (3.39% N) in February 1970 and the lowest was 6.1% (0.94% N) at 10 sh/ha in January 1969 and at 5 sh/ha in July 1970. Note how the diet quality of the highest stocking rate treatment was as adequate as that at the lightest stocking rate until availability of forage in winter 1968 fell to low levels and the sheep could not select an adequate diet, while sufficient standing forage still existed in all other paddocks to allow adequate selectivity (Figure 16 (a)). However, in subsequent years total forage availability often fell to such low levels that the sheep could not select an adequate diet, especially at 5 sh/ha. In the very poor forage growth year in 1969, diet quality never reached the transient heights that were seen in all other years of Phase 1 (Figures 16 (a) and (b)).

Significant (P<0.05) stocking rate effects on faecal phosphorus were recorded on four occasions only. At three of these times (July 1968, March and December, 1969) concentrations were lowest in the most heavily stocked treatment with no significant differences amongst the remaining stocking rates.

Maximum faecal phosphorus concentration was 1.22% (May 1968) at 5 sh/ha and the minimum concentration was 0.12% (January and March 1969) after months without effective rain.



(a)



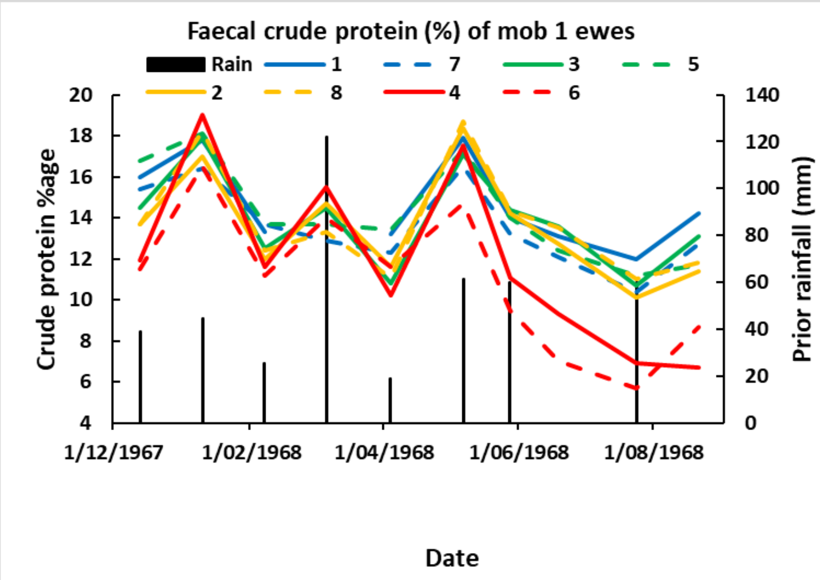
(b)

Figure 16 Temporal fluctuations in faecal (a) protein and (b) phosphorus under changing seasonal conditions and a range of stocking rates.

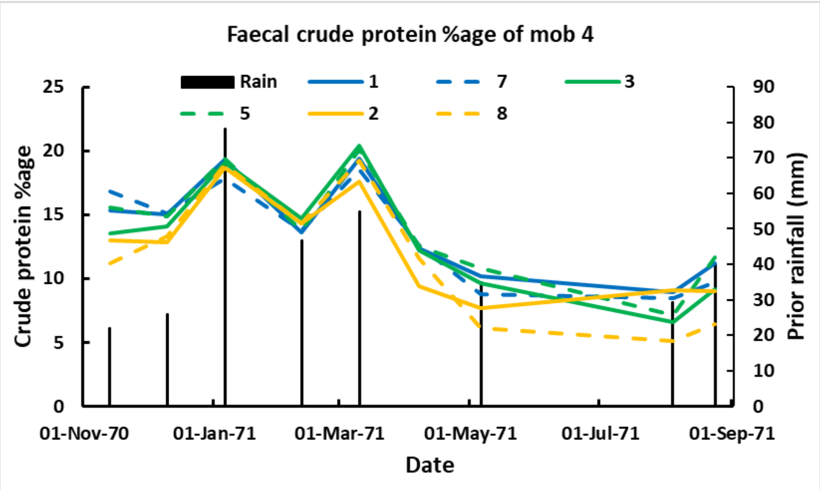
Lucerne hay supplements produced a distinct smoothing of the seasonal fluctuation in faecal protein and phosphorus levels in samples from the sheep at the heaviest stocking rate compared to the three other unsupplemented treatments in the 1969-70 year (Figure 16). Individual paddock data for Mobs 1 and 4 are presented in Figure 17 to illustrate the degree of variability sometimes shown between paddocks being grazed at the same intensity.

Forage quality was lowest in late spring before the pasture renewed growth after some rain fell in mid-October and highest in mid-summer after good rain (Appendix 3). Appreciable differences between replicates of the same stocking rate were not common (Figure 17) but the great variation over time in the unsupplemented buffel pastures was very clear compared to that of the ewes that received regular lucerne hay after 1968 to prevent them from starving at the highest stocking rate (Figure 16). It is also obvious that seasonal conditions had a far greater impact on diet quality than stocking rate provided grazing pressure was not so great as to limit the animals' ability to achieve gut-fill as happened at 10 sh/ha (Figure 17 (a), paddocks 4 and 6).

Dietary protein levels following rain differed depending on the season in which the rain fell. Early in the 1967-68 summer, faecal N increased 6% (11.7 to 17.7) in sheep grazing at 10/ha after only a small amount of rain (50 mm in 5 falls), while in mid-summer, 130mm over a month produced only a 3% increase (Figure 17 (a)). After that dietary protein level fell in the absence of appreciable rain but faecal protein jumped up 5% after 70 mm of rain in autumn 1968. Such changes were generally less under lighter grazing pressure after the same rainfall but the amount of standing forage at the time was also a factor as shown by the data from 5 sh/ha (Appendix 6). Individual paddock differences also seem to become important in the 1971 winter (Figure 17 (b)) with paddock 8 providing lower quality forage than its duplicate paddock 2. Further good late May/early June rain did not prevent the start of the normal decline in buffel protein levels which continued until mid-August 1968 (Figure 16).



(a)



(b)

Figure 17 Seasonal variation in faecal (a) crude protein for Mob 1 and (b) for Mob 4 in each paddock. Rainfall bars show cumulative rain since the previous weighing.

Thus, there appeared to be a trade-off in buffel grass's response to rain under different seasonal or temperature-daylength scenarios. In early summer, a small amount of rain resulted in a marked increase in faecal protein level, probably linked to extra soil N mineralisation after a relatively dry period and only a moderate plant growth rate. Conversely in mid-summer, good rains increased plant N levels but rapid plant growth rate under high temperatures diluted the available N in buffel leaves and thus in a sheep's diet. Buffel pasture diet quality fell steadily during winter but sometimes improved in early spring without the need for more rain, maybe due to spring herbage growth rather than buffel grass growth? Only at extremely high grazing pressure (about 7 DSE/ha) did stocking rate influence the diet available to sheep grazing these buffel pastures in late winter.

The levels of faecal nitrogen reached greater concentrations than those recorded by Gartner and Murphy (1972) for Mitchell grass pastures near Julia Creek but declined to similar very low levels in late winter, below 1% at high grazing pressure (Figure 17). Faecal phosphorus levels were in the same range as those of Gartner and Murphy (1972) and were consistently adequate for good animal health.

Faecal ash content

On three occasions, the ash content of the faecal samples was reported. There is no obvious trend or stocking rate effect evident in the data (Table 14) except somewhat higher ash in the 10 sh/ha paddocks.

Table 14 Faecal ash content (% on DW basis) on 3 dates during 1968

Stocking rate	Paddock	Date		
		10/01/1968	24/07/1968	21/08/1968
1.25 sh/ha	1	32.9	27.2	30.3
	7	31.2	28.1	29.3
2.5 sh/ha	3	28.6	31.5	28.7
	5	31.4	28.4	30.0
5 sh/ha	2	34.7	27.3	33.5
	8	34.4	31.8	30.3
10 sh/ha	4	33.8	34.7	37.3
	6	40.1	39.4	27.6

Diet selection results

There are no results available for the diet selection study. Samples were collected from all paddocks on several occasions but analysis of those oesophageal extrusa proved very difficult and the unreliable results were abandoned.

Fleece weight

In each of the four mobs, greasy fleece weights per head (bellies included) decreased as stocking rates increased except in the first year when there was no difference between the two lightest rates. Only at the August 1970 shearing of Mob 3 was there a significant difference ($P<0.05$) between 2.5 and 1.25 sh/ha when fleeces were heavier in the latter treatment (Table 15). Greasy and clean wool per hectare were very sensitive to stocking rate. Production per hectare almost doubled by increasing stocking rate from 1.25 to 2.5 sh/ha and continued to increase at heavier stocking rates (Table 15). Clean wool production rate measured by the dye-banding process was greatest in late summer to early autumn in the first three mobs but occurred in November 1970 in the fourth period when 40 mm of rain fell in 3 falls over 14 days. In 1967/68 and 1969/70 peak wool production from the heavier stocked treatments 10 sh/ha (1.21 mg/cm^2/d) and 5 sh/ha (1.45 mg/cm^2/d) respectively, was significantly ($P<0.05$) greater than from the other treatments (means of 1.00 and 1.20 mg/cm^2/d respectively for each of the above years). This advantage was not maintained during winter when clean wool production was greatest from the lightly stocked treatments (Figure 18).

Table 15 Annual greasy fleece weights per head and per hectare from 1968 to 1971 for sheep grazing buffel grass at four stocking rates.

Stocking rate (sheep/ha)	August 1968		September 1969		August 1970		August 1971	
	kg/hd	kg/ha	kg/hd	kg/ha	kg/hd	kg/ha	kg/hd	kg/ha
10	3.08	30.8	2.62	26.2	2.73	27.3		
5	4.28	21.4	3.40	17.0	3.08	15.4	3.04	15.2
2.5	4.58	11.45	3.90	9.75	3.94	9.85	3.91	9.75
1.25	4.56	5.70	4.12	5.15	4.25	5.31	4.10	5.13
LSD P = 0.05	0.19		0.22		0.27		0.22	

When averaged over the 4 years, there was no consistent difference in the assessed wool growth rate in different seasons and for the three lightest grazing pressures but it was usually much less on sheep grazing at 10 sh/ha, except in summer (Figure 19). More details for individual assessment periods are provided in Appendix 7 along with the test results for statistical effects for each period.

These results are also incorporated into Appendix 9 which summarises the greasy fleece production by each mob of sheep throughout the 4 phases of the trial and relates that data to the time available to grow each fleece and the rainfall received for pasture growth during that flock time. The data are not strictly comparable when different mobs of sheep are involved, sometimes full-mouth wethers in later years rather than weaner ewes as used in this first (and dry) phase.

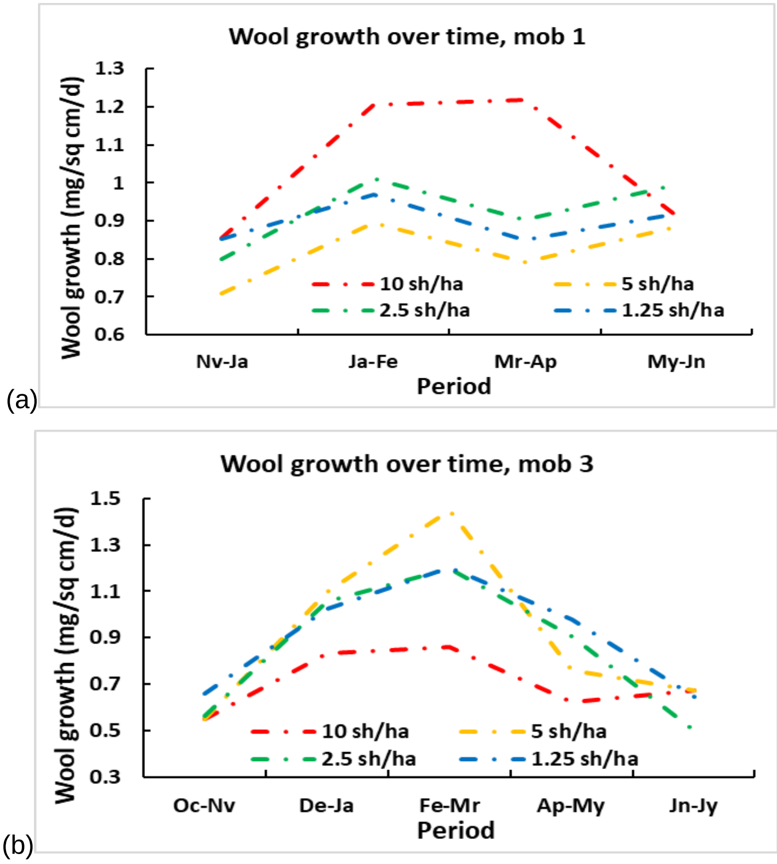


Figure 18 Clean wool growth rate variation over the treatment period for (a) Mob 1 (1967-68) and (b) Mob 3 (1969-70) as affected by grazing pressure. The 10 sh/ha treatment in Mob 3 received lucerne hay supplement for survival and thus lacked the strong seasonal variation seen for the other stocking rates and for Mob 1 at this grazing pressure (Figure 17 (a))

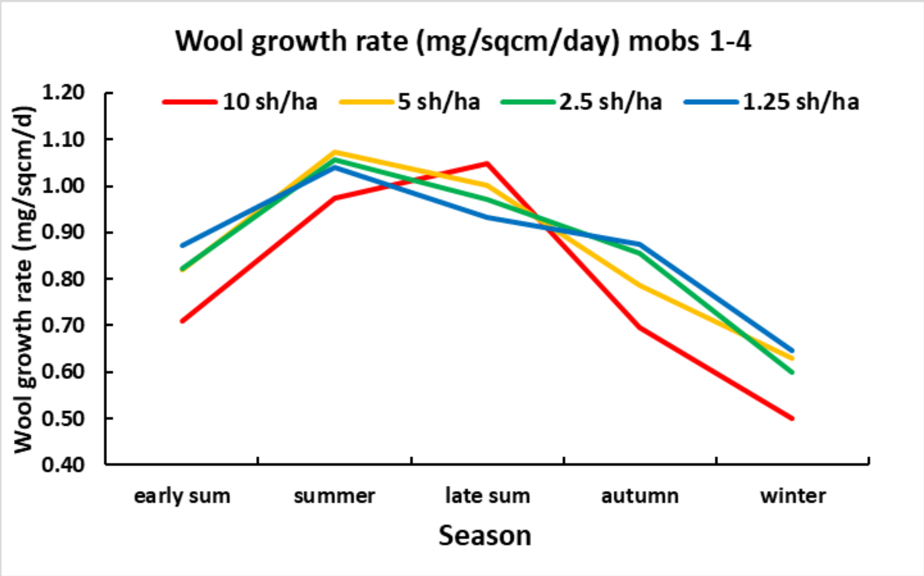
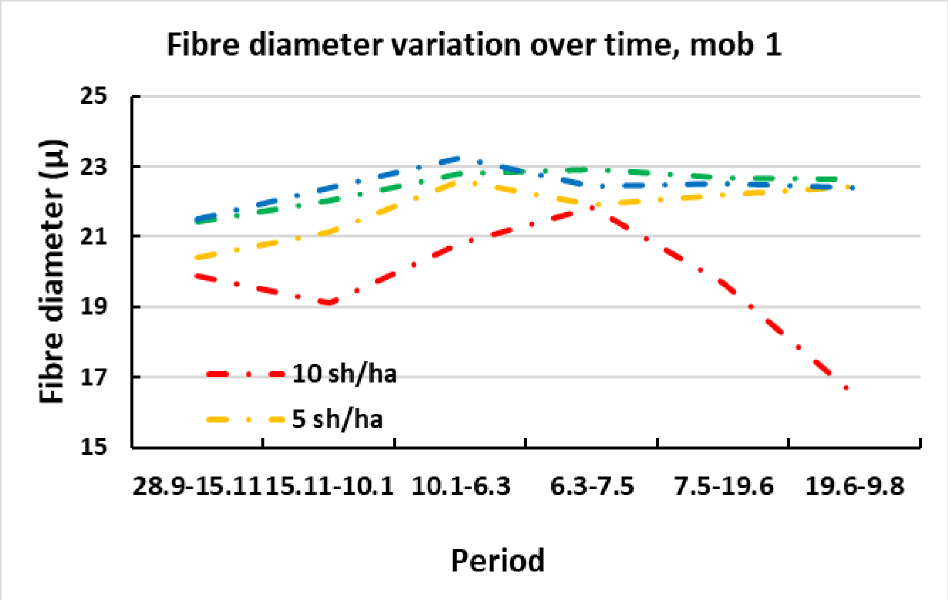


Figure 19 Clean wool growth rate during different periods of the year and the effect of grazing pressure on that rate, averaged over four different mobs of weaner ewes grazing buffel grass.

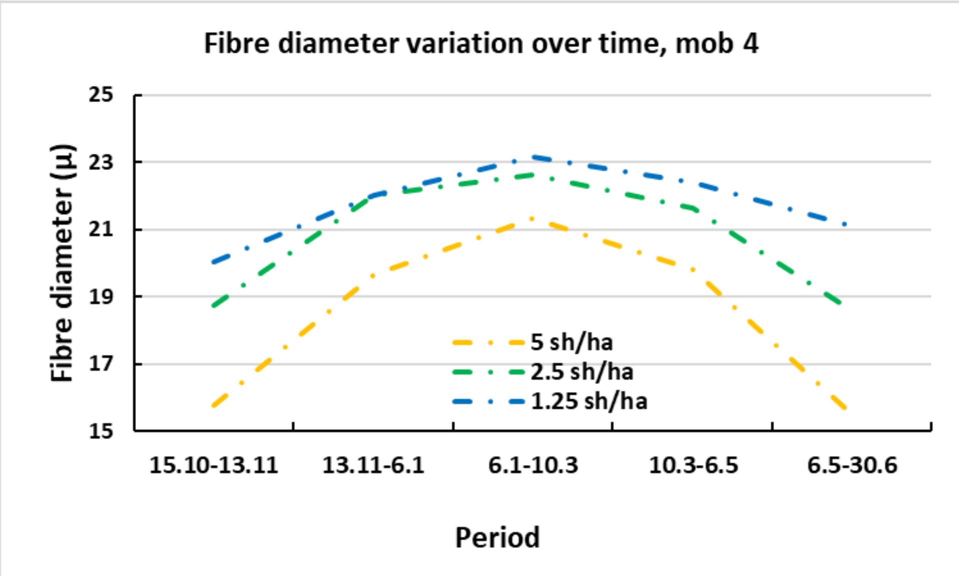
Fleece quality

Fibre diameter, yield, tenderness, strength and brightness

Peak mean fibre diameter along wool staples varied from 21 to 23 microns between years and occurred during late summer. Conversely, in early spring and winter, mean fibre diameter often thinned temporarily to under 16 microns in the more heavily stocked treatments (Figure 20 (b)). The means disguise a large variation amongst the individual sheep in a paddock and a mob which was often as great as 5-6 microns. However, the change in wool fineness over a year generally followed the same pattern for individual sheep. This was unaffected by stocking rate except in 1970/71 (Figure 20 (b)) when average peak diameter at 5 sh/ha (21.4 microns) was significantly ($P<0.05$) thinner than that at 1.25 sh/ha (23.2 microns). Significant treatment differences occurred at other times of the year with diameters reducing as stocking rate increased (Figure 20). Fibre diameter and clean wool production were significantly and positively correlated ($r = 0.58$, $P<0.05$) over time.



(a)



(b)

Figure 20 Wool fibre diameter variation over the seasons as affected by year and by grazing pressure. Mob 1 (a) was 1967-68 year and Mob 4 (b) was the 1970-71 year.

When micron count variation with season is meaned over the 4 ewe mobs a clear pattern and trend emerges (Figure 21) with little difference between the 1.25 and 2.5 sh/ha grazing pressure but then a marked effect of grazing pressure as it increased further. Details of mean fibre diameter during each assessment period, on a stocking rate basis, are provided in Appendix 8 along with the test for statistical effects for each period.

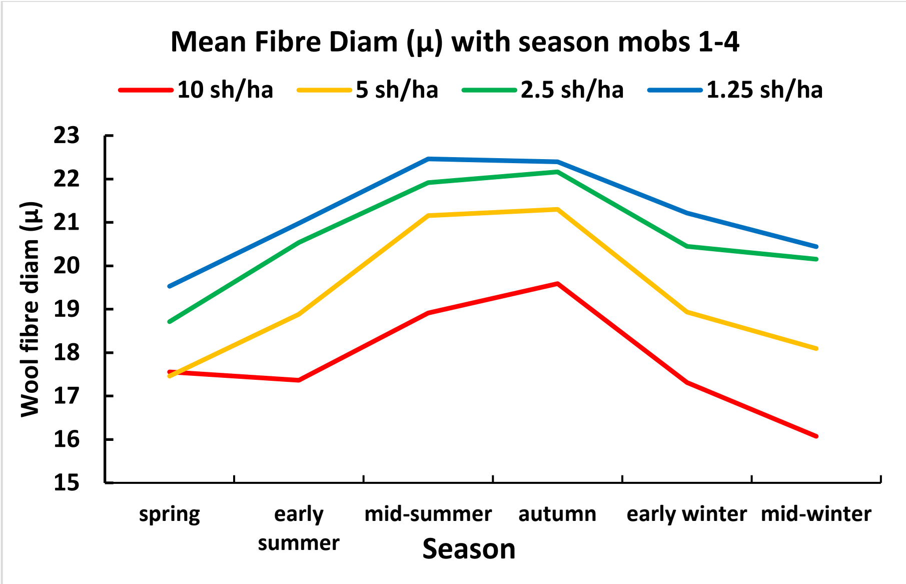


Figure 21 Seasonal and grazing pressure effects on wool fibre diameter averaged over 4 mobs of weaner ewes grazing buffel grass pastures

Percentage yield in each of the four years was insensitive to stocking rate. Mean yields were 65.6%, 59.1%, 56.6% and 56.8% for the 1968, 1969, 1970 and 1971 shearings respectively.

Tender fleeces (staple breaks easily) were recorded in 1968/69 at 1.25 sh/ha (2 sheep) and 5 sh/ha (2 sheep) and again in 1970/71 at 5 and 2.5 sh/ha, with one sheep in each case. Fibre strength and brightness were never objectively measured during this trial.

Fleece wool samples graded by the wool classer using the Bradford method provided the following grades (Table 16). The greater proportion of finer fleeces grown in the drier fleece years of 1968-69 and 1969-70 is obvious; higher ‘counts’ mean finer wool.

Table 16 Number of fleeces from each grazing pressure meeting the Bradford count values shown for each of the four mobs grazed at 4 different stocking rates on buffel grass pasture.

	Stocking rate	Mob 1				Mob 2				Mob 3				Mob 4		
Count	(sh/ha)	1.25	2.5	5	10	1.25	2.5	5	10	1.25	2.5	5	10	1.25	2.5	5
58s		3	3	1	0	0	0	0	0	0	0	0	0	0	0	0
60s		15	21	21	20	13	15	14	10	14	19	13	14	25	29	23
64s		13	8	9	11	16	12	14	16	16	5	13	11	6	3	8
70s		1	0	1	1	3	5	4	5	2	7	2	4	1	0	0

Parasites

Worm Burden

During this phase, intestinal worm burdens in faecal samples were measured 18 times. At all recordings in all treatments nematode egg burdens were less than 200 eggs/g and no anthelmintic treatments were applied during the dry first 4 years. However, worm egg counts did exceed desired levels on a few occasions in the wetter Phase 2 years of the mid-1970s.

Flystrike

Flystrike was a continual problem throughout this project and jetting of all sheep off-shears assisted in its control. However, it was common for 1 or 2 sheep in a paddock to be struck during each year and the incidence was unrelated to grazing pressure. All trial sheep were mulesed at lamb marking as a standard local practice to help reduce the potential for fly-strike, especially in ewes. Afflicted sheep were treated individually by clipping the wool over the affected area and then applying insecticide such as diazinon. If undetected early, flystrike could lead to almost complete loss of a long fleece or even death of very susceptible animals.

Lice

Lice were managed by jetting all sheep off-shears with insecticide via a hand-held wand before they returned to their paddocks. Commonly used insecticides were diazinon and ivermectin.

Pasture/Animal production relationships

Average daily gain (ADG) was significantly correlated with faecal N ($r = 0.59$, $P<0.05$) and with faecal P ($r = 0.54$, $P<0.05$), the regression equations being:-

$$\text{ADG (g/hd/d)} = -94.1 + 72.0\ (\pm 6.8)\ \text{faecal N(\%)}$$

$$\text{ADG (g/hd/d)} = -28.2 + 142\ (\pm 15)\ \text{faecal P(\%)}$$

In a multiple regression equation of average daily gain on both faecal nitrogen and faecal phosphorus, a test of the additional explained variation (in average daily gain) due to the inclusion of faecal phosphorus was not significant ($P>0.05$).

Fibre diameter was also significantly correlated with faecal nitrogen levels ($r= 0.56$, $P<0.05$) -

Fibre diameter (µ) = 16.5 + 2.06 (± 0.3) faecal nitrogen (%)

Stocking rate expressed as Dry Sheep Equivalents (DSE) per hectare

The effective average stocking rate achieved by stocking each paddock with 16 weaner ewes and letting them grow to maturity was often less than the nominal rate when calculated in terms of dry sheep equivalents (DSE) (Table 17). The method used to calculate grazing pressure in terms of standardised DSEs was described earlier in the Methods section. The relative intensity of grazing across the 4 treatments was clearly maintained by this approach although the sheep in the 10 sh/ha paddocks received regular extra lucerne hay after year 1 because the pasture was unable to provide sufficient for them to survive at that grazing intensity. Sheep in paddocks 2 and 8 also required hay supplementation for a short period in several winters when they ran very short of available pasture.

Table 17 Stocking rate of each paddock and treatment each year when expressed as dry sheep equivalents (DSE). 1 DSE represents the pasture consumption by a 50kg dry sheep just maintaining its bodyweight.

Year	Mob	Paddock								Treatment			
		Pk4	Pk 6	Pk 2	Pk 8	Pk 3	Pk 5	Pk 1	Pk 7	10 sh/ha	5 sh/ha	2.5 sh/ha	1.25 sh/ha
1967-68	1	7.0	6.8	4.7	4.8	2.5	2.5	1.3	1.2	6.91	4.76	2.50	1.25
1968-69	2	6.6	6.7	3.7	3.7	2.4	2.2	1.1	1.2	6.66	3.68	2.29	1.16
1969-70	3	5.0	5.2	2.8	3.1	1.9	2.0	1.1	1.0	5.06	2.96	1.96	1.04
1970-71	4			2.6	3.4	2.1	2.0	1.1	1.1		3.02	2.04	1.11

The short-term grazing intensity was often 50% greater than these averages during periods of rapid pasture growth after rain when the sheep were able to put on weight at a rapid rate (100-200 gm/d) and thus their intake was far greater than that needed simply to maintain their bodyweight. For simplicity of calculation, no allowance has been made for the regular growth of wool but that is very small compared to the rate of change that could occur to the total body mass – around 3 to 4 orders of magnitude. Loss of weight at similarly great rates was also recorded in dry winters with a concomitant decrease in effective grazing pressure due to a much-reduced rate of food passage through the gut and thus reduced intake.

Other sheep data

Oestrus cycling

Earliness to puberty and the reproduction performance of the first four mobs of weaner ewes were studied. One of 8 vasectomised teaser rams with a Siresign raddle harness was located in each paddock for 2 months in late summer, rotated weekly, when the ewes were about a year old and they were assessed weekly during that period for evidence of service by the ram. A ewe was considered to have experienced ovarian cycling and thus puberty if recorded as served at least twice and thus potentially capable of becoming pregnant.

Table 18 Puberty and oestrus cycling of 4 mobs of maiden ewes as affected by grazing pressure, liveweight change and condition while in the company of vasectomised rams. Numbers out of 16.

Mob 1		No detailed data has been recovered from archives to date					
Mob 2	Paddock	Start condition	Av LWt (kg)	End condition	Av End LWt (kg)	LWt change	Oestrus nbr
	1	15FS, 1S	31.9	14FS,2S	36.3	4.4	11
	7	12FS, 4S	34.8	13FS, 3S	39.6	4.8	10
	3	7FS, 9S	32.7	14FS,2S	36.7	4.1	9
	5	4FS, 12S	31.2	15FS, 1S	36.2	5.1	6
	2	1FS, 11S, 4P	27	6FS, 10S	30.6	3.5	4
	8	3FS, 11S, 2P	27.4	8FS, 8S	31.9	4.5	4
	4	5S, 11P	24.8	8S, 8P	29.9	5.1	5
	6	3S, 9PS, 4P	24.1	5S, 11P	27	2.9	4
	1.25 sh/ha	27FS,5S	33.4	27FS, 5S	38.0	4.6	10.5
	2.5 sh/ha	11FS,21S	32.0	29FS, 3S	36.5	4.6	7.5
	5 sh/ha	4FS,22S, 6P	27.2	14FS, 18S	31.3	4	4
	10 sh/ha	8S, 9PS, 15P	24.5	13S, 19P	28.5	4	4.5
Mob 3	Paddock	Start condn	Start LWt (kg)	End condn	Av. End LWt (kg)	LWt change	Oestrus nbr
	1	3.0	33.8	2.8	37.6	3.8	9
	7	2.8	32.1	2.7	34.5	2.3	7
	3	2.8	31.9	2.9	36.1	4.1	5
	5	2.8	32.6	2.8	37.2	4.6	6
	2	2.0	28.6	1.8	29.6	1.0	1
	8	2.6	30.8	2.0	32.7	1.9	4
	4	1.3	23.0	1.0	22.9	-0.1	0
	6	1.6	23.2	1.1	22.8	-0.3	0
	1.25 sh/ha	2.9	33.0	2.8	36.1	3.1	8.0
	2.5 sh/ha	2.8	32.3	2.8	36.6	4.4	5.5

	5 sh/ha	2.3	29.7	1.9	31.2	1.5	2.5
	10 sh/ha	1.4	23.1	1.0	22.9	-0.2	0.0
Mob 4	Paddock	Start condn	Start LWt (kg)		Av. End LWt (kg)	LWt change	Oestrus nbr
	1	2.9	33.5		38.1	4.6	6
	7	2.9	34.2		39.0	4.8	6
	3	2.8	33.4		36.2	2.8	4
	5	3.0	32.7		36.1	3.4	5
	2	1.5	26.3		20.6	-5.8	0
	8	2.6	31.4		33.2	1.8	2
	1.25 sh/ha	2.9	33.8		38.5	4.7	6
	2.5 sh/ha	2.9	33.1		36.2	3.1	4.5
	5 sh/ha	2.1	28.9		26.9	-2.0	1

*P = poor, S = store and FS = forward store condition

Rams were in the paddocks from 8 February to 4 April in 1968, 12 February to 10 April in 1969, 24 February to 21 April in 1970, and 8 April to 4 June in 1971. Mean body weights and condition scores recorded for these ewes individually during that period are shown in Table 18. No condition details were found for Mob 1 ewes but a memo to H.O. states that nearly half the sheep in the 3 lightest stocking rates had reached puberty compared to 1/8th at the heaviest stocking rate. This was despite plenty of feed in all pastures and all sheep gaining weight (Tables 8 and 11).

Ovarian cycling was quite closely related to liveweight and liveweight change over the test periods but no treatment had all ewes reaching reproductive maturity at one year of age. The data is not complete and the measures used to categorise the ewes' condition changed over time but the expected pattern of maturity caused by grazing pressure was seen. Data collected on the service activity of the rams as they rotated through the paddocks on a weekly basis shows variability amongst them (Table 19) and the clear impact of stocking rate on Mob 2 ewe maturation.

Table 19 Number of ewes served by each teaser ram in each paddock of Mob 2 ewes in autumn 1969

	Paddock number								
Ram #	1	7	3	5	2	8	4	6	Total
1	2	5	5	4	2	9		1	28
2	5	3	3	8			11	2	32
3	10				1	2		2	15
4		5	1	12		4		5	27
5	5	11	6		2	6	1		31
6	3	3	9		4	2	2		23
7	3	1	4	5	10	2	3		28
8	7		2	1				9	19
Total	35	28	30	30	19	25	17	19	

A large difference in the service activity amongst the 8 rams was evident and also in the weekly level of activity in individual paddocks.

Joining and lambing

After each shearing in August 1968,1969 and 1970, the ewes were then boxed together in a nearby paddock and joined by entire rams over a 2-month period. The number of ewes served was generally greater than seen earlier in the year. The data for Mob 1 has not currently been retrieved but at least 29 of the 32 ewes from paddocks 4 and 6 (10 sh/ha) did not become pregnant. In the following spring, those 29 were compared against 30 of the other Mob 1 sheep that had conceived the previous year for their comparative lambing performance over the next summer of 1969-70 (Table 20). Half again failed to be served by a ram but 70% of those that were became pregnant compared to 80% pregnancy amongst the others that had conceived the previous year.

Another memo of 17/10/1969 reported that 15% of the 10 sh/ha ewes still had never exhibited clear signs of oestrus after a second joining when they were in good condition. Thus, severe nutritional stress during their first year could leave some ewes effectively barren forever.

Table 20 Lambing performance of Mob 1 ewes that failed to conceive as 'maidens' in spring 1968 when returned to rams the next year (1969), compared to others from the same mob that had conceived at their first joining in 1968.

	Nbr	No Served	Lambed and/or +ve pregnancy†	% of served ewes pregnant
Mob 1 Paddocks 4and6 barrens	29	14	10	71
Mob 1 1968 conceivers	30	26	21	80

† tested positive for pregnant with Sonicaid on 13/1/70 and/or 'wet and dried' on 22/4/70

The results for the Mob 2 ewes from their spring 1969 joining to entire rams are shown in Table 21. Again, the lambing performance was inversely related to the stocking rate under which they had matured over the previous year. Note that the 10 sh/ha ewes had received regular lucerne hay supplements to keep them alive but not sufficient to allow them to gain much weight (Table 11).

Table 21 Lambing success of Mob 2 maiden ewes joined to entire rams in spring 1969 as affected by the stocking rate regime that they experienced on buffel grass pastures as weaners during the year before.

S/Rate (sh/ha)	Paddock	Nbr served	+ve Sonicaid 13/01/1970	Lambed nbr	% Lambed if served
1.25	1	7	4	4	57
	7	12	5	8	67
2.5	3	8	5	5	63
	5	7	4	3	43
5	2	4	2	1	25
	8	5	1	3	60
10	4	0	0	0	-
	6	0	0	0	-

Again, the ewes from the 10 sh/ha treatment that did not conceive at their first joining in spring 1969 were retained and joined again in spring 1970 and compared with counterparts that had conceived at that first joining. The results are presented in Table 22 and again show the poorer lambing rate from their second joining despite having grazed on similar pasture throughout the previous year.

Table 22 Lambing performance at second joining of Mob 2 ewes from the 10 sh/ha treatment that failed to conceive as maidens when compared with others from the same mob in spring 1970 that had conceived at first joining.

	Paddock	Nbr used	Served	Lambed	% of served that lambed	Nbr Lambs reared
Mob 2	4and6	30	26	16	61	6
Mob 2	others low SR	29	26	19	73	14

The lambing rate this time was better but the ewes that had grown poorly as weaners were far less successful at raising their lamb to weaning, 37% compared to 74%.

A similar assessment was done with the Mob 3 ewes that were joined with entire rams in spring 1970 and lambed in late summer 1971 (Table 23). This time lambing performance was not as greatly influenced by prior stocking rate but still conception rates were much poorer from the two most heavily stocked treatments, 75% compared to 97%. Of the served ewes, again the percentage that dropped a lamb was proportional to the prior stocking rate, 90% for the lighter two, 75% for the 5 sh/ha ewes and only 55% for the 10 sh/ha ewes that received regular hay supplement. Success in rearing their lambs to weaning was not significantly influenced by prior stocking rate and was generally poor (mean 49%) due to high pig predation rates at the site in that year.

Table 23 Lambing performance of Mob 3 ewes when joined to entire rams in spring 1970 after grazing buffel grass pasture for a year at 4 different stocking rates as they grew to adulthood.

S/rate	Paddock	Nbr	% served	% lambed of served	% reared lambs	Nbr lambs reared
	1	16	100	87.5	42.8	6
	7	16	94	93	35.7	5
1.25 sh/ha	Avg	16.0	97.0	90.3	39.3	
	3	15	100	86.6	53.8	7
	5	16	94	93	50	7
2.5 sh/ha	Avg	15.5	97.0	89.8	51.9	
	2	13	69	77	28.6	2
	8	13	85	72.7	50	4
5 sh/ha	Avg	13.0	77.0	74.9	39.3	
	4	13	77	70	57	4
	6	14	71	40	75	3
10 sh/ha	Avg	13.5	74.0	55.0	66.0	

Some of these Mob 3 ewes had their oestrus cycling followed again at a second joining in November 1971 (Table 24). Again, the ewes from the very heavily stocked treatments still did not appear as ready to conceive after 2 years as those from more lightly stocked treatments but the difference was less marked.

Table 24 Lambing performance at second joining of Mob 3 ewes from the very heavy 10 sh/ha treatment compared to other Mob 3 ewes that had grazed at light or moderate stocking rates in their first year after weaning.

	Nbr	Nbr served	% served
Pdks 4 and 6 (Mob 3)	21	15	71.4
Other pdks (Mob 3)	25	21	84.0

Copper deficiency

Fleeces from two sheep at 1.25 sh/ha in 1968/69 and one in 1969/70 exhibited copper deficiency symptoms, - less wool growth, wider crimp, more lustre, less strength (Making more from Sheep 2015).

Interpretation of Phase 1 results

Much of the data is presented as the mean performance of the 16 sheep in a paddock, such as their liveweight or as the mean of 8 records for the dye-band information. This 'hides' the extent of variation within the group, variation which was occasionally quite large but which is accounted for to a large degree when the statistical significance of the difference amongst means is calculated. Initial variation within and between each paddock group was minimised as much as possible by selecting similar animals from within the few hundred that were available from which to choose the minimum 128 sheep needed. That variability, expressed as the percentage that the standard deviation was of the calculated mean, was often initially 3 to 7% of the mean although it reached as high as 14% for Mob 2 sheep. By the end of any mob's year, that variability rarely changed and animals at the extreme of a paddock group's weights generally remained towards that extreme. However, the correlation coefficient between initial and final liveweights, r, was only fair at between about 0.5 and 0.75.

Stocking rate

In this experiment, stocking rates were designed to provide sheep with a range of forage levels from ample (1.25 sh/ha or 1.25 DSE/ha) to potentially sub-maintenance (10 sh/ha, >6.5 DSE/ha). In terms of total buffel grass on offer during this first phase this objective was achieved, aided by low rainfall years -decile 2 summers in 1968-69 and 1969/70 (Table 6). Performance of sheep and pasture was similar at the two lowest stocking rates 1.25 and 2.5 sh/ha but wool production per hectare was doubled for the latter treatment. Although a further increase in stocking rate to 5 sh/ha increased wool production/ha it resulted in reduced available forage yields, a decline in buffel grass basal area and a decline in wool production/head. A further increase to 10 sh/ha had similar but greater effects and sheep could only be maintained for the first year under average rainfall seasons before supplementary feeding was required. Thereafter, regular supplementation was needed for the animals run at that high grazing pressure.

When the grazing pressure is expressed in terms of dry sheep equivalents, these stocking rates with young ewes after 4 years were equivalent on average to 5.80, 3.52, 2.09 and 1.07 DSE/ha in small paddocks. The results indicate that while the crowns of these pastures could withstand a prolonged period of heavy grazing pressure (3.5 DSE/ha) quite well, the sheep were unable to maintain themselves and required supplementation for short periods to survive such seasons in continuously grazed pasture.

Total liveweight change at 5 sh/ha was greatest in the first grazing period 1967/68 (Figure 12) and this undoubtedly is a reflection of the forage reserves available at the trial's commencement (Table 8). The positive total liveweight gain in this treatment in 1970/71 occurred as basal area and forage on offer were declining. Rainfall from October 1970 to March 1971 was well distributed although only 75% of the long-term average. This suggests that sheep were able to make very efficient use of the green forage that grew during those summer months.

To arrive at an optimum stocking rate, it is necessary to consider the various aspects of animal performance as well as pasture productivity and condition. In these respects, it would appear that the optimum short-term stocking rate was often 5 sh/ha based only on liveweight gain/ha up to mid-summer (Figures 10 and 11) but thereafter 2.5 sh/ha is indicated as optimal by the sheep and pasture data presented here. However, even under the poor seasonal conditions, there was no advantage in animal growth by stocking at less than 2.5 sh/ha and the advantage per head in wool production was small and resulted in much less wool grown per hectare (Table 15). Wool quality was marginally different between the two lightest grazing pressures (Figures 19 and 20) but the much finer micron count for wool from sheep grazed at 5 sh/ha (Figure 19) would partially counteract the loss in potential income due to lower fleece weights (Table 15).

Pasture quality

Nitrogen and phosphorus concentrations in the bulk harvested buffel grass (Tables 9 and 10) were at most times below the published minimum requirements for growing sheep of 1.25% nitrogen (Milford and Haydock 1965) and 0.16% phosphorus (National Research Council 1956). However, with the exception of one occasion, concentrations in the green buffel grass were above these levels. Whilst quality of forage was adequate to maintain liveweight increases well into winter at 1.25 and 2.5 sh/ha, it was inadequate to maintain high levels of clean wool production and fibre diameter in most winters (Figure 18). This suggests that nutrients other than energy were probably limiting for wool production in winter unless rain stimulated appreciable winter herbage growth. A similar relationship between clean wool production and body-weight has been shown by Roe *et al.* (1959) and Stewart *et al.* (1961) with body growth maintained after clean wool production had dropped.

The infrequency of dry matter recordings permits few observations to be made on the effect of total buffel grass yield on sheep liveweight changes. Average daily gains, at certain times, were similar in all treatments despite widely different amounts of buffel grass on offer (Table 8 and Figure 14). In this respect our data support Wilson's (1974) comments that availability of digestible forage in arid communities is not adequately described by DM yield/ha. Liveweight losses in the July/August period each year at 2.5 and 1.25 sh/ha apparently were associated with inadequate forage quality. This is probably correlated with the high proportion of stem in the pasture, a feature of buffel grass also noted in semi-arid Brazil by Voltilini *et al.* (2011). There stem often comprised 70% or more of the available forage from pastures with a similar total standing biomass. We did not separate stem from leaf when assessing green and dead pasture proportions.

The relationship between average daily gain and either faecal nitrogen or faecal phosphorus does offer a means of assessing the likely performance of sheep, at least in the short term, when grazing a particular pasture. Also it provides an indication of quality of available forage and hence the need for supplementation. Based on the regression equations, zero daily gain occurs at a faecal nitrogen concentration of 1.3% (95% confidence limits: 1.1%, 1.5%) or a faecal phosphorus concentration of 0.20% (95% confidence limits: 0.18%, 0.28%). The faecal nitrogen concentration of 1.3% corresponds with that quoted by Winks *et al.* (1979) as the level below which cattle grazing black spear grass (*Heteropogon contortus*) pastures in north Queensland respond to non-protein nitrogen supplements.

Pasture basal area

Percentage basal area of buffel grass was used as a measure of pasture condition (Roberts 1972). Botanical composition was not a useful pasture quality measure initially as buffel grass formed a near monospecific sward except at very high stocking rates after the first summer. Basal area measurements were not made on speedy weed when it invaded the 10 sh/ha paddocks and later the 5 sh/ha paddocks, as the technique is not suited to single stemmed species.

Our results agree with earlier comments that, in areas which suit it, buffel grass is extremely difficult to kill by grazing (Paull and Lee 1978). At 10 sh/ha some plant deaths occurred after twelve months grazing, but after three years stocking at this rate with the aid of supplementary lucerne hay, buffel grass basal area had only been seriously reduced in one paddock (Table 7, Paddock 6). The further big decline occurred in the fourth year despite the fact that sheep were removed in August 1970. A gradual decline in buffel grass basal area was apparent at 5 sh/ha but not at 2.5 and 1.25 sh/ha (Table 7). Treatment effects were not significant when this could have been expected, such as in 1969 and 1971, probably due to the few degrees of freedom available for the error term and replicate variation at 10 sh/ha.

Wool production

The seasonal pattern of clean wool production follows that described by Brown and Williams (1970) for the northern Australian summer rainfall environment. Production data from sheep grazing at very different stocking rates under similar conditions are not available. However, our maximum recorded rate of 1.47 mg/cm^2/d is higher than that reported by Entwistle (1972) where unsupplemented control sheep at Toorak Sheep Field Research Station in north-west Queensland, grazing a Mitchell grass (*Astrebla* spp.) pasture produced 1 mg/cm^2/d. However, it does match the 1.46 mg/cm^2/d recorded from flock sheep at Toorak in 1963 (Anon. 1963). Environmental differences between the north-west and central west of Queensland can account for an average difference of 0.43 kg/hd in clean fleece weights in favour of the central west (Robards 1979).

The fact that clean wool production rate from sheep in the heaviest stocked treatments (10 sh/ha in 1967/68 and 5 sh/ha in the next three years) was either equivalent to or greater than that from the lighter treatments during summer (Figure 18) is not easily reconciled. Perhaps at times during summer, new high protein shoot predominated in those over-stocked paddocks providing a short-term boost that was not achieved in the more heavily grassed paddocks. A much-reduced rate of growth for the rest of the year would still result in the reduced annual fleece weights recorded at high stocking rates. Clean wool production was measured for only a portion of each grazing year and winter production was much reduced at high stocking rates (Figure 19).

The decreasing percentage yield of clean wool over time is probably a function of the light late summer-autumn rainfall experienced which would reduce the leaching of yolk from the fleece. Since yields were not subject to treatment effects, the differences between years would not appear to be due to increased dust contamination. Such an effect might be expected to show up as a treatment effect when pasture density decreased, as it did at 5 sh/ha.

Fleece abnormalities were rare occurrences. The detection of copper deficiency, even though only in three fleeces, is of interest in that copper deficient fleeces have been reported from north-west Queensland Mitchell grass regions (Moule 1948). Bob Anson, former Charleville sheep and wool advisor, (pers. comm.) reports that copper deficiency was common in 1963 in the Tambo district southeast of Blackall. The small number of observations of tender fleeces was associated with a history of flystrike on those sheep during the year.

Breeding potential

Though the data on this aspect has caveats about the lambing results, the oestrus cycling and joining data show clearly that very high stocking rates seriously diminished the breeding potential of maiden ewes. A similar outcome has been reported by Bennett *et al.* (1970) for Peppin merinos at Canberra where pregnancy percentage from April joining was proportional to ewe liveweight at joining. In that report the joining liveweight effect continued through into weaning percentages next summer, similar to the way conception rates in subsequent joinings of this trial were diminished by the initial heavy stocking rate effect.

Summary

Conversion of gidyea woodlands to highly productive buffel grass pastures is the only successful, large-scale plant introduction venture in the under 500 mm MAR area of semi-arid Queensland. The work reported in Phase 1 was conducted during four below-average rainfall years. This suggests that in more favourable rainfall years sheep could be maintained and produce satisfactorily without causing deterioration of the forage source at stocking rates in excess of some of those where that was achieved here. This is supported and discussed in the later phases of this project. Nevertheless, in terms of this Phase 1 work on a buffel pasture that was not newly established, a stocking rate of 2.5 sh/ha could be maintained in small paddocks without detriment to sheep production or pasture productivity and condition.

However, some local producers thought this was too heavy a stocking rate and our observations around the trial site may confirm this. After a few years it was noticed that there was more pasture available within the more lightly grazed trial paddocks than in the surrounding commercial paddock that was grazed at a similar overall stocking rate. It was hypothesised that the distance walked each day to water and shade was far less in our trial paddocks and thus animals needed far less nutrients and therefore forage to achieve a given rate of growth on similar pasture. No quantified data was collected to prove or disprove this idea. Other observations taken from project files and notes summarising project annual reports are collated in Appendices 13 and 14.

Phase 2 (February 1972 – August 1977; wethers, 3 stocking rates)

In this phase the emphasis on determining a sustainable, productive stocking rate continued but the use of young, breeding females ended and wethers grazed the paddocks. They entered as weaners but were grown out and allowed to mature on the same pastures at the same stocking rate for 6 years. In this way the cumulative effect of each stocking rate on the sheep was to be gauged.

Rainfall

Annual 'Eastwood' house rainfall for the years 1972 to 1977 was 380, 593, 509, 365, 615 and 539 mm compared with the long-term mean of 530 mm for Blackall. Summer rainfall (November-March) for the period 1971-2 to 1976-7 was 306, 444, 453, 251, 577 and 461 mm compared with the mean for Blackall of 375 mm. Most summers experienced two or more months during which rainfall exceeded the mean by 50 mm or more (Table 25) and only one was below decile 5 (the median). Summers of 1973, 1974, 1976 and 1977 were all excellent with only that of 1975 preventing a run of 5 consecutive excellent summers. This contrasted markedly with the summers of Phase 1.

Good rains fell during the cooler months in 1971, 1973 and 1977 and that would have stimulated recruitment of some valuable herbage in any sparsely grassed areas to supplement the grass-dominant diet of the sheep.

Pasture data

Pasture basal cover

Differences in basal area of buffel grass in 1972 and 1973, resulting from grazing pressure earlier in this study, had been largely eliminated by October 1974 (Table 26) due to the run of good summers. Nevertheless, differences in basal area between stocking rates over the period 1972 to 1977 were statistically significant ($P<0.05$) between some years and some treatments (Table 26). Favourable rain early and late in the 1971-72 summer caused basal cover of the 10 sh/ha paddocks to recover rapidly while destocked for 18 months. Those paddocks were restocked at a moderate grazing pressure of 2.5 sh/ha for the first 2 years of this phase.

Table 25 Monthly kriged rainfall (mm) for the 'Eastwood' location during Phase 2 (1972-1977) compared to long term Blackall data. Values rounded to the nearest mm.

	Long term	1971	1972	1973	1974	1975	1976	1977
January	84	33	65	78	304	58	133	72
February	81	31	4	172	9	54	122	212
March	63	42	105	65	16	72	93	51
April	36	**36**	0	**53**	39	2	0	**46**
May	33	16	39	16	23	1	23	**112**
June	27	0	0	3	0	33	7	1
July	25	14	0	21	0	5	20	3
August	17	**48**	1	7	21	25	2	2
September	19	0	0	**75**	33	3	6	3
October	33	33	2	14	32	22	14	15
November	43	18	102	84	60	0	34	1
December	69	123	55	58	16	141	94	42
Year	529	392	372	643	554	415	547	560
Cool months	188	146	43	187	149	90	71	182
Warm months	343	276	314	470	471	260	489	463
Warm mth decile		4	5	8	8	4	9	8

Long term values are for Blackall P.O. Warm months deciles include the prior Nov and Dec falls.
Warm months is taken as November to March inclusive; Cool months are April to October inclusive
Bold values indicate cool season rain effective enough to stimulate some buffel grass regrowth.

Table 26 Basal area (%) of buffel grass pastures grazed at four stocking rates between 1972 and 1974 and then three rates from 1975 onwards.

				Sample date			
Shp/ha	Pdk	31/10/1972	23/10/1973	23/10/1974	9/09/1975	26/11/1976	Oct-77
1.25	1	8.3	7.6	6.85	8.3	10	9.3
	7	7.5	8.45	6.5	6	8.6	12.55
2.5	3	5.9	6.15	7.05	7.8	8.95	9.5
	5	4.95	5.6	5.75	6.8	7.2	10.35
5	2	1.3	4.3	5.25	7.3	8.4	9.25
	8	2.9	5.6	6.8	6.05	7	9.3
10	4	3.9	6.7	5.25			
	6	1.1	4.05	5.9			

Mean basal area across all stocking rates increased steadily between 1972 and 1977 (Table 27) while it differed between stocking rates. Basal cover values over 10% are exceptional for commercial pastures in the region.

Table 27 Meaned basal cover values for the 3 sustained grazing pressures and for each spring showing statistically significant trends (P<0.05) over time and treatment

(a)	**Between treatments**		
	Stocking rate (sheep/ha)		
	1.25	2.5	5
Basal area	8.32[a]	7.09[b]	6.18[b]

(b)	**Between years**					
				Years		
	1972	1973	1974	1975	1976	1977
Basal area	5.13[a]	6.28[ab]	6. 37[ab]	7.04b[c]	8.33[c]	10.04[d]

Pasture standing dry matter

Measurement of standing pasture dry matter was continued until October 1974 although not all paddocks were recorded on every occasion. Yields rapidly increased in all paddocks as good seasons returned (Image 17) and by 1974 yields over 6000 kg/ha were regularly recorded under better than average summer rainfall (Table 28). By then there was more than adequate forage always available to the sheep at all stocking rates and green pasture predominated. Not even the highest grazing pressure applied (5 sh/ha) could keep up with the rate of pasture growth prevailing and in the most lightly stocked paddocks patch grazing became entrenched as sheep regularly returned to regraze new growth. Seedling recruitment of buffel grass was noted in all paddocks in 1973.

Table 28 Standing total pasture dry matter (kg/ha) recordings in the years 1972, 1973 and 1974.

Values of 30 kg/ha represent a visual assessment that was recorded as 'negligible harvestable pasture' at that date rather than zero

Trmt		Sample date									
Sh/ha	Pdk	7/01/72	14/02/72	18/05/72	6/10/72	29/11/72	15/03/73	11/09/73	22/05/74	16/10/74	29/10/74
1.25	1		2697	3867	2834	3082	4862	3238	6350	8418	
	7	2115	3026	3854	3497	4107	5415	2774		5667	
2.5	3	2897	1602	2426	1813	2800	4454	2609	5933		6785
	5	2562	1941	2620	2345	2428	3070	1930			6286
5	2	1581	30	30	30	30	871	30	3864	3788	2903
	8	100	998	1164	30	30	2073		4481		5334
10	4	100		2633			2993				
	6			529			1207		7285		

The amount of available green pasture at these times is shown in Table 29 along with the total rain received up to that date (in mm) since the previous sampling. The great effect of the excellent summer rains in 1973 and 1974 is evident with over 3000kg/ha of green leaf and stem available to the sheep in spring which is often the time of year when feed is most limiting.

Image 17 Pasture in Paddock 5 (2.5 sh/ha) in March 1973 in good health as the buffel recovered from the earlier run of dry years.

Table 29 Standing green pasture at various dates between Feb 1972 and Oct 1974 plus rainfall received (mm) since the previous sampling date.

Trmt		Sample date								
sh/ha	Pdk	14/02/72	18/05/72	6/10/72	29/11/72	15/03/73	11/09/73	22/05/74	16/10/74	29/10/74
1.25	1	970	852		508	2202		3492		
	7	900	347		480	2398				
2.5	3	592	509		257	2320		3559		
	5	698	393		170	1654				
5	2					490		2318		
	8	509	442			1038		2643		
10	4		579			1661				
	6		163			683		4516		
Prior	rain	34.2	150.7	1.5	87.4	332.1	158.9	634.8	86.1	13.6

Pasture quality

Analysis of harvested pasture samples for nitrogen and phosphorus content was not undertaken during this phase. Numerous samples taken during Phase 1 had already provided data about the levels that could be expected at different times of year and after rain. Quality was however followed indirectly via regular faecal sampling when the sheep were weighed (see below).

In early 1972 there were still big crops of soft roly-poly (*S. kali*) and speedy weed in the former 10 sh/ha paddocks (Image 18) but the buffel soon dominated again and the sheep grazed these regenerating non-grass seedlings lethargically for some variation in their diet.

Image 18 Soft roly-poly plants in recovering heavily grazed paddocks towards the end of Phase 1.

Animal data

After the removal of the fourth mob of ewes for shearing, there was a delay in organising the wethers that were planned to continue the trial as a grazing trial without any reproductive studies. Until they arrived and were introduced to the paddocks on 8 February 1972, 2 year-old ewes were put into the paddocks on 26 August 1971 at the appropriate stocking rates so as to maintain that component of the project.

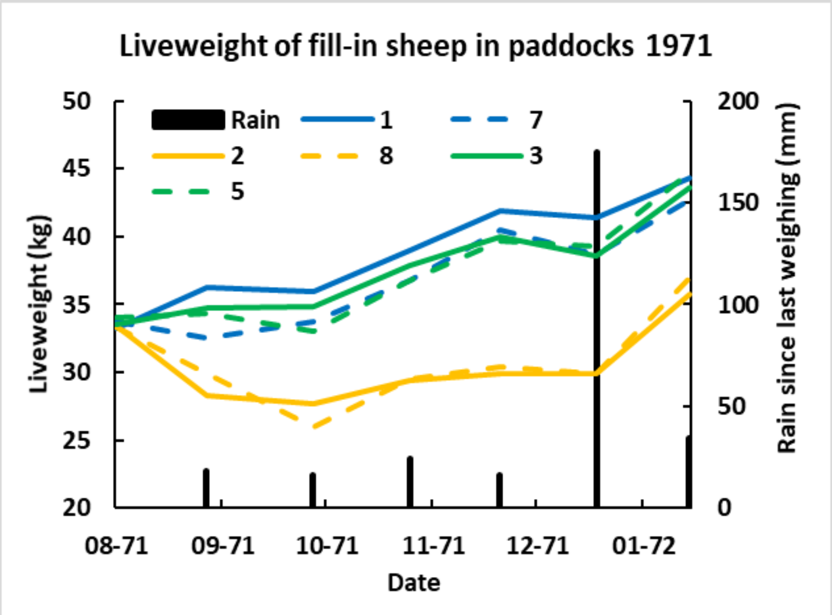


Figure 22 Liveweight changes of the interim mob of sheep in late 1971 at 3 different stocking rates.

Vertical bars show cumulative rainfall (mm) since the previous weighing.

These were 'Eastwood' ewes averaging about 33kg and their growth was monitored regularly in the same way as the previous mobs. The formerly very heavily stocked paddocks 4 and 6 continued to be rested. The animals' performance, shown in Figure 22, continued that of the previous mobs with little difference between 1.25 and 2.5 sh/ha and much poorer growth of the sheep running at 5 sh/ha. The replicates performed similarly and the dry end to 1971 exacerbated the nutritional situation so that even the most lightly stocked paddocks only increased liveweight slowly while sheep in the heavily grazed paddocks lost weight for 2 months (Figure 22). Hay ($50/ton) had to be fed to paddock 8 sheep for 2 weeks in December 1971 before relief rain arrived on the 25th.

Once the wethers were introduced in February 1972, they were retained on the trial throughout this phase, a further 5.5 years. Deaths and escapes became more common but were expeditiously replaced with animals from the 'Eastwood' flock. Flystrike of occasional sheep was a regular occurrence and not related to grazing treatments. Its incidence did increase during the wet seasons and required more regular jetting of the entire mob to deal with the issue. Hay ($75/ton) had to be fed to Paddock 2 sheep for one week in November 1972 before relief rain came to remove that need (Figure 23). The first widespread incidence of struck sheep was in September 1973. Some sheep escaped from paddock 3 in February 1974 when water ran short in their paddock.

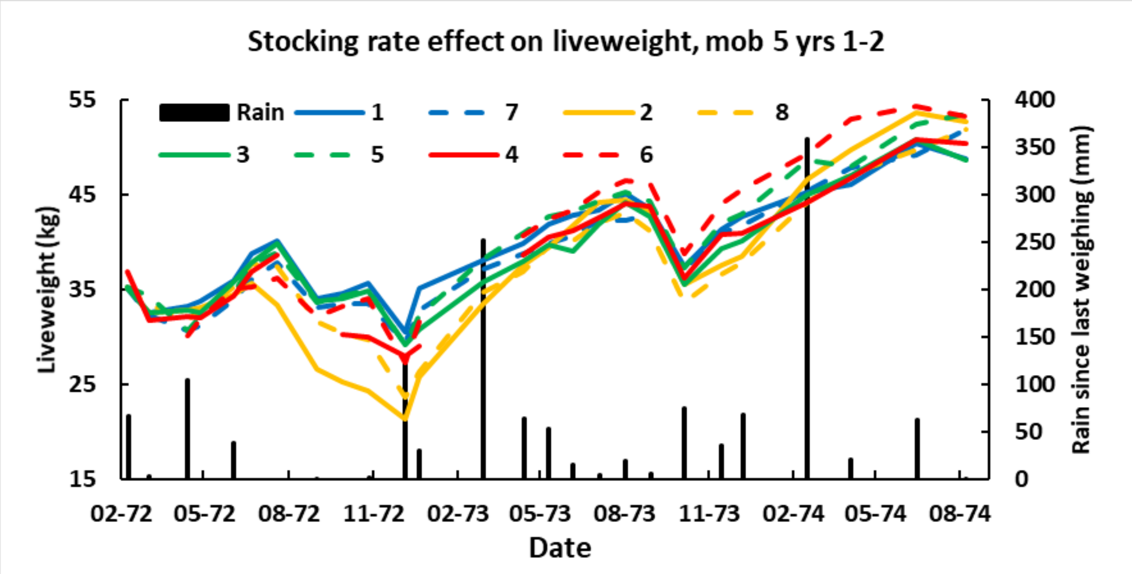


Figure 23 Annual trends in sheep liveweight due to stocking rate and rainfall for the first 2.5 years of Mob 5 wethers.

Vertical bars show cumulative rainfall (mm) since the previous weighing. Block 1 paddocks are shown as solid lines and block 2 dashed.

Grazing of paddocks 4 and 6 was discontinued after shearing in August 1974 to reduce workloads as finances for labour declined. By then, the paddocks had been shown to have recovered their productive capacity under more moderate grazing pressure (see Figure 23) and matched that of all the other treatments. Managerial activity was minimal in the 1976-77 year due to staffing shortages and no liveweight recordings were made during the year and quite a number of escapes or deaths from paddocks 2, 3 and 8 went unnoticed until shearing time.

Sheep liveweight

The way the sheep grew and matured from 1972 until 1977 is shown in Table 30. They put on little weight in 1972 because of the poor summer rain and dry autumn-winter, then an increase over each of the next two good rainfall years until August 1974 with only small, variable annual change thereafter during good rainfall years (Table 30).

Table 30 Average treatment liveweight of Mob 5 wethers at each August shearing time from 1972 to 1977.

* Only 4 sheep mustered for weighing at shearing time in paddock 3.

		Stocking	rate	(sh/ha)
Month	10/2.5	5.0	2.5	1.25
Feb-72	36.7	35.2	35.2	35.2
Aug-72	37.5	35.4	39.4	39.0
Aug-73	45.0	42.1	43.5	43.2
Aug-74	51.8	52.3	51.0	50.3
Aug-75		52.2	52.3	50.8
Aug-76		50.5	49.7	49.4
Aug-77		50.6	53.2*	47.6

Animals increased their liveweight over the course of the shearing year with most rapid weight gain in summer and little gain and sometimes weight loss in winter. Some of that weight was wool growth, between 250 and 375 gm/month depending on stocking rate and the seasons. The results are shown graphically in 2 figures, Figure 23 for the period when the stocking of paddocks 4 and 6 resumed and Figure 24 for the remaining 3 years when the sheep were mature and only 3 stocking rates were continued.

The decline in liveweight in late 1972 (Figure 23), particularly at 5 sh/ha, appeared due to reduced pasture yield resulting from a dearth of rainfall since April. Sheep at 5 sh/ha were lighter than at the other two stocking rates from July 1972 until April 1973 and between October and December 1973. A significant difference in liveweight between the two lighter stocking rates, 1.25 and 2.5 sh/ha, occurred only once in December 1972. The growth of the sheep that returned to paddocks 4 and 6 at 2.5 sh/ha followed closely that of the other 2 paddocks (paddocks 3 and 5) that had always been stocked at that rate (Figure 23).

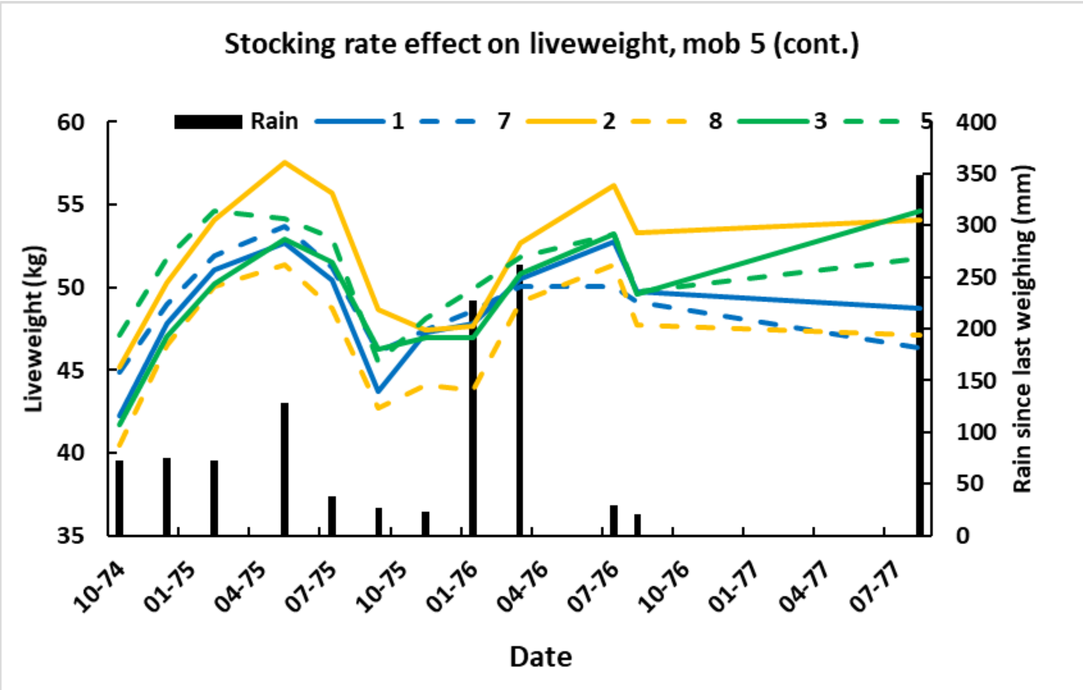


Figure 24 Trends in liveweight of the mature Mob 5 wethers over the last 3 years of their presence under 3 different stocking rates.

Vertical bars show rainfall (mm) since the previous weighing.

Only in 1972 was the effect of grazing pressure on liveweight gain significant with sheep at 5 sh/ha losing weight in the winter, especially in paddock 2, while those in the other two lighter stocking rates continued to gain (Figure 23). All these young sheep had lost an appreciable amount of weight before good rain (105 mm) fell in early March 1972. The seasonal pattern of liveweight change over the next two years by the now mature wethers is shown in Figure 24.

The strong differential developed between paddocks 2 and 8 after 1974 (Figure 24) was due to lighter replacement animals going into paddock 8 after animals were lost due to flystrike in those and other paddocks earlier that year. Replicates of the other two stocking rates followed similar liveweight paths but those at the low 1.25 sh/ha rate unexpectedly finished with a much worse weight than those at 2.5 sh/ha at the final 1977 weighing. Loss of most sheep in Paddock 3 at unknown times during 1977 means that the conclusions about the performance of the 2.5 sh/ha treatment has to be treated with caution. Their larger weight gain may be due to far less grazing pressure on the pasture for a considerable part of the year, particularly over the dry 1977 winter finish (Table 25).

There is no data to show the liveweight trends amongst treatments for the 1976-77 year because no weighings were conducted between shearings. That intervening summer saw rainfall fairly evenly spread from November to January, a wet February and a wet May but then a very dry period up to shearing in August. Table 31 shows the liveweight of each paddock at the start and end of year 10 (1976-77) where little overall change occurred, as had been the case the previous two years because the animals were fully matured 6 year-old wethers.

Table 31 Changes in paddock and treatment average liveweights (kg) of Mob 5 wethers between August 1976 and August 1977.

* Only 4 sheep contribute to this mean.

	Paddock						Stocking rate (sh/ha)		
Date	2	8	3	5	1	7	5	2.5	1.25
24/08/1976	53.3	47.7	49.6	49.8	49.8	49.1	50.5	49.7	49.4
23/08/1977	54.1	47.1	54.6	51.8	48.8	46.3	50.6	53.2	47.6
Change (kg)	0.8	-0.6	5.0*	2.0	-1.0	-2.8	0.1	3.5	-1.9

Grazing pressure expressed as Dry Sheep Equivalents (DSE) per hectare

To allow more stringent comparisons across phases and animal types, the grazing pressure has been converted from numbers into DSEs based on the liveweight and growth rates of the sheep for each grazing period and those shorter periods combined to give an average annual rate. Those paddocks grazed at a nominal 5 sheep/ha averaged 4.5 DSE/ha (range 3.91 to 5.32 – Table 32), the 2.5 sh/ha treatment averaged 2.3 and the 1.25 sh/ha treatment had an average grazing pressure of 1.18 DSE/ha. Thus, the two lightest grazing pressures were nominally very close to the equivalent in standardised DSEs while the 5 sh/ha treatment was a bit lighter. These values take into account the short periods during which animal numbers in a paddock were reduced due to deaths and absences during shearing but did not have the big gaps that arose in Phase 1 while replacement sheep were sourced and prepared.

The 5 sh/ha paddocks varied much more amongst the individual years in their DSE rating than did the 2.5 and 1.25 sh/ha treatments (Table 32). This reflects the big fluctuations in rate of animal growth that introduces big shifts in the calculated DSE over a period due to the implied change in intake between growing animals and those that are losing weight.

Table 32 Average annual grazing pressure expressed as Dry Sheep Equivalents (DSE) for each year during which the wethers of Mob 5 were grazing the buffel grass pastures

Year	Paddock								Treatment			
	Pk4	Pk 6	Pk 2	Pk 8	Pk 3	Pk 5	Pk 1	Pk 7	10* sh/ha	5 sh/ha	2.5 sh/ha	1.25 sh/ha
1971-72	1.6	2.0	3.6	4.2	2.2	1.8	1.2	1.1	1.84	3.91	2.00	1.15
1972-73	2.2	2.3	4.2	4.1	1.9	2.3	1.1	1.0	2.25	4.16	2.13	1.06
1973-74	2.7	2.6	4.7	4.5	2.3	2.6	1.2	1.2	2.64	4.57	2.46	1.23
1974-75			5.7	5.0	1.9	2.7	1.3	1.1		5.32	2.27	1.22
1975-76			5.0	4.6	2.4	2.6	1.3	1.1		4.81	2.50	1.20
1976-77			5.0	4.6	2.4	2.6	1.3	1.1		4.81	2.50	1.20

* These treatment paddocks now stocked at 2.5 sh/ha after being destocked for 18 months

Faecal protein and phosphorus

All faecal crude protein and phosphorus data is contained in Appendix 6 and a graphical presentation by paddock for Phase 2 is shown in Figure 25. Extreme high levels were over 20% but more commonly peaked around 15-17% at all stocking rates while lowest values were 6-8% in dry or late-winter times, most often for sheep grazing at 5 sh/ha. Stocking rate had no consistent effect on which animals had the lowest or highest level of faecal crude protein, but sheep grazing at 5 sh/ha were most likely to have the lowest level, but not statistically lower than all others.

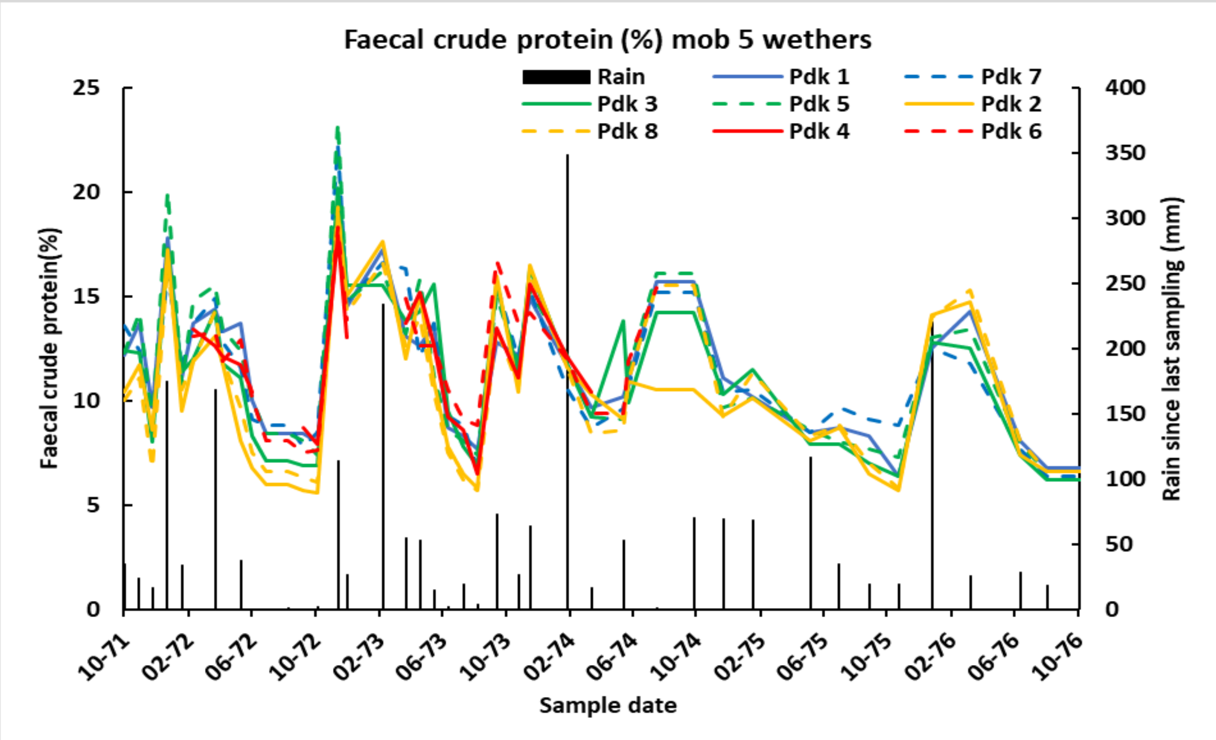


Figure 25 Faecal crude protein levels at different times from sheep grazing at different stocking rates during Phase 2, plus rainfall received since the prior sampling time.

The effect of good rainfall in boosting the protein in the diet is obvious in most cases with the exception of February 1974. After the 7/12/73 sampling when values of 15-16% crude protein were recorded after 55 mm of useful early summer rain in late November, about 235 mm of rain fell in 18 falls between 26/12/73 and 18/1/74 followed by a further 112 mm in 9 falls between 23/1/74 and 31/1/74 (Appendix 3). This resulted in crude protein levels of only 11-12% which is still indicative of high potential animal growth rates which are confirmed in Figure 23. It is now assumed that such a great amount of rain in a short period in mid-summer promoted great growth of buffel grass with an excessive drain on available soil nitrogen so that the high biomass had a much-diluted concentration of nitrogen in the growing tissues that the sheep would be preferentially eating. Little effective rain fell then before the next sampling on 4/4/74 and the low point in the graph is reached with values around 9-10% (Figure 25) which are still adequate for animals to hold condition.

The generally very high peak on 5/12/1972 followed 110 mm of rain over a week in late November after a long, dry spring and winter. Thus, conditions were perfect for high rates of soil nitrogen mineralisation (Birch 1958) so that all the pastures, irrespective of prior grazing intensity, were quick to take up that N into the new grass tiller growth that the sheep ate with relish.

At the same time phosphorus levels always remained adequate for animal growth but fluctuated appreciably like the protein levels (Figure 26). Peaks were generally between 1 and 1.1% while low values in spring were around 0.2% P. The peaks and troughs mimicked those of faecal crude protein as both depended on the growth stage and vigour of the pasture at the time. Peak levels were measured when the pasture first made appreciable growth after the first early summer rain. Stocking rate had no consistent effect on faecal phosphorus levels. Sheep grazing at a lighter stocking rate were able to select a slightly higher quality diet than the others, probably aided by the greater degree of patch grazing in those paddocks.

Another study of buffel cultivars growing on gidyea soils would suggest that a close relationship between changes in shoot protein and phosphorus in response to rainfall may not always exist (Silcock 2020).

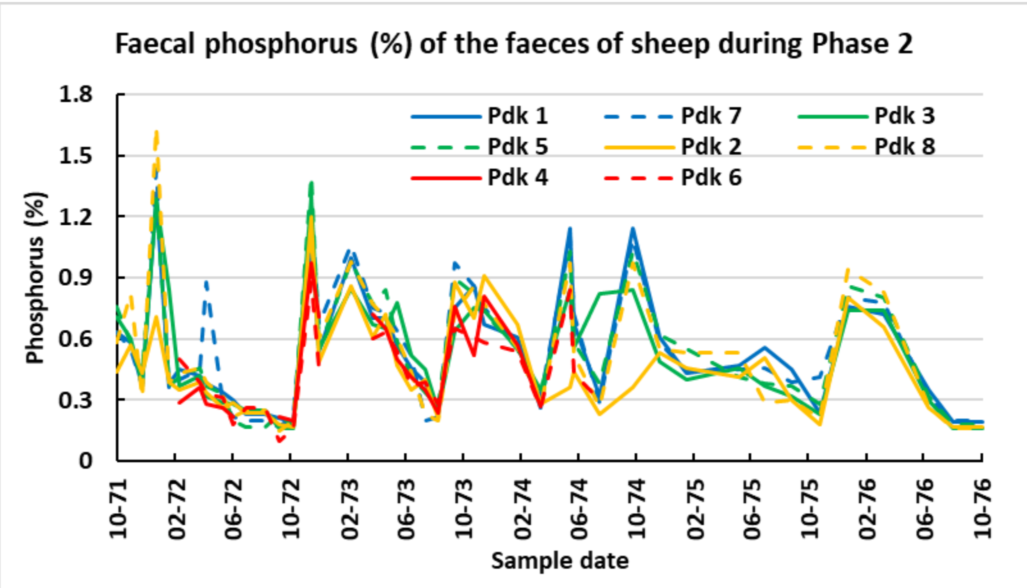


Figure 26 Faecal phosphorus (%) of sheep grazing buffel grass pastures at a range of stocking rates during Phase 2.

Fleece weight

There were no statistical differences in greasy wool production per head between stocking rates within each year (Table 33 and Appendix 9). Thus, wool production per hectare increased with stocking rate. There was a noticeable drop in wool production in the 1976-77 year which is not easily explained. Summer rains were excellent, but the winter was very dry, 6mm total for June, July and

August. There was minimal monitoring of the sheep that year so observations on health and animal welfare are not available and dye-banding was not undertaken for the first time since 1967. Perhaps the run of very good seasons and the accumulation of a large bulk of old buffel pasture (Table 28 is indicative) meant there was a limited amount of available soil nitrogen and a high level of retention of local ecosystem nitrogen in unpalatable mature, low-protein forage. Thus, sheep had enough pasture to maintain bodyweight (Table 31) but less than normal pasture quality to grow wool at the rate more commonly seen. Faecal crude protein levels early that year were very low (Figure 25).

The 25% difference also cannot be explained by presuming that belly wool was not included because bellies contribute only about 6% of total greasy fleece weight (1972 trial data). Perhaps intestinal worm burdens were higher than normal but the lack of faecal samples precludes confirmation of that or otherwise. Likewise, lice and flystrike monitoring were not undertaken although serious cases of the latter would have been treated if detected during routine checks of the water supply. Many paddock 3 sheep were lost during the year and 4-5 sheep failed to be mustered from paddocks 2, 5, 7 and 8 for shearing in August 1977, so overall confidence in this year's data is lower than usual. However, there were still 11-12 sheep in most paddocks and all 16 in paddock 1 from which to gauge this year's performance.

Table 33 Greasy wool production (kg/hd and kg/ha) from wethers grazing buffel grass pastures at three stocking rates between 1972 and 1977.

	Stocking rate (sheep/ha)					
Year	1.25		2.5		5	
	kg/hd	kg/ha	kg/hd	kg/ha	kg/hd	kg/ha
1972	5.03	6.29	4.74	11.85	4.59	22.95
1973	4.94	6.18	4.83	12.07	4.35	21.75
1974	4.79	5.99	4.64	11.60	4.71	23.55
1975	5.09	6.36	5.07	12.68	5.07	25.35
1976	4.51	5.64	4.55	11.38	4.41	22.05
1977	3.37	4.21	3.41	8.53	3.41	17.05

The amount of grease, dust and vegetative fault in the fleeces tended to be less in later years but there were no statistically significant differences within a shearing (Table 34). The difference between about 55% clean fleece yield for wool at the 1972 shearing and 66% at the 1976 shearing is potentially quite significant in economic terms if the average micron counts are similar.

Table 34 Yield (%) of clean wool for each shearing after washing and removing debris from fleece samples from each paddock and also averaged for grazing pressure

			Shearing			
Paddock	1972	1973	1974	1975	1976	1977
1	54.8	61.6	64.0	63.9	66.1	65.0
7	54.8	61.5	64.3	67.8	68.7	65.7
3	55.3	59.4	63.5	64.3	67.5	66.2
5	55.8	60.5	62.8	63.6	65.7	64.4
2	57.4	57.8	62.9	63.1	65.1	65.3
8	56.4	62.2	63.7	66.5	67.8	66.5
4	57.0	n.d.	60.0			
6	58.8	n.d.	65.8			
Treatment						
1.25 sh/ha	54.8	61.5	64.1	65.8	67.4	65.4
2.5 sh/ha	55.5	60.0	63.1	64.0	66.6	65.3
5 sh/ha	56.9	60.0	63.3	64.8	66.5	65.9
new 2.5 sh/ha	57.9	-	62.9	-	-	-

Removal of fleece yolk, dust and vegetable fault resulted in clean fleece production per sheep being slightly affected by grazing pressure (Table 35) with more per head on average from a reduction in grazing pressure. However, this was not consistent each year but affected total wool production per hectare so that stocking rate greatly affected the weight of wool grown in all years. Wool grown each year did vary appreciably, governed by the seasons – range 2.27 kg clean fleece in 1977 to 3.28 kg in 1975 around a mean of 2.84 kg. That is a 45% difference between extreme years and 15-20% around the mean.

There were no statistically significant differences between the treatments within a shearing.

Table 35 Average clean wool production per sheep at the various stocking rates for the years 1972 to 1977.

			Shearing				Six year
Paddock	1972	1973	1974	1975	1976	1977	average
1	2.84	3.05	3.00	3.24	3.06	2.20	2.90
7	2.67	3.03	3.10	3.45	3.02	2.22	2.91
3	2.64	2.80	2.85	3.23	3.08	2.64	2.87
5	2.63	3.00	3.03	3.16	3.03	2.06	2.82
2	2.51	2.57	2.97	3.28	2.89	2.31	2.76
8	2.71	2.67	2.98	3.31	2.96	2.19	2.80
4	1.92	n.d.	3.16				
6	2.68	n.d.	3.70				
Treatment							
1.25 sh/ha	2.76	3.04	3.05	3.35	3.04	2.21	2.91
2.5 sh/ha	2.63	2.90	2.94	3.19	3.06	2.35	2.85
5 sh/ha	2.61	2.62	2.98	3.30	2.93	2.25	2.78
new 2.5 sh/ha	2.30	-	3.43				

n.d. = no data available

Wool growth rate per square centimetre of Mob 5 sheep was only recorded consistently for all treatments during 1975-76. During that year it ranged between 0.3 and 1.58 mg/sq cm/d of clean wool for individual sheep over about 70 days (range 53 to 94) and averaged between 0.66 and 1.03 mg/sq cm/d for that mob of sheep during different times of the year. Peak growth rate was usually in autumn each year (Table 36).

Table 36 Rate of clean wool growth (mg/sq cm/day) by 5 year-old wethers grazing buffel grass pastures at 3 different stocking rates in the 1975-76 year

Stocking rate	Period				
(sheep/hectare)	Nov-Jan	Feb-Mar	Apr-Jun	Jun-Aug	Total
5 sh/ha	0.663	0.778	1.054	0.698	3.193
2.5 sh/ha	0.786	0.977	1.088	0.681	3.532
1.25 sh/ha	0.818	0.946	0.952	0.589	3.305

On average, the 5 sh/ha treatment grew 13.9 kg of clean wool per hectare compared to 7.1 kg at 2.5 sh/ha and only 3.6 kg at 1.25 sh/ha. The quality of the wool would determine its commercial value and that would primarily depend on the micron count of the wool. We have no data about the strength of the wool grown by the various treatments but know that it was almost invariably non-tender. The wool from the more heavily stocked paddocks was generally finer than that from the lighter stocked ones but the difference between the 1.25 and 2.5 sh/ha treatments was small and inconsistent (Table 37). Thus, the very light grazing pressure treatment produced far less wool value for no apparent benefit in other ways on these buffel pastures.

It needs to be noted that the number of the original 16 weaner wethers that were still alive in their same paddock after 6 years was variable. The extreme cases were one in Paddock 3 and 12 in Paddock 1 with 6 in Paddocks 2, 7 and 8 and 5 in Paddock 5. The greasy fleece weights of those original sheep in the 3 remaining treatments were not statistically different from their paddock mean at the August 1977 shearing. Hence presentation of performance data for the entire group in a paddock over time seems justified and is what has been done in this report.

Fleece quality

Fibre diameter, yield, tenderness

Table 37 Dates when dye-bands were applied to sheep during Phase 2 and dates dyed wool samples were clipped for analysis

Year	Staple	Dates when dye-bands applied					Date clipped off
1971/72	A.	21/09/71	19/11/71	12/01/72			7/2/72
	B.	2/03/72	27/04/72	22/06/72			31/7/72
1972/73	A.	31/08/72	27/10/72	21/12/72			28/2/73
	B	21/12/72	28/02/73	10/05/73	4/07/73	2/08/73	28/8/73
1973/74	A	5/10/73	7/12/73	15/02/74			3/4/74
	B	15/02/74	3/04/74	14/06/74			9/8/74
1974/75		16/10/74	13/12/74	6/02/75	28/05/75	22/07/75	21/8/75
1975/76		10/09/75	14/11/75	16/01/76	30/03/76	2/07/76	16/9/76
76/77		nil					

Clean wool yields during this phase were unaffected by stocking rate. Mean yields were 55.8, 60.5, 63.5, 64.9, 66.8 and 65.6% for the years 1972 to 1977 respectively (Table 34).

No data has been retrieved about the quality of the fleece wool grown by this mob of wethers, apart from yield. However, dye-banding continued regularly up until 1976 and the dates when bands were applied are given in Table 37. In each paddock, only 8 of the 16 sheep were usually dye-banded, that being done at every second weighing time. Appendix 10 provides an example of the typical variability seen in the diameter of the wool grown by individual sheep over different time periods and the rate at which it grew on different sheep. There was over 6 microns difference on average between individual sheep and almost 6 microns difference at different times of the year.

There was a general but weak trend for wool micron count (µ) to increase as the rate of liveweight change and absolute liveweight of the sheep increased and vice versa (Figures 27, 28). Paddock 1 had two notable exceptions that may be confounded with animal age (Figure 28).

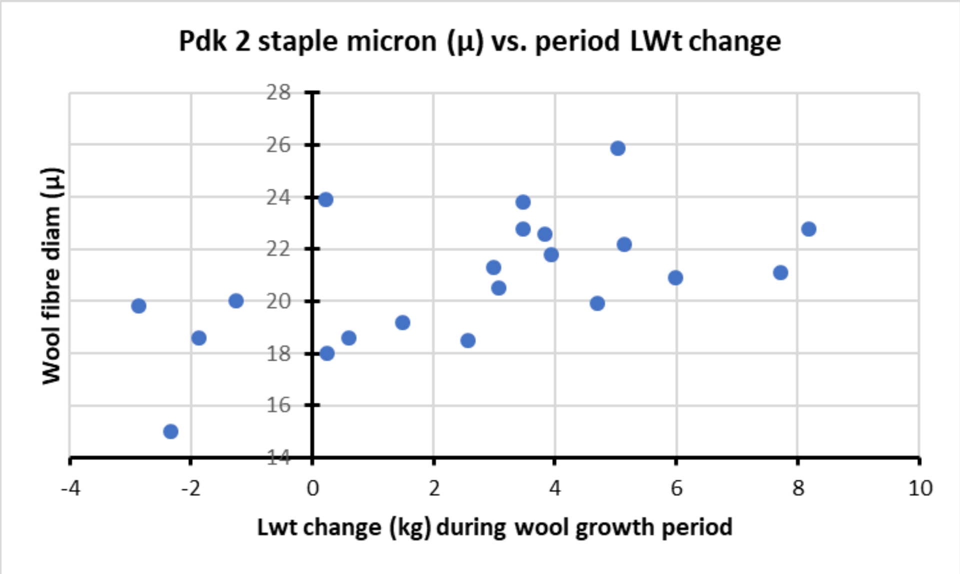


Figure 27 Relationship between wool fibre diameter (µ) and amount of sheep liveweight change (kg) during the same period for Paddock 2 sheep during 1972-73.

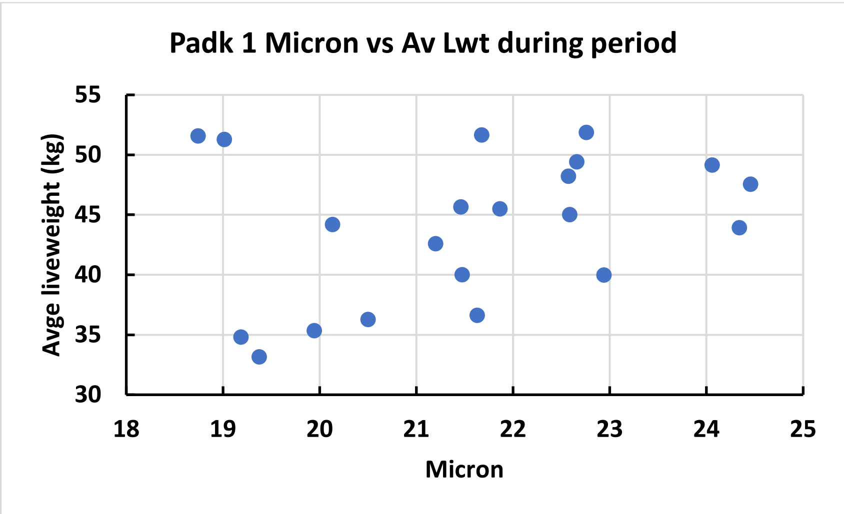


Figure 28 Relationship between average liveweight (kg) and wool micron diameter (µ) over short intervals for sheep in Paddock 1 during Phase 2, 1972-76.

Hence, micron counts dropped in winter-grown wool and rose in summer in response to pasture growth and greenness (Figures 29, 30). Also, in late 1972 when Paddock 2 and 8 sheep had to be fed supplementary hay, their micron count fell to the lowest level of the whole phase. The finer wool for sheep stocked at 1.25 sh/ha compared to the more heavily stocked treatments (Figure 29) is a bit unusual but it does reflect the fact that those sheep did not grow as rapidly in later years as the others

(Figure 24). Wool fibre diameter also increased slightly as the sheep aged, independently of the usual seasonal variation (Figure 30).

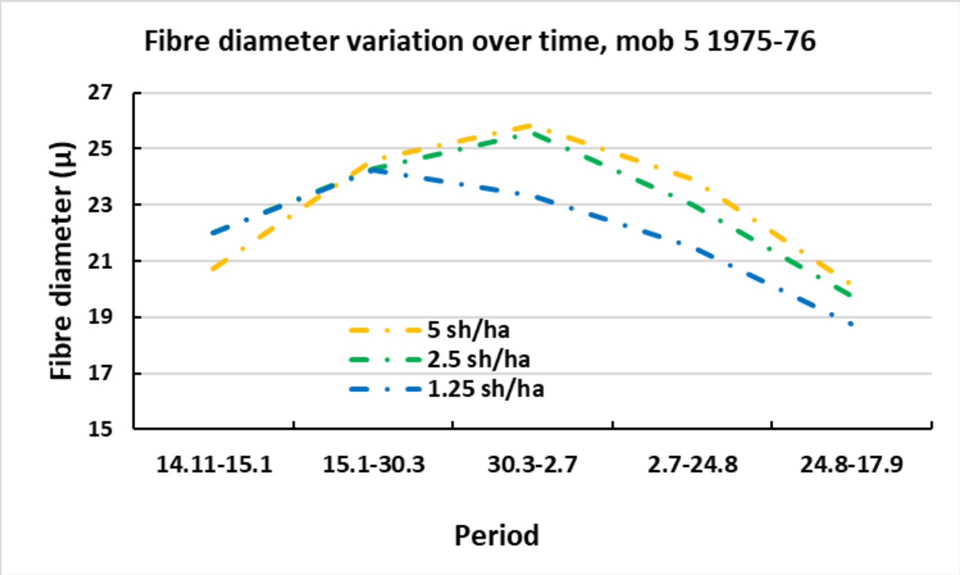


Figure 29 Variation in mean wool fibre diameter (µ) in a fleece over time as affected by stocking rate of 5 year-old wethers on buffel grass pasture in 1975-76.

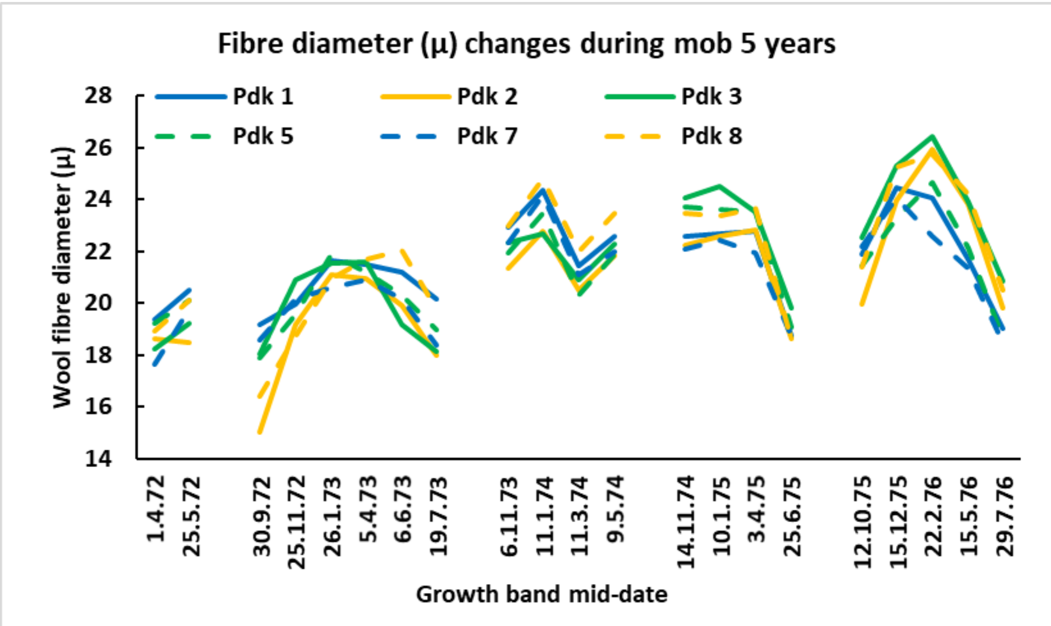


Figure 30 Steady increase in peak wool fibre diameter (µ) as wethers aged plus annual parabolic traces over time.

Any difference in average fibre diameter that initially existed between paddocks was maintained throughout despite the seasonal fluctuations that altered wool fineness appreciably during each year and between years (Table 38). This would match industry expectations that fibre diameter is moderately related to individual animal genes and can be reliably selected for (Taylor 2013). Overall, there was little difference in the mean fibre diameter due to grazing pressure in these better rainfall years (Table 38) compared to during the dry Phase 1.

Table 38 Mean wool fibre diameter (microns) for each fleece year derived from the dye-band data from 8 sheep in each paddock.

	Fleece yr					
Paddock	1972	1973	1974	1975	1976	Average
1	22.1	20.0	22.8	21.8	22.2	21.8
7	21.0	19.8	22.4	21.4	21.7	21.3
3	21.1	20.0	21.7	22.9	23.8	21.9
5	21.4	20.0	21.9	22.3	22.0	21.5
2	19.5	19.0	21.6	21.6	22.7	20.9
8	19.8	20.0	23.2	22.5	23.4	21.8
Average	20.8	19.8	22.3	22.1	22.6	21.5
Treatment						
1.25 sh/ha	21.5	19.9	22.6	21.6	22.0	21.5
2.5 sh/ha	21.3	20.0	21.8	22.6	22.9	21.7
5 sh/ha	19.7	19.5	22.4	22.0	23.1	21.3

Thus, rate of wool growth per unit skin area and wool fibre thickness both generally increased as sheep liveweight increased and decreased if weight loss occurred but individual sheep were recorded to sometimes not follow the general trend. This may have been due to illness, flystrike or sampling error, the chances of the latter being allied with the extensive field trial nature of the study and the large number of animals involved at most times.

Worm Burden, Lice, Flystrike

Monitoring for intestinal worms continued in this phase with results in the first 2 years continuing to record counts of less than 100 eggs/gm. On 10 February 1974 the first recoded instance of a significant worm burden occurred for sheep in Paddock 2, 300 eggs/gm. Other paddocks at the time still showed <100 epg except Paddock 6 which recorded 100 epg. No further appreciable roundworm burdens were recorded up to December 1975 when small egg counts (100 epg) were recorded but they had all been drenched off shears in August 1975 as a precaution. Then, on 30 March 1976, 800 epg were recorded from Paddock 1 sheep, 400 epg from Paddock 4 and 300 epg from Paddock 3. Significant worm burdens were recorded again on 2 July 1976 but counts were variable amongst the 4 sheep tested in each paddock and amongst the paddocks (Table 39). Two paddocks, 2 and 3, had very low counts but individual sheep in other paddocks had up to 1700 epg which is high and demands drenching (Cobon and Sullivan 1992; NSW DPI 2007). No cultures were made to help identify the main roundworm species involved in these samples.

No further sampling for roundworm burden was apparently undertaken for the remainder of this phase of the trial.

Table 39 Individual sheep intestinal roundworm egg counts (eggs per gram -epg) from faecal samples taken on 4 July 1976.

Paddock	Stocking rate	Counts (epg) from 4 sheep
1	1.25 ha/sheep	100, 100, 1000, 1000
7	1.25 ha/sheep	100, 200, 300, 400
3	2.5 ha/sheep	<100, <100, <100, <100
5	2.5 ha/sheep	<100, 100, 1600, 1700
2	5 ha/sheep	<100, <100, <100, <100
8	5 ha/sheep	<100, 600, 600, 800

Flystrike continued at low levels in all years and some deaths were attributed to it. While regular weighings occurred, there was the chance to observe it on individual sheep and treat it accordingly. Deaths from flystrike were abnormally high in February 1974 after persistent rain in January totalling over 300 mm.

Lice were never recorded as a significant problem and jetting off-shears was practised each year as a standard precautionary husbandry practice. Few details exist in the files about what chemicals were used and whether the jetting products used also helped control flystrike.

Other sheep data

In March 1973, **grazing clocks** like those used by Stobbs (1970) were trialled in an attempt to find if there was a correlation between the time sheep spent grazing and stocking rate, the latter also being confounded with presentation pasture biomass. Anecdotal reports say that the clocks fell off the sheep too readily and some were lost in the tall, dense buffel grass pastures. No data has been found from that study in the project archives.

Oesophageal Fistulated (OF) sheep were acquired in early 1973 and put into some of the trial pastures. Samples of the pasture being grazed were collected over a short period in the early morning after overnight starvation. The contents of the collection bags were frozen in expectation that they would be assayed for *in vitro* digestibility and scanned to determine the proportions of the major dietary components being preferentially consumed. Identification of species and plant components in the samples via microscope proved very difficult and there are no results to report. Likewise, the digestibility assay proved difficult to run and the results were unreliable.

Interpretation of Phase 2 results

Pastures

Average to above-average summer rainfall during this phase largely eliminated the differences in pasture basal area produced by differential grazing pressure during the dry Phase 1. Standing pasture biomass became exceptionally high, over 5000 kg/ha under the two lightest grazing pressures. Thus, data from this phase represents a fairly extreme example of the growth potential of these buffel pastures once the initial post-clearing nutritional flush has disappeared. By 1973 the pasture was over 10 years old. High pasture biomass caused concern about potential wildfires in the district which resulted in a firebreak being graded around the trial site for the first time. Basal area increased significantly and independently of grazing pressure throughout this phase from about 5% to

10%. However, the residual effect from the end of Phase 1 on the crown cover of pastures grazed at 5 sh/ha took over 4 years of good seasons to be eliminated (Table 26).

The nutritional quality of the bulky pasture was probably reduced in the last few years of this phase as the pool of available soil nitrogen was diluted but no sampling for pasture quality was done during this phase to confirm such a suggestion. Faecal protein and phosphorus have been used as a *de facto* gauge of the pasture quality and they were no worse than that recorded at times during Phase 1. Use of older, mature sheep would also probably make animal liveweight less sensitive to pasture quality, partly because they had 'full mouths' (complete adult teeth complement) that could better chew coarse pasture stems.

Animal performance

Liveweight trends were similar each year with a gain by animals after shearing in early spring until next shearing in August unless available green forage was very limited. Treatment effects were only obvious in late 1972 when forage remained in short supply due to a very dry winter and spring. Mature sheep weighed between 50 and 55kg at shearing and carried about 5kg of greasy wool. The incidence of high worm counts in mid-1976 shows that this was a possible constraint on production and may have been the cause of the poor fleece weights at the 1977 shearing following a year when minimal monitoring of the animals occurred. May 1978 is the next worm burden count found in the records and numbers were still significant then but not as extreme (see Phase 3 results). It was probably fortunate that the animals were mature, used to the paddocks and thus less susceptible to ill-thrift due to a moderate worm burden (NSW DPI 2007). Cobon and Sullivan (1992) showed in NW Qld at Toorak Research Station that moderate loads of *H. contortus* worms that did not result in clinical signs of ill-health could sometimes significantly reduce the rate of liveweight and wool growth of ewes, lambs and weaners.

A good inverse correlation (r = -0.62) existed between pasture basal cover and wool production per head for sheep grazing at 1.25 sh/ha during this phase but the correlation declined as stocking rate increased, -0.36 at 2.5 sh/ha and -0.04 at 5 sh/ha. Mean basal cover over 6 years decreased under heavier stocking from 8.3 to 7.1 to 6.2% (Table 27) but that largely reflects the difference at the start of this phase and the time needed to regain good crown cover once it has been reduced. The inverse nature of this correlation probably reflects how rank and moribund the most lightly grazed buffel pastures can become in a run of good summer rains. Economically, it would be sensible for a producer to increase stocking rates during a run of good seasons to counteract the reduced value of the wool per kilogram evident when sheep liveweights are heavier (Figure 28).

There was no indication that any sustained high stocking rate had a permanent effect on the production capacity or quality of the wool of individual sheep. However, the proportion of the original animals still present in a paddock after 6 years was sometimes very low, making such a judgement problematic. Nonetheless, it highlights the far greater importance of seasonal conditions and forage availability on wool growth of healthy sheep rather than some fixed, nominal stocking rate.

Phase 3 (November 1977 – August 1979; wethers, 2 grazing systems)

This phase tried to take advantage of excess grazing capacity in the lowest stocking rate paddocks to compare the effect on animal production of a structured rotational grazing system with that of a traditional fixed grazing system. The criterion for moving sheep into the next cell in the 4-paddock system was when their liveweight fell to less than 95% of the liveweight of the sheep grazing under the fixed stocking system. It experienced a few disasters, with the water supply to some paddocks being unreliable in summer which led to sheep breaking through fences to find water or perishing if unable to get into another paddock. Only 1 replicate of each treatment provided data for the entire two years of the phase.

Shearing was unusually late at 16/10/1978 for the 1977/78 year, instead of August. All sheep were drenched for worms on 6/6/1979.

Rainfall

Table 40 Monthly kriged rainfall (mm) for the trial locality during Phase 3 – rotational grazing v. fixed. Long-term Blackall data shown for comparison.

	Long term	1977	1978	1979
January	84	72	51	12
February	81	212	16	103
March	63	51	34	27
April	36	**46**	2	15
May	33	**112**	**61**	13
June	27	1	27	37
July	25	3	**118**	0
August	17	2	**53**	1
September	19	3	**43**	9
October	33	15	36	24
November	43	1	15	10
December	69	43	72	28
Year	529	560	528	277
Cool months	188	182	339	98
Warm months	343	463	145	228
Warm mth decile		7	1	3

Long term values are for Blackall P.O. Warm month deciles include prior November and December falls. Warm months is taken as November to March inclusive; Cool months are April to October inclusive.
Bold values indicate cool season rain effective enough to stimulate some buffel grass regrowth.

The summer immediately after the rotational grazing study began was as dry as any during this project but the rain was quite evenly distributed (Table 40) and followed two exceptionally wet summers. Thus, there was plenty of deep soil moisture for the well-established pastures to draw on and pasture growth, though unmeasured, was adequate for healthy sheep growth (Figure 31). The 1978/79 summer rain was well below average and the following dry autumn-winter meant a very poor finish to that phase in August 1979.

Pasture data

Pasture basal cover

Pasture basal cover of each paddock was recorded each October as the measure of the persistence and density of the pastures under different stocking rates and grazing management systems. The level of cover in each sub-paddock in the rotation trial was high and fairly similar in the 4 sectors derived from the original large paddocks if gauged from the dissected raw data of Nov 1976 and Oct 1978 (Table 41).

Table 41 Basal cover levels (%) in November 1976 and October 1978 in each of the 4 sub-paddocks of the two large original paddocks repurposed for the rotational grazing system

Sub-pdk	Basal cover		%	Sub-pdk	Basal cover	
	Nov '76	Oct '78			Nov '76	Oct '78
Pdk 1, s1	10.4	9.0		Pdk 7, s1	9.6	10.6
Pdk 1, s2	10.4	10.8		Pdk 7, s2	8.6	9.8
Pdk 1, s3	9.8	10.0		Pdk 7, s3	7.8	10.6
Pdk 1, s4	9.4	10.0		Pdk 7, s4	8.2	11.6
Mean	10.0	9.95		Mean	8.6	10.65

However, there was a differential change from November 1976 to October 1977, just before the rotations began, with a slight overall decrease in Paddock 1, 10 to 9.3%, and a notable increase, 8.6 to 12.6%, for Paddock 7 over that period. There is no obvious reason for this difference between the then replicate paddocks apart from sampling error as all other paddocks also recorded an increase in basal cover over that period (Table 42). In October 1978 after 1 year of rotations, changes in the sub-paddocks were not large although sub-paddock 1 at 5 sh/ha had declined whereas the cover on the other 3 sections had increased (Table 41). In the 2.5 sh/ha rotational system there was a general increase in cover which reflects the big increase recorded between 1976 and 1977 prior to creating the 4 sub-paddocks (Table 42). No evidence has been found of the basal area being measured for the rotationally grazed pastures in October 1979, after that study concluded in August.

Table 42 Basal cover level (%) in each spring of paddocks grazed continuously or rotationally at two different stocking rates during Phase 3 and at the end of Phase 2.

Paddock	S/rate	26/11/76	Oct-77	11/10/1978	18/10/1979
1R	5.0R	10.0	9.30	9.95	
7R	2.5R	8.60	12.55	10.65	
3	2.5	8.95	9.50	10.50	8.55
5	2.5	7.20	10.35	9.15	10.45
2	5.0	8.40	9.25	10.15	7.65
8	5.0	7.00	9.30	10.85	9.15

There was no consistent change in basal cover related to grazing pressure or grazing system during this phase. All paddocks maintained a very high cover for such a climatic zone. By October 1978, the animals had been shifted through all 4 sub-paddocks at both stocking rates and Paddock 1 sheep (5 sh/ha but effectively 4 times that for a few months at a time on each sub-paddock) were back in sub-paddock 2 for the second time. Paddock 7 sheep (2.5 sh/ha overall) were back in sub-paddock 1 at this time. Lack of extant basal cover data for the abandoned Paddocks 1 and 7 in October 1979 limits potential interpretation of the impact of rotational management on the pasture. Judging by the liveweight of the Paddock 1 sheep at this time (Figures 31 and 32), there might have been a reduction in crown cover of one or two sub-paddocks that were stocked during a relatively low rainfall period, such as autumn 1978 (Table 40). Yet the excellent rain during the 1978 winter may have counteracted such short-term loss of cover prior to the spring recording of basal cover.

Pasture standing dry matter

There are no data about the amount of standing pasture present for the sheep to graze during this phase nor were any photographs found in the archived files.

Pasture quality

There are no explicit data during this phase for the levels of protein and other nutrients in the pastures. However, faecal samples were collected regularly and analysed by the ARI labs for crude protein and phosphorus levels as a surrogate measure (see below).

Animal data

General

In March 1978, the Paddock 3 sheep became mixed up with those of Paddock 8 for a few weeks before the error was realised. Then in February 1979 those Paddock 3 sheep suffered a water supply crisis during very hot weather causing some deaths while others escaped to the surrounding commercial paddock. Paddock 3 was then abandoned for the rest of this phase. In March 1979 another water supply failure in the 2.5 sh/ha rotational sub-paddock 2 and Paddock 8 caused the death of most of those sheep. As a result, the rotation at 2.5 sh/ha was abandoned and Paddock 8 was excluded from data collection until the next phase in late 1979.

Sheep liveweight

The animals on the rotationally grazed pastures put on weight less rapidly than those in the continually grazed pastures. This effect was most dramatic in the 5 sh/ha rotation (effectively 20 sh/ha) where they lost weight over the first 2 months between late November and late January, during which time 64 mm of rain was received (Figure 31). Though they then gained weight for the rest of the summer, they did so at a slower rate than those in the other rotation at half the stocking rate. The sheep in the rotation at 2.5 sh/ha also did not grow as well during summer as those in the fixed regime of the same stocking rate (Paddocks 3 and 5).

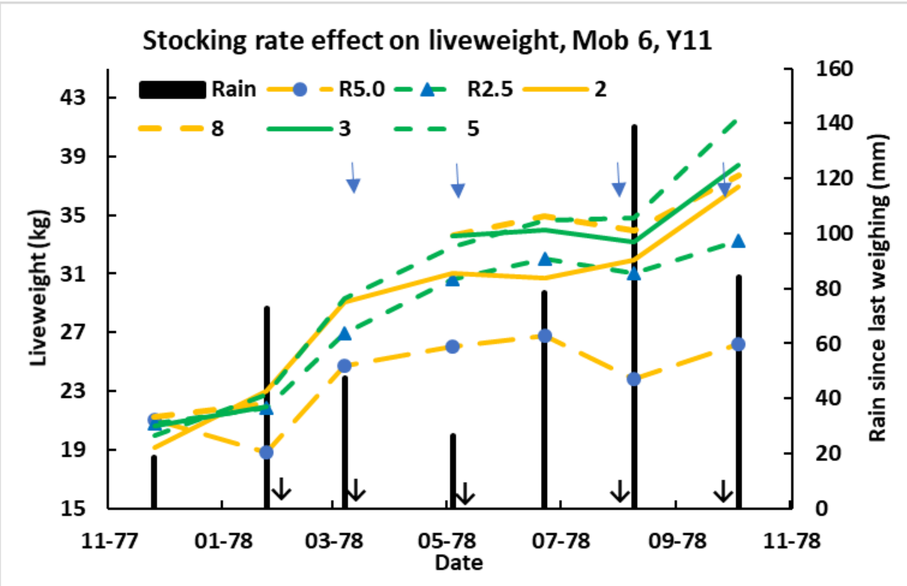


Figure 31 Sheep liveweight change over the first year of the comparison of grazing systems at two different stocking rates, either 2.5 sh/ha (Paddocks R2.5, 3 and 5) or 5 sh/ha (Paddocks R5.0, 2 and 8).

Arrows show when sheep were moved to the next sub-paddock in the rotationally grazed paddocks. ↓ 5 sh/ha, ↓ 2.5 sh/ha.

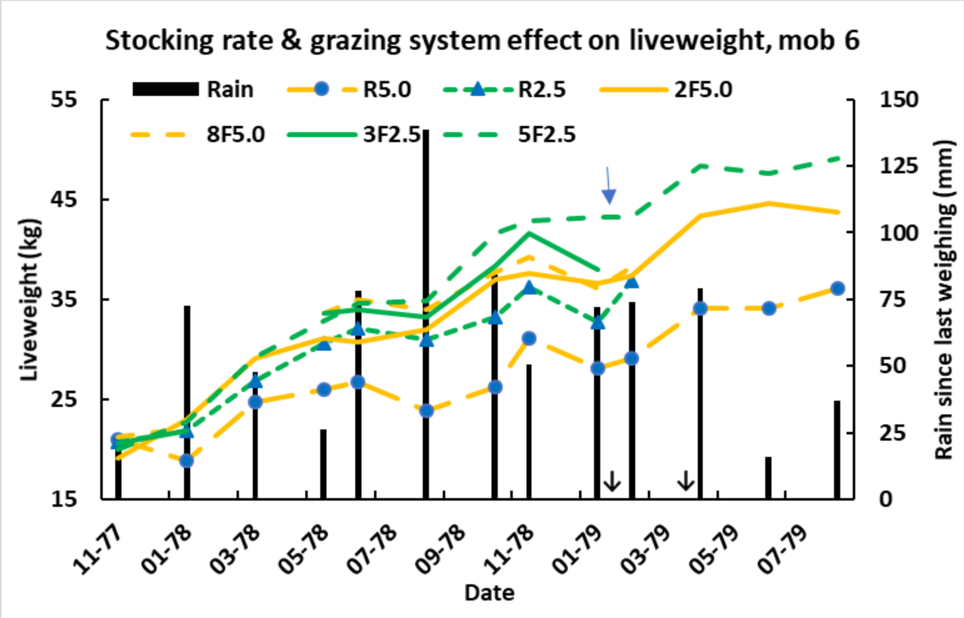


Figure 32 Recorded mean sheep liveweight during both years comparing fixed vs. rotational grazing at either 2.5 sh/ha (Paddocks R2.5, 3F2.5 and 5F2.5) or 5 sh/ha (Paddocks R5.0, 2F5.0 and 8F5.0).

Arrows show when sheep were moved to the next rotationally grazed sub-paddock in 1979.
↓ 5 sh/ha, ↓ 2.5 sh/ha

During the second year of the rotation versus fixed grazing system, sheep generally lost or failed to gain weight in early summer in all paddocks for some unexplained reason (Figure 32). Rainfall was reasonable at 72mm during that time with significant falls in early and late December, and prior to the first weighing after shearing, 49mm had fallen at scattered times to presumably boost pasture greenness and growth. Thereafter, the available data (Figure 32) showed similar liveweight change patterns for the 3 remaining paddocks but no closing of the residual gap in weight that existed after shearing in October 1978. Rainfall during that period from January to August 1979 (207 mm) was only above average in February and June and well below average (362 mm) for the entire period (Table 40). Thus, opportunities for the sheep in any treatment to make appreciable weight gains were limited and gains were only about 6kg in that 8-month period. That compares with 10-15kg over the same period the previous year for all treatments except the 5 sh/ha rotational one.

Until their untimely death, the sheep in the rotational 2.5 sh/ha treatment continued to show a weight change pattern similar to that of the 5 sh/ha fixed stocking treatment, albeit slightly heavier. They never achieved the liveweight of the comparison 2.5 sh/ha fixed stocking treatment (Figures 31 and 32). Moving sheep to a new sub-paddock only produced a marked improvement in weight gain in the short term on 2 occasions, late January 1978 in the 5 sh/ha rotation (Figure 31) and early January 1979 for the 2.5 sh/ha rotation (Figure 32). Even in the former case, that increase was no more rapid than that in all the other continuously grazed paddocks and thus may have been unconnected with the paddock shift. The sheep grazing at 5 sh/ha continuously again failed to improve their weight once winter arrived.

Faecal protein and phosphorus

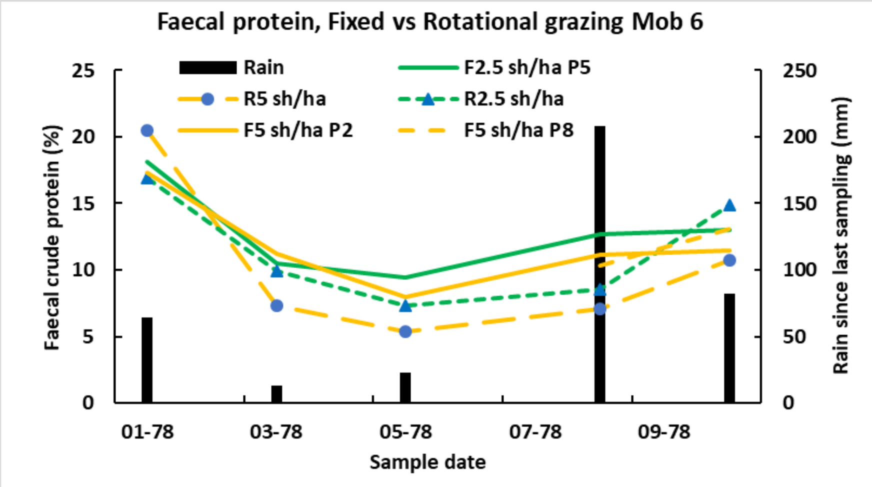


Figure 33 Faecal crude protein (%) during the first year of rotational vs. fixed grazing systems at two stocking rates.

Rain (mm) received during the interval before each sample date is also shown. Some data series are incomplete.

These faecal data indicate that during the relatively dry first half of 1978 the nutritional value of the pastures being grazed deteriorated appreciably from early January and did not pick up much during the winter despite exceptionally good winter rains (Figure 33, Table 40). The rotationally grazed animals seemed at a disadvantage compared to those under the fixed grazing system at both stocking rates with the poorest nutrition occurring in the heavier stocking rate rotationally grazed system. However, the protein available in the pastures were generally adequate to allow liveweight gain for all treatments early in the winter (Figure 31). In late winter and despite exceptional winter rains, sheep lost weight in all paddocks irrespective of grazing management, except Paddock 2 for some unexplainable reason (Figure 31). No samples were apparently collected from Paddock 3 sheep during this time or they were lost or accidently destroyed before analysis was possible.

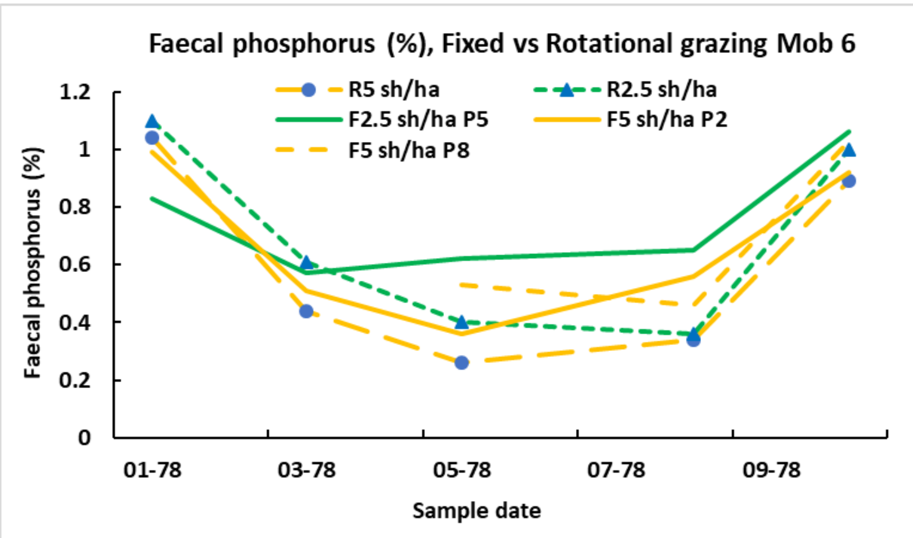


Figure 34 Faecal phosphorus (%) during the first year of rotational vs. fixed grazing systems at two stocking rates, 2.5 and 5 sheep/ha.

Some data series are incomplete.

The faecal phosphorus levels also showed an appreciable decline during the relatively dry months after January 1978 and improved little during the very wet winter until warmer weather came in spring (Figure 34). Nonetheless, these values indicate that the sheep had adequate amounts of phosphorus available to them in the pastures at all times in all treatments. Still the 5 sh/ha rotational grazing system exhibited the poorest nutritional values and, in mid-winter, the rotation management system resulted in a poorer plane of nutrition than for the fixed stocking system at both stocking rates. However, all improved to similar levels once warmer weather returned.

In the second year of comparison of the contrasting grazing management systems, faecal sampling was less comprehensive and there was no discernible difference in the values for sheep run under the rotational management system from those in fixed-stocked paddocks at the same annual stocking rate (Table 43). There was a considerable drop in faecal protein and phosphorus levels between mid-February and late April 1979 probably largely because most of the 73 mm of rain that fell during the interval was in late February.

Table 43 Faecal crude protein and phosphorus in the second year comparing fixed and rotational grazing management at two different stocking rates, plus rainfall received prior to each sampling.

			Sample	date		
Paddock	18/12/78	9/01/79	19/02/79	24/04/79	6/06/79	10/08/79
	Crude protein (%)					
R5 sh/ha	10.3	13.0	19.2	6.1	5.6	6.1
R2.5 sh/ha	10.3	15.4	20.9			6.7
3F2.5 sh/ha						8.4
5F2.5 sh/ha	9.1	12.9	22.4	10.0	7.2	
2F 5 sh/ha	8.9	15.7	23.0	9.6	7.3	
8F 5 sh/ha	9.1	14.7	22.7			
Rain (mm)	49.2	69.3	71	73.2	14.1	37
	Phosphorus (%)					
R 5 sh/ha	0.58	0.63	1.66	0.41	0.21	0.24
R2.5 sh/ha	0.90	1.41	1.76			0.23
3F2.5 sh/ha						0.24
5F2.5 sh/ha	0.87	0.94	1.28	0.69	0.27	
2F5 sh/ha	0.69	1.25	1.76	0.33	0.25	
8F5 sh/ha	0.80	1.29	1.58			

The extreme values recorded in this phase were generally similar to those in Phase 2 although peak phosphorus levels over 1.7% in February were the highest ever recorded in this trial.

Fleece weight and quality

The fleece data is fragmented due to losses in the 1979 summer but the much poorer wool growth of the rotationally grazed sheep is very clear at the August 1978 shearing (Table 44) and the trend continued in 1979 which was a better wool-growing year overall (3.8 vs. 3.3 kg greasy for the same 3 treatments). The sheep grazing rotationally at the higher stocking rate (Paddock 1R5.0) also grew appreciably less wool than those in the rotation at half that stocking rate, 1.5kg of clean wool compared to 1.8 kg. That comparison again held at the 1979 shearing where Paddock 1R5.0 cut 1.9 kg clean wool/head compared to 2.7 kg for sheep from Paddock 2.

Table 44 Fleece data per head for the various grazing pressure treatments from shearings in August 1978 and August 1979

	Greasy wgt (kg)		Yield (%)		Clean wgt (kg)		Fibre diam. (µ)		Sheep nbr	
	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979
Pdk 1R5.0	2.4	3.0	60.2	64.3	1.5	1.9	19.3	21.6	53	61
Pdk 7R2.5	2.9		60.9		1.8		20.5		27	0
Rotation	**2.65**		**60.5**		**1.65**		**19.9**			
Pdk 3	3.4		61.0		2.0		21.9		8	0
Pdk 5	3.7	4.3	62.3	64.3	2.3	2.7	21.8	23.2	10	15
2.5 sh/ha	**3.55**		**61.6**		**2.15**		**21.85**			
Pdk 2	3.9	4.1	63.5	64.9	2.5	2.7	21.4	22.4	13	15
Pdk 8	3.4		61.4		2.1		21.2		5	0
5 sh/ha	**3.65**		**62.4**		**2.3**		**21.3**			
Year av	3.33	3.8	62.0	64.5	2.10	2.43	20.83	22.4		

Somewhat surprisingly, the sheep grazing non-rotationally at 5 sh/ha in Paddock 2 in 1977-78 grew slightly more wool than the ones in either paddocks at 2.5 sh/ha and its Paddock 8 replicate. This was not common in previous years. The better wool production in 1979 was accompanied by higher yields of clean wool, 64.5% compared to 62% in 1978.

Fleece quality

The poorer amount of wool growth from the rotationally grazed sheep was associated with the normal pattern of a decrease in fibre diameter, apparently related to more stressful conditions, most probably protein levels in the pasture. That wool was more than 1 micron finer for the 1978 fleeces (Table 44) and thus potentially more valuable. The fleece wool from both rotational paddocks was finer in both years than that from the equivalent fixed-stocked paddocks. The wool from fixed grazing pressure paddocks was slightly finer where sheep ran at a higher stocking rate in both years, 21.3µ versus 21.8µ in 1978 (Table 44). This would be expected. The lower yield of fleeces from the rotationally grazed paddocks may indicate a higher worm burden in those sheep but the limited data about that aspect is inconclusive (see below).

Worm Burden, Lice, Flystrike

Worm burdens were only assessed once during the first year of Mob 6, on 15 May 1978 after a relatively dry summer and before the very wet 1978 winter-spring set in. On that date, faecal samples were taken from 4 sheep in each paddock. Egg counts were relatively low (<100 to 700 epg, average 200 epg) and the rotationally grazed animals did not have significantly different results from the set-stocked treatments. In the second year of this phase, assessments for worms were done 3 times, on 9 January, 19 February and 24 April, during which period February was the only month to receive appreciable rain. In January the counts were low, mostly 100 epg or less with a maximum of 400 epg in 2 sheep from Paddock 5. The February counts were much higher in both grazing systems but only 2 sheep were sampled from each paddock (Table 45). Counts continued to be high at the late April sampling where 5 animals were tested in each of the surviving 3 paddocks. Therefore, all sheep were drenched on 6/6/1979. The great inter-animal variation with so few animals tested makes interpretation fraught except to say that the rotationally grazed sheep potentially had at least as high counts as sheep in the continuously grazed paddocks.

Table 45 Worm counts from samples taken from individual sheep at two dates in 1979

Date	Pdk	Sheep 1	Sheep 2	Sheep 3	Sheep 4	Sheep 5	
19/02/1979	1R	5300	1000				
	7R	1800	1200				
	2	400	200				
	8	4000	700				
	5	900	400				
							Mean
24/04/1979	1R	3400	200	200	100	100	800
	2	400	200	100	100	100	180
	5	2000	1700	1700	1500	100	1400

The samples were cultured to identify the main roundworm species involved. The February samples from paddocks 2 and 5 produced 66% *Haemonchus* sp. (barber's pole worm) and 34% *Trichostrongylus* sp. (black scour worm) while the April samples were 84% *Haemonchus* sp. and only 16% *Trichostrongylus* sp.

Other sheep data

No other ancillary data was collected during this phase.

Phase 3 stocking rate expressed as Dry Sheep Equivalents (DSE) per hectare

Table 46 Mean paddock and treatment grazing pressure each year during Phase 3 expressed as DSEs/ha.

1 DSE equals a 50kg wether maintaining its weight.

Year	Paddock						Treatment			
	Pdk 2	Pdk 8	Pdk 3	Pdk 5	Pdk 1	Pdk 7	5 sh/ha	2.5 sh/ha	5 Rotn	2.5 Rotn
1977-78	4.1	2.4	0.9	2.2	2.7	1.7	3.25	1.58	2.7	1.7
1978-79	4.4	1.6	0.2	2.4	3.5	0.8	3.00	1.32	3.5	0.8

The problems of maintaining nominal stocking rates during this phase are well illustrated by Table 46. Replicates were very different in all years and grazing pressures were sometimes temporarily very low based on the head counts from liveweights recorded at each weighing. However, anecdotal evidence suggests that the weight of some sheep was not recorded if they were regarded as strays that should not have been in that paddock or they had only been recent replacements for others lost since the last weighing. The differential between the 5 and 2.5 sh/ha rotations in the 1978-79 year is exaggerated because the water failure terminated the 2.5 sh/ha rotation system prematurely and the sheep were not replaced that year. Though the overall means over the 2 years may calculate to be similar for the rotational and the fixed grazing pressures, those means hide the large replicate differences shown in Table 46.

In general, the grazing pressure in this phase in animal liveweight terms was lower than that during the later years of Phase 2 (Table 32) and nearer to that in the later years of Phase 1 (Table 17).

Interpretation of Phase 3 results

Loss of large numbers of trial animals during this phase due to water supply failures has meant the animal performance data has uncertain reliability. However, the comparison of a structured rotational grazing system against the traditional fixed stocking system ran for long enough to show that a simple rotational system with 4 paddocks did not confer anywhere near the benefits needed to justify the extra infrastructure costs and management required.

Some would argue that there were insufficient sub-paddocks/cells created to allow the potential benefits to manifest themselves. Those benefits theoretically include pasture and environmental benefits (McCosker 2000; Topos and Anthros 2019). The project staff believed, in hindsight, that the research criterion to move sheep to the next sub-paddock was too great because a relative loss of 5% liveweight only occurred long after there had been an appreciable reduction in edible forage in a paddock in an environment where weight loss by all treatments occurs at certain times. The sheep at this phase were young wethers and thus were expected to be sensitive to nutritional stress and that seems to have been borne out by the liveweight (Figure 31) and fleece data (Table 44).

Sheep growth and weight retention

Nothing in the data shown in Figures 31 and 32 indicates that the rotational grazing system at either stocking rate conferred an advantage to those sheep. There seemed to be a distinct disadvantage when the stocking rate was 5 sh/ha (Figure 32) but only a marginal to negligible disadvantage at 2.5 sh/ha. This illustrates well the claim of many researchers that the purported advantages of various grazing management systems depend primarily on having the appropriate stocking rate (Kemp *et al.* 2000; McCosker 2000; Scott *et al.* 2013). Perhaps the pastures were too rank initially and forced sheep to eat an inappropriately high proportion of stem than would have been the case if the starting state was far less mature. In this study the appropriate long-term rate was between 2.5 and 5 sh/ha on most measures used, with heavier stocking acceptable in above-average seasons.

Wool production

The weight of fleece grown under rotational grazing also suffered without a sufficiently marked fining of the fibre diameter to compensate financially (Table 44), except possibly at 5 sh/ha in the first year (19.3 vs 21.3µ from 1.5kg vs 2.3kg clean fleece). Fibre diameter generally accounts for 70-80% of clean merino wool value (AWI 2019) especially when below 20µ (Figure 35). In the second year, the difference was much less, 21.6 vs. 22.4µ on 1.9 vs 2.7kg clean fleece and offered no financial advantage at sale in that micron range. There can be times when nett income is greater when less, but finer, more valuable wool is grown under moderate nutritional stress (AWI 2019). The chart below (Figure 35) from Australian Wool Innovation (AWI 2019) shows the general pattern of value seen in the market long term for medium merino wool, although relative values can shift as manufacturer requirements change over the years.

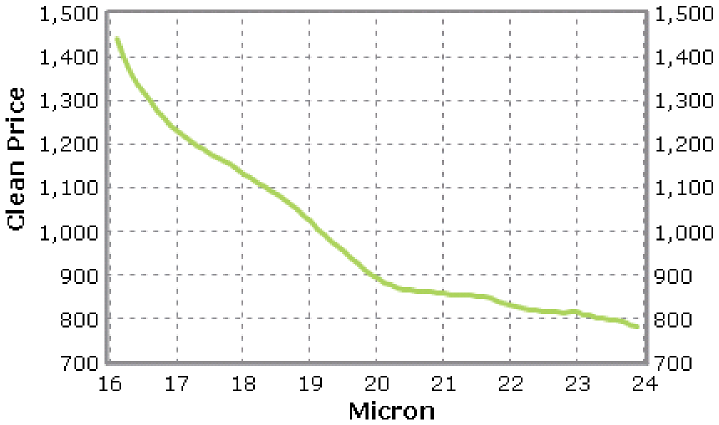


Figure 35 Influence of wool fibre diameter (µ) on average clean fleece wool sale price (c/kg) in Australia over several recent decades up to 2019.

Worm burden

Sampling for worms was done primarily to monitor the intestinal health of the sheep so that remedies could be provided if worm counts became too high. They were not aimed at getting a close measure on the comparative burden between paddocks, particularly as counts in the first 7 years had almost always been very low and often not within the laboratory technique's confidence limits at that time.

Rotational grazing did not confer any obvious benefit towards lowering intestinal worm burdens. That is often claimed as a positive outcome for rotational grazing systems (Colvin *et al.* 2008) but in the relatively dry climate of Blackall, harbouring worm eggs or larvae in extensive pastures is rarely likely and any transmission or reinfection would probably occur within the heavily populated zone close to water troughs. That area was often the only site of readily accessible green shoot on the buffel grass in this trial and sheep selectively grazed that shoot at all times of the year. Thus there was every opportunity in the paddocks used for sheep to transmit worms to others but it did not happen to any degree in most years.

Pasture health

With little data to work with, it is only possible to say that in the first year under the different grazing systems all treatments, on average, increased their pasture basal area (Table 42). No final basal area data was collected from the rotationally grazed paddocks in October 1979 and thereafter. Any potential damage from having sheep in Paddock 1R grazing sub-section 3 for many months at 20 sh/ha (Table 42) would probably have still been evident because little rain fell between the 1979 shearing and the usual October basal cover assessments (Table 40). Unfortunately, it was not recorded because those paddocks were then regarded as discarded.

Phase 4 (February 1980 – August 1982; wethers, 2 stocking rates)

Rainfall

During this phase annual rainfall was fair in the first calendar year (397 mm), above average the second and very low in the last year (Table 47). However, the important summer rain was low in 1980/81 and above average for the 1981/82 summer. The 1981 cool season (April to September) was exceptionally wet in the first half but then very dry in August and September. Low April to August 1982 rainfall ensured a very dry, frosty end to this long study.

Table 47 Monthly kriged rainfall (mm) for the trial locality during Phase 4, plus Blackall long term data for comparison.

Month	Long term	1979	1980	1981	1982
January	84	12	83	60	86
February	81	103	69	95	12
March	63	27	67	26	112
April	36	15	9	13	3
May	33	13	**49**	**162**	21
June	27	**37**	0	9	1
July	25	0	30	**85**	0
August	17	1	13	0	0
September	19	9	0	0	0
October	33	24	32	**41**	1
November	43	10	22	97	-
December	69	28	24	26	-
Year	529	277	397	614	235
Cool months	188	98	132	31	26
Warm months	343	228	257	227	333
Warm mth decile		3	4	3	6

Long term values are for Blackall P.O. Warm month deciles include prior November and December falls. Warm months is taken as November to March inclusive; Cool months are April to October inclusive. Bold values indicate cool season rain effective enough to stimulate some buffel grass regrowth

Pasture data

Pasture basal cover

Basal cover was the only direct measure made of pasture biomass or quality during this phase. Cover was significantly and consistently greater (P<0.05) at the lighter of the two stocking rates remaining (Table 48) but was still high to very high in both treatments by many pasture condition standards (Silcock 1993). The dry 1980/81 summer saw basal cover drop to levels commonly recorded for healthy pastures during drier times but then recovered during the good 1981/82 summer to high levels. The October 1982 results probably were not affected by the lack of sheep in all paddocks since the August shearing because no significant rain had fallen over that interval or for months before.

Table 48 Paddock basal cover of buffel pastures over 4 years at the 2 stocking rates that had been maintained since 1967.

		Spring of				
sh/ha	Pdk	1979	1980	1981	1982	Mean
2.5	3	8.55	8.55	7.5	11.95	9.14
	5	10.45	8.85	8.9	10.35	9.64
5	2	7.65	5.95	5.45	5.75	6.20
	8	9.15	6.9	6.65	9.45	8.04

Pasture standing dry matter

No assessments were made of the standing dry matter in the pastures nor of the seasonal growth of new pasture. The GRASP modelling (GRASP Modelling Team 2010), the Botanal pasture sampling and analysis system (Tothill *et al.* 1992) and the Swiftsynd protocol for matching pasture production to rainfall (Day and Philp 1997) all had yet to be developed to make such undertakings something that could be done regularly with an acceptable level of effort.

Pasture quality

No samples were taken during this phase to document the protein status of the pastures, nor was faecal chemistry available as a *de facto* assay.

Animal data

General

Use of external insecticides and internal anthelmintics increased in this phase but care was taken to use a range of products so as to minimise the risk of a build-up of resistance by the parasites. The new mob of wethers (Mob 7) was drenched with Thibenzole (thiabendazole) on 22/2/1980. Off-shears on 13/8/1980, all sheep were dipped for lice control and injected with 4ml of Nilverm (levamisole) for worm control. All sheep were crutched and jetted with Lucijet on 24/6/1981. Flystrike was a regular low-level problem that was normally dealt with on an individual animal basis. However, it was deemed necessary to jet all sheep in Paddocks 2, 3 and 8 with Vetrazin (cyromazine) on 10/12/1981. In this phase, losses were generally minimal until March 1982 when another water reticulation failure led to most sheep in Paddock 3 dying and the termination of data collection from that paddock. Two sheep died in Paddock 8 in Feb 1981 and some sheep escaped from Paddock 5 for a while in March. The wet February 1982 encouraged drenching for worms and jetting for fly-strike of the remaining sheep on 19/3/1982.

Sheep liveweight

Liveweights generally reflected the seasonal conditions prevailing with the sudden general drop in weights in August 1981 due to shearing that day which saw 4-5kg of fleece removed (Figure 36). Over 200 mm of rain during the 1979-80 summer should have seen plenty of pasture available to the new sheep in all 4 paddocks. Thereafter the sheep grazing at 2.5 sh/ha grew better than those at 5 sh/ha and Paddock 2 sheep were consistently lighter than those in the replicate Paddock 8 until after the 1982 summer (Figure 36). By contrast, sheep liveweight of the two reps at 2.5 sh/ha followed very closely after 1980. Again, these growing sheep showed a general increase in their average weight as time went on, if pasture quality allowed.

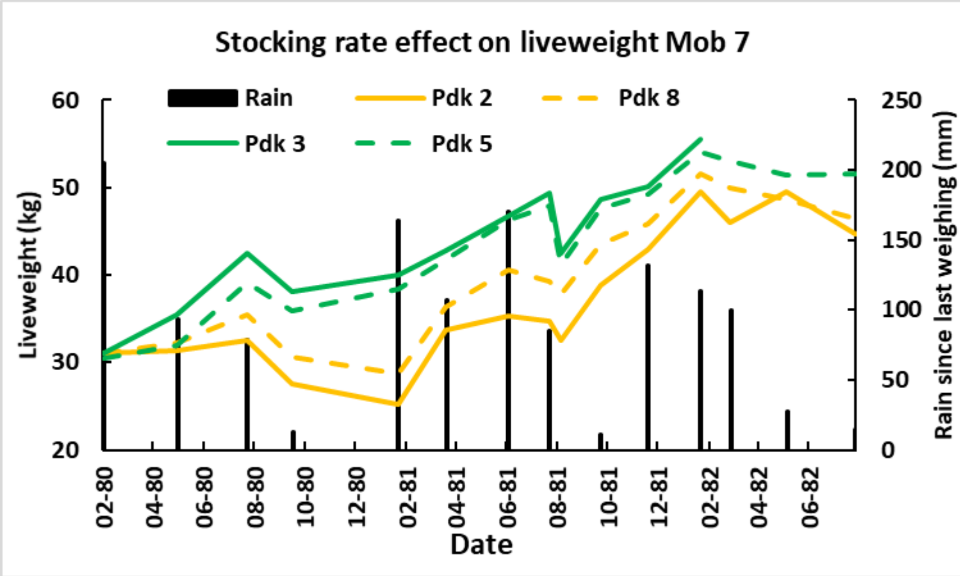


Figure 36 Sheep liveweight changes for each paddock at 2 stocking rates, Mob 7, 1980-1982, plus rainfall received since the prior sampling time.

Faecal protein and phosphorus

No faecal protein assays were done during this phase in response to earlier head office queries about the need to continue them when budgetary constraints were increasing.

Fleece weight

Table 49 Paddock mean greasy and clean fleece weights for Mob 7 sheep at 1980, 1981 and 1982 shearings.

Number of fleeces involved at each shearing is also listed.

Shearing Parameter	1980 Greasy	1981 fleece	1982 (kg)	1980 Clean	1981 fleece	1982 (kg)
Pdk 3	3.7	4.8	4.2	2.2	3.1	3.3
Sheep no.	14	13	3	14	13	3
Pdk 5	3.7	5.5	5.3	2.1	3.5	4.1
Sheep no.	14	7	18	14	7	12
2.5 sh/ha mean	**3.7**	**5.1**	**4.8**	**2.2**	**3.3**	**3.7**
Pdk 2	3.4	3.6	5.0	2.0	2.2	3.7
Sheep no.	16	13	15	16	13	14
Pdk 8	3.4	4.2	4.9	2.1	2.7	3.9
Sheep no.	16	9	16	16	9	16
5 sh/ha mean	**3.4**	**3.9**	**4.9**	**2.0**	**2.5**	**3.8**

In some years, only a few sheep survived in their initially allotted paddock up until shearing. Thus, the mean fleece weights calculated for Paddock 3 in 1982, Paddock 5 in 1982 and Paddock 8 in 1981 need to be interpreted with some caution. Greasy fleece weight per head increased each year in most paddocks with no consistent difference due to grazing pressure. The high weights in August 1982 are surprising given how poor the rainfall was in the last 5 months of that year (Table 49). The improved clean fleece weights are partly due to the high yield percentages for the year (76%, Table 50) and partly to the increased size of the sheep that were now over 3 years old.

It is interesting to compare the clean fleece production with that from a trial conducted at the same time with the same bloodline of Terrick Terrick wethers at Longreach and Julia Creek at local stocking rates of 0.6 and 0.8 sh/ha (Eady *et al.* 1990). The results for the September 1980 shearing at Longreach and Julia Creek were 2.09 and 1.71 kg/hd respectively compared to 2.1 at 'Eastwood', while the average over the former two sites in 1981 was 2.85 kg/hd and in 1982 it was 3.46 kg/hd compared to 2.9 and 3.75 kg at 'Eastwood'. 'Eastwood' stocking rates were higher which should have reduced the per head wool growth although the paddocks were smaller. Thus, 'Eastwood' buffel pastures would seem to be as productive for wool-growing as Longreach Mitchell grass wooded downs.

Fleece quality

Fibre diameter, yield, tenderness

The yield of clean wool increased with each shearing of this mob of wethers and was uncharacteristically high from the 1982 shearing at around 76% (Table 50). This compares with values in the high 50s and low 60s for most earlier fleeces of this and other mobs (compare with Tables 34 and 44). Wool fibre diameter also increased each year and tended to be finer from sheep run at the higher grazing pressure.

Table 50 Yield percentage and fibre diameter (μ) of wool from fleeces of Mob 7 wethers at the last 3 shearings on a paddock and treatment basis.

Parameter	Wool yield (%)			Fibre diameter (μ)		
Shearing year	1980	1981	1982	1980	1981	1982
Pdk 3	57.8	65.4	77.3	20.8	22.6	23.7
Pdk 5	57.1	63.9	75.1	20.4	22.5	23.8
2.5 sh/ha mean	**57.5**	**64.6**	**76.2**	**20.6**	**22.6**	**23.8**
Pdk 2	57.9	62.8	74.7	20.5	21.2	22.0
Pdk 8	60.4	63.9	78.5	20.5	22.2	23.6
5 sh/ha mean	**59.1**	**63.3**	**76.6**	**20.5**	**21.7**	**22.8**

Worm Burden, Lice, Flystrike

Faecal samples taken from all treatments on 30/6/1980 were assayed for intestinal worm eggs. All samples returned less than 40 epg.

Other sheep data

Nil

Phase 4 stocking rate expressed as Dry Sheep Equivalents (DSE) per hectare

Table 51 Mean annual grazing pressure for each paddock and treatment expressed as DSEs/ha during Phase 4.

1 DSE equals a 50kg wether maintaining its weight

Year	Paddock				Treatment	
	Pdk 2	Pdk 8	Pdk 3	Pdk 5	5 sh/ha	2.5 sh/ha
1979-80	3.3	3.5	2.1	2.0	3.43	2.01
1980-81	3.1	3.5	2.3	1.6	3.31	1.92
1981-82	5.1	5.2	2.2	2.8	5.13	2.47

Grazing pressure was kept much more consistent and near target during this phase although the pressure in paddocks 2 and 8 was substantially higher in the final year at over 5 sh/ha (Table 51). This was due to a combination of greater individual sheep weights and consistently complete numbers compared to the previous 2 years. The average of almost 4 DSE/ha was almost double that of the other pair of more lightly stocked paddocks (2.1 DSE/ha), which was the intention.

Interpretation of Phase 4 results

The trial was continued through this phase largely to clearly demonstrate beyond doubt that grazing such buffel grass pastures at these apparently near optimal stocking rates was sustainable in the long term. By now it was well recognised that a nominal stocking rate could not be scientifically set in advance because a number of factors were involved, including rainfall, sheep age, sheep weight and breeding status. The pasture basal cover data remained high and showed no evidence of decline outside the normal fluctuations due to seasonal rainfall patterns.

Fleece weight and quality continued to fall within the bounds of previous years except for the unusually high yield of 76% in 1982. That may reflect the long dry winter in pastures that contained no burrs or sharp-seeded grasses such as wiregrasses. In this phase after over 12 years of moderate grazing pressure, there was minimal biologically vacant ground for weeds and ephemerals to exploit between the robust buffel grass tussocks (like in Image 17). Close to watering troughs there were always some bare areas but trampling and casual grazing by sheep as they had their drink always kept any colonisation by ephemeral ruderal species to a bare minimum and no seriously weedy species invaded those pastures.

Aggregated data from whole project

Climate

Table 52 Seasonal and annual rainfall during the trial expressed in terms of decile values

Deciles are based on 129 years of SILO synthetic data kriged to the trial site location (SILO 2018). Summer is Nov-Mar inclusive, winter is Jun-Sep inclusive. Mob year deciles are calculated from the total rain falling between shearings compared against calendar year deciles but adjusted to a standard 365-day year.

Year/period	Mob #	Decile			
		summer	winter	mob year	calendar
1966/67		2	6	-	2
1967/68	1	6	3	7	3
1968/69	2	1	1	1	3
1969/70	3	3	5	2	3
1970/71	4	6	5	5	6
1971/72	5	7	1	6	4
1972/73	5	6	8	7	9
1973/74	5	6	5	9	7
1974/75	5	5	5	5	5
1975/76	5	9	3	7	7
1976/77	5	6	1	9	7
1977/78	6	2	10	5	3
1978/79	6	3	4	5	2
1979/80	7	5	4	5	5
1980/81	7	3	7	7	8
1981/82	7	7	1	5	2
Values >6		3	3	6	5
Values <4		5	6	2	5

Compared to the local rainfall records, the trial began under average rainfall conditions but then quickly deteriorated into two very poor periods for Mobs 2 and 3 before returning to more normal rainfall for Mob 4 and the first year of the Mob 5 wethers. Then there were many good to excellent years up to and including the first year of the rotation vs. set stocking comparison, Phase 3. There was a prolonged very dry, decile 1, period during the winter and early summer of 1977 but the adjacent periods experienced good rainfall. However, that dry period persisted long enough to significantly affect wool growth and fleece weights in August 1977 (see Table 53). Thereafter the final years experienced mostly average to good annual rainfall but with the final 1982 winter being very dry. Such dry winters had occurred six times earlier during the trial (Table 52). Extremely dry summers were only experienced in 1968/69 and 1977/78 but only 3 summers were well above average (decile >6) while 5 rated below decile 4.

The mob year deciles are only an approximation because the period was not often exactly a year in length and the kriged calendar decile values were used as the basis. However, discrepancies due to the approximation used would only shift the category one place; six rated well above average and only 2 well below (Mobs 2 and 3) out of 15 years (Table 52). Using the 'Eastwood' house rainfall records would be unlikely to provide a more definitive rating given that it was several kilometres distant.

The excellent 1973, 1974, 1976 and 1977 summers probably had a greater beneficial impact on ecological processes than on sheep production because intestinal worms and fleece rot became an episodic problem and blowfly attacks happened even more readily on wool-growing sheep that are well-adapted to semiarid rather than humid environments.

Pasture

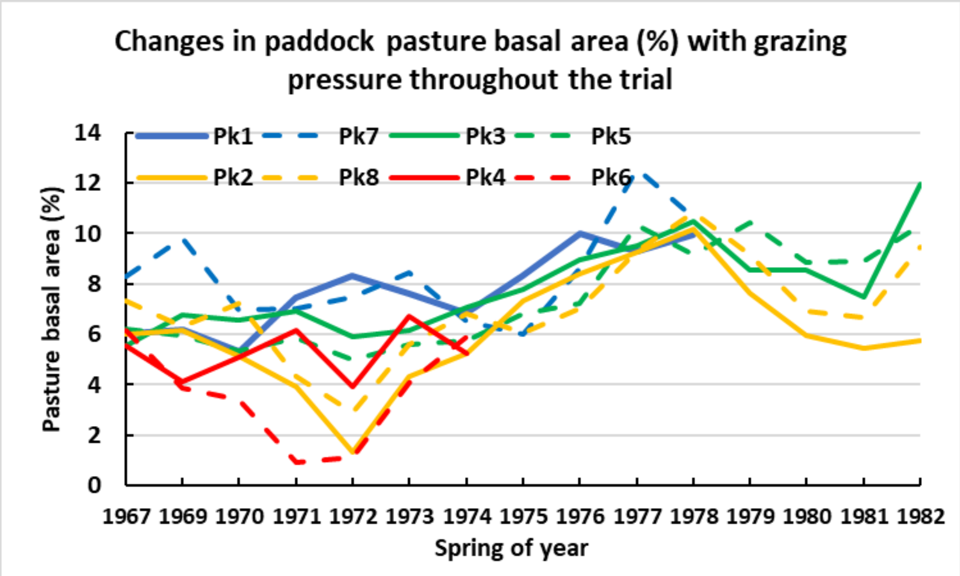


Figure 37 Changes in pasture basal area (%) of each paddock during its time in the trial. Block 1 paddock data has full lines, block 2 uses dotted lines.

The fairly abrupt changes between years in the early stages probably reflects differing operator opinion about what counted as a 'strike' as much as the stocking rate effects. From 1973 onwards, the same person determined a 'strike' every year and thus potentially minimised one source of sampling error. Nonetheless, the heavy stocking in poor rainfall years early on caused a reduction in basal area of the paddocks grazed at 5 and 10 sh/ha (Figure 37). In contrast, the more lightly grazed treatments, 2.5 and 1.25 sh/ha, maintained their crown area despite the early dry times and, when good seasons returned, they increased their basal area significantly to 10% and more.

The big difference between the replicate paddocks grazed at 10 sh/ha in 1971 may have been due to the presence of many annual herbs replacing buffel grass tussocks in the bare areas of Paddock 6 or strikes on buffel grass seedlings in Paddock 4 that emerged after 25 mm of rain a week beforehand. An extra basal cover assessment on some paddocks in January 1972 found that 50% of the basal area of Paddock 6 was provided by non-grasses as opposed to 7% in Paddock 4, 2% in Paddock 2 and zero in Paddock 8. Despite the 3 years of intense grazing, lots of buffel grass seeds blew into these small, 80m-wide paddocks from adjacent lightly grazed pastures. Differentiating between a clump of new buffel seedlings and tiny resprouts from heavily-grazed old tussocks was not easy for the inexperienced operators then staffing the project. The fairly rapid pasture regeneration of the 10 sh/ha paddocks when rested for 15 months over 2 summers (1971-72) would have been assisted by the influx of seed from adjacent paddocks. Thus, if a large commercial paddock was reduced to such low levels of crown cover, they may not have the potential to recover as rapidly and be dependent on seed initially set during the rest period to provide all the propagules needed to populate a year later the large gaps between surviving tussocks.

The other feature to notice is that when seasons returned to slightly drier summers than usual late in the trial, the 5 sh/ha paddocks lost crown cover very noticeably (Figure 37). That reinforces the general opinion held by project members that this rate is unsustainable in all years and can only be applied in exceptionally good years. Otherwise the pasture will suffer and, with that, wool production while the need for expensive supplementary feeding will become highly likely at certain times.

There was no indication of pasture disease of any kind during this trial, including with hindsight, nor of pasture dieback, leaf necrosis or dryland salinity symptoms.

Animal performance

Greasy fleece production

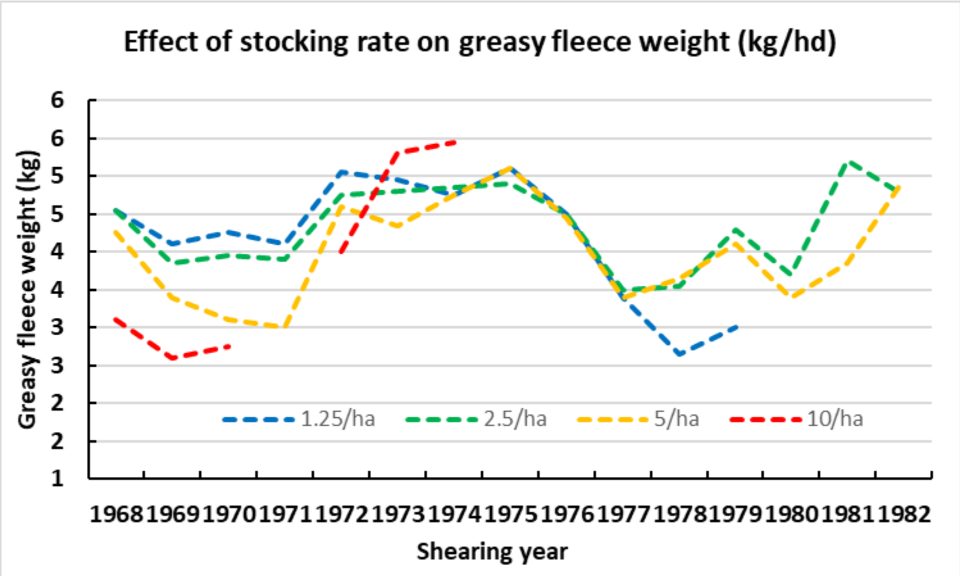


Figure 38 Effect of stocking rate on greasy fleece growth per sheep throughout the trial

In the early years, the effect of stocking rate was very obvious with 5 sh/ha far too high in those dry years. The improved performance of sheep in the 10 sh/ha paddocks after a 15 months rest is because they were then grazing at only 2.5 sh/ha and performing more like those sheep that were always run at that stocking rate. The difference between the 1.25 and 2.5 sh/ha rates is small and consistently in favour of the lighter grazing pressure in this dry phase (Figure 38).

During the wet years in the mid-1970s, stocking rate had no effect on wool production except when rotational grazing management was introduced. Then in 1978 and 1979 fleece weights were significantly less from the sheep in the rotationally grazed paddocks irrespective of the stocking rate. The blue 1.25 sh/ha line in Figure 38 shows the mean of rotational grazing at 5 and 2.5 sh/ha during Phase 3 but at the 1978 shearing, greasy fleece weight from the 5 sh/ha averaged only 2.4kg compared to 2.9kg from sheep also grazed rotationally but at 2.5 sh/ha. The equivalent wool production from set stocked grazing was 3.65 and 3.55 kg respectively. Note also the annual variation in fleece growth late in the trial when seasonal conditions fluctuated a lot (Table 52) between dry summers and wet winters. The difference due to a lighter stocking rate was particularly large for fleeces from the 1980/81 year.

The effect of stocking rate on wool production per hectare was predictable and consistent when no account is taken of possible pasture degradation when seasons are poor (Table 53). Under a fixed stocking regime over the whole trial period, the mean fleece grown per hectare was only 5.6kg at 1.25 sh/ha compared to 11 kg at 2.5 sh/ha and 19.6 kg at 5 sh/ha. Short periods of supplementation with lucerne hay were needed to achieve that result from stocking at 5 sh/ha. The generally low weight of the 1977 fleeces is not readily explained from the available data but did occur at all stocking rates. Lack of regular animal weighings during that year conspires to hide a logical explanation.

Table 53 Greasy fleece production per hectare when grown at different fixed stocking rates

	Shearing year														
S/rate	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1.25/ha	5.7	5.1	5.3	5.1	6.3	6.2	6.0	6.4	5.6	4.2					
2.5/ha	11.4	9.6	9.9	9.8	11.9	12.1	11.6	12.7	11.4	8.5	8.9	10.8	9.3	12.9	11.9
5/ha	21.3	17.0	15.5	15.0	23.0	21.8	23.6	25.4	22.1	17.1	18.3	20.5	17.0	19.5	24.8
10/ha	31.0	26.0	27.5		10.0	13.3	13.6								

Stocking rate

It was never going to be possible to maintain a steady grazing pressure on the pastures for any length of time because the plants grew at different rates at different times of the year and in tight response to variable rainfall timing. As well, average sheep size varied between mobs and over each year as they gained weight or matured in age in later mobs. However, as far as possible, relative grazing pressure due to animal demand has been standardised by expressing it as Dry Sheep Equivalents (DSEs) where 1 DSE equates to the intake demand of a 50 kg non-breeding, mature merino sheep that is just maintaining its bodyweight. Gain or loss of weight over a period alters that demand on the pasture and thus the DSE rating; so too does the digestibility of the pasture. Our presented values are the time-weighted average for a year from the calculated DSE in each paddock over each interval between weighings of the sheep. They are derived from between 1 and 12 weighings for any one year, mostly 4-8, and more frequently in the initial years. There are 2 components for the 1971-72 year because a fill-in mob of ewes were run for 5 months before the wethers of Mob 5 arrived in February 1972 (Figure 22).

Physiologically, grazing pressure on plants works through the rate of loss of photosynthesising leaf area and removal of tiller buds from an individual plant. The greater these losses as a proportion of the living shoot biomass, the greater the grazing pressure on that plant. A pasture contains many plants and stock selectively consume only part of that on most days. That proportion is distributed such that it varies greatly between plants and thus the grazing pressure ascribed by sampling methodology is a crude average compared to the impact on a single plant each day and over months. The stage of growth, growing conditions (temperature, moisture, light intensity etc.) and season of the year alter the rate at which a plant is trying to replace or expand leaf, axillary buds and new tillers. Thus, the real physiological grazing pressure that potentially prejudices the survival and vigour of a plant is governed by the interaction of both these systems. Plant survival also depends on how much healthy plant tissue remains exposed to sunlight to support the life of the root system plus the survival of those roots to provide water and nutrients to the leaves and buds above them. Other insectivorous defoliators, sap suckers and diseases also have an effect but grazing trials like ours cannot incorporate those effects, only record them if they are obvious.

Thus, the DSE values presented are a crude *de facto* measure of grazing pressure at a paddock scale and small variations are not to be interpreted as important. It is the long-term average value that provides the best guidance about whether grazing pressure on a perennial pasture should be altered to ensure the pasture is not weakened or degraded.

The annual DSE values are lower than the nominal stocking rate expressed as head/ha (Figure 39) because in many years the animals began as weaners that weighed only half what a mature animal normally would. However, DSEs per animal during the interval between weighings were often above 1 when 40-45kg sheep were rapidly gaining weight at over 100 g/day but then fell well below 1 when they sometimes were losing weight at 100 g/day for a short period. Allowing for the loss in weight after shearing and its effect on the average rate of weight change up to the next weighing was shown to have little bearing on the DSE calculation for each year (calculations on file). The maximum effect was a 34% reduction in the rate of loss but it sometimes only had a 5% impact depending on the time interval between the pre- and post-shearing weighings. This translated into a difference in only the 2nd decimal place for the average annual DSEs, eg. 0.84 vs. 0.83.

The clear diversion from prior levels in 1977/78 and 1978/79 is due to a combination of the rotational grazing system used in those two years (Paddocks 1 and 7) plus the unusually frequent escapes and the deaths from the 1979 summer water crises. The animals in the rotation at 2.5 sh/ha plotted as Paddock 7 during that period never reached 2 DSE/ha, nor did those rotated in the nominally 5 sh/ha treatment achieve 5 sh/ha. Loss of all animals in Paddock 3 and 8 halfway through the 1978-79 year also dragged the annual average well down (Figure 39).

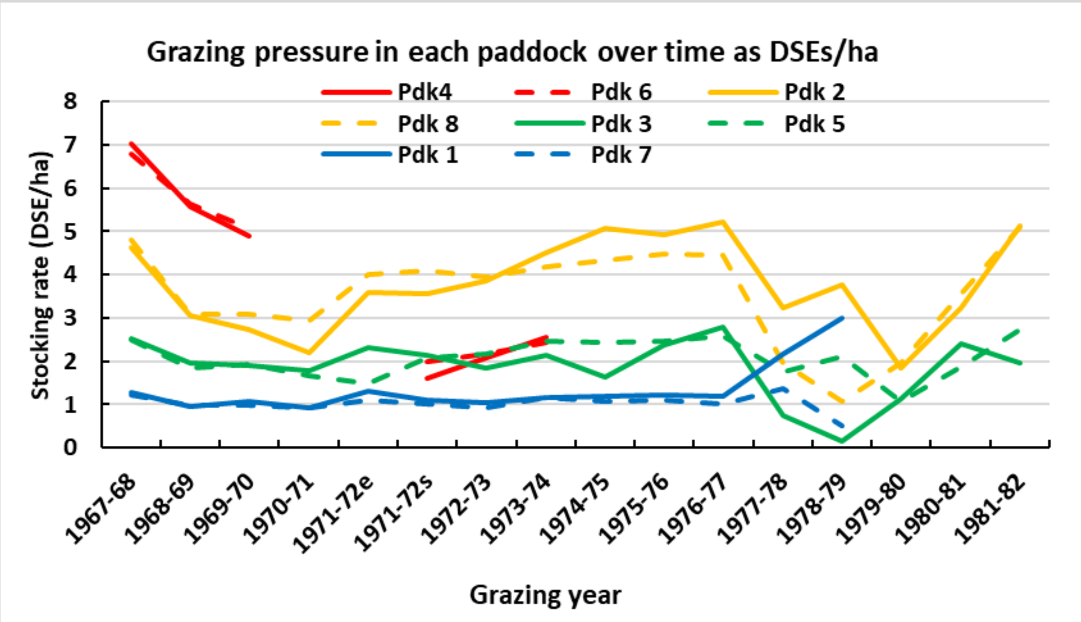


Figure 39 Shifts in mean annual grazing pressure (Dry Sheep Equivs per hectare) during the trial

Once those issues were overcome, the stocking rates returned to their previous long-term rates by the 1980-81 year. The extremely high grazing pressure of 10 sh/ha that could not be maintained is obvious from 1967-70 but red lines for those paddocks in 1972-74 show when they were successfully restocked at 2.5 sh/ha after an 18-month rest (Figure 39). The average over 3 seasons (1971-74) was 2.14 DSE/ha for the ongoing paddocks 3 and 5 and for the restocked paddocks 4 and 6 which were all stocked at 2.5 sheep/ha.

When the grazing pressure data is summed for the whole trial period, the 5 sh/ha treatment averaged 3.68 DSE/ha, the 2.5 sh/ha averaged 1.97 DSE/ha and the 1.25 sh/ha treatment 1.09 DSE/ha. The estimated long-term carrying capacity of the Linden land system once developed to buffel grass pasture was estimated in the 1970s to be 1.25 sh/ha or greater (Division of Land Utilisation 1979). That would suggest that the small paddocks used allowed the stocking rate to be increased by nearly 60% if the consensus value provided by the 1979 DLU report was correct.

Sheep reproduction

This aspect of the study only continued for 3 years because it became too onerous to find the labour and land needed with the financial resources available. Nonetheless, the results show that if weaner ewes are put under too much nutritional stress as they grow towards their first joining, their puberty is delayed (Table 18) and their conception rates will be very poor (Tables 21 and 23). At about 1 year of age, not all ewes were cycling even at the lightest grazing pressure (Table 18), 66% from Mob 2, 50% of Mob 3 and only 37% of Mob 4. Such modest rates of conception by young ewes is not uncommon (Entwistle 1972). Hence, early joining of maiden ewes on such pastures would not be advisable, even if in good condition. If their plane of nutrition is poor or declining, they will be most unlikely to become pregnant.

Table 19 probably confirms anecdotal reports that some rams a better than others at covering a mob of ewes, unrelated to an individual's testicular health (Business Qld 2016). Size of paddock and number of ewes in a mob would not be a factor in this trial with such small paddocks.

The data in Table 23 shows that the ability to raise a lamb once a ewe is pregnant was not compromised by prior grazing pressure but their ability to become pregnant was, while Table 22 shows that it was a factor for a different mob. This seemed due to a lack of ovarian maturity in both cases as the proportion of those from the high stocking rate paddocks that were served was less (Table 24). Also, those ewes from a moderately high grazing pressure paddock that had poor nutrition at early puberty were the ones to continue to have lower degrees of oestrus activity 6 months later (Tables 18, 21 and 23, Paddock 2). Thus overall, grazing pressure had a consistent impact on ovarian activity but an inconsistent effect on a pregnant ewe's ability to raise a lamb to lamb marking stage where other factors such as predation were sometimes significant, as Orr *et al.* (1988) also found for western Queensland. There is no data about the milk production ability of these sheep but may not be an important factor (Davies 1958).

Nothing in the data indicates any serious reproductive limitations being imposed by these buffel grass pastures compared to other western Queensland pastures, provided the ewes were allowed to grow to an adequate size at a reasonable rate before being introduced to rams. Equally there is nothing in the data to suggest that these pastures will be unable to raise young ewes to reproductive maturity as well as Mitchell grass pastures that are so highly regarded (McMeniman *et al.* 1986). However, the seasonal conditions under which these reproduction trials were conducted were not good compared to the long term in this district and there is no comparable data on which to make any definitive statement on this aspect of the potential of buffel grass pastures. Lack of certainty about the pasture type where the final joinings and lambings occurred means that those results cannot be used to directly compare buffel grass pastures with Mitchell grass or mulga pastures.

Discussion

Climate

The range of seasons experienced was typical of that region although no calendar year had extremely poor (decile 1) rainfall but there was a decile 9 one at the opposite end of the spectrum. Also, no two consecutive years were extremely dry with no effective rainfall relief as has been recorded, eg. 2002 and 2003, but 1969-70 was amongst the six worst consecutive years in the 129 years of records that we have. The kriged summer rainfall in years 1968/69 and 1977/78 were the eleventh and twelfth driest on record for that area (SILO 2018). The good years in the mid-1970s, though welcome, were not record-breaking compared to historical records, eg. 1996/97 and 1954-56. No years or summers during the trial fell within the top twelve on record. No extreme weather phenomena were recorded, such as violent hail, tornados, snow or wildfires.

Stocking rate

Stocking rate can be expressed in a number of ways, numbers/unit area, area/animal etc. Area is measured in well-defined units but animal numbers can be very imprecise when they relate to grazing pressure. Attempts to minimise inaccuracy has led to the development of parameters such as Animal Equivalents (AE), Livestock Units (LSU; Eurostat 2019), Dry Sheep Equivalents (DSE) and Cow/calf units. Each is defined by the user of the term and that measure may only apply to those results unless the definition is the same as that used by others. Commonly these days, an AE is defined as the liveweight of a 450 kg steer that is not gaining weight (McLean and Blakeley 2014), a DSE is a 50kg wether sheep that is not gaining weight (+/- wool growth depending on the user of the term). This report uses the DSE without any wool growth factor as the standardisation measure.

The accuracy to which the probable DSE of animals could be calculated was not high, based on the extrapolation required from the small number of core values provided by the RCS tables. Those values also differ slightly from those provided by other sources that purport to use the same methodology. Thus, our DSE values are a standardisation of stocking rates to account for different starting animal sizes of different mobs and the diverging liveweights that resulted within a year from the range of stocking rates used. However, for ease of recall from the data already presented, we still compare amongst the treatments using the 1.25, 2.5, 5 and 10 sh/ha terms.

Good quality Mitchell grass country in the Blackall area was often cited to run 1 sheep/1.2 ha (3 acres) (Courier Mail 1937; Rockhampton Bulletin 1949) so the sustainable mean of better than 2.5 sh/ha in this trial demonstrates, in simplistic terms, that these buffel grass pastures were at least as good as Mitchell grass country for sheep. Other factors such as wool growth and quality, rate of liveweight gain and lambing rates now need to be incorporated but the only comparable experimental data published for Mitchell grass country in central western Queensland comes from Eady *et al.* (1990).

Animal growth

The average rate of liveweight change of sheep in each paddock has been calculated between each weighing and those results aggregated into rough seasonal periods for the whole of the trial. Results are summarised in Tables 54 and 55 below. Table 54 shows the average growth rate of the 15 years for the 4 main seasons, and for the whole shearing year/mob time with or without an accounting for the fleece shorn from each animal. Table 55 shows the results for each year on an individual paddock basis to present an impression of the pattern of weight change that occurred which was sometimes inconsistent between reps and in response to rainfall.

Poor growth rates could occur at any time of year but winter was a consistent period for weight loss or no gain (Table 54). Average rate of weight gain was similar in mid-summer to that in the autumn-pre-winter period with severe loss of weight much less likely in autumn than in mid-summer in this region. Weight gain rates in the short term of over 100 g/day were common in fair to good seasons irrespective of stocking rate. Good rates of weight gain could occur in exceptionally wet winters but they never reached 100 g/day (Table 54). Winter weight losses were a regular occurrence and were exacerbated by heavy stocking, averaging -21 g/day at 5 sh/ha compared to a tiny gain of 1 g/day at 2.5 and 1.25 sh/ha over the 15 years. Discounting the fleece growth resulted in lesser rates of peak gain and greater rates of loss.

Table 54 Average liveweight change (g/hd/d) during the main seasons and for each shearing year (mobtime) at the 3 main stocking rates used throughout the trial.

Period	Stocking rate								
	5 sh/ha			2.5 sh/ha			1.25 sh/ha		
	Max	Avge	Min	Max	Avge	Min	Max	Avge	Min
Pre-Xmas	98	29	-52	123	60	-19	133	71	3
Summer	113	49	-44	85	48	-53	83	38	-51
Pre-winter	138	49	-3	102	49	0	108	49	-3
Winter	43	-21	-107	90	1	-101	86	1	-72
Mobtime + fleece	58	23	-7	66	33	6	72	31	-5
Mobtime - fleece	43	12	-27	53	22	-6	59	18	-8

Table 55 illustrates the variability in the liveweight gain achieved by growing sheep in different years when seasonal conditions differed greatly. The stocking rate effect is usually evident but, in some years, it was very limited. In the first year when plenty of pasture was available initially and rainfall was reasonable (470 mm), stocking rate had a minor influence as again occurred in the 1973-74 year when rainfall was high (624 mm). However, excellent rainfall was not a guarantee of excellent annual weight gains when the sheep were mature and had achieved their full adult size the previous year, as occurred in the 1976-77 year (Table 55). The data show that the weaner sheep used in many years continued to grow for about 3 years even if pasture conditions were good and only in the fourth and subsequent years where the same sheep were retained did weight gain annually become minimal, such as for Mobs 5.4, 5.5 and 5.6. Mob 7 which was retained for 3 years had not yet achieved full mature weight before the trial ended, partly because of poorer rainfall that limited their growth in year 1. Full individual liveweight data for all mobs at all weighing dates, except Mobs 1 and 2, are contained in Appendices 5.1 to 5.8.

Table 55 Change is sheep liveweight recorded (g/d) in each paddock over each shearing year after the fleece weight was deducted.

Total rainfall (mm) during each year is also shown.

	Period			Liveweight	change			Rainfall
		Pdk 2	Pdk 8	Pdk 3	Pdk 5	Pdk 1	Pdk 7	(mm)
Mob 1	Sep67 – Aug68	43	43	51	49	58	44	470
Mob 2	Oct68 – Sep69	-7	10	19	14	19	20	168
Mob 3	Sep69 – Aug70	-15	-3	14	15	29	24	265
Mob 4	Oct70 – Aug71	13	21	53	47	55	59	440
Mob 5.1	Feb72 – Jul72	-39	-16	-1	-6	-2	-14	411
Mob 5.2	Jul72 – Aug73	33	14	13	16	12	14	569
Mob 5.3	Aug73 – Aug74	27	30	16	27	16	26	624
Mob 5.4	Aug74 – Jul75	7	-10	11	-2	4	-3	395
Mob 5.5	Jul75 – Aug76	-4	-1	-6	-7	-1	-4	587
Mob 5.6	Aug76 – Aug77	5	1	15	9	1	-5	641
Mob 6.1	Nov77 – Oct78	39	43	45	53	11	31	466
Mob 6.2	Oct78 – Aug79	21			22	30		328
Mob 7.1	Feb80 – Oct80	-11	6	45	29			390
Mob 7.2	Oct80 – Aug81	15	20	10	11			527
Mob 7.3	Aug81 – Aug82	30	22	43	30			399
Paddock	Average	10	13	23	21	19	17	445
	Maximum	43	43	53	53	58	59	641
	Minimum	-39	-16	-6	-7	-2	-14	168
		5 sh/ha		2.5 sh/ha		1.25 sh/ha		
Treatment	Average	12		22		18		
	Maximum	43		53		59		
	Minimum	-27		-6		-8		

The most obvious stocking rate effect was seen in the 1969-70 year which experienced low total rainfall (265 mm) after the previous year had produced little pasture growth and left all paddocks with little or no green leaf to supplement that which grew on the limited rain that fell early in the 1969-70 year. There were few years when grazing at a very light rate (1.25 sh/ha) produced better individual sheep growth compared to the very moderate 2.5 sh/ha. Conversely, there were many years and seasons when 5 sh/ha resulted in very poor animal performance compared to 2.5 sh/ha. Thus economically 1.25 sh/ha is a poor option even if certain aspects of biodiversity and landscape stability may have certain appeal. Conversely, grazing at 5 sh/ha was economically risky and environmentally unjustified in the long term. In those years of repeated good rainfall, grazing at 5 sh/ha is justifiable as animal output is greatly increased per hectare and environmental damage is probably unmeasurable. The 10 sh/ha treatment which crashed so rapidly in the initial dry years would not have proven very good business practice in even the wet years because the winter losses experienced by all treatments would have been exacerbated.

To bring these grazing pressure/stocking rates into perspective, the conversion to Dry Sheep Equivalents done earlier means that 1.1 DSE/ha was far too conservative, 2 DSE/ha long-term was about right for this buffel grass pasture in small paddocks and 3.7 DSE/ha was very risky and potentially environmentally damaging if sustained long term. In large commercial paddocks with shadelines, timbered patches, watercourses and rough ridges, a reduced rate would be needed, and local grazier opinion was to halve those rates. A fixed stocking rate measured as DSEs is impractical to maintain year-on-year because that should be adjusted to reflect the rainfall received, both in amount and timing, the marketing strategy employed, the flock structure and the grazing system being used. This trial used continual stocking, but some system of occasional rest is recommended in most grazing management courses (FutureBeef 2017, Land water and wool 2006).

Compared to other pastoral country in Queensland, the soils were much higher in phosphorus and clay content than many others. This meant that the need for P supplementation was unnecessary compared to many areas of north Queensland (FutureBeef 2019). It also explains why adding faecal P content to the liveweight gain prediction formula (see Phase 1 Pasture/Animal production relationships) did not improve its fit to the data. The heavy clay soil meant that pasture responses to small falls of rain were muted in dry times. Much more rain is needed on this site than on a sandy or mulga soil before it becomes available to plant root systems for uptake that restarts small shoot growth or mature leaf photosynthesis (Reynolds *et al.* 2004). That said, there is little difference to most Queensland Mitchell grass country except in soil P and a greater difference compared to some sandier types of gidyea country in the region (Silcock 2020) in terms of clay content.

Cattle and sheep grazing intensity is often compared by equating 8 DSE to 1 yearling steer (MLA 2019) but this may not apply when comparing their growth rates on similar pasture. A similar grazing trial using young steers with 3 stocking rates was conducted by Walker *et al.* (1987) over 4 years on buffel grass pastures on brigalow clay soil near Theodore in a 700 mm MAR rainfall area. Presentation pasture yields were generally higher (4000 – 8000 kg/ha) under the greater rainfall (540-810 mm per year) but the same strong cool season drop in animal growth was evident on pastures with little legume component. They achieved 124 kg/ha/yr liveweight gain on average at the mid-range stocking rate of 0.7 beasts/ha, which would convert to 5.6 DSE/ha, and 71 kg/ha/yr at 0.4 beasts/ha (3.2 DSE/ha). On our trial over the 8 seasons where young growing animals were present, 2.5 sh/ha produced only about 30kg liveweight gain/ha/yr while at 5 sh/ha that figure rose to around 90 kg/ha/yr in good rainfall years compared to 40-50 kg/ha/yr for the best 2.5 sh/ha results. This indicates that young cattle may produce more total liveweight gain per hectare at ‘Eastwood’ provided they can achieve comparable intake levels from the pastures. A study by Rees and Little (1980) found that cattle tend to achieve higher digestibility than sheep when fed tropical grasses at contrasting growth stages, further indicating that cattle liveweight performance should be at least comparable to that of sheep.

Wool production

The data in Figure 38 shows that fleece weight was sensitive to stocking rate when rainfall was low to average early and late in the project but was unaffected by the 2 moderate stocking rates used in better-than-average seasons. The use of a rotational grazing system proved to be deleterious to fleece growth irrespective of the stocking rate (Table 44) but this may be due to the particular criterion chosen for shifting the sheep to a new cell rather than the rotational concept itself. The sheep seemed to have, proportionally, a slower rate of weight loss than wool growth decline when the pasture deteriorated over the time taken to produce a 5% drop in liveweight relative to sheep in the continuously grazed system. The reduction in clean fleece weight was 35% for the 1978 shearing and 42% at the 1979 shearing, which is very sizeable loss. This big difference was unexpected given the results from a simple summer/winter rotation system used for 10 years at Cunnamulla by Roe and Allen (1993). Nonetheless, they concluded that in the long term, rotational grazing had no advantage over a continuous stocking system at a moderate stocking rate.

The amount of greasy fleece grown by these buffel pastures falls within the range of fleece weights (2.0 – 4.8 kg) recorded for NW Queensland between 1959 and 1972 (Pepper *et al.* 1998). That study found that wool growth was strongly correlated with the nutritional status of the pastures being grazed. By comparison mulga country near Charleville with pasture plus browsable mulga (see Brown 1985) between 1978 and 1984 grew an average 4.5 kg/hd of greasy wool (Charleville Lab unpublished).

The very poor fleece growth from all treatments in the 1976/77 year (Table 33) is hard to explain given the good summer-autumn rain received (Table 25) and general industry (Roshier and Barchia 1993) and research experience (Freudenberger *et al.* 1999). Unfortunately, ancillary data about dietary protein, wool growth rate and worm burdens that might have helped explain the reasons were not collected in that year. Sheep liveweight at the start and end of that year is also unhelpful (Figure 24) as some paddocks held or gained weight while others lost weight, particularly at the lightest grazing pressure. The faecal data for the previous year (Figure 25) shows the usual low protein level in spring but a poor level in the summer-autumn period in 1975. Thus, the prior run of very wet summers may have led to an entrenched low protein level in the rank pasture at the lighter stocking rates. This effect has been recorded before in both sheep (McKeon *et al.* 2004, p.206) and cattle (Silcock *et al.* 2005, p. 306).

The sharp loss of weight during protracted rainy weather in some treatments in February 1968 would seem to be caused by exposure to cool temperatures while the wool was soaked and there was limited edible pasture available.

Wool quality

Nothing was indicated from the wool measurements that the quality of the wool grown on buffel pastures was any different from that off other pasture types. Lack of data about the strength of the wool is unfortunate. The quality of each year's fleeces varied as occurs in all other rangeland districts depending on the seasons and the bloodline of the sheep. However, the data from Eady *et al.* (1990) from the same bloodline show that the wool from 'Eastwood' was comparable to that from Longreach wooded downs country.

Copper deficiency was detected in two fleeces in the early years of the trial but that did not continue and is not unheard of in the region (Bob Anson, Charleville sheep and wool advisor, pers. comm). Visual appraisal was only done on fleeces from the first 4 mobs and though lustre and brightness are noted by buyers they are not major determinants of the price paid compared to fibre diameter, staple length and strength (AWI 2019a).

Ewe reproduction

The fecundity of sheep raised and run on buffel grass pastures has not been put in serious doubt by this study although comprehensive data was not collected. Lambing rates of maiden and young ewes (Table 21) were never very high compared to other more southern regions (Orr *et al.* 1988; ABC Rural 2011) but they were as good as or better than those from NW Queensland (Entwistle 1972). The lambing data was collected in quite dry years and would thus be expected to be worse than in good years.

However, it was conclusively established that weaner ewes grown out on buffel grass pasture at very high grazing pressure suffer a significant reduction in their conception rate for several years at least and perhaps permanently. No data was collected about the milking ability of these ewes in later life but that is an acknowledged important factor in how successfully lambs are raised (Jordan and Mayer 1989). Other lambing success factors such as newborn suckling urge and degree of twinning were not assessed.

Animal pests and diseases

Pests and diseases were encountered but to no greater extent than experienced by the sheep industry generally in western Queensland. Sheep blowfly was ever-present, worse in some years such as those with wet summers, and potentially deadly to individual animals if not detected and treated early enough. Lice were observed but were routinely combatted by jetting off-shears and never became a serious problem. Intestinal worms were always a potential problem, especially in wetter years. Regular faecal sampling monitored the level of worms via egg counts and later by culturing to identify the dominant species present. Barber's pole worm was always the dominant one but black scour worm was regularly present.

Regular faecal sampling is now recommended best industry practice with guidelines on when treatment with nematicide is warranted. When significant worms were detected, the sheep were drenched, and the drench used was changed as appropriate to combat potential build-up of resistance. Fortunately, only wethers were being used when worm burdens became serious because lambing ewes are more sensitive to worm burden (Cobon and Sullivan 1992).

Wild dogs and feral pigs can be present in the area but were not found to be a problem with our trial site. However, pig predation on lambs was a problem in one year at the nearby site where the lambing study was being conducted. Such pig predation is not unheard of throughout southern Queensland (Orr *et al.* 1988) and can be very serious (Plant *et al.* 1978).

Pasture growth

When it rained, the buffel grass produced large amounts of pasture, far more than the sheep could consume in moderately stocked paddocks. We have little data for the pasture response to good rainfall under extremely high stocking rate such as our 10 sh/ha but suspect that such a rate could constrain the production of large amounts of stemmy old grass that normally develops at moderate stocking rates in good seasons. The caveat to that is, that in large paddocks, sheep will tend to start patch grazing, preferring to return to shorter tufts of grass rather than taller, long-leafed plants. This effect tends to become entrenched close to water and shade sources, similar to what happened in the most lightly stocked treatment and has also been reported by Silcock and Hall (1996).

Pasture composition

The results of this trial show that buffel grass can become a very dominant component of cleared gidyea country on clay soils of the Linden Land System and maintain that strong dominance over a wide range of grazing pressure. Where such pastures become sparse under heavy grazing in dry years, ephemeral forbs such as soft roly-poly and speedy weed can become major components in the short term but when good summer rains return, they are quickly overcome by the regenerating buffel grass. If extremely high grazing pressure had been maintained the rate of buffel grass reassertion of dominance may have been slowed, but nothing observed since in the district has suggested that that would have happened. Under normal property management in the district, when good seasons return the stock available for restocking can never increase the stocking rate enough to keep up with the pasture growth everywhere. On other gidyea land types with poorer or stonier or more saline soils that may not be the case.

Unpalatable wiregrasses and feathertop (*A. latifolia*) were not a problem at our site and generally are not problematic on best quality gidyea country. Conversely, desirable alternative grasses such as Queensland bluegrass (*D. sericeum*) were seen in small amounts in wet years as can occur on Mitchell grass downs, but it never became a significant component of our pasture nor showed signs of an ability to dominate should grazing management consistently favour its recruitment. The persistence and productivity of this Gayndah buffel cultivar confirms the results of the Bkl P13 WR study of the comparative quality and persistence of a range of buffel cultivars on gidyea soils from 1963 to 1970 (Silcock 2020). There was no indication of an increase in native legume populations in our buffel pastures nor of *Pimelea* spp. which have become a problem for cattle owners on some gidyea soil types in western Queensland since our trial ended (Fletcher *et al.* 2009). Such consistent dominance by buffel grass has been recorded in many pasture types in Queensland (Jackson 2005) and is a feature of buffel grass pasture where well adapted.

A far more likely and pressing issue is woody weed regeneration overwhelming a weak buffel pasture. At our site, false sandalwood was common in the paddocks but never seemed to increase greatly over the 15 years and at the highest stocking rate was heavily browsed by sheep receiving supplementary feeding for survival. At other locations and on other gidyea soil types, gidyea and a range of native cassias (*Senna* spp.) and flannel weeds (*Abutilon* spp.) can be serious local problems (Purcell 1964) and restrict the dominance of buffel grass. Anecdotal evidence from satellite imagery shows that the site of the trial and a large area of surrounding country has been stick raked in the early 2000s apparently because the property owners thought the woody regrowth, mostly false sandalwood, was becoming a problem and reducing pasture productivity.

Image 19 Excellent buffel grass pasture in March 1989 in the area previously centred on Paddock 6 which was initially extremely heavily grazed with light grazing on either side. Shallow gilgai effect is evident in the foreground. Summer rain up to then had been below average (<200 mm).

Buffel grass persistence

This trial has conclusively demonstrated that buffel grass pastures on gidyea clay soils are very persistent and recent surveys of the region would continue to support that contention. Only very long-term (100-300 years?) observations will demonstrate if the conversion from gidyea shrubland to buffel grass pasture will perpetuate in perpetuity in the way that Mitchell grass pastures are viewed in the region. Even they can be degraded sometimes by persistent poor management or failed attempts to convert to cropping or use of artesian water for irrigation but what good buffel grass pastures might degrade to is speculative at this time after 60 years of experience. A visit to the site in March 1989, then commercially grazed, found a dense cover of buffel grass and minimal woody weed regrowth since the trial ended in 1982. Even the places that had been severely denuded in Phase 1 such as Paddocks 4 and 6 were impossible to differentiate based on the buffel grass density and health (Image 19). Ebersohn (1970) reports that buffel pastures sown in 1953 near Yalleroi were also showing no signs of a fall in cattle carrying capacity after 15 years.

Nonetheless, pasture rundown must always be kept in mind as a long-term result from conversion of a woodland to a grassland for intensive livestock production. There would certainly have been higher production from the buffel pasture at our site in the first few years as nutrients abounded after burning the pulled scrub (Robbins *et al*. 1986). However, after 6 years when our project began, that initial fertility boost should have subsided considerably. Continued grazing of the pasture would theoretically remove nutrients in the wool and animals taken off it, although new animals often replaced those removed. That rate of removal of the key production nutrients nitrogen and phosphorus would be very low, maybe 2 kg/ha/yr as N (assuming 16% N in a greasy fleece) and far less as P. The knowledge to calculate what proportion of the cycling organic pool that figure represents, and what the size of the input of atmospheric N via lightning and microbial activity is, does not currently exist. This project and other's research would indicate that it is not an issue at present or in the foreseeable future in this land system under pastoral use (Angus and Grace 2016).

Poisoning

There were no recorded instances during this trial where the buffel grass was suspected of poisoning the sheep but oxalate poisoning of sheep by lush buffel grass regrowth has been confirmed (McKenzie 2012). That occurred on newly established pasture growing on an ash seedbed where very high levels of available nitrogen would have existed. Buffel grass can contain significant amounts of oxalate at times (Silcock and Smith 1983) and that is the cause of 'bighead' in horses that graze pure buffel pasture for many months (Walthall and McKenzie 1976). The possibility of poisoning in well-established buffel pastures of stock that are resident in the paddock is very low, far less than from other ephemeral species with poisonous potential such as pigweed (*Portulaca oleracea*) and buttongrass (*Dactyloctenium radulans*) (McKenzie 2012).

Soil stability

Stability of the soil at this site did not appear to be threatened after conversion from shrubland to grassland. Bare areas amongst the grass tussocks were a feature of the paddocks but basal/crown cover remained at least as high as that commonly recorded for Mitchell grass pastures (Orr 1975). Tussock grasslands in semi-arid, summer rainfall environments all over the world exhibit such a structure be they natural or sown (Walker 1979). Localised soil surface damage will occur around watering points and shade areas where stock congregate, as happens anywhere in the world, including conservation parks.

On more steeply sloping land, erosion potential of gidyea land types would be an issue as is streambank erosion everywhere. Hence, management would need to address them when and where required, but for the major portion of this very flat to gently sloping landscape, the conversion to buffel grass pasture does not pose any new soil erosion problems. In fact, the potential problem during floods on ground adjacent to normally dry watercourses may be reduced by the presence of thick grass as opposed to predominantly bare soil and tree leaf litter.

Timber regrowth

Regrowth of the original dominant tree species is not as common from gidyea shrublands as it is for eucalypt woodlands and brigalow and mulga shrublands. This is because gidyea country has no persistent seedbank in the soil (Reynolds *et al*. 1992) unlike mulga country and does not root sucker like brigalow does (Butler and Fairfax 2003). It also lacks an ability to produce large quantities of seed in a fairly short time from isolated plants that escape death during and shortly after clearing such as can occur in eucalypt savannahs. Where gidyea does regrow as isolated plants or occasional patches, its ability to produce viable seed is regularly compromised by lack of follow-up rainfall after flowering (Fensham and Fairfax 2005) and heavy bruchid beetle predation on the seeds that are formed (Silcock, personal observations). The most common species to cause regrowth problems is false sandalwood (Ebersohn 1970) as it was at this project trial site.

Buffel grass is very tolerant of fire (NT Government 2019) and is often accused of causing enhanced fire damage to native woody vegetation (Butler and Fairfax 2003; McDonald and McPherson 2011). Thus, it could be used to set-back woody weed regeneration in these buffel pastures as is done in brigalow country (Anderson and Back 1990). Fire was never experienced during this project although precautions were taken to strengthen firebreaks during the high dry matter production years. Anecdotal evidence would suggest that few producers in gidyea country would use fire because it involves a big loss of feed in the short term and the risk of wildfire damaging infrastructure. Also, the risk of litigation by neighbours should a hot fire escape is quite high.

Weeds

Woody weeds can be a problem as discussed above but other seriously weedy plants are uncommon. Hardseededness of *Senna*, *Sida* and *Abutilon* species mean that, if scattered, small numbers of such plants set seed, which they can do in abundance, those seeds enter the ecosystem and can exploit biological gaps for decades into the future (Jaganathan 2016). Other potentially weedy species include *Malvastrum americanum*, *Pimelea* spp., *Amaranthus* spp., *S. kali*, *F. australasica*, *Sclerolaena* spp. (gidyea or copperburrs) such as *S. birchii* (galvanised burr), *S. calcarata* and *S. muricata* (black roly-poly). Some are annuals but most are short-lived perennials so there would be times when any sizeable population could dramatically die back which would allow buffel grass to recolonise there. The burrs tend to recruit in cool weather when buffel is least active and thus they would seem more of a potential long-term threat than the summer ephemerals such as speedy weed and *Armaranthus* spp.

Weed control, when needed, would be best done by encouraging buffel grass competition while selective grazing by sheep will always be potentially helpful as stock search for variety in their grass-dominated diet.

Pasture diseases and pests

There were and still are no known pests or diseases of buffel grass in this region. Elsewhere a seed predating moth grub (*Mampava rhodoneura*) can reduce seed set (Cook *et al.* 2005) but that is most pronounced in the Biloela-type buffels with tight seedheads rather than the more-open heads of the Gayndah type that is mostly grown in western Queensland (Partridge 2003). This moth also seems to be confined in its incidence to wetter, sub-coastal regions as do ergot attacks on buffel seedheads in irrigated seed production plots (Loch 1999). In the 21st century, buffel grass dieback has become an issue for which there is no confirmed cause at this stage (Nason 2018). It is not generally reported for gidyea country nor is buffel ill-thrift that has been a problem at times in North America and is thought to be caused by a leaf fungus (CABI 2014). However, in more coastal areas of Queensland where similar leaf reddening symptoms have been recorded, no definite confirmation of a fungal agent has been published (Perrott 2000).

Grasshoppers were reported to be present in large numbers in December 1969 and some were laying eggs in patches of bare ground in the lightly stocked paddocks. At this time defoliation damage to false sandalwood shrubs was also noted but not obviously by the grasshoppers. Later experience would suggest that this defoliation was caused by a hawkmoth caterpillar (*Coenotes eremophilae*) that episodically attacks this plant (Butterfly House 2019). Leafhoppers were also seen ovipositing in sandalwood twigs with ants then feeding on resin-like secretions that were associated with that. Some groups of sandalwood leaves turned black before falling and such insect damage may assist in slowing the rate of regrowth of sandalwood in buffel pastures. This is just one example of the complex interactions that are often occurring in rangelands, often unnoticed, but leading to 'unexplained' effects when pastoral records are collated later.

Animal management issues

No special adaptive animal management requirements have been identified by this study for the successful, economic grazing of buffel grass pastures by merino sheep, compared to Mitchell grass pastures. However, our attempt to define the reproductive potential of ewes grazing buffel grass pastures as opposed to Mitchell grass, with respect to the perceived great value placed on the ancillary herbage that Mitchell grass pastures can grow, has not been fully answered. There was a serious lack of species diversity in our buffel pastures but how big an impact that would have on a ewe's ability to raise a well-grown lamb, how well she might support twins and whether health issues like pregnancy toxaemia would be more prevalent than on Mitchell grass pastures, were not answered. This was somewhat disappointing because, historically, the economics of wool-growing in western Queensland is strongly influenced by the improved reproductive rates achieved in good seasons when twins become common and the merino ewe, not well-regarded as a good milking mother, successfully brings most of them through to lamb marking in strong condition (Jordan and Mayer 1989). However, this aspect of the project was not its primary focus and thus the incomplete answer needs to be kept in perspective.

Sheep versus cattle or goats

With the expansion of beef cattle and meat goats into these traditional wool-growing areas since the 1960s, interest lies in how they would perform under the same conditions. There is no cattle research data for buffel grass pastures on gidyea soils and very little good data anywhere making that sort of comparison (Pahl 2019b). Theory would suggest that the larger the animal the smaller the proportion of food intake that is needed for bodyweight maintenance (Rode *et al.* 1986; Lewer 2013) and thus cattle might gain more weight per day than an equivalent total liveweight of goats or sheep. Rees and Little (1980) found that cattle tend to achieve higher digestibility than sheep when fed tropical grasses, further indicating that cattle liveweight performance should be at least comparable to that of sheep.

However, cattle are traditionally regarded as being less able than sheep to graze short feed and regrowth (Bennett *et al.* 1970; Hassall and Associates 2006) and so, over a year at higher grazing pressure, they may not grow as well when green shoot is scarce or pasture height very low. In the early years of buffel pastures in western Queensland, mixing cattle with sheep in the same paddock was not looked upon favourably by graziers (Purcell 1964). Ebersohn (1970) reports on a producer switching successfully from merino sheep to cattle in conjunction with developing gidyea scrub to buffel pastures during the 1950s when seasons were good and at the same time increasing that country's carrying capacity from a beast to 20 hectares to a beast to 6.2 hectares.

One study done on fertilized perennial pastures in Ireland found that cattle added 4.5 times the weight per head that sheep did when grazing at an equivalent grazing pressure (6 young sheep = 1 225 kg steer) during summer (Nolan and Connolly 1976). Stock were grazed at 18.5 sheep/ha over 120 days in mid-summer and generally gained 5.7kg/ha/day at that intensity. Others in extensive grazing systems use an 8:1 ratio (Pahl 2019a) but some believe that the effective rate was nearer to 6:1 with seasonal variations around that mean (Bennett *et al*. 1970). When comparing cow-calf systems against ewe-lamb operations, USA researchers often use a 5:1 conversion (Abaye *et al.* 1994).

Such comparisons are less problematic for sheep versus goats although goats might consume more of any woody regrowth (MLA 2018; Pahl 2019b). Goats may be useful in controlling particular problem weeds such as *Senna* or *Abutilon* species but unpublished research (Silcock, pers. comm.) has shown that they only eat unpalatable browse in appreciable quantities when forced by starvation and, even then, some plants are not eaten, such as tobacco weeds (*Nicotiana* spp.). Sheep and goat breeds selected genetically for meat production rather than wool would also be more likely to gain weight more rapidly than the merino type used in this study. However, on an annual basis that includes periods of poor pasture quality, such gains may just as rapidly be lost or never achieved (Rode *et al.* 1986). The reproductive capacity of such breeds also becomes a factor (Hassall and Associates 2006). These possibilities will not be canvassed further in this report because a wide range of factors become involved when it comes to industry and product selection and the economic and social goals of the rural producer.

An appropriate approach to this conundrum would be that of Bennett *et al.* (1970) – "A statement that *x* sheep are equivalent to *y* cattle must include a definition of the criteria on which the ratio is based." Pahl (2019a) agrees in a rangeland context that encompasses marsupials as well. Furthermore, only grazing pressure defined as animal metabolic biomass per weight of available live pasture is a consistent measure of the interaction that is occurring between the grazing animals and the pasture (Abaye *et al.* 1994).

Economics versus broad environmental perceptions

No serious attempt was made during the time of the project to calculate the economics of running sheep on buffel grass as opposed to Mitchell grass or mulga country. That will not be attempted now in this belated report but the data now provided would be more than adequate to allow a comparative economic analysis by a competent economist. The output from such an analysis would be strongly dependent on the value placed on the fleece which, history has shown, is dependent on market demand and wool fibre specifications - and they have shifted appreciably over the years. It would probably also be appropriate to assess the value of buffel grass pastures on Blackall district gidyea country under beef cattle or meat-sheep or goat grazing as well as for wool sheep. Perhaps even mixed enterprises might be investigated given that published literature often shows that total liveweight gain/ha from mixed species can be greater than from single species pasture use (Nolan and Connolly 1976; d'Alexis *et al.* 2014). The latter ideas would require many more assumptions to be made and some extrapolation from other land types in the absence of actual cattle, goat and meat-sheep production data off sown gidyea country.

There are some people who argue strongly that buffel grass and any other exotic plant should be treated as a weed (Hussey *et al.* 2007) and even an environmental disaster (Lonsdale 1994; Jackson 2005). Others paint a mixed but balanced view of the role of buffel grass in Australia (Friedel *et al.* 2006). Most 20th century literature up to 1990 portrayed buffel grass as a great success story and the salvation of many pastoral enterprises. From 1990 onwards, some reviews in Australia and overseas wish to concentrate on examples of where its introduction or invasion has been detrimental (Marshall *et al.* 2012). With time some of those projected fears have proven unfounded, such as the impact on the diet and survival of the northern hairy-nosed wombat (Department of Environment and Science 2019) while others are of ongoing concern, such as invasion of conservation reserves. This is acknowledged but will not be discussed further in this report.

Summary

Answers to the 6 questions posed before the trial began are addressed below —

1. Sheep liveweight changes:

   Sheep grew well, over 100g/day for young sheep if the seasonal conditions were reasonable, and performed similarly to sheep on Mitchell grass country in the Blackall district. In drought years weight gain was minimal or negative and some weight loss in winter was normal once pastures were frosted. Stocking rate had a big effect on sheep growth rate if the pasture was not growing vigorously and a major influence on liveweight gain per hectare at all times.

2. Wool growth and quality:

   Wool growth and quality were similar to that from western Queensland Mitchell grass country. The paper by Eady *et al.* (1990) shows how closely the wool production of buffel grass on a heavy clay gidyea soil compares to that of Mitchell grass country in semi-arid subtropical Queensland. Table 56 provides an almost direct comparison for animal growth and wool production from 'Eastwood' against identical parameters for sheep derived from the same Terrick Terrick bloodline in the same 3 years at two other locations, Longreach and Julia Creek. The methods used to measure the wool traits were apparently identical and done by the same laboratories. Paddock size was 100 ha at Julia Creek and 80 ha at Longreach. The fleece data are similar each year and the trend over time is identical despite rainfall and seasonal conditions differing markedly amongst the 3 sites. Rainfall (mm) from September to August of each shearing year for Blackall, Longreach and Julia Creek was –

	Blackall	Longreach	Julia Creek
1979-80	390	211	298
1980-81	527	365	564
1981-82	399	260	317

Table 56 Sheep and wool parameters of Terrick Terrick wethers in 1980, 1981 and 1982 grazing pastures at 3 different locations in Queensland, - Blackall ('Eastwood'), Longreach and Julia Creek.

Site	Stocking rate (sh/ha)	Liveweight (kg)			Clean fleece wt (kg)		
		Feb-80	Feb-81	Mar-82	1980	1981	1982
Eastwood 2.5	2.5	31.1	39.2	53.0	2.2	3.3	3.7
Eastwood 5.0	5	30.8	27.0	48.0	2.0	2.5	3.8
Longreach	0.8	29.9	37.1	50.7	2.1	2.9	3.5
Julia Creek	0.6	#	#	#	1.7	#	#
		Yield (%)			Fibre diam (µ)		
		1980	1981	1982	1980	1981	1982
Eastwood 2.5	2.5	57.5	64.6	76.2	20.6	22.6	23.8
Eastwood 5.0	5	59.1	63.3	76.6	20.5	21.7	22.8
Longreach	0.8	56.1	59.7	67.8	20.3	22.0	22.5
Julia Creek	0.6	#	#	#	19.6	#	#

Data from Eady *et al.* (1990). Note, their published data were meaned for Longreach and Julia Creek when no significant difference existed between the individual site averages, and are shown here against Longreach.

3. Pasture growth and quality:

   Buffel grass was shown to be a high yielding, good quality pasture provided seasonal rains were adequate. Its quality was diminished in winter by frosts.

4. Buffel pasture stability and resilience:

   Gayndah buffel grass pasture was shown to be highly stable and resilient under a wide range of seasonal conditions and sheep grazing pressure. No data was collected about the impact of fire.

5. Optimal stocking rate:

   Under the experimental conditions imposed, the optimum was slightly above 2.5 DSE/ha (1 DSE/acre) but may not be as high as this in large paddocks. This is greater than the 2-3 acres/sheep that Purcell (1964) estimated prior to this trial commencing. The rate may be lower for cattle at equivalent grazing pressure because Bennett *et al.* (1970) have shown that cattle production is more sensitive to stocking rate than sheep on the same pastures in the Canberra district. For sheep, conception rates and weaning percentages were the most sensitive production parameters to stocking rate at Canberra. There is considerable debate about the appropriate ratio for equivalence of grazing pressure between sheep and cattle which can vary at different times of the year depending on pasture biomass and greenness (Bennett *et al*. 1970; Ebersohn 1966) as well as the proportion of sheep to cattle on a pasture.

6. Unforeseen issues and comparison to Mitchell grass country:

   No unforeseen pastoral, animal, pest or grazing management issues arose but oxalate toxicity was never imagined and so may have been the cause of occasional deaths that could not be attributed to anything in particular with the knowledge that existed at that time.

Further general and sometimes specific observations made by project team members during this long trial can be perused, in roughly chronological order, in Appendices 13 and 14. Raw data from this trial has been lodged with the Queensland Deptartment of Agriculture/Primary Industries Archives at Salisbury, Corner Nettleton Crescent and Blomfield St. – within the Forest Products Research Facility.

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Appendices

Appendix 1. - Blackall climate monthly means (ex BOM website Jun 2018)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Nbr	Years
Temperature															
Mean maximum temperature (°C)	36.0	35.1	33.7	30.3	25.8	22.7	22.3	24.6	28.5	32.2	34.7	36.0	30.2	44	1957 2001
Mean minimum temperature (°C)	22.4	22.0	19.9	16.1	11.8	8.0	6.9	8.4	12.1	16.5	19.5	21.4	15.4	44	1957 2001
Rainfall															
Mean rainfall (mm)	83.7	81.0	62.6	35.8	32.7	26.7	24.8	16.5	19.0	32.7	42.8	69.0	528.9	136	1880 2018
Decile 5 (median) rainfall (mm)	56.6	60.2	34.6	15.0	18.3	15.7	12.0	8.3	6.9	21.1	28.6	54.2	470.2	132	1880 2018
Mean number of days of rain ≥ 1 mm	5.7	5.2	4.3	2.4	2.5	2.2	2.1	1.7	1.9	3.3	4.1	5.1	40.5	133	1880 2018
Other daily elements															
Mean number of clear days	11.4	8.6	14.4	15.0	15.6	17.8	20.9	21.4	21.4	18.3	14.7	13.0	192.5	44	1957 2001
Mean number of cloudy days	7.5	7.6	6.6	5.0	6.8	4.3	4.3	3.1	2.8	4.2	5.7	6.6	64.5	44	1957 2001
Mean nbr of frost days				0	0.15	2.0	3.5	1.6	0.05	0					
9 am conditions															
Mean 9am temperature (°C)	28.3	27.4	25.9	22.5	17.7	13.6	12.8	15.6	20.3	24.3	27.0	28.3	22.0	44	1957 2001
Mean 9am relative humidity (%)	53	58	55	55	62	64	60	51	44	43	43	48	53	37	1957 2001

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Nbr	Years
Mean 9am wind speed (km/h)	10.9	10.5	9.9	10.1	9.1	8.7	9.2	11.6	13.3	13.5	12.2	11.0	10.8	44	1957 2001
3 pm conditions															
Mean 3pm temperature (°C)	34.6	33.7	32.5	29.3	25.0	22.0	21.6	23.8	27.7	31.0	33.3	34.6	29.1	44	1957 2001
Mean 3pm relative humidity (%)	33	38	34	34	40	36	33	28	24	26	27	29	32	37	1957 2001
Mean 3pm wind speed (km/h)	10.3	9.6	9.5	9.1	9.1	9.5	10.2	10.9	11.0	11.1	10.8	10.1	10.1	43	1957 2001

Appendix 2. - Frost incidence during the project and historically for nearby Blackall (036143)

Frost incidence (=<2.2°C) at Blackall during each month of the project and historically

Year	Month							Year	Lowest
	Apr	May	Jun	Jul	Aug	Sep	Oct	total	screen (°C)
1967				1	3			4	0.5
1968				6	2			8	-1.1
1969			2					2	1.6
1970				4	1			5	0.3
1971			3	4				7	-0.6
1972				9	2			11	0.7
1973								0	3.4
1974			1	3	1			5	0.5
1975			1					1	0.1
1976			7	1	8			16	0.2
1977			3	7	1			11	0.5
1978			2	2				4	1.6
1979				3	2			5	-0.4
1980			2	2				4	1.0
1981			2		1			3	-0.3
1982			8	8	1			17	-0.7

Historical Blackall frost incidence (1890-2018)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Year total	Lowest screen (°C)
Counts	0	11	81	99	87	5	0	283	
Annl Max		4	15	16	9	2		29	
Annl Min		0	0	0	0	0		0	-3.3
Median		2	3	5	2	1		7	1.3
Mean								8.2	

Years between 1890 and 2018 with frost counts in these 9 categories

Categy	zero	1	2	3	4-7	8-12	13-17	18-22	>22
Count	6	9	8	8	35	34	19	6	4

Appendix 3. - Monthly kriged rainfall (mm) for the Eastwood area (-24.65°, 145.45°E) and totals for each summer (Nov-Mar), winter (Jun-Sep) and calendar year during the trial.

The corresponding decile values for each year, summer and winter season based on the long-term kriged results for the location are also provided. Source: SILO 2018

Month	Monthly Rain (mm)	Calendar Year	Nov-Mar Summer	Jun-Sep Winter	Deciles Year	Deciles Summer	Deciles Winter
Nov-66	34.8						
Dec-66	0.8						
Jan-67	7						
Feb-67	57.9						
Mar-67	45.9		146.4			2	
Apr-67	0.1						
May-67	2.3						
Jun-67	71.8						
Jul-67	0.2						
Aug-67	5.9						
Sep-67	0			77.9			6
Oct-67	24.3						
Nov-67	4						
Dec-67	103.8	323.2			2		
Jan-68	38.7						
Feb-68	92.1						
Mar-68	40.5		279.1			6	
Apr-68	68.1						
May-68	63.4						
Jun-68	2.6						
Jul-68	32.3						
Aug-68	1						
Sep-68	1.1			37			3
Oct-68	0						
Nov-68	0.2						
Dec-68	8	348			4		
Jan-69	29.7						
Feb-69	16.5						
Mar-69	82		136.4			1	
Apr-69	0						
May-69	24.5						
Jun-69	2.1						
Jul-69	3.1						
Aug-69	0.5						
Sep-69	0			5.7			1
Oct-69	33.5						
Nov-69	3.2						
Dec-69	61	341			3		

Month	Monthly Rain (mm)	Calendar Year	Nov-Mar Summer	Jun-Sep Winter	Deciles Year	Deciles Summer	Deciles Winter
Jan-70	70.1						
Feb-70	42.9						
Mar-70	45.9		223.1			3	
Apr-70	7.1						
May-70	0						
Jun-70	1						
Jul-70	0.1						
Aug-70	0.4						
Sep-70	55.6			57.1			5
Oct-70	12						
Nov-70	44.1						
Dec-70	82.8	362			4		
Jan-71	38.7						
Feb-71	55.1						
Mar-71	51		271.7			6	
Apr-71	45.3						
May-71	3.7						
Jun-71	0						
Jul-71	20						
Aug-71	31.1						
Sep-71	17.3			68.4			5
Oct-71	20.5						
Nov-71	24.7						
Dec-71	136	443.4			6		
Jan-72	65						
Feb-72	3.9						
Mar-72	104.5		334.1			7	
Apr-72	0						
May-72	39						
Jun-72	0						
Jul-72	0						
Aug-72	1.2						
Sep-72	0			1.2			1
Oct-72	2.3						
Nov-72	101.6						
Dec-72	54.8	372.3			5		
Jan-73	77.5						
Feb-73	171.7						
Mar-73	64.5		470.1			9	
Apr-73	52.9						
May-73	15.6						
Jun-73	2.5						
Jul-73	21.3						
Aug-73	6.7						

Month	Monthly Rain (mm)	Calendar Year	Nov-Mar Summer	Jun-Sep Winter	Deciles Year	Deciles Summer	Deciles Winter
Sep-73	74.6			105.1			7
Oct-73	13.7						
Nov-73	84.4						
Dec-73	57.6	643			8		
Jan-74	303.6						
Feb-74	9.2						
Mar-74	15.8		470.6			7	
Apr-74	39.2						
May-74	23.4						
Jun-74	0.3						
Jul-74	0						
Aug-74	20.7						
Sep-74	33			54			5
Oct-74	32.4						
Nov-74	60.3						
Dec-74	16.4	554.3			8		
Jan-75	57.6						
Feb-75	53.8						
Mar-75	72		260.1			5	
Apr-75	1.8						
May-75	0.7						
Jun-75	32.9						
Jul-75	5.1						
Aug-75	24.5						
Sep-75	2.5			65			5
Oct-75	22.2						
Nov-75	0.4						
Dec-75	141.4	414.9			6		
Jan-76	132.6						
Feb-76	121.9						
Mar-76	92.6		488.9			9	
Apr-76	0.1						
May-76	22.6						
Jun-76	7.1						
Jul-76	20.4						
Aug-76	1.5						
Sep-76	5.7			34.7			4
Oct-76	13.9						
Nov-76	34.4						
Dec-76	94.3	547.1			8		
Jan-77	71.9						
Feb-77	211.6						
Mar-77	50.7		462.9			9	
Apr-77	46.2						

Month	Monthly Rain (mm)	Calendar Year	Nov-Mar Summer	Jun-Sep Winter	Deciles Year	Deciles Summer	Deciles Winter
May-77	111.8						
Jun-77	1.2						
Jul-77	2.6						
Aug-77	2.3						
Sep-77	2.9			9			1
Oct-77	15						
Nov-77	0.6						
Dec-77	42.8	559.6			8		
Jan-78	51.2						
Feb-78	16.4						
Mar-78	34.4		145.4			1	
Apr-78	2						
May-78	61						
Jun-78	26.5						
Jul-78	118.3						
Aug-78	52.9						
Sep-78	42.5			240.2			10
Oct-78	35.8						
Nov-78	14.7						
Dec-78	72	341			3		
Jan-79	12						
Feb-79	102.5						
Mar-79	27		228.2			3	
Apr-79	14.5						
May-79	12.9						
Jun-79	36.6						
Jul-79	0.1						
Aug-79	1.1						
Sep-79	8.6			46.4			4
Oct-79	23.7						
Nov-79	9.9						
Dec-79	28.4	277.3			2		
Jan-80	82.9						
Feb-80	69.1						
Mar-80	66.7		257			5	
Apr-80	8.7						
May-80	49.1						
Jun-80	0.1						
Jul-80	29.7						
Aug-80	12.7						
Sep-80	0			42.5			4
Oct-80	31.6						
Nov-80	22.4						
Dec-80	23.7	396.7			5		

Month	Monthly Rain (mm)	Calendar Year	Nov-Mar Summer	Jun-Sep Winter	Deciles Year	Deciles Summer	Deciles Winter
Jan-81	59.7						
Feb-81	94.6						
Mar-81	26.2		226.6			3	
Apr-81	13.1						
May-81	161.9						
Jun-81	8.8						
Jul-81	85.1						
Aug-81	0						
Sep-81	0			93.9			7
Oct-81	40.9						
Nov-81	97.4						
Dec-81	26	613.7			9		
Jan-82	85.8						
Feb-82	12.3						
Mar-82	111.9		333.4			7	
Apr-82	2.8						
May-82	20.9						
Jun-82	0.6						
Jul-82	0.1						
Aug-82	0.2						
Sep-82	0.4			1.3			1
Oct-82	0.9						
Nov-82	10.6						
Dec-82	18.5	265			1		

Appendix 4. - Days when rainfall (mm) recorded at the trial site plus SILO kriged values at -24.65, 145.45°E and Blackall rain (-24.42°, 145.47°E) for comparison during the first 4 years, 1967-1971.

Date (dd/mm/yyyy)	Blackall (mm)	Eastwood krig (mm)	Eastwood house (mm)	Trial site (mm)	In LWt interval#
1/01/1967	0.8	0.2			
2/01/1967	0.5				
4/01/1967		0.5	5		
5/01/1967	3	0.7			
13/01/1967	1.3	0.3			
18/01/1967	0.3		2		
19/01/1967	1.8	2.1			
28/01/1967		0.3			
30/01/1967		1.6	11.2		
31/01/1967		1.3			
1/02/1967		6.5			
2/02/1967	2.5	5	4.2		
16/02/1967			19.5		
17/02/1967	3	4.9			
19/02/1967	0.5	1.2	12.5		
20/02/1967	15	6.9			
25/02/1967		2.4	42.7		
26/02/1967	5.8	11.1			
27/02/1967	48.3	19.4			
28/02/1967		0.5			
2/03/1967		2.7			
3/03/1967	5.8	7.8	9.2		
4/03/1967	13	9.5	10.5		
5/03/1967		2.5			
6/03/1967		1			
7/03/1967	1.8	9.9	5		
8/03/1967	8.1	11.3	15		
9/03/1967	2.8	1			
13/03/1967	0.5	0.2			
11/04/1967		0.1			
4/05/1967	1	0.2			
6/05/1967		1.5			
20/05/1967	0.3				
21/05/1967	0.3	0.6			
4/06/1967		0.1			
5/06/1967	3	2.6			
6/06/1967	16.8	19.6	41.8		
7/06/1967	0.5	5.4			
8/06/1967	15.5	12	9.7		
9/06/1967	2.3	6.7			

Date (dd/mm/yyyy)	Blackall (mm)	Eastwood krig (mm)	Eastwood house (mm)	Trial site (mm)	In LWt interval#
19/06/1967		0.7			
20/06/1967	14.7	11.4	10		
21/06/1967	19.1	9.3	6.5		
23/06/1967		0.2			
24/06/1967		3	3.5		
25/06/1967	2	0.8			71.5
12/07/1967	0.8	0.1			
28/07/1967	1	0.1			
4/08/1967		0.1			
5/08/1967	1.3	0.1	2		
16/08/1967	7.6	2.4			
17/08/1967	0.5	0.3			
18/08/1967		0.4			
19/08/1967		0.6			
20/08/1967	0.8	1.6			
21/08/1967		0.4			2
7/10/1967		1	3.2		
8/10/1967	1.8	0.3			
11/10/1967		0.1			
13/10/1967	4.8	1.4	1.2		
14/10/1967	4.3	2.6	29.2		
15/10/1967	32.3				
24/10/1967	24.4	8.8	4		
31/10/1967		0.8	3.2		
1/11/1967	1	0.3			
2/11/1967		0.5	27.8		
3/11/1967	2.8	0.6			
6/11/1967		0.1	6.2		
8/11/1967	4.1	0.9			
9/11/1967	0.3				74.8
25/11/1967			8.7		
26/11/1967	3.6	0.8			
28/11/1967		0.1			
29/11/1967	0.5	0.7			
2/12/1967		1.7	7.8		
3/12/1967	2	4			
6/12/1967		9.8	14.5		
7/12/1967	10.7	13.7			
8/12/1967	24.1	7.7	8		39
20/12/1967		3.5			
21/12/1967		10	11.2		
22/12/1967	18.3	6.9			
23/12/1967	3.3	1			
25/12/1967	4.1	1.5			

Date (dd/mm/yyyy)	Blackall (mm)	Eastwood krig (mm)	Eastwood house (mm)	Trial site (mm)	In LWt interval#
27/12/1967		3.8			
28/12/1967		9.8			
29/12/1967	13.7	13	15.8		
30/12/1967	6.4	1.5	4.5		
31/12/1967		15.9			
3/01/1968		0.1			
4/01/1968		1.1			
5/01/1968	3.6	3.6	14.1		
6/01/1968	1.3			10	
7/01/1968		5.1	3		
8/01/1968	1.3	0.2			48.6
11/01/1968	1				
12/01/1968	2.5	3.1	15.5	10	
13/01/1968			10.5		
14/01/1968	5.1	10.6	10.5		
15/01/1968	1.8	9.2		15	
16/01/1968	4.6	1.9			
27/01/1968	1.3	1.8			
28/01/1968		2			
30/01/1968				0.5	36.5
10/02/1968			10		
11/02/1968	13.7	6.9		10	
12/02/1968			28		
13/02/1968	2	3.7	3.5	12.2	
14/02/1968	14.2	5.1	3.2		
15/02/1968	12.4	11.6	19.2		
16/02/1968	79.5	50	52.2		
17/02/1968	5.1	3.4	1.8		
18/02/1968	0.3	1.3		70	
19/02/1968		9.3			
20/02/1968		0.7			
21/02/1968		0.1			
3/03/1968		6.3			
4/03/1968	18.8	11.1	13.5	28.7	
5/03/1968	4.1	1.6		1	131.4
12/03/1968		0.2			
17/03/1968		0.1			
19/03/1968			2.8	8.5	
20/03/1968	1.5	3.9			
21/03/1968			12.8		
22/03/1968	1	7.8			
24/03/1968		0.3		10.5	
26/03/1968		0.7			
29/03/1968		5.6			

Date (dd/mm/yyyy)	Blackall (mm)	Eastwood krig (mm)	Eastwood house (mm)	Trial site (mm)	In LWt interval#
31/03/1968		2.9			15.6
24/04/1968		6.8			
25/04/1968	6.6	4.2	15		
26/04/1968				15	
28/04/1968		4.8			
29/04/1968	40.9	44.9	50.2		
30/04/1968	14	7.4		46.2	
10/05/1968		0.9			
11/05/1968	3.8	9.1	6.2		
12/05/1968	6.1	11.3	29		
13/05/1968	29.2	27.4	23.2		
14/05/1968	9.9	4.4			
15/05/1968				48.8	
21/05/1968		1.8			
22/05/1968	6.4	7.6	12.8		
23/05/1968	1.3	0.9	1.5		
26/05/1968				11.2	137.9
5/06/1968		1.6			
7/06/1968		0.1			
27/06/1968		0.1			
28/06/1968		0.5			
29/06/1968	0.8	0.3			
2/07/1968		0.2			
3/07/1968	1.3	0.6	3.5		
4/07/1968	3.6	3.4	15.5		
5/07/1968	18.3	16.3	0.5	18	
6/07/1968	0.3	0.9			
7/07/1968	2	0.7			
11/07/1968		0.4			
14/07/1968	0.3	0.2			
15/07/1968	0.8	0.7	0.7		
16/07/1968	0.8	0.2		1.2	
17/07/1968	2.5	5.4	1.8		
18/07/1968	9.1	2.4	33.8		
19/07/1968		0.9		26	55.8
12/08/1968		0.2			
29/08/1968	2.3	0.8			
6/09/1968	1	0.1			
15/09/1968	0.3				
17/09/1968	0.3	0.3			
18/09/1968		0.3			
21/09/1968		0.1			
30/09/1968	1.5	0.3			
10/10/1968	0.5				

Date (dd/mm/yyyy)	Blackall (mm)	Eastwood krig (mm)	Eastwood house (mm)	Trial site (mm)	In LWt interval#
16/10/1968				3.2	
9/11/1968	1.3	0.2			
12/11/1968				3	0
4/12/1968	4.6	2.2	3		
5/12/1968	3	2.4			
6/12/1968		0.1			
16/12/1968		0.2			
17/12/1968	2.5	0.8			
21/12/1968			5		
22/12/1968		0.2	11.2		
23/12/1968		0.2			
24/12/1968	2.5	1.9	3		
1/01/1969		0.1			
2/01/1969	2.3	0.7			
8/01/1969	0.3				
11/01/1969	2.5	0.7			
12/01/1969		0.1			
13/01/1969		1.8			
14/01/1969		0.7	5.2		
15/01/1969	15.2	6.4		1.8	27.4
16/01/1969		2			
17/01/1969	11.9	6.9			
18/01/1969	0.3	1.8	23.1	32.5	
19/01/1969	23.1	8.5	5.8	6	
22/01/1969				2	
6/02/1969	36.8	8			
7/02/1969	0.3	0.5	25	10	
8/02/1969	2.8	1		8.2	53.9
13/02/1969		0.1			
14/02/1969		1.9	7.5	8.2	
15/02/1969	8.1	3.8		1.2	
24/02/1969		0.1			
27/02/1969			18.8	7.5	
28/02/1969		1.1			
7/03/1969	3	1			
8/03/1969		0.4			
10/03/1969	0.5				
11/03/1969	0.3				26.3
13/03/1969			4		
14/03/1969		0.3			
15/03/1969		1.6	7.5		
16/03/1969	50	49.1	33.5	32.5	
17/03/1969	0.3	1			
18/03/1969		0.1			

Date (dd/mm/yyyy)	Blackall (mm)	Eastwood krig (mm)	Eastwood house (mm)	Trial site (mm)	In LWt interval#
19/03/1969	38.9	20.4	120	90	
20/03/1969	2.3	0.4			
23/03/1969		0.9			
25/03/1969		0.4			
26/03/1969		3.2			
27/03/1969	1.8	0.9			
28/03/1969		0.2			
29/03/1969	1.5	0.5			
30/03/1969	0.3	1.6			165
2/05/1969		0.2			
3/05/1969	6.4	1.9		2.2	
13/05/1969		0.1			
14/05/1969	0.8				
15/05/1969		0.1			
23/05/1969				6.2	
24/05/1969				14	
26/05/1969	8.4	3.9	22.5		
27/05/1969	8.6	14.7			
28/05/1969	0.3	3.6			
19/06/1969		0.8	8.8	13.2	
20/06/1969	6.9	1.3			8.8
15/07/1969		2	10		
16/07/1969	7.1	1.1	0.8	10.5	
22/08/1969	4.8	0.4			
30/08/1969	0.8	0.1			
11/10/1969		3.7	14.2	13.5	
12/10/1969	6.1	9.5	6.7	1.7	
13/10/1969	0.5	3.3	6.5	10	
14/10/1969	4.6	1.8			27.4
16/10/1969		1.6	8		
17/10/1969	6.9	9.6		17.2	
18/10/1969	1.5	1.6			
19/10/1969		1.4			
23/10/1969		0.1			
28/10/1969		0.1			
29/10/1969		0.8			
5/11/1969		0.3			
6/11/1969	1.5	0.3			
10/11/1969		0.3			
12/11/1969		0.7			
13/11/1969	2.5	0.9			
15/11/1969		0.5			
16/11/1969	0.3	0.1			
23/11/1969		0.1			

Date (dd/mm/yyyy)	Blackall (mm)	Eastwood krig (mm)	Eastwood house (mm)	Trial site (mm)	In LWt interval#
11/12/1969		0.3			
12/12/1969	0.5	4	17.5		
13/12/1969	10.2	16.4	13.8		
14/12/1969		1.4			
16/12/1969		0.7			
17/12/1969	0.8	3.6	3		
18/12/1969	2.8	2.2			
20/12/1969		0.4			
21/12/1969		0.9	6		
22/12/1969	3.8	5.8	7		
23/12/1969	10.9	11.2	4.8		
24/12/1969	13.5	4.7			
25/12/1969		3.8			
26/12/1969		0.7			
27/12/1969		0.7			
29/12/1969		1.4	14		
30/12/1969	3.8	2.2			
31/12/1969	0.8	0.6			66.1
10/01/1970	10.4	5.3			
12/01/1970	5.3	8.9			
15/01/1970		1.8	5.2		
16/01/1970	5.1	3.1			
19/01/1970			10.8		
20/01/1970	2.3	2.6			
23/01/1970		0.3			
26/01/1970	1	0.4			
27/01/1970		2.9			
28/01/1970	2	9.7	3.5		
29/01/1970	14.5	8.1			
30/01/1970	0.8	3.7	57.5		
31/01/1970	43.2	23.3	0.8		
1/02/1970		4.2			
2/02/1970	4.6	2.6			
3/02/1970	1.3	0.8			
4/02/1970	7.4	4.8	2.5		
5/02/1970	4.6	2.3			80.3
14/02/1970		1.6			
15/02/1970		2.7			
17/02/1970		0.4			
21/02/1970		0.1	1.8		
22/02/1970	6.9	5.6			
23/02/1970	1	5.1	4.5		
24/02/1970	11.2	7			
25/02/1970		0.4			

Date (dd/mm/yyyy)	Blackall (mm)	Eastwood krig (mm)	Eastwood house (mm)	Trial site (mm)	In LWt interval#
27/02/1970		5.3			
1/03/1970			20		
2/03/1970	9.9	4.4	10		
3/03/1970	11.4	4.3			
4/03/1970	4.3	1.8			36.3
12/03/1970		1.1			
13/03/1970		5.2			
14/03/1970	1.8	14.4			
15/03/1970	21.1	10.7	16.8		
16/03/1970		2.9			
17/03/1970	0.5				
18/03/1970		0.5			
19/03/1970		0.1			
20/03/1970		0.1			
21/03/1970	0.5	0.4			
22/03/1970	4.8				16.8
9/04/1970		0.2			
16/04/1970	1	0.2			
21/04/1970		0.6			
23/04/1970		3.5	9.5		
24/04/1970	9.7	2.6			9.5
6/06/1970		0.1			
15/06/1970		0.3			
21/06/1970		0.1			
22/06/1970	4.6	0.5			
31/07/1970	0.5	0.1			
14/08/1970		0.3			
24/08/1970	0.5				
26/08/1970		0.1			
12/09/1970		0.4			
13/09/1970	2.5	3.1			
14/09/1970	5.1	12.2	3.5		
15/09/1970	14	11.2	19.5		
16/09/1970	6.9	3.7			
20/09/1970		2.3			
21/09/1970	5.3	4	7		
22/09/1970	9.7	9.7	6		
23/09/1970	20.3	8.7	2.5		
27/09/1970	0.3	0.3			
11/10/1970		2.2			
12/10/1970	1.5	4.3	18		
13/10/1970		0.8			56.5
20/10/1970	1.5	0.5			
24/10/1970		0.8			

Date (dd/mm/yyyy)	Blackall (mm)	Eastwood krig (mm)	Eastwood house (mm)	Trial site (mm)	In LWt interval#
25/10/1970	7.6	3.4			
3/11/1970	2	0.7			
6/11/1970	2.5	9	14.5		
7/11/1970	19.3	5.8			
8/11/1970		0.1			
10/11/1970	0.5	2.9			
11/11/1970	12.7	9.9			
12/11/1970	1.5		7.5		
13/11/1970		0.6			22
14/11/1970		0.7			
19/11/1970		0.2			
20/11/1970		2	17.5		
21/11/1970	18.3	11.6			
30/11/1970	1.8	0.6			
6/12/1970		0.2			
7/12/1970	1	3	8.5		
8/12/1970	3.3	0.1			
9/12/1970		2.6			
10/12/1970		0.3			26
14/12/1970		0.4			
15/12/1970		0.7			
16/12/1970		4.6	5.8		
17/12/1970	46.2	15			
19/12/1970		4.7			
20/12/1970	52.8	19.6			
21/12/1970		2.7			
22/12/1970	11.7	8.5	38.2		
23/12/1970	13.2	4.1			
25/12/1970		1.8	9.2		
26/12/1970		0.3			
27/12/1970	5.3	2.3	25		
28/12/1970	1.3	0.5			
29/12/1970	4.8	3			
30/12/1970	19.1	8.4			78.2
10/01/1971			6.2		
14/01/1971		0.3			
15/01/1971		4.2			
17/01/1971		1.9	5.8		
18/01/1971	11.4	3.5			
23/01/1971		2.9			
24/01/1971	8.9	2.5			
25/01/1971	8.9	3.3			
26/01/1971	2.8	4.3			
27/01/1971	2	2.3	6.5		

Date (dd/mm/yyyy)	Blackall (mm)	Eastwood krig (mm)	Eastwood house (mm)	Trial site (mm)	In LWt interval#
28/01/1971		0.3	7		
29/01/1971	0.8	6			
30/01/1971	14.7	6.5			
31/01/1971	0.3	0.7			
1/02/1971	0.3	0.3			
3/02/1971		0.4			
5/02/1971	7.9	5.2			
6/02/1971	9.1	3.6			
7/02/1971	1	3.3	21.2		
8/02/1971		9			
9/02/1971		0.4			
10/02/1971	2	4.3			
11/02/1971		2.5			40.5
13/02/1971	2	0.8			
15/02/1971		0.1			
21/02/1971	0.3	8.8	6.8		
22/02/1971	43.2	16.4			
3/03/1971	0.8	0.3			
4/03/1971	3.3	3.8			
5/03/1971	22.1	27.2	42.5		
6/03/1971	1.3	4.5			
7/03/1971		1.9			
8/03/1971	1.8	3	5.5		
9/03/1971	9.1	3.8			54.8
26/03/1971	2	0.7			
27/03/1971		1.3			
28/03/1971	0.3	4.5			
11/04/1971		1			
12/04/1971	1.3	0.6			
13/04/1971	1.8	0.5			
14/04/1971	0.5	0.2	35		
15/04/1971		12.2			
16/04/1971	25.9	19.6			
17/04/1971	11.4	9.3			
18/04/1971	3	1.9			
19/05/1971		0.6			
20/05/1971	1.8	1.4			
21/05/1971			6.8		
27/05/1971	4.6	1.7	9		15.8
11/07/1971			13.5		
13/07/1971		0.1			
14/07/1971	4.1	2.7			
15/07/1971	4.1	5.1			
16/07/1971	9.4	6.4			

Date (dd/mm/yyyy)	Blackall (mm)	Eastwood krig (mm)	Eastwood house (mm)	Trial site (mm)	In LWt interval#
17/07/1971		0.3			
22/07/1971	0.3	3.8			
23/07/1971	8.4	1.6			
6/08/1971		0.2			
7/08/1971		6.7	9.5		
8/08/1971	11.7	3.8			
9/08/1971		1.5			
10/08/1971		0.1			
12/08/1971		0.2	5.8		
13/08/1971	1.8	0.7	9.2		
14/08/1971	1.5	1.5			
15/08/1971	0.5	0.5			
19/08/1971		2.3			
20/08/1971	6.4	4.7			
21/08/1971	5.8	4.8	15.5		
22/08/1971	3	3.6			
24/08/1971	0.8	0.5			40
3/09/1971	0.3	0.1			
4/09/1971	0.5	0.2			
12/09/1971		1.3			
13/09/1971	6.1	2.9			
15/09/1971		4.8	10.5		
16/09/1971	11.9	7.7			
21/09/1971	0.5	0.2			
26/09/1971		0.1			
15/10/1971	1.3	0.6	3		
16/10/1971	1.3	8.8			
17/10/1971	7.1	3	23.5		
18/10/1971	3.6	1.9	6.2		
19/10/1971		0.9			
30/10/1971	1.5	1.8			
31/10/1971	1	3.5	3.8		
1/11/1971	15.7	8.6	41.2		
2/11/1971	1.5	0.8			
3/11/1971	2.3	0.8			
6/11/1971		0.5			
7/11/1971	13.2	7.6			
20/11/1971		0.2			
21/11/1971	2.3	0.1	17.5		
24/11/1971		0.2			
25/11/1971	5.1	2.7			
26/11/1971	4.3	1.1			
29/11/1971		1.2			
30/11/1971	1.8	0.9			

Date (dd/mm/yyyy)	Blackall (mm)	Eastwood krig (mm)	Eastwood house (mm)	Trial site (mm)	In LWt interval#
3/12/1971		2.7			
4/12/1971	3.8	4.6			
5/12/1971		1.1			
14/12/1971		1			
15/12/1971	1.5	0.6			
21/12/1971	0.5				
22/12/1971		0.6			
24/12/1971		3.3			
25/12/1971	23.4	29.9	36		
26/12/1971	63	59.8	85.2		
27/12/1971	19.1	32.4			226.9

In the interval between consecutive weighings of the sheep

<u>Notes and comments:</u>

Trial site gauge may not have been read each day, just when someone visited the site.

Trial site records only exist from January 1968 until October 1969.

Often a big rain event is followed by a smaller, shorter one a few days later

9am daily readings often create an artificial demarcation into 2 separate events that is really one

There can be big differences between sites 30km apart, especially from storm rains

Rain events move on a front usually SW to NE in winter but sometimes NW to SE in autumn

Summer events are more N to S moving but can come in from Coral Sea in NE to SW direction

The Eastwood site and its kriged data is directly S of Blackall's point data

In W Qld you generally get a build-up of cloud and humidity before serious rain falls

Rain events generally end with a sharp clearance of clouds and rain rather than the opposite

Good cool season rains are often cleared away by strong, cool winds

There are very few nearby rainfall stations SE of Eastwood

Rain can dribble on for days in La Nina years

Blackall is on average a wetter location than Eastwood

Sometimes a similar fall is offset by a day between Blackall and Eastwood house when it really is the same event and fell in the same 24 hours.

Appendix 5.1 - Mean paddock liveweight (kg) for mob 1 and 2 ewes (1967 – 1969) on all weighing occasions, with individual sheep weights in February and April 1969 also.

Original data sheets have been lost and only treatment means exist for most dates. Rainfall (mm) between weighings is also shown as are shearing dates

Date	29.9.67	15.11.67	13.12.67	10.1.68	7.2.68	6.3.68	4.4.68	7.5.68	28.5.68	19.6.68	24.7.68	21.8.68	12.9.68
Rainfall	2	74.8	39.1	44.5	25.5	121.9	19	61.2	60	0	60	0	shorn
Eartag	Pdk 1	Mob1											
006													
024													
030													
032													
036													
039													
059													
069													
101													
115													
118													
140													
149													
153													
156													
162													
Mean	27.9	31.5	31.3	33.4	37.5	37.4	40.4	41.0	43.1	44.9	46.4	46.9	
Count	16	16	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 7	Mob1											
012													
017													
076													
092													
095													
103													
109													
110													
123													
128													
136													
143													
151													
154													
161													
168													
Mean	29.4	34.0	31.5	34.1	37.9	37.1	40.2	39.4	41.1	41.8	43.1	43.9	
Count	16	16	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 2	Mob1											
008													
011													
033													
043													
046													
052													

Date	14.10.68	20.11.68	15.1.69	12.2.69	12.3.69	10.4.69	6.5.69	11.6.69	2.7.69	30.7.69	4.9.69
Rainfall	0	6.2	1.8	58.7	16.9	122.5	2.2	20.2	13.2	10.5	shorn
Eartag	Pdk 1	Mob2									
186				29.1		34.1					
196				27.7		32.7					
211				35.4		38.1					
220				29.5		34.5					
221				29.1		32.2					
248				34.1		38.6					
261				35.9		42.7					
267				29.1		33.6					
275				34.1		39.0					
282				32.2		38.6					
298				35.9		40.4					
301				37.2		42.7					
302				28.6		31.8					
312				30.4		31.3					
336				32.2		36.8					
337				30.4		34.5					
Mean	28.3	33.6	33.4	31.8	35.5	36.4	39.3	40.5	41.0	41.9	
Count	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 7	Mob2									
184				33.1		37.2					
188				35.4		40.4					
194				34.1		39.0					
200				33.6		38.6					
233				32.2		37.7					
247				37.2		40.9					
253				31.3		35.9					
260				37.7		43.6					
264				33.1		37.2					
270				36.8		41.3					
287				28.6		34.1					
294				36.8		41.3					
305				35.0		39.0					
320				40.0		44.9					
338				33.6		37.7					
342				38.1		44.0					
Mean	30.1	33.3	36.2	34.8	38.6	39.6	41.4	41.0	41.9	43.9	
Count	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 2	Mob2									
178				28.6		32.2					
180				30.0		32.2					
192				25.9		29.1					
193				30.9		35.0					
197				23.6		26.3					

Date	29.9.67	15.11.67	13.12.67	10.1.68	7.2.68	6.3.68	4.4.68	7.5.68	28.5.68	19.6.68	24.7.68	21.8.68	12.9.68
Rainfall	2	74.8	39.1	44.5	25.5	121.9	19	61.2	60	0	60	0	shorn
065													
074													
082													
088													
090													
097													
131													
133													
137													
148													
Mean	29.5	31.9	29.3	30.6	35.6	35.1	38.1	38.4	40.1	42.6	44.0	43.5	
Count	16	16	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 8	Mob1											
018													
037													
045													
054													
067													
070													
071													
073													
105													
111													
130													
139													
142													
145													
164													
rep													
Mean	28.8	32.7	28.2	30.7	35.4	34.9	38.2	38.0	39.9	41.6	42.6	43.0	
Count	16	16	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 3	Mob1											
003													
007													
014													
029													
040													
041													
051													
064													
068													
094													
098													
107													
116													
126													
146													

Date	14.10.68	20.11.68	15.1.69	12.2.69	12.3.69	10.4.69	6.5.69	11.6.69	2.7.69	30.7.69	4.9.69
Rainfall	0	6.2	1.8	58.7	16.9	122.5	2.2	20.2	13.2	10.5	shorn
198				25.9		29.5					
206				28.1		32.7					
222				25.0		27.7					
231				26.3		29.1					
252				23.6		27.7					
289				27.7		31.3					
292				30.0		33.6					
304				29.1		31.8					
315				27.7		31.3					
329				23.6		30.4					
341				26.3		29.1					
Mean	28.1	30.7	27.9	27.0	28.2	30.6	34.7	35.0	34.2	33.3	
Count	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 8	Mob2									
187				29.1		33.1					
203				27.2		31.8					
209				27.2		30.9					
213				30.0		34.5					
228				27.2		31.3					
243				27.2		33.6					
245				26.8		31.8					
256				24.5		29.1					
259				26.3		30.4					
265				28.1		31.3					
271				29.1		33.1					
272				26.8		31.3					
306				24.5		30.0					
307				25.4		29.5					
339				28.6		33.6					
340				30.4		35.4					
Mean	28.3	29.4	28.5	27.6	29.0	32.0	36.1	37.4	37.1	35.9	
Count	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 3	Mob2									
174				34.1		37.7					
179				32.2		35.9					
185				29.5		34.5					
190				34.5		39.0					
199				36.8		40.4					
208				35.0		39.0					
214				35.4		39.0					
215				31.3		34.5					
229				29.5		34.5					
241				31.3		35.9					
249				26.8		30.4					
269				33.6		36.8					
291				35.9		40.0					
300				32.2		37.2					
309				30.4		35.0					

Date	29.9.67	15.11.67	13.12.67	10.1.68	7.2.68	6.3.68	4.4.68	7.5.68	28.5.68	19.6.68	24.7.68	21.8.68	12.9.68
Rainfall	2	74.8	39.1	44.5	25.5	121.9	19	61.2	60	0	60	0	shorn
159													
Mean	28.7	33.6	30.9	33.6	37.3	37.0	40.1	40.3	41.7	43.8	45.1	45.5	
Count	16	16	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 5	Mob1											
009													
019													
044													
047													
057													
061													
062													
084													
085													
087													
119													
122													
135													
152													
169													
170													
Mean	28.6	33.2	30.1	33.4	37.1	37.3	40.0	40.0	40.6	43.7	45.4	44.8	
Count	16	16	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 4	Mob1											
002													
020													
022													
025													
038													
063													
079													
099													
102													
104													
113													
132													
150													
158													
160													
165													
Mean	28.5	31.6	25.2	26.0	31.9	30.2	33.6	30.0	30.5	30.3	26.6	26.9	
Count	16	16	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 6	Mob1											
001													
004													
015													
021													
023													

	14.10.68	20.11.68	15.1.69	12.2.69	12.3.69	10.4.69	6.5.69	11.6.69	2.7.69	30.7.69	4.9.69
	0	6.2	1.8	58.7	16.9	122.5	2.2	20.2	13.2	10.5	shorn
330				34.1		37.7					
	29.1	34.6	34.1	32.7	36.9	36.7	40.5	40.8	41.2	42.9	
	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 5	Mob2									
173				29.5		34.1					
176				29.5		34.5					
212				26.8		30.9					
240				34.5		39.5					
255				28.1		33.1					
278				35.4		40.4					
280				28.6		36.3					
281				32.7		37.2					
285				30.9		36.8					
293				32.2		36.8					
299				27.7		33.6					
318				35.0		40.0					
324				30.9		36.8					
325				29.5		34.1					
328				34.1		38.1					
331				33.1		37.2					
	27.9	30.5	31.6	31.2	35.8	36.2	38.7	39.0	39.9	41.3	
	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 4	Mob2									
171				24.1		28.6					
201				24.5		30.9					
205				22.7		25.4					
210				26.3		29.1					
216				27.2		31.8					
219				24.5		29.1					
226				23.2		27.2					
232				28.6		32.2					
237				23.2		32.2					
238				23.6		30.0					
262				27.7		31.8					
290				23.2		30.4					
297				30.4		34.5					
317				21.3		26.8					
319				24.1		30.0					
333				22.7		28.1					
	29.4			24.8		29.9					
	16	16	16	16	16	16	16	16	16	16	
Eartag	Pdk 6	Mob2									
182				28.1		30.0					
204				25.9		28.6					
218				25.9		30.9					
230				22.7		25.4					
234				19.5		23.6					

Date	29.9.67	15.11.67	13.12.67	10.1.68	7.2.68	6.3.68	4.4.68	7.5.68	28.5.68	19.6.68	24.7.68	21.8.68	12.9.68		14.10.68	20.11.68	15.1.69	12.2.69	12.3.69	10.4.69	6.5.69	11.6.69	2.7.69	30.7.69	4.9.69
Rainfall	2	74.8	39.1	44.5	25.5	121.9	19	61.2	60	0	60	0	shorn		0	6.2	1.8	58.7	16.9	122.5	2.2	20.2	13.2	10.5	shorn
028														254				25.9		28.1					
034														266				22.7		25.4					
035														284				25.9		28.1					
050														286				23.2		25.9					
053														288				18.6		20.4					
060														295				22.7		25.4					
077														296				31.3		35.0					
093														308				21.3		23.6					
100														314				23.2		25.9					
120														323				24.1		27.2					
167														326				25.4		29.1					
Mean	28.6	31.0	25.2	26.0	30.1	30.2	33.6	30.0	30.5	30.3	26.6	26.0			28.3			24.1		27.0					
Count	16	16	16	16	16	16	16	16	16	16	16	16			16	16	16	16	16	16	16	16	16	16	

Appendix 5.2 - Individual sheep liveweights (kg) for all mob 3 ewes (1969 – 1970) on all weighing occasions, listed within each paddock.

Rainfall (mm) between weighings is also shown as are the shearing dates

Date	25.9.69	15.10.69	13.11.69	10.12.69	7.1.70	11.2.70	5.3.70	1.4.70	29.4.70	28.5.70	25.6.70	23.7.70	11.8.70	12.8.70
Rainfall	0	25.3	17.2	0	66.1	80.3	36.3	16.8	9.5	0	0	0	0	shorn
		½ shorn												
Eartag	Pdk 1	Mob3												
401	18.6	18.6	20.4	24.5	26.3	28.6	30.4	32.2	33.1	35.9	33.6	36.8	28.1	
402	23.6	25.4	27.2	30.4	33.6	35.9	38.6	41.3	43.1	43.6	42.7	43.6	36.8	
403	19.5	20.9	24.5	28.1	30.9	32.2	34.5	37.2	38.6	40.9	38.6	41.8	35.4	
404	20.4	22.2	23.6	28.1	29.5	31.8	34.1	36.8	38.1	39.0	38.1	39.0	33.1	
405	21.3	22.2	25.0	29.5	31.3	32.2	33.6	36.3	37.7	39.0	36.8	39.5	34.1	
406	21.8	24.1	28.6	34.5	35.0	35.9	38.1	41.3	43.1	45.9	44.0	45.4	37.2	
407	20.4	23.2	23.6	28.1	29.5									
408	17.3	17.7	21.3	26.3	28.6	30.0	32.2	34.5	35.9	36.8	36.3	38.1	33.6	
409	19.1	20.9	21.8	25.9	27.7	29.1	31.3	34.5	35.0	36.8	35.4	38.6	32.2	
410	17.7	18.6	21.8	24.1	26.8	27.2	29.5	32.7	32.7	34.5	31.8	34.1	27.7	
411	20.0	21.3	24.5	28.6	30.4	32.2	34.5	38.6	40.0	42.2	41.3	42.7	36.3	
412	22.7	23.2	24.5	28.1	31.8	31.8	34.5	38.1	38.6	41.3	40.0	42.2	35.4	
413	16.3	16.8	20.9	25.0	25.9	27.2	29.5	31.8	33.6	34.5	32.2	35.0	30.4	
414	25.9	25.4	29.1	31.8	35.0	36.8	40.4	43.6	41.3	44.5	42.7	46.3	41.3	
415	19.1	20.0	23.2	26.8	28.1	31.3	34.1	36.8	37.2	40.0	39.0	41.3	35.0	
417	21.8	22.7	26.8	30.9	33.6	31.3	35.0	39.0	40.9	43.6	41.3	44.0	35.4	
544							30.9	31.3	33.1	36.8	35.9	36.8	33.1	
Mean	20.3	21.5	24.2	28.2	30.2	31.6	33.8	36.6	37.6	39.7	38.1	40.3	34.1	
Count	16	16	16	16	16	15	16	16	16	16	16	16	16	
Eartag	Pdk 7	Mob3												
497	20.9	21.3	22.2	24.1	28.6	29.5	31.8	32.2	32.2	35.4	34.1	34.5	32.2	
514	17.7	20.0	22.7	25.9	28.6	30.9	31.8	34.5	35.0	37.2	35.9	36.3	32.2	
515	23.2	24.5	25.4	30.0	30.9	33.1	33.6	37.2	33.6	38.1	37.7	29.1	27.2	
516	23.6	21.3	26.8	30.0	31.3	32.7	33.6	36.3	36.8	39.5	37.7	40.4	37.2	
517	24.1	23.6	27.7	30.9	33.6	35.4	36.3	39.5	39.0	42.2	39.5	42.7	38.1	
518	23.2	23.6	24.5	28.1	32.2	32.7	33.6	36.3	36.3	40.0	37.2	38.1	34.5	
519	19.1	21.3	24.1	27.7	28.6	30.4	31.3	33.6	34.1	36.3	33.6	35.0	30.9	
520	18.2	18.2	20.9	23.6	25.9	29.1	30.4	35.0	35.0	38.6	35.4	38.6	33.6	
521	19.1	19.5	22.7	25.4	28.1	29.5	30.9	32.7	33.6	35.9	33.6	34.5	30.9	
522	15.9	16.3	20.0	23.2	25.9	28.6	29.5	31.3	32.2	33.6	31.8	33.6	30.4	
523	23.2	24.1	25.4	30.4	30.4	30.9	32.2	36.3	36.8	39.5	36.3	39.5	35.4	
524	23.2	24.1	24.5	28.6	31.3	34.1	35.9	35.9	35.0	38.1	35.0	38.1	29.5	
525	18.2	20.0	23.6	27.2	28.1	30.9	30.4	32.2	30.0	33.1	30.9	29.5	27.2	
526	19.1	23.6	22.7	25.9	30.0	30.9	32.2	35.4	35.4	36.8	35.0	34.5	30.4	
527	17.3	18.6	20.4	24.1	25.0	29.5	30.4	29.1	32.7	33.6	32.2	33.1	28.6	
528	16.3	15.9	18.6	23.2	26.3	29.1	30.4	34.1	34.1	36.8	34.5		32.2	
Mean	20.1	21.0	23.3	26.8	29.1	31.1	32.1	34.5	34.5	37.2	35.0	35.8	31.9	
Count	16	16	16	16	16	16	16	16	16	16	16	15	16	
Eartag	Pdk 2													
418	20.0	15.9	17.7	17.7	21.8	24.5	25.4	29.1	27.7	24.5	20.0	19.1	15.9	
419	19.1	13.6	19.1	18.2	23.6	25.9	29.1	31.8	29.1	25.4	21.3	20.4	17.7	
420	17.7	15.4	19.1	19.5	22.2	23.2	25.4	29.5	26.8	24.5	20.9	19.1	16.3	
421	20.9	15.0	18.6	18.6	22.2	25.0	27.2	29.1	28.1	24.1	21.8	20.0	19.1	
422	20.9	16.8	20.4	20.0	23.6	25.0	27.7	31.3	30.0	25.4	21.3	20.9	17.7	

Date	25.9.69	15.10.69	13.11.69	10.12.69	7.1.70	11.2.70	5.3.70	1.4.70	29.4.70	28.5.70	25.6.70	23.7.70	11.8.70	12.8.70
Rainfall	0	25.3	17.2	0	66.1	80.3	36.3	16.8	9.5	0	0	0	0	shorn
		½ shorn												
423	26.3	21.8	26.3	24.1	29.5	33.1	35.9	38.1	36.8	32.2	25.9	25.4	22.2	
424	20.9	18.2	21.8	22.2	27.2	28.1	30.9	31.8	29.1	25.4	22.2	21.8		
425	22.2	17.3	21.8	21.3	25.9	27.7	31.3	32.7	32.7	29.1	25.9	23.6	21.3	
426	23.6	21.8	22.2	22.7	25.0	26.8	30.4	34.5	33.6	30.4	25.4	25.0	22.7	
427	20.4	17.3	20.4	19.5	24.1	25.9	30.0	31.8	30.0	26.3	23.6	21.8	19.1	
428	21.3	18.6	20.9	20.4	23.6	24.5	27.2	29.5	26.8	25.0	20.0	19.1	17.3	
429	20.0	15.9	19.1	18.2	22.7	22.7	24.5	27.7	26.8	24.1	20.9	20.9	16.8	
430	20.4	16.8	20.4	19.5	24.1	26.3	29.1	31.8	30.4	28.1	24.5	24.5	22.2	
431	18.2	17.3	18.2	18.2	22.2	24.1	25.9	26.8	26.3	23.2	19.1	19.5	17.3	
432	20.0	22.2	19.5	19.1	23.2	25.4	27.7	30.4	29.1	26.3	23.2			
433	19.5	15.9	20.4	20.0	24.5	26.3	29.5	31.3	30.0	26.3	22.7	21.3	17.7	
Mean	20.7	17.5	20.4	19.9	24.1	25.9	28.6	31.1	29.6	26.3	22.4	21.5	18.8	
Count	16	16	16	16	16	16	16	16	16	16	16	15	14	
Eartag	**Pdk 8**													
498	16.8	15.9	19.5	20.9	24.5	28.6	30.4	35.4	34.5	31.8	30.0	28.1	23.6	
499	23.2	20.4	20.0	19.1	24.5	28.1	30.4	33.1	33.6	31.8	28.6	27.7	22.2	
500	23.6	19.1	20.4	19.5	25.9	30.0	32.7	35.0	32.7	31.8	28.1	27.2	22.2	
501	25.4	23.6	25.4	26.3	30.0	33.6	35.9	39.5	32.2	32.2	29.5	29.1	23.6	
502	18.6	17.7	20.0	20.4	23.6	26.8	29.1	34.1	34.1	32.7	29.5	27.2	22.7	
503	17.3	17.7	19.5	19.1	24.5	26.3	30.4	32.7	31.3	29.5	26.8	25.9	20.9	
504	21.8	20.4	20.9	20.9	25.4	30.0	31.3	34.5	35.0					
505	20.4	17.7	21.8	19.5	25.9	28.6	30.9	30.9	28.6	23.2	23.6	24.1	19.1	
506	17.7	15.9	19.1	17.3	22.2	25.4	27.7	31.3	29.5	27.7				
507	19.1	17.7	18.6	18.2	23.2	25.4	26.8	30.4	29.5	26.8	25.0	23.2	22.7	
508	20.4	18.2	19.5	20.0	23.6	26.3	28.1	31.8	30.0	28.6	24.5	24.5	19.5	
509	20.4	19.5	21.8	23.2	26.8	30.0	31.8	35.0	34.5	32.7	30.0			
510	19.1	18.2	19.1	20.0	21.3	25.0	27.2							
511	21.8	19.1	20.9	20.9										
512	16.8	15.0	17.7	18.2	23.2	25.9	27.7	30.9	30.9	30.4	26.8	27.2	22.7	
513	24.1	21.3	25.4	25.0	30.0	30.9	35.0	38.6	37.2	35.0	33.1	30.9	25.4	
540								30.0	30.0	29.1	25.9	25.9	20.9	
545							37.7	42.2	40.4	41.8	35.0	33.6	26.8	
546										32.7	29.5	28.1	23.2	
Mean	20.4	18.6	20.6	20.5	25.0	28.1	30.8	34.1	32.7	31.1	28.4	27.3	22.5	
Count	16	16	16	16	15	15	16	16	16	16	15	14	14	
Eartag	**Pdk 3**													
466	21.8	21.8	23.2	25.0	27.2	29.1	30.4	32.7	35.0	33.1	34.1	34.5	27.2	
467	18.2	16.3	20.4	23.6	26.3	28.6	29.5	32.7	34.5	33.6	33.1	34.1	29.1	
468	17.3	17.3	20.9	24.1	27.7	30.4	31.8	35.0	36.3	35.0	34.5	34.5	25.9	
469	22.7	21.8	25.4	29.5	31.8	32.2	31.8	35.0	36.3	34.1	34.5	34.5	29.5	
470	16.3	16.3	16.8	20.9	22.7	24.5	25.9	30.0	30.4	28.6	28.1	30.0	23.6	
471	20.4	20.4	24.5	27.7	28.1	28.1	29.5	30.4	32.7	32.7	33.1	33.1	26.3	
472	19.5	21.8	23.2	26.3	28.6	30.4	32.2	33.6	36.8	36.3	30.9	33.1	28.1	
473	23.2	23.2	22.2	26.3	29.1	30.9	32.7	35.9	37.2	38.1	36.3	38.6	32.2	
474	18.2	18.6	20.4	23.6	26.8	29.5	31.3	34.5	35.4	35.9	36.8	36.8	30.9	
475	19.5	22.7	24.1	29.1	31.8	32.7	34.5	39.5	39.0	38.6	39.0	39.5	32.2	
476	20.0	20.9	21.8	25.9	28.6	30.9	31.8	35.0	36.3	34.1				
477	20.9	21.8	25.0	28.6	29.5	30.4	29.5	33.6	30.0	30.9	31.3	32.7	26.8	

Date	25.9.69	15.10.69	13.11.69	10.12.69	7.1.70	11.2.70	5.3.70	1.4.70	29.4.70	28.5.70	25.6.70	23.7.70	11.8.70	12.8.70
Rainfall	0	25.3	17.2	0	66.1	80.3	36.3	16.8	9.5	0	0	0	0	shorn
		½ shorn												
478	17.3	17.7	21.8	25.9	29.1	31.3	33.1	37.2	38.1	36.3	33.1	35.4	28.6	
479	19.5	21.3	25.0	28.1	30.4	32.7	34.1	34.1	36.3	36.3	36.8	37.2	30.9	
480	25.4	25.4	27.2	31.3	34.1	36.8	39.0	44.0	44.9	45.4	43.6	43.1	28.1	
481	20.4	20.0	24.5	27.7	30.4	31.8	33.6	36.3	37.7	32.7	33.6	35.9	28.6	
Mean	20.0	20.5	22.9	26.5	28.9	30.6	31.9	35.0	36.1	35.1	34.6	35.5	28.5	
Count	16	16	16	16	16	16	16	16	16	16	15	15	15	
Eartag	**Pdk 5**													
434	20.4	21.3	25.0	30.9	32.2	36.8	37.2	41.8	43.1					
435	18.2	18.2	22.2	25.9	28.1	30.4	31.8	35.0	36.3	36.8	32.7	35.0	24.1	
436	19.5	19.5	24.1	26.8	30.4	34.1	35.9	39.0	39.5	40.4	38.1	37.7	24.5	
437	19.5	20.0	22.2	26.3	26.8	27.7	29.5	33.6	31.8	35.4	33.6	35.4	28.6	
438	16.3	15.4	15.0	19.1	21.8	25.0	26.8	28.1	30.0	31.8	30.0	28.6	23.6	
439	21.8	21.8	23.6	28.1	30.0	33.1	35.9	39.0	39.5	40.9	38.1	38.1	31.3	
440	18.6	18.2	20.4	24.1	26.3	29.1	30.4	33.6	35.9	35.4	34.1	32.7	29.5	
441	17.3	17.3	20.4	23.6	26.3	26.8	29.5	32.2	34.1	35.0	33.6	30.9	23.6	
442	26.3	27.2	28.6	35.0	37.7	36.8	38.6	44.0	45.4	46.8	45.4	40.9	33.6	
443	20.4	21.3	25.4	29.5	31.8	34.5	35.4	38.6	40.9	42.7	41.3	41.3	32.7	
444	21.3	21.3	25.4	28.1	30.9	29.1	30.4	34.5						
445	20.0	19.5	20.9	24.1	26.3	26.3	29.1	31.8	32.7	34.1	30.9	31.3	27.7	
446	18.2	17.3	21.3	25.0	27.7	30.9	31.8	36.8	36.8	27.7	30.9	33.1	24.1	
447	22.2	23.2	24.5	29.1	30.4	33.6	35.0	38.6	40.4	40.9	38.6	39.0	30.4	
448	22.2	21.8	21.8	26.3	28.1	30.0	31.3	35.0	33.6	35.0	33.6	35.4	29.1	
449	22.2	20.4	21.3	25.4	28.1	28.1	33.1	37.7	39.0	40.9	39.5	39.0	37.2	
543									36.3	36.8	35.0	35.0	28.1	
547										43.6	42.2	42.7	37.7	
Mean	20.3	20.2	22.6	26.7	28.9	30.8	32.6	36.2	37.2	37.7	36.1	36.0	29.1	
Count	16	16	16	16	16	16	16	16	16	16	16	16	16	
Eartag	**Pdk 4**													
416	21.8	21.8	21.8	21.8	25.0	26.3	25.0	23.2	24.5	26.3				
482	20.4	19.1	18.2	18.2	20.9	20.9	20.0	19.1	20.0	20.9	21.3	21.8	18.6	
483	22.2	22.2	23.2	24.5	26.8	27.2	26.3	25.0	25.9	27.7	28.1	30.9	26.8	
484	20.0	19.1	20.4	21.8	22.7	22.2	23.2	21.3	23.2	23.6	24.1	23.6	20.4	
485	20.0	18.2	16.3	18.2	19.5	18.6	20.4	20.0	20.4	21.8	19.5	21.3	18.2	
486	16.8	15.4	17.3	17.7	16.8	18.6	19.1	17.7	18.6	19.5	20.0	20.0	17.7	
487	17.7	17.7	19.1	19.5	20.9	21.8	21.8	20.4	21.8	21.8	22.2	23.2	17.7	
488	22.2	21.8	22.7	23.2	24.1	25.0	25.0	25.0	26.3	28.1	29.5	29.5	25.0	
489	21.3	20.9	20.0	20.0	22.2	22.7	23.2	21.8	23.2	24.5	25.4	25.4	20.4	
490	19.5	17.3	21.8	22.7	23.2	25.0	25.0	24.1	24.5	25.9	27.2	30.0	23.6	
491	17.7	17.7	17.7	19.5	20.9	18.2	19.5	18.6	20.4	20.4	20.4	20.4	16.3	
492	21.8	20.0	20.0	19.5	22.7	23.2	24.5	23.2	24.1					
493	20.4	20.9	21.3	21.8	23.2	23.6	24.5	24.1	25.0	26.3	27.2	28.6	25.0	
494	19.5	16.8	19.5	21.3	22.2	23.2	23.2	21.8	22.2	23.6	24.1	24.5	21.3	
495	17.7	17.7	17.3	19.1	20.0	20.4	20.4	19.1	20.0	21.3	21.8	20.4	18.6	
496	25.0	21.8	23.2	22.7	25.9	25.9	26.3	23.6	25.9	27.7	28.1	32.2	29.1	
Mean	20.3	19.3	20.0	20.7	22.3	22.7	23.0	21.7	22.9	24.0	24.2	25.1	21.3	
Count	16	16	16	16	16	16	16	16	16	15	14	14	14	

Date	25.9.69	15.10.69	13.11.69	10.12.69	7.1.70	11.2.70	5.3.70	1.4.70	29.4.70	28.5.70	25.6.70	23.7.70	11.8.70	12.8.70
Rainfall	0	25.3	17.2	0	66.1	80.3	36.3	16.8	9.5	0	0	0	0	shorn
		½ shorn												
Eartag	**Pdk 6**													
450	19.5	20.4	21.3	21.3	22.7	22.7	23.6							
451	20.9	17.3	19.5	19.1	20.0	21.8	22.2	21.3	21.3	21.3	23.6	24.1	20.4	
452	19.1	17.7	17.3	18.6	20.4	21.8	22.2	23.2	21.8	23.2	23.2	23.6	20.9	
453	21.3	19.1	17.7	18.6	21.3	22.7	23.2	21.8	21.3	22.7	22.2	22.2	19.5	
455	20.9	18.6	18.2	19.5	22.7	22.7	24.1	22.2	23.6	24.5	25.4	23.2	20.0	
456	18.2	15.9	17.7	18.6	20.4	17.7	21.3							
457	20.4	20.4	17.3	18.6	20.4	20.9	22.2	22.2	22.2	21.8	23.6	24.1	21.8	
458	25.9	25.0	24.1	26.3	26.3	26.3	26.8	24.5	25.0	25.4	26.3	26.3	21.8	
459	20.9	17.3	17.7	19.1	20.4	20.0	21.8	20.9	20.9	22.2	21.3	21.3	19.1	
460	20.0	18.2	19.1	20.4	22.2	23.6	24.1	23.6	23.2	24.5				
461	19.5	19.1	19.1	20.0	19.1	19.5	20.4							
462	21.3	20.9	17.3	14.5	19.5	20.4	20.4							
463	16.3	15.9	16.8	17.7	18.6	19.5	20.0	20.0	20.4	18.2	20.0	25.4	19.1	
464	17.7	17.7	19.1	21.3	21.8	24.1	25.0	25.0	25.0	26.3	27.7	29.5	25.0	
465	20.4	20.0	21.8	21.8	22.7	23.6	24.5	24.5	24.1	25.4	25.4	24.5	21.3	
454	24.5	22.2	23.2	25.9	27.2	29.1	28.6			30.9	31.3	33.1	28.1	
534								29.1	29.1	30.9	31.3	33.1	28.1	
535								22.7	24.1	24.5	25.4	25.9	23.2	
536								21.3	20.9	21.8	22.7	23.6	20.0	
548								21.8	21.3	24.1	17.3	22.7	20.0	
550								20.4	21.3	21.3	22.2	22.2	19.5	
Mean	20.4	19.1	19.2	20.1	21.6	22.3	23.2	22.8	22.8	24.1	24.3	25.3	21.7	
Count	16	16	16	16	16	16	16	16	16	17	16	16	16	

Appendix 5.3 - Individual sheep liveweights (kg) for all mob 4 ewes (1970 – 1971) on all weighing occasions, listed within each paddock.

Rainfall (mm) between weighings is also shown, as are shearing dates.

Date	15.10.70	13.11.70	10.12.70	6.1.71	11.2.71	10.3.71	7.4.71	6.5.71	9.6.71	30.6.71	4.8.71	24.8.71	25.8.71	16.9.71	13.10.71	11.11.71
Rainfall	38.5	22	26	78.2	46.7	54.8	0	35	15.8	0	13.5	40	shorn	10.5	0	77.7
Eartag	**Pdk 1**	**Mob 4**												**Weights during pregnancy study**		
013	14.5	17.7	25.0	25.9	29.1	30.4	34.1	35.0	40.4	41.8	40.4	36.3		34.1	34.1	37.7
080	15.0	19.1	24.1	24.1	30.9	32.7	37.2		35.9	37.2	38.6	35.9		30.9	31.8	32.7
144	15.0	19.5	23.6	26.3	26.3	29.1	32.2	31.8	37.2	36.8	37.7	35.9		32.7	33.6	35.0
189	16.8	19.1	23.2	26.3	27.2	29.1	33.1	35.0	38.6	36.3	38.6	36.8		34.5	36.3	38.6
355	13.6	16.8	20.4	23.6	25.9	27.7	28.6	29.5	33.1	34.1	34.5	32.7		30.4	30.9	30.9
367	16.3	19.5	23.6	25.4	27.2	28.6	31.8	33.6	37.2	38.1	39.0	35.4		33.1	33.1	33.1
368	13.6	16.3	19.1	21.8	24.5	26.3	29.1	30.0	30.9	32.2	30.9	29.1		28.1	30.4	30.0
377	16.3	19.5	24.1	27.7	30.9	32.7	36.8	37.7	40.4	41.8	41.3	38.6		35.9	35.4	38.1
384	14.5	19.1	23.2	20.9	25.9	28.6	33.1	34.1	38.1	40.0	39.5	36.3		33.6		35.4
387	15.4	19.1	24.5	28.6	32.7	34.1	38.6	40.4	44.9	44.5	46.3	42.2		40.9	40.9	42.2
398	15.4	19.1	24.5	27.7	30.4	31.8	33.6	35.9	40.0	41.8	41.3	37.2		39.5	39.5	35.4
559	14.5	18.2	22.2	25.9	28.6	30.4	32.7	32.7	36.8	37.2	38.1	35.4		31.8	33.1	35.4
580	13.6	17.3	21.3	24.5	28.1	29.5	32.2	33.1	36.3	36.8	37.7	35.9		31.8	32.7	31.8
597	15.0	18.6	24.1	27.2	31.3	33.6	36.8	38.1	41.3	44.0	44.0	39.5		35.4	39.5	41.8
599	15.9	19.5	23.6	27.2	30.0	30.0	30.4	34.5	37.7	39.0	40.0	35.4		34.5	35.4	37.7
600	15.4	19.5	24.5	27.7	29.5	32.2	35.4	37.2	40.9	41.8	42.2	39.5		35.4	37.2	39.0
Mean	15.1	18.6	23.2	25.7	28.7	30.4	33.5	34.6	38.1	39.0	39.4	36.4		33.9	34.9	35.9
Count	16	16	16	16	16	16	16	15	16	16	16	16		16	15	16
Eartag	**Pdk 7**	**Mob 4**														
048	14.5	17.3	21.8	24.5	27.2	29.5	32.2	33.6	36.8	36.8	36.3	36.8		31.3	33.1	31.8
072	14.1	12.3	12.7	11.8	28.1	30.4	33.1	34.5	38.1	39.0	40.0	37.2				
172	14.5	17.3	21.3	24.5	25.0	28.1	32.2	33.6	34.5	37.7	37.7	36.3		30.9	32.7	33.6
369	16.3	19.5	23.6	25.9	29.1	30.9	33.6	35.9	38.6	39.5	39.0	36.8		33.1	34.5	34.1
379	15.0	17.3	20.4	25.0	30.0	31.8	36.3	36.8	41.3	41.8	41.3	40.0		36.8	33.6	38.6
385	17.7	20.0	25.0	28.6	32.2	33.6	38.6	37.2	41.8	43.6	43.1	40.4		36.8	37.2	37.2
388	15.9	20.0	23.6	25.9	29.5	30.0	33.6	35.4	37.7	36.8	38.6	36.8		35.4	34.1	32.7
389	15.0	18.2	24.1	25.9	30.4	33.1	37.7	40.9	43.6	45.4	43.1	43.6		40.4	38.1	39.0
400	14.1	15.9	20.0	23.2	26.8	28.1	31.8	34.1	35.9	38.6	37.7	36.8		32.2	33.1	34.1
576	15.0	17.7	21.3	24.5	27.2	29.5	33.1	34.1	37.2	38.1	38.6	36.8		39.0	30.0	33.1
578	13.6	15.4	19.1	23.6	27.2	29.5	32.7	34.5	37.2	38.1	39.5	36.8			32.7	36.3
579	15.4	18.6	23.6	26.8	30.0	32.2	35.9	38.6	42.7	44.5	45.4	42.2		38.1	40.9	42.2
582	15.9	20.9	25.0	29.1	32.7	34.5	38.6	41.3	44.5	45.9	46.8	43.1		35.9	37.7	40.9
590	15.9	19.1	24.1	26.8	27.7	30.9	33.1	37.2	41.8	41.3	41.8	40.4		35.9	36.3	39.0
593	15.4	18.6	22.2	24.5	28.6	30.4	32.7	34.1	36.8	36.8	38.1	36.3		32.2	33.6	35.4
372	14.1	18.2	21.8	25.0	27.2	28.1	31.3	32.7	35.4	36.8	37.2	34.5		30.0	30.4	32.2
373														33.1	34.1	39.0
Mean	15.2	17.9	21.8	24.7	28.7	30.7	34.2	35.9	39.0	40.0	40.3	38.4		34.7	34.5	36.2
Count	16	16	16	16	16	16	16	16	16	16	16	16		15	16	16
Eartag	**Pdk 2**	**Mob 4**														
083	14.1	14.5	18.2	20.0	21.8	22.7	26.3	23.6	20.4	20.9	21.8	20.4			25.0	27.2
166	14.1	14.5	18.2	20.0	21.8	22.7	28.1	25.0	24.1	23.2	22.7	20.9		21.8	25.0	25.9
175	14.1	15.4	18.2	18.2	20.0	20.4	24.1	20.9	17.3	18.6	19.1	18.6			23.2	21.3
223	15.0	16.8	19.1	21.3	23.6	24.5	29.1	27.2	24.1	24.5	25.0	24.1		25.0	25.4	28.1
224	13.6	14.1	16.8	18.6	20.4	20.9	25.4	23.2	18.2	18.2	17.7	17.7		18.2	21.3	25.9

Date	15.10.70	13.11.70	10.12.70	6.1.71	11.2.71	10.3.71	7.4.71	6.5.71	9.6.71	30.6.71	4.8.71	24.8.71	25.8.71	16.9.71	13.10.71	11.11.71
Rainfall	38.5	22	26	78.2	46.7	54.8	0	35	15.8	0	13.5	40	shorn	10.5	0	77.7
227	14.5	16.3	18.6	20.4	22.7	23.6	27.2	25.4	21.8	22.2	23.6	21.8		25.0	28.1	26.3
359	14.1	14.5	18.2	18.2	20.9	21.3	25.9	22.7	20.0	19.1	20.0	17.7		21.8	25.0	27.2
364	13.2	15.0	17.3	18.6	19.5	20.9	25.9	22.2	17.7	16.3	19.5	18.6				
372	12.7	14.5	17.3	19.1	20.4	20.9	25.4	24.1	21.3	22.2	22.2	22.7		20.4		
555	13.6	14.5	20.0	20.4	21.3	21.3	26.3	24.1	21.8	20.9	20.4	20.0		21.8	23.2	25.0
557	13.6	15.9	19.1	20.9	22.7	22.7	26.3	23.2	22.2	21.3	21.3	21.8		25.4	26.3	26.8
565	15.9	16.8	19.1	20.4	23.6	23.2	29.1	25.4	22.7	22.2	23.6	22.7		24.1	26.3	26.8
577	15.9	17.3	20.4	21.8	23.2	24.5	30.4	26.3	23.6	22.7	22.7	22.7			24.5	28.1
583	14.1	14.5	16.8	18.6	20.4	20.0	24.1	21.8	19.1	18.2	19.5	20.9		19.1		
585	12.7	13.2	15.9	17.7	19.1	19.1	23.6	20.9	18.2	17.7	18.2	19.1			18.2	21.8
586	12.7	13.2	16.3	17.7	19.1	19.1	23.6	20.0	16.3	17.3	15.0					
364														21.3	23.6	22.7
Mean	14.0	15.1	18.1	19.5	21.3	21.7	26.3	23.5	20.5	20.3	20.8	20.6		22.2	24.2	25.6
Count	16	16	16	16	16	16	16	16	16	16	16	15		11	13	13
Eartag	**Pdk 8**	**Mob 4**														
055	15.0	14.1	20.0	21.8	27.2	28.6	32.7	34.5	34.5	33.1	28.6	25.0		26.8	28.1	32.7
078	13.6	13.6	18.2	20.0	23.2	25.0	30.0	30.0	30.9	28.1	25.0	22.7		23.2	23.6	26.3
086	15.4	15.0	20.9	23.2	27.2	28.1	33.6	33.6	33.1	31.8	29.1	26.3		26.8	29.5	30.9
117	15.9	15.4	19.5	20.9	23.6	25.4	31.3	33.1	32.7	31.3	27.7	24.1		24.5	25.4	27.7
207	13.6	14.5	17.7	20.9	24.1	24.5	26.8	29.1	30.4	29.1	25.9	22.7		23.2	25.0	24.5
363	13.6	14.5	20.0	21.3	26.8	28.1	32.7	34.5	34.5	32.7	30.4	26.8		28.1	31.8	31.8
376	17.7	16.8	21.8	24.5	27.7	29.5	32.2	34.1	34.1	32.2	29.1	26.8		26.3	29.5	30.9
386	14.5	14.1	18.2	20.9	23.6	24.1	29.1	31.3	31.3	30.4	28.1	25.4				
390	14.1	14.1	19.5	20.0	25.9	27.2	32.7	33.6	33.1	30.9	28.1	25.9		26.3	28.6	29.5
394	14.1	14.5	18.6	21.3	25.4	25.9	30.9	32.2	33.1	29.5	26.8	25.0		25.9	29.1	30.9
396	16.8	15.9	20.4	22.7	26.3	27.7	33.1	33.1	33.1	17.3	29.1	25.4		28.6	28.1	32.7
560	12.7	12.3	17.3	18.2	25.0	25.0	27.7	30.9	30.9	29.5	27.2	26.3		25.4	29.1	30.0
561	17.3	16.3	20.9	21.8	28.1	30.0	34.5	36.3	35.9	26.3	26.3	25.4		27.2	30.0	30.9
563	15.0	16.3	20.0	23.2	26.8	29.5	33.1	31.3	34.1	32.7	30.0	27.2		27.2	29.5	29.1
584	14.1	14.1	18.6	19.5	25.4	26.8	31.3	32.7	34.1	25.4	23.6	21.3		22.7	27.2	27.2
594	15.9	15.4	19.5	22.2	26.3	26.3	31.3	33.6	35.4	33.6	30.9	25.0		27.2	30.4	30.0
244														25.0	27.2	29.5
Mean	15.0	14.8	19.4	21.4	25.8	27.0	31.4	32.7	33.2	29.6	27.9	25.1		25.9	28.3	29.7
Count	16	16	16	16	16	16	16	16	16	16	16	16		16	16	16
Eartag	**Pdk 3**	**Mob 4**														
049	17.7	19.5	25.9	28.6	30.0	32.2	35.9	36.8	39.5	40.0	37.7	36.8		32.7	35.4	35.4
108	12.7	15.4	20.4	23.2	25.9	27.2	30.9	31.8	27.7	32.2	32.7	30.9		29.5	30.4	32.7
114	15.0	17.7	20.9	25.0	26.8	29.1	32.7	33.6	37.7	36.8	35.9	35.4		30.0	33.1	32.7
141	15.0	17.3	22.2	23.2	27.7	30.0	33.1	35.4	30.9	35.4	34.5	34.1		30.9	32.7	33.6
155	15.4	18.6	23.6	26.8	30.4	33.1	37.7	39.0	43.6	43.6	42.2	40.4		37.7	36.3	33.6
181	14.5	17.7	22.7	25.0	29.1	30.0	31.3	34.1	36.3	38.1	38.1	36.3		33.6	37.2	39.0
228	13.2	16.8	22.7	24.5	27.7	29.1	33.1	33.6	38.1	39.0	38.6	36.8		35.0	34.5	35.4
378	13.2	16.8	22.2	26.3	28.1	30.0	34.5	35.9	38.6	40.0	39.5	36.8		33.1	33.1	34.5
395	15.0	18.6	23.2	25.9	31.3	30.0	32.7	33.1	36.8	36.8	36.8	35.4		32.7	33.1	34.1
399	14.5	17.3	20.4	23.2	25.0	27.7	30.9	31.3	31.8	35.0	33.1	33.1		30.9	32.7	31.3
554	14.5	16.8	21.8	25.4	27.7	30.4	33.6	34.5	38.6	39.0	38.6	36.8		33.1	35.0	35.9
558	14.1	15.9	20.9	22.2	25.9	27.2	30.4	31.3	31.8	31.3	30.0	29.1			29.5	29.1
564	15.4	18.6	24.1	25.4	30.9	32.7	37.2	38.1	43.1	42.7	41.3	38.6		36.3	34.1	33.6

Date	15.10.70	13.11.70	10.12.70	6.1.71	11.2.71	10.3.71	7.4.71	6.5.71	9.6.71	30.6.71	4.8.71	24.8.71	25.8.71	16.9.71	13.10.71	11.11.71
Rainfall	38.5	22	26	78.2	46.7	54.8	0	35	15.8	0	13.5	40	shorn	10.5	0	77.7
569	14.1	17.7	22.7	26.3	29.1	31.3	35.9	35.4	34.5	36.8	36.8	35.9		31.3	31.8	33.1
574	14.5	16.3	20.9	23.2	26.8	29.1	31.8	33.1	32.2	34.1	34.1	32.7		30.9	31.8	35.4
581	14.1	17.3	20.9	24.1	27.2	29.5	33.1	33.6	38.6	38.6	37.2	36.3				
242														33.6	33.1	34.1
Mean	14.6	17.4	22.2	24.9	28.1	29.9	33.4	34.4	36.2	37.5	36.7	35.3		32.7	33.4	34.0
Count	16	16	16	16	16	16	16	16	16	16	16	16		15	16	16
Eartag	Pdk 5	Mob 4														
075	14.5	13.6	19.5	22.7	26.8	27.2				38.1	37.2	35.4				
371	14.5	15.0	19.1	24.1	27.7	28.6	33.1	33.1	34.5	35.0	33.6	33.1		30.4	32.7	31.8
191	14.5	15.0	19.1	23.2	25.4	26.3	31.3	31.3	34.5	34.5	34.5	32.7		30.4	30.4	36.3
352	15.0	14.5	20.4	25.4	29.1	31.3	37.2	38.1	40.9	38.1	39.5	35.9				
360	14.5	14.1	19.1	23.6	25.4	26.3	29.5	30.4	30.9	30.9	31.3	28.1		28.1	27.2	35.4
361	15.0	14.1	19.5	21.8	25.9	27.7	31.8	32.7	35.0	35.0	34.5	34.1		31.3		
365	15.4	15.4	21.8	22.2	27.2	29.5	33.6	35.4	39.0	39.5	40.4	36.8		32.7	35.4	36.8
380	15.4	15.0	20.9	24.5	27.2	28.1	31.8	32.7	35.9	35.4	35.0	33.6		29.5	32.7	32.7
392	14.5	13.6	20.9	25.4	28.1	28.6	33.1	33.6	35.4	36.3	35.0	33.6				
393	13.6	13.6	18.6	23.2	25.9	26.3	30.4	31.3	33.1	32.7	32.7	31.3		27.7	28.6	29.5
553	15.4	15.0	20.0	24.1	28.1	30.0	33.1	34.5	36.8	37.7	37.2	35.4		32.7	31.8	34.1
562	15.9	15.9	20.4	26.3	30.4	29.5	34.5	35.9	38.6	38.6	39.0	36.8		34.1	35.0	35.4
567	15.4	15.0	20.9	25.0	28.6	29.5	34.1	35.4	36.8	38.6	36.8	34.1		34.1	33.1	35.9
587	15.4	15.0	20.4	25.0	26.3	28.6	34.1	35.4	40.0	40.0	38.6	35.4		33.6	36.3	35.9
591	15.0	15.4	20.0	23.2	25.9	27.2	31.8	32.7	35.9	36.3	35.9	33.6		30.9	30.0	35.0
595	14.5	13.6	19.1	23.6	26.8	27.7	31.8	32.2	35.0	35.4	33.6	33.1		30.0	29.5	34.1
386														34.1	34.1	36.3
370														34.1	37.7	35.4
010														30.9	30.9	32.7
Mean	14.9	14.6	20.0	23.9	27.2	28.3	32.7	33.7	36.1	36.4	35.9	33.9		31.5	32.4	34.5
Count	16	16	16	16	16	16	15	15	15	16	16	16		16	15	15

	23.10.70	20.11.70	21.12.70
Eartag	Pdk 4	Mob 4	
482	22.2	25.4	26.3
483	29.1	35.0	36.3
484	20.4	26.3	30.0
485	19.5	25.9	29.1
486	18.6	25.4	27.2
487	21.8	26.8	30.4
488	25.4	33.1	36.3
489	24.5	33.6	31.8
490	28.1	32.7	36.8
493	28.6	32.7	34.5
494	24.5	30.0	36.3
495	20.4	26.3	30.9
496	24.5	34.1	37.2
Mean	23.7	29.8	32.5
Count	13	13	13

destocked

	23.10.70	20.11.70	21.12.70
Eartag	Pdk 6	Mob 4	

Date	15.10.70	13.11.70	10.12.70	6.1.71	11.2.71	10.3.71	7.4.71	6.5.71	9.6.71	30.6.71	4.8.71	24.8.71	25.8.71	16.9.71	13.10.71	11.11.71
Rainfall	38.5	22	26	78.2	46.7	54.8	0	35	15.8	0	13.5	40	shorn	10.5	0	77.7
451	22.7	0.0	32.2		destocked											
452	20.9	27.7	31.8													
453	20.9	27.7	30.4													
455	19.1	28.6	31.3													
457	26.8	28.1	30.9													
458	24.5	31.3	34.1													
459	27.2	25.4	30.0													
463	20.4	25.4	28.1													
465	21.8	28.6	33.6													
534	27.2	33.6	34.5													
535	24.5	31.3	36.3													
536	20.4	27.2	31.8													
548	20.9	30.0	32.7													
550	20.9	26.3	29.1													
Mean	22.7	26.5	31.9													
Count	14	14	14													

Appendix 5.4 - Individual sheep liveweights (kg) for the fill-in ewes (1971 – 1972) on all weighing occasions between mobs 4 and 5, listed within each paddock.

Rainfall (mm) between weighings is also shown.

Date	26.8.71	21.9.71	22.10.71	19.11.71	15.12.71	12.1.72	8.2.72
Rainfall		18	16.5	24.1	16.4	174.8	34.1
Eartag	**Pdk 1**	**Fill-in mob**					
600	31.3	33.1	34.5	38.1	40.9	40.0	44.0
601	31.3	32.2	32.2	35.4	36.8	37.7	40.9
602	32.7	37.7	39.0	42.7	45.4	45.4	48.6
603	33.1	40.4	40.9	44.5	47.7	48.1	52.2
604	33.6	39.5	40.0	40.9	44.5	43.6	45.4
605	32.7	35.9	36.8	40.0	42.7	42.2	45.4
606	32.2	40.9	32.2	34.5	38.1	35.0	39.5
607	32.2	33.1	31.8	35.9	39.5	39.0	40.4
608	32.7	35.4	35.0	38.6	40.9	40.9	44.5
609	33.1	39.0	40.0	43.6	46.8	46.3	50.4
610	33.6	33.6	33.6	35.4	37.2	38.6	0.0
611	35.0	35.0	35.9	38.1	40.4	39.5	34.5
612	35.0	36.8	37.2	41.8	44.0	43.1	46.3
613	34.1	35.9	34.1	37.2	38.1	38.1	41.8
615	35.4	35.0	36.3	38.6	44.9	43.1	46.3
Mean	33.2	36.2	36.0	39.0	41.9	41.4	41.3
Count	15	15	15	15	15	15	15
Eartag	**Pdk 7**	**Fill-in mob**					
177	31.8	30.0	30.4	33.6	38.1	37.2	41.8
661	32.7	32.7	34.1	37.2	40.0	38.1	41.8
662	31.3		31.8	34.1	38.1	35.4	40.4
663	35.0	32.7	32.7	36.8	40.4	38.6	42.7
664	32.2	30.9	32.7	34.1	38.1	36.3	40.0
665	32.7		33.6	36.8	40.0	36.3	42.7
666	33.1		35.9	37.7	41.8	38.1	42.7
668	34.5		38.1	41.8	46.3	44.5	49.0
669	35.0	34.5	34.1	38.6	42.7	40.9	43.1
670	33.6		33.6	35.4	38.6	37.2	39.5
671	34.1	32.7	31.8	35.0	38.6	36.8	41.8
672	34.1		32.2	35.4	39.5	38.6	42.2
673	34.1	33.1	34.1	37.7	40.0	40.9	44.0
674	35.9		34.5	39.5	43.1	39.5	43.6
675	35.4	33.6	36.3	38.1	42.2	41.8	45.9
Mean	33.7	32.5	33.7	36.8	40.5	38.7	42.7
Count	15	8	15	15	15	15	15
Eartag	**Pdk 2**	**Fill-in mob**					
616	31.8	26.3	26.8	28.6	29.5	29.5	34.1
617	31.8	25.0	25.0	26.8	26.8	24.5	32.7
618	32.7	28.1	25.9	28.1	28.1	28.1	32.7
619	32.7	26.3	26.3	26.8	26.3	28.1	35.4
620	34.1	32.7	30.4	32.2	32.2	33.6	40.0

Date	26.8.71	21.9.71	22.10.71	19.11.71	15.12.71	12.1.72	8.2.72
Rainfall		18	16.5	24.1	16.4	174.8	34.1
621	35.0	28.6	28.6	30.4	30.4	31.3	35.4
622	35.9	31.3	30.0	32.2	32.2	30.9	36.3
623	35.4	27.7	28.1	29.1	29.1	30.9	35.9
625	33.6	31.3	30.4	34.5	35.0	35.0	42.2
626	34.1	28.6	28.1	30.0	30.9	30.0	35.9
627	32.7	27.7	25.4	28.1	29.5	28.1	37.7
628	32.2	29.1	29.5	31.3	32.2	31.3	36.8
629	32.7	25.9	24.5	26.8	27.7	25.9	31.8
630	33.1	26.8	25.4	27.2	27.7	29.1	32.2
631	34.1	28.1	30.0	28.6	30.4	31.8	37.2
Mean	33.4	28.2	27.6	29.4	29.9	29.9	35.7
Count	15	15	15	15	15	15	15
Eartag	**Pdk 8**	**Fill-in mob**					
646	31.3	30.9	28.6	32.7	33.6	31.8	37.7
647	31.8	33.6	27.2	30.4	30.4	29.5	35.4
648	32.2	26.8	22.7	28.6	28.1	29.5	35.9
649	32.2	30.0	26.3	30.4	30.9	31.8	38.6
650	32.2	29.5	26.8	31.8	31.8	31.8	40.4
651	32.7	27.2	22.2	27.2	27.2	27.7	35.0
652	32.2	31.8	28.1	32.2	33.1	33.6	41.3
653	32.7	26.3	27.2	26.8	27.2	27.2	33.1
654	33.6	30.4	27.2	25.0	25.9	25.0	32.7
655	35.0	30.0	27.2	31.3	32.7	31.3	37.7
656	34.1	27.2	23.2	27.2	29.5	28.1	34.5
657	34.1	32.2	22.7	27.2	29.1	29.5	37.7
658	35.4	30.0	25.9	29.5	31.3	30.9	40.0
659	34.1	29.5	25.0	30.0	30.9	28.6	35.4
660	34.1	31.8	27.7	31.3	32.7	31.3	39.0
081	35.9	31.8	27.2	30.4	31.3	30.4	36.8
Mean	33.3	29.9	26.0	29.5	30.4	29.9	36.9
Count	16	16	16	16	16	16	16
Eartag	**Pdk 3**	**Fill-in mob**					
631	31.3	32.2	32.2	36.3	39.5	37.7	43.1
632	31.8	35.4	32.7	38.6	41.8	40.4	45.4
633	32.7	32.2	32.2	37.2	39.5	37.2	41.8
634	32.2	33.6	33.6	35.9	37.2	37.2	40.9
636	32.7	34.1	34.1	37.7	39.5	37.7	41.8
638	32.2	32.7	32.7	36.3	37.7	36.3	40.4
639	35.0	40.0	39.5	41.8	44.0	41.8	48.6
640	35.0	34.5	34.1	37.2	40.9	39.5	44.0
641	33.6	35.0	36.3	39.5	43.1	41.8	48.1
642	34.1	35.0	35.9	36.8	38.6	39.5	44.0
643	34.1	32.7	31.8	35.0	37.2	35.9	40.4
644	33.6	34.1	34.1	38.1	41.8	40.9	46.8
645	35.4	35.9	36.8	39.0	41.8	38.1	44.0
589	35.9	39.0	42.2	40.0	37.7	35.4	41.8
Mean	33.5	34.7	34.9	37.8	40.0	38.5	43.6

Date	26.8.71	21.9.71	22.10.71	19.11.71	15.12.71	12.1.72	8.2.72
Rainfall		18	16.5	24.1	16.4	174.8	34.1
Count	14	14	14	14	14	14	14
Eartag	Pdk 5	Fill-in mob					
588	33.6	34.5	33.1	38.1	42.7	41.8	47.7
676	35.9	29.5	29.1	32.7	36.3	35.9	42.2
678	33.1	31.8	30.4	33.1	36.3	35.9	40.9
679	32.2	34.5	32.7	34.5	38.1	38.1	43.1
681	34.1	34.1	33.6	36.8	40.4	37.7	43.1
683	32.2	33.6	32.7	36.3	38.6	37.7	45.4
684	33.6	38.6	37.2	39.5	42.2	42.2	42.7
686	35.4	37.2	35.4	41.3	44.5	43.1	48.6
689	35.9	35.0	32.7	38.1	38.1	40.9	48.6
Mean	34.0	34.3	33.0	36.7	39.7	39.2	44.7
Count	9	9	9	9	9	9	9

Appendix 5.5 - Individual sheep liveweights (kg) for all mob 5 wethers (1972 – 1973) on all weighing occasions up to the 1973 shearing, listed within each paddock.

Rainfall (mm) between weighings is also shown, as are shearing dates

Date	8.2.72	2.3.72	13.4.72	27.4.72	2.6.72	22.6.72	19.7.72	8.8.72	31.8.72	28.9.72	27.10.72	5.12.72	21.12.72	28.2.73	13.4.73	10.5.73	6.6.73	4.7.73	2.8.73	29.8.73	30.8.73
Rainfall		0	168.2	0	37.2	0	0	shorn	1	0	1.7	114.3	26.5	233.7	54.9	53	15.1	2.1	19	4.3	shorn
Eartag	**Pdk 1**	**Mob 5**																			
782	32.3	30.6	33.2	33.8	36.2	39.2	39.8		34.6	34.8	35.8	32.2	37.2	42.4	45.2	46.4	43.6	44.6	46.6	45.2	
783	31.4	30.2	31.2	31.4	32.4	35.4	35.4		31.2	31.6	31.6	26.4	31.6	33.8	36.0	37.6	39.2	40.0	41.8	38.8	
784	32.7	29.0	30.8	31.4	33.6	37.9	38.8		34.2	35.8	37.6	31.4	35.8	39.0	40.8	43.2	44.6	46.6	48.2	47.0	
785	33.2	30.8	33.0	33.2	35.0	36.0	38.2		31.6	32.4	33.0	28.4	34.0	37.4	39.6	41.8	43.0	43.8	45.0	43.2	
786	33.6	31.6	33.2	34.0	35.4	37.6	39.2		31.4	32.4	34.6	29.2	33.4	36.4	38.0	40.0	42.2	42.8	44.2	41.8	
787	34.1	32.4	32.0	32.4	34.4	37.0	38.8		33.0	33.6	34.0	29.2	34.2	37.8	38.8	41.0	42.2	42.2	44.2	43.0	
788	35.0	31.2	30.0	30.8	32.8	35.2	35.6		29.6	30.8	32.6	27.8	30.8	34.4	35.0	37.2	37.6	37.6	40.0	38.6	
789	34.1	32.4	33.6	34.0	35.8	38.2	39.2		33.0	34.0	34.8	30.4	34.6	38.6	40.0	42.6	43.6	44.6	45.8	44.4	
790	35.0	30.0	26.8	27.2	31.4	35.2	38.0		32.6	34.0	35.2	29.4	35.8	39.8	41.0	43.4	44.6	45.8		43.4	
791	35.5	31.0	32.2	32.6	35.0	37.6	37.6		31.2	32.6	34.6	30.0	34.0	36.4	38.2	39.8	40.5	41.2	42.6	42.6	
792	36.3	33.2	34.0	35.0	36.4	40.0	38.8		33.4	35.0	36.0	31.0	34.4	37.4	40.2	41.8	42.6	43.2	45.8	44.2	
793	36.3	34.8	34.4	35.0	38.8	41.2	44.8		38.0	38.0	38.4	33.2	37.8	41.6	43.0	45.0	45.4	41.0	45.8	43.0	
794	37.3	34.4	35.6	35.8	38.2	41.0	42.6		36.6	37.8	38.0	34.6	38.2	42.8	44.2	46.8	48.6	49.4	50.8	49.2	
795	38.6	36.4	37.2	37.4	39.8	43.1	44.8		38.8	39.8	40.2	33.8	38.6	43.0	44.0	47.0	48.6	49.0	51.2	48.6	
796	39.5	35.4	36.0	37.2	38.0	40.8	43.6		35.8	36.6	37.4	30.8	36.2	40.4	41.0	44.0	45.4	46.0	48.0	46.0	
797	40.0	36.6	38.0	39.6	41.2	44.4	47.4		39.4												
650														29.0	31.8	32.4	33.6	34.9	36.4	37.2	
Mean	35.3	32.5	33.2	33.8	35.9	38.7	40.2		34.0	34.6	35.6	30.5	35.1	38.1	39.8	41.9	42.8	43.3	45.1	43.5	
Count	16	16	16	16	16	16	16		16	15	15	15	15	16	16	16	16	16	15	16	
Eartag	**Pdk 7**	**Mob 5**																			
750	31.4	28.0		23.6	26.8	28.0															
751	31.7	31.2	29.2	30.0	33.2	35.0	36.4		30.6	30.4	32.0	28.4	32.4	36.2	37.0	38.8	39.6	40.6	41.4	41.8	
752	32.7	24.0	25.6	26.6	29.6	31.6	32.8		28.2	29.6	30.2	26.4	27.8	31.2	32.8	34.4	35.2	36.2	36.4	37.4	
753	33.2	31.6	31.2	32.4	34.6	37.2	37.8		32.2	33.4	34.0	30.0	35.0	39.4	41.2	43.2	41.4	44.6	43.0	44.4	
754	33.2	31.6	25.0	27.2	30.2	33.2	35.2		31.5	32.6	32.8	27.6	33.0	34.2	34.6	35.6	36.8	38.0	39.8	39.8	
755	34.1	33.0	26.2	28.8	31.4	34.0	36.0		32.6	33.2	33.6	29.0	33.0	36.0	37.8	39.6	39.8	41.6	41.9	41.8	
756	34.1	32.8	29.2	30.2	33.8	36.2	35.8		35.0	35.4	35.2	30.4	35.0	37.4	39.6	41.0	42.0	42.6	43.2	43.6	
757	34.1	33.0	32.8	34.8	37.2	40.0	42.0		35.6	35.6	34.4	30.2		41.4	43.6	45.2	46.2	48.8	49.8	49.4	
758	34.5	28.2	30.8	32.8	35.4	38.6	40.6		37.0	38.2	38.0	33.6	34.0	42.8	44.8	46.0	47.0	49.0	48.2	49.2	
759	35.5	33.8		29.2	32.4	35.0	38.8		33.4												
760	36.3	34.2	33.8	34.8	35.8	37.2	38.0		34.0	33.6	34.4	31.2	31.6	38.4							
761	36.3	35.8	36.4	35.8	38.8	41.2	42.2		36.8	37.2	37.2	32.4	38.4	40.6	42.6	44.6	44.9	46.8	46.4	47.0	
762	37.3	34.0	32.8	32.8	35.4	36.8	33.4		29.2	29.2	27.2	25.2	30.4	35.2	37.0	36.2			44.2		
763	38.6	37.6	34.8	35.4	37.6	40.0	40.8		35.0					38.4	40.2	40.2	41.8	43.0	43.6	44.0	
764	39.5	31.2	28.2	30.4	34.6	35.8	37.2		32.0	33.0	31.4	28.6	31.6	36.4	37.8	37.0	36.8	38.2	34.2	39.8	
765	40.0	36.8	33.6	34.8	36.4	37.8	40.2		33.6	33.8	35.4	31.6	34.4								
687												27.2	29.7	34.0	34.8	37.0	36.8	38.0	38.0	38.2	
652														35.8	38.8	39.8	40.6	41.4	41.4	41.8	
Mean	35.2	32.3	30.7	31.2	34.0	36.1	37.8		33.1	33.5	33.5	29.4	32.8	37.2	38.8	39.9	40.7	42.2	42.3	42.9	
Count	16	16	14	16	16	16	15		15	13	13	14	13	15	14	14	13	13	14	13	
Eartag	**Pdk 2**	**Mob 5**																			
701	31.4	28.6	30.0	30.2	32.4	34.2	32.6		26.4	25.6	24.0	19.6	18.8	30.6	36.0	39.4	42.0	44.0	45.8	44.6	
702	31.7	28.6	29.6	30.8	30.6	30.6	28.8		23.2	22.0											

Date	8.2.72	2.3.72	13.4.72	27.4.72	2.6.72	22.6.72	19.7.72	8.8.72	31.8.72	28.9.72	27.10.72	5.12.72	21.12.72	28.2.73	13.4.73	10.5.73	6.6.73	4.7.73	2.8.73	29.8.73	30.8.73
Rainfall		0	168.2	0	37.2	0	0	shorn	1	0	1.7	114.3	26.5	233.7	54.9	53	15.1	2.1	19	4.3	shorn
703	32.7	27.0	27.2	26.4	29.6	32.2	31.0		25.2	24.2	23.8	15.2	22.6	30.8	35.6	37.8	40.0	41.8	43.2	41.4	
704	33.2	31.0	32.8	33.0	34.2	36.2	32.8		26.5	25.4	24.0	21.8	27.6	33.4	36.0	39.2	41.4	44.6	44.4	42.6	
705	33.2	30.4	29.8	30.4	31.4	32.8	30.0		22.4	22.0	20.6	18.0	23.8	31.0	36.8	38.2	40.2	42.2	41.2	39.2	
706	34.1	33.0	33.2	33.2	35.4	36.6	35.4		28.8	27.0	26.2	21.2	25.6	36.6	41.0	43.0	45.0	48.0	49.2	47.2	
707	34.1	30.6	31.6	31.8	31.8	33.4	30.2		23.2	21.4	21.0	19.0	24.6	32.6	36.0	37.2	38.5	40.4	40.4	39.4	
708	34.1		31.8	32.0	32.8	32.8	30.0		24.2	23.0	21.0										
709	35.5	33.2	33.2	34.0	34.6	35.2	32.6		23.5	23.4	21.6										
710	36.3	34.2	34.8	34.8	35.8	36.2	32.8		25.0	23.4	21.8	18.8	17.0	26.4	31.2	36.0	38.0	40.0	39.8	39.0	
711	36.3	33.8	35.2	37.4	36.6	37.4	35.6		29.6	27.4	26.2	20.6	26.4	37.8	45.0	48.2	50.2	51.2	53.0	51.4	
712	37.3	33.0	33.6	33.8	36.4	37.2	36.2		30.0	28.2	26.0	20.4	27.6	35.2	41.0	42.8	45.4	48.0	48.6	47.4	
713	40.5	36.8	35.2	35.2	37.4	39.2	36.8		29.5	27.8	28.0	23.4	26.8	36.0	40.2	43.2	43.2	46.2	45.8	45.4	
714	39.1	36.6	36.6	35.4	37.6	38.2	35.2		27.8	26.8	25.8	22.2									
716	40.0	37.0	36.8	37.0	38.6	41.0	38.4		31.8	29.6	29.0	24.0	29.2	36.6	41.0	43.0	44.5	48.0	48.6	47.2	
717	34.5	33.8	33.8	34.4	36.2	37.8	35.8		29.0	27.8	25.4										
690												28.6	34.6	36.8	39.8	40.0	44.4	46.8	47.8	46.2	
653															38.0	38.2	41.0	42.2	42.2	40.8	
689												28.6	34.6	38.8	39.2	39.2	42.8	44.2	45.6	43.8	
654															33.2	30.4	32.8	39.2	35.2	34.6	
651												19.6	21.8	26.4	31.2	36.0	38.0	40.0	39.8	39.0	
Mean	35.3	32.5	32.8	33.1	34.5	35.7	33.4		26.6	25.3	24.3	21.4	25.8	33.5	37.6	39.5	41.7	44.2	44.4	43.1	
Count	16	15	16	16	16	16	16		16	16	15	15	14	14	16	16	16	16	16	16	
Eartag	**Pdk 8**	**Mob 5**																			
734	31.7	29.6	27.6	28.6	31.2	34.0	32.4		29.0	27.8	29.0	22.0	27.4	32.2	34.2	37.0	37.5	39.0	41.2	40.4	
735	31.7	30.2	28.0	28.6	30.4	32.0	31.8		26.4	25.2	25.8	20.6	23.4	31.2	32.0	33.8	33.5	35.2	35.8	34.6	
736	32.7	31.8	33.0	33.4	35.6	37.8	37.2		31.2	29.8	29.0	22.8	28.2	34.8	36.8	39.6	40.6	42.6	44.2	43.2	
737	33.2	30.4	27.4	28.8	31.0	33.8	32.4		25.2	25.4	23.6	20.2	18.4	29.4	32.6	35.0	35.4	37.8	37.8	35.6	
738	33.2	31.4	27.8	28.4	32.6	33.2	32.8		27.0	25.6	24.6	19.8	15.8								
739	34.1	31.4	30.4	30.8	34.8	35.8	36.8														
740	34.1	33.4	31.2	32.8	36.8	40.8	40.4		33.6	32.4	31.4	25.4	28.2	40.2	44.8	48.2	50.0	51.4	53.0	51.4	
741	34.1	29.2	28.8	29.8	32.4	34.6	35.2		29.6	28.4	29.0	22.4	23.8	34.0	35.8	38.2	38.5	41.0	41.6	40.4	
742	34.5	32.4	30.0	31.0	34.2	37.0	37.2		32.4	31.2	31.0	25.0	29.0	34.2	38.8	41.4	42.8	44.8	45.2	44.4	
743	35.5	32.6	32.2	32.0	33.2	36.2	35.6		30.2	29.6	28.2	21.4	26.4	32.8	36.0	38.0	35.8	39.8	41.0	40.2	
744	36.3	35.6	33.6	35.0	37.6	38.8	39.6		33.4	31.6	32.0	25.8	31.0	35.4	38.0	41.0	42.0	43.8	44.4	43.2	
745	36.7	37.4	35.8	36.0	38.2	40.6	40.2		34.8	33.4	32.8	25.8	32.4	38.4	40.4	43.0	44.0	45.8	46.6	45.2	
746	37.3	36.2	36.4	36.8	38.4	40.6	40.8		33.4	32.6	30.6	24.6	24.8	35.0	38.2	42.0	44.2	46.0	46.4	43.0	
747	38.2	36.8	36.8	37.8	37.8	41.8	40.8		34.4	32.6	32.4	26.2	32.8	41.2		44.6	45.4	46.6	47.8	45.6	
748	39.1	37.8	37.0	37.4	40.2	44.0	42.4		35.8	34.8	35.0	27.2	24.8								
749	40.0	37.8	34.4	36.2	39.2	41.8	42.4														
665															34.8	35.0	34.2	35.8	38.0	37.2	
688												20.8	21.8	28.6	30.8	32.6	33.4	35.2	38.2	36.0	
778									37.2	36.2	32.0	28.0	33.4	38.6	42.8	45.4	46.6	48.0	48.0	45.0	
672															36.2	37.8	37.4	38.6	39.2	32.6	
Mean	35.2	33.4	31.9	32.7	35.2	37.7	37.4		31.6	30.4	29.8	23.6	26.4	34.7	36.8	39.5	40.1	42.0	43.0	41.1	
Count	16	16	16	16	16	16	16		15	15	15	16	16	14	15	16	16	16	16	16	
Eartag	**Pdk 3**	**Mob 5**																			
718	31.7	31.0	30.2	30.4	31.8	34.4	37.6		34.6	34.8	35.4	30.6	31.6	38.6	41.0	42.8	44.0	46.0	45.8	45.2	
719	31.7	30.6	30.6	30.8	33.8	35.2	37.0		31.4	31.4	32.2	28.2	30.6	36.0	38.6	40.6			45.6	44.4	
720	32.7	30.2	30.4	30.6	33.4	36.0	38.2		32.2	32.4	33.8	25.6	31.2								

Date	8.2.72	2.3.72	13.4.72	27.4.72	2.6.72	22.6.72	19.7.72	8.8.72	31.8.72	28.9.72	27.10.72	5.12.72	21.12.72	28.2.73	13.4.73	10.5.73	6.6.73	4.7.73	2.8.73	29.8.73	30.8.73
Rainfall		0	168.2	0	37.2	0	0	shorn	1	0	1.7	114.3	26.5	233.7	54.9	53	15.1	2.1	19	4.3	shorn
721	33.2	35.0																			
722	33.2	31.8	31.6	30.8	35.0	37.0	39.6		34.0	34.6	35.4	30.2	32.0								
723	34.1	30.2	29.6	27.8	31.0	32.6	34.2		29.6	28.6	26.8	23.4	26.8	29.8	33.4	35.2	36.0	37.6	37.4	37.0	
724	34.1	31.0	33.0	32.6	35.8	37.2	38.8		32.4	33.2	33.8	28.6	27.4								
725	34.1	30.6	31.6	30.4	32.8	35.0	36.8		29.8	31.0	31.0	26.2	27.6	32.8	35.4	37.4	36.0	39.8	40.4	39.4	
726	34.5	32.6	33.0	32.8	36.6	37.8	39.4		34.6	34.8	36.2	29.6	25.0								
727	35.5	31.6	35.2	35.2	37.6	39.0	40.8		37.0	36.2	36.8	31.6	30.2								
728	36.3	26.2	30.8	32.0	33.8	35.2	36.4		31.4	29.6	30.0	26.8	25.6	33.2	36.8	39.2			42.8	41.4	
729	36.3	30.2		32.4	36.4	38.4	40.6		32.8	33.2	34.4	29.6	33.6								
730	37.3	35.4	32.2	32.4	36.2	37.2	39.8		34.8	34.6	36.4	28.6	34.8	37.0	40.8	43.0			46.2	44.8	
731	38.6	35.0	35.0	34.4	37.4	40.2	44.0		34.8	36.2	35.8	30.8	30.4	37.6	40.8	43.0	43.2	45.6	46.6	45.4	
732	39.1	39.6	37.4	38.2	43.8	47.6	48.6		36.4	39.8	42.0	32.4	32.2								
733	40.0	39.4	38.4	38.2	41.0	43.0	44.3		37.2	38.0	39.2	35.0	37.6				41.0	42.0	49.0	47.6	
695					36.2	39.8	41.8		37.2	36.0	37.4	30.2	36.6	41.4	43.8	46.8	38.0	45.4	47.6	46.8	
655															35.0	36.6	36.2	39.0			
656															35.8	36.2	35.6	38.8	39.8	37.2	
664															38.8	40.8	41.4	43.2	47.0	46.4	
661															35.6	36.2	36.5	38.2	40.2	39.3	
657															39.0				44.2	42.6	
658															34.2	36.2					
659															39.8	41.8	41.8	44.4	45.8	43.6	
Mean	35.2	32.5	32.8	32.6	35.8	37.9	39.9		33.8	34.0	34.8	29.2	30.8	35.8	37.9	39.7	39.1	41.8	44.2	42.9	
Count	16	16	14	15	16	16	16		16	16	16	16	16	8	15	14	11	11	14	14	
Eartag	**Pdk 5**	**Mob 5**																			
766	31.7	30.2	28.4	30.4	32.4	35.4	37.8		31.8	31.6	32.4	28.0	31.2	36.0	38.0	40.2	40.8	42.8	43.4	42.6	
767	31.7	30.4	28.2	30.0	33.2	35.4	36.4		31.2	32.6	33.2	27.8	32.2	36.0	38.0	39.8	39.8	40.0			
768	32.7	29.8	27.6	29.0	31.0	32.4	33.6		29.0	30.4	31.0	26.2	30.2	34.6	36.2	38.2	37.5	38.6	39.6	37.2	
769	33.2	33.2	28.8	29.8	33.0	36.8	37.2		32.4	33.6	33.8	28.6	32.4	37.2	39.8	41.0	42.5	43.2	43.2	41.8	
770	33.6	33.6	28.8	30.8	29.2																
771	34.1	32.6	29.2	30.2	33.2	35.8	37.4		31.4	31.8	33.4	29.0	27.6	33.6	36.0	38.0	38.0	39.8	40.6	39.0	
772	34.1	33.4		32.2	34.6	37.4	37.6		31.5	32.6	33.8	28.4	33.4	37.6	38.6	41.2	41.4	41.0	42.6	41.2	
773	34.5	32.8																			
774	34.5	34.8	30.6	32.6	35.8	39.0	40.2		35.8	37.2	38.6	32.6	33.2	41.4	43.2	45.4	46.0	47.0	48.2	47.4	
775	35.5	36.6	34.8	36.0	40.2	43.0	45.0		38.2	40.2	40.2	32.2	38.0	43.4	44.8	47.0	48.8	49.6	50.2	50.4	
776	36.3	36.4	31.0	31.4	34.8	34.8	37.8		33.0	34.2	34.4	30.4	27.8	37.2	41.0	42.8	43.0	44.0	44.8	43.0	
777	36.3	35.4	30.8	32.4	35.2	37.4	37.6		32.0	32.0	33.6	27.6	29.2	37.2	40.0	43.6	43.0	43.6	42.8	42.8	
778	37.3	35.6	29.0	30.4	34.6	37.8	39.4		35.2	35.8	36.2	30.4	31.6	39.6	42.8	43.2	44.4	45.4	47.0	45.4	
779	39.1	37.0	34.4	36.0	38.8	41.6	42.4		37.0	37.6	38.0	31.0	34.2	39.6	42.4	43.8	44.5	45.2	47.4	45.8	
780	38.6	36.4	32.0	33.4	37.2	39.8	40.6		36.0	37.2	35.8	29.2	33.8	39.8	44.8	47.0	48.0	50.2	49.8	48.6	
781	40.0	39.8	35.8	37.0	38.8	42.2	44.0		37.5			28.2	33.4								
692						42.0	42.4		36.5	37.4	39.0	32.4	37.2								
693					31.2	32.8	33.4		29.4	29.8	31.0	25.2	30.4	36.4	38.6	40.2	40.2	41.8	40.4	40.4	
663														42.6	46.2	48.0	49.0	50.2	50.8	50.6	
662														40.2	44.0	44.0	44.8	47.2	47.4	47.8	
Mean	35.2	34.3	30.7	32.1	34.6	37.7	38.9		33.6	34.3	35.0	29.2	32.2	38.3	40.9	42.7	43.2	44.4	45.2	44.3	
Count	16	16	14	15	16	16	16	0	16	15	15	16	16	16	16	16	16	16	15	15	
Eartag	**Pdk 4**	**Mob 5**																			

Date	8.2.72	2.3.72	13.4.72	27.4.72	2.6.72	22.6.72	19.7.72	8.8.72	31.8.72	28.9.72	27.10.72	5.12.72	21.12.72	28.2.73	13.4.73	10.5.73	6.6.73	4.7.73	2.8.73	29.8.73	30.8.73
Rainfall		0	168.2	0	37.2	0	0	shorn	1	0	1.7	114.3	26.5	233.7	54.9	53	15.1	2.1	19	4.3	shorn
798	36.8	34.4	34.4	34.2	38.5	41.8	44.2														
799	35.0	28.2	27.8	27.8	28.0	30.8	39.2			29.6	29.2	25.6	26.8		35.8	37.2	37.8	39.0	40.2	39.4	
800	36.8																				
697	38.6	32.6	34.2	34.2	36.6	38.0	32.6														
700										34.2	34.0	29.6	30.2		38.0	40.0	40.6	42.2	43.6	42.8	
801										30.4	30.2	32.4	33.4		46.2	47.6	48.0	49.0	51.0	50.4	
477										26.6	26.8	24.4	25.6		34.4	37.0	38.5	40.0	41.4	42.5	
Mean	36.8	31.7	32.1	32.1	34.4	36.9	38.7			30.2	30.1	28.0	29.0		38.6	40.5	41.2	42.6	44.1	43.8	
Count	4	3	3	3	3	3	3		0	4	4	4	4		4	4	4	4	4	4	
Eartag	**Pdk 6**	**Mob 5**																			
715	36.8		34.6	36.2	38.8	32.8	32.0		29.2	29.8	30.8	24.8	28.2		38.3	40.8	41.6	43.8		45.8	
700	36.8		28.4	29.8	34.2	36.2	37.4														
699	33.2		26.2	27.4	30.8	33.0	35.2		30.6	31.8	32.0	25.4	28.8		36.2	37.2	38.8	40.4	42.2	43.6	
698	39.5		31.2	34.2	36.8	39.2	40.4		36.2	37.8	39.2	31.0	37.4		48.1	50.2	51.6	54.8	54.8	54.8	
694									32.8	33.4	34.2	28.2	32.2		39.8	41.6	41.4	42.0	42.2	40.5	
Mean	36.6		30.1	31.9	35.2	35.3	36.3		32.2	33.2	34.1	27.4	31.7		40.6	42.5	43.4	45.3	46.4	46.2	
Count	4	0	4	4	4	4	4		4	4	4	4	4		4	4	4	4	3	4	

Appendix 5.6 - Individual sheep liveweights (kg) for all mob 5 wethers continued (1973 – 1977) on all weighing occasions after 1973 shearing, listed within each paddock

Rainfall (mm) between weighings is also shown, as are shearing dates

Date	30.8.73	5.10.73	14.11.73	7.12.73	15.2.74	4.4.74	14.6.74	7.8.74	12.8.74	16.10.74	13.12.74	6.2.75	28.5.75	22.7.75	22.8.75	10.9.75	14.11.75	16.1.76	30.3.76	2.7.76	24.8.76	18.9.76	23.8.77	23.8.77
Rainfall	shorn	73.2	26.2	63.6	348.2	16.9	53.3	0.4	shorn	69.9	69.5	68.4	116.3	34.9	shorn	19	19	220.2	26	28.2	18.2	shorn	616.2	shorn
Eartag	**Pdk 1**	**Mob 5**																						
782		39.2	42.4	44.4		32.6	45.0	43.8																
783		34.4	37.2	39.0	42.6	44.0	48.0	48.0		38.2	44.2	48.2	49.8	47.8		41.8	45.4	44.0	46.8	50.0	48.6		44.8	
784		39.6	45.2	45.6	47.6	50.4	55.4	54.4		40.0	52.8	56.2	56.8	54.4		47.8	52.2	52.0	54.0	57.8	53.6		51.8	
785		37.2	41.2	42.2																				
786		35.6	39.2	41.4	41.8	44.8	48.2	48.8		42.0	47.6	50.6	51.8	49.8		43.0	47.6	47.8	48.8	50.4	48.6		44.2	
787		36.4	42.0	42.4	45.0	48.6	50.2	49.6		44.2	51.0	53.8	54.6	51.8		44.4	47.8	50.0	52.0	52.2	47.0		42.0	
788		32.4	36.2	37.2	40.6	40.8	42.4	41.8		36.0	40.2	43.6	44.2	42.8		37.4	40.8	42.0	44.0	45.4	44.0		44.2	
789		39.2	41.8	43.8																				
790		37.8	41.6	43.6	47.2	51.0	54.2	50.2		45.0	50.4	54.0	57.0	51.4		45.0	48.8	50.8	54.8	55.6	53.6		51.8	
791		35.1	39.0	40.2	42.2	43.8	47.0	45.6		41.0	43.0	47.0	48.6	46.4		40.4	45.8	46.2	47.4	49.8	45.8		48.4	
792		38.0	41.4	42.8	45.6	48.6	52.0	46.8		43.0	48.6	51.0	51.6	50.0		44.0	49.2	44.2	49.2	52.8	50.8		47.8	
793		38.6	43.6	44.2	46.6	48.8	53.0	50.8		46.0	50.0	52.8	55.8	54.6		47.2	50.8	51.2	53.6	55.0	51.0		51.8	
794		43.4	48.2	49.2	51.4	51.4	57.2	54.8		49.4	54.0	56.4	57.6	55.0		49.2	52.4	53.6	55.2	57.0	53.0		51.6	
795		42.0	46.4	47.6	51.4	50.4	54.8	53.4		48.4	52.4	57.4	58.0	54.2		47.2	52.0	53.0	56.0	57.2	52.4		47.6	
796		38.0	40.4	43.4	47.4	49.2	52.6	51.8		44.6	49.2	52.6	53.4	51.2		45.2	50.2	50.6	52.6	55.2	53.8		52.0	
797																								
650		30.8	34.6	34.6	38.6	40.8	45.0	43.0		39.8	45.0	47.0	48.0	46.8		40.2	44.8	46.0	48.2	49.4	46.4		46.4	
722										39.0	44.8	47.2	49.8			38.2	44.2	44.4	47.4	49.2	46.2		47.6	
723										37.0	43.8	47.8	53.2	50.4		45.2	48.8	49.8	54.4	58.4	54.6		56.8	
988																	35.4	39.4	43.6	49.0	46.8		51.6	
Mean		37.4	41.3	42.6	45.2	46.1	50.4	48.8		42.2	47.8	51.0	52.7	50.5		43.7	47.3	47.8	50.5	52.8	49.8		48.8	
Count		16	16	16	13	14	14	14		15	15	15	15	14		15	16	16	16	16	16		16	
Eartag	**Pdk 7**	**Mob 5**																						
750																								
751		35.8	39.4	40.2	45.0	49.2	49.6	53.0																
752		32.4	36.4	36.4	42.8	45.2	45.2	48.2		42.0	45.2	48.4	49.6	48.8		42.4	45.2	46.0	47.4	48.0	46.2		40.0	
753		38.2	41.8	43.4	48.6	51.2	51.2	54.8		45.8	51.0	55.4	57.2	54.8		48.6	51.8	51.8	51.2	54.4	55.0			
754		32.4	35.6	37.8	35.2	36.2	39.8	43.6		40.0	46.0	47.4	48.8	46.8				45.0	46.6	47.6	43.2		40.4	
755		35.2	39.6	39.6	39.4	39.0		45.4																
756		37.8	42.4	43.4	46.0	48.0	49.8	51.8		44.2	48.6	50.8	52.6	51.0		46.8		48.4	49.2	50.2	47.6		45.2	
757		42.8	47.6	48.8	55.0	58.4	56.6	61.6		50.6	58.4	62.8	63.4	60.2		52.8		58.6	54.8	59.0	54.0			
758		42.0	45.6	47.2	52.8	53.6	54.8	57.2			52.4	56.8	58.2	56.8		51.2	56.4	55.8	56.8	48.2	55.2		50.4	
761		39.8	44.4	45.0	49.8	51.6	51.6	54.6		47.0	50.2	53.2	56.4	53.8		49.0	52.2	51.0	54.8	56.4	55.6		51.0	
763		37.6	41.0	42.8	48.2	48.6	51.0	52.6		45.8	49.8	51.8	53.8	51.2		47.4	51.0	49.8	49.8	49.0	50.4		44.4	
764		34.0	37.4	38.4	43.6	46.4	46.4	49.0		42.2	46.0	49.8	49.6	46.6		41.0	45.8	44.8	45.2	46.4	38.4			
687		33.2	37.6	38.4	40.8	44.0	44.4	46.6			43.6	47.2	47.2	44.4		40.4	45.0	44.4	45.2	45.2	45.6		46.2	
652		36.0	40.2	40.6	44.6	47.6	49.0	51.6			49.0	53.0	54.8	52.6		46.8	51.4	52.4	54.0	55.4	54.8		51.0	
644		37.2	39.2	41.2																				
646		42.2	45.4			49.0		54.2		48.0	53.4													
645		38.4			43.2	49.2	49.8	54.0		45.4	51.4		56.0	51.8										
703										42.4	47.2	51.4	56.0	52.4		46.8	51.6	50.1	52.2	54.2	54.2			
708											42.4	46.4	48.2	45.6		39.8	44.2	45.6	46.0	47.2	47.8		44.6	
750																46.8	50.0	52.2	54.2	55.8	54.0		51.0	
990																	36.6	40.4	43.4	46.0	45.4		51.4	
991																	35.8	40.6						

Date	30.8.73	5.10.73	14.11.73	7.12.73	15.2.74	4.4.74	14.6.74	7.8.74	12.8.74	16.10.74	13.12.74	6.2.75	28.5.75	22.7.75	22.8.75	10.9.75	14.11.75	16.1.76	30.3.76	2.7.76	24.8.76	18.9.76	23.8.77	23.8.77
Rainfall	shorn	73.2	26.2	63.6	348.2	16.9	53.3	0.4	shorn	69.9	69.5	68.4	116.3	34.9	shorn	19	19	220.2	26	28.2	18.2	shorn	616.2	shorn
992																				37.4	38.0		40.4	
Mean		37.2	40.9	41.7	45.4	47.8	49.2	51.9		44.9	49.0	51.9	53.7	51.2		46.1	47.5	48.6	50.1	50.0	49.1		46.3	
Count		16	15	14	14	15	13	15		11	15	13	14	14		13	13	16	15	16	16		12	
Eartag	**Pdk 2**	**Mob 5**																						
701		36.8	39.8	41.6	46.4	46.8	52.8	52.4		46.6	53.0	55.4	59.2	56.4		49.0	45.4	47.2	52.8	55.6	52.4			
703		34.2	35.8	34.4																				
704		34.4	37.2	36.8	43.4	47.2	50.8	50.0		45.6	49.6	53.8	56.6	54.4		46.8	44.0	44.8	49.4	55.2	51.6		53.6	
705		31.6	33.8	36.2	42.2	44.2	49.2	47.2		40.0	44.6	49.0	52.8	49.8		42.5	36.2	39.4	46.2	48.8	42.8		43.4	
706		38.4	41.6	41.8	49.8	54.0	56.0	56.0		48.0	55.4	59.8	63.0	60.8		53.2	52.0	54.0	57.8	61.8	59.4			
707		31.2	33.0	34.4																				
710		32.2	34.2	35.2																				
711		42.8	44.4	45.8	52.8	57.4	62.2	62.8		53.6	62.0	65.8	60.8	66.0		58.4	55.4	58.2	63.0	66.0	63.2		62.4	
712		39.4	41.2	41.4		49.8	53.6	52.8																
713		37.8	40.6	41.0	47.4	48.6	52.0	50.6		44.8	50.2	53.6	56.8	55.4		49.2	47.4	49.2	54.4	56.8	54.2		55.2	
714										33.2	39.4	43.0	48.2	45.8		40.0	49.8	40.4	44.6	48.2	47.2		47.8	
716		38.2	40.6	40.2	47.8	51.6	55.0	53.0		47.0	52.6	56.2	58.0	55.6		49.8	49.2	48.4	52.0	54.4	51.8		53.6	
690		36.8	39.6	40.6	46.6	49.6	52.0	52.8		47.2	52.4	53.0	59.2	56.4		49.6	48.2	48.8	52.4	58.0	56.2			
653		33.8	33.8	36.6	43.4	46.2	51.6	51.0		49.2	53.0	55.8	63.0	58.8		50.2	46.0	50.2	57.2	62.2	58.8			
689		35.9	37.2	37.8	45.0	48.9	52.2	50.0		43.4	40.0	52.6	57.4	53.4		47.8	43.0	44.6	49.6	53.8	51.4		54.0	
654		27.6	30.6	31.4																				
651		36.4	38.2	40.2	48.2	52.2	56.4	53.8		48.2	54.4	59.0	62.1	59.2		50.4	47.4	50.6	58.8	60.0	55.2		58.0	
993										46.4	51.8	53.2	57.6	56.6		50.6	59.8	49.0	54.0	57.4	55.4		57.4	
747										46.4	53.2	55.4	59.3	57.2		50.4	47.6	50.0	55.0	58.0	55.8		56.4	
715										37.6	42.6	46.0	49.6	49.8		42.4	39.6	41.0	44.0	48.0	46.2			
994																	47.8	46.6	51.8	54.2	51.0		53.2	
Mean		35.5	37.6	38.5	46.6	49.7	53.7	52.7		45.1	50.3	54.1	57.6	55.7		48.7	47.4	47.7	52.7	56.2	53.3		54.1	
Count		16	16	16	11	12	12	12		15	15	15	15	15		15	16	16	16	16	16		11	
Eartag	**Pdk 8**	**Mob 5**																						
734		32.6	35.2	36.6	42.2	44.8	48.0	50.2		42.4	47.2	50.8	52.4	51.2		43.4	45.6	42.8	47.8	51.2	48.8		51.8	
735		28.2	31.2	32.6	37.4	39.2	42.4	43.0		36.0	41.4	44.6	45.4	43.0		37.2	37.2	36.0	42.2	43.2	39.2		41.8	
736		35.0	37.6	39.2	45.0	47.8	49.8	51.6		42.8	47.2	50.0	52.2	50.8		44.2	45.2	45.4	50.6	52.8	47.2			
737		30.0	32.0	34.0	39.0	42.8	43.2	45.2		38.2	42.0	45.6	46.4	44.2		38.2	37.6	40.0	44.4	45.0	40.0		41.8	
740		41.8	46.6	46.2	54.4	56.2	61.0	63.4		50.6	59.4	60.4	62.4	58.8		52.4	52.6	52.6	59.4	61.6	60.8			
741		32.1	33.8	36.2																				
742		37.6	40.4	42.0																				
743		32.2	34.8	35.6	42.0	45.4	46.8	48.4		39.0	45.7	49.0	48.8	46.8		41.2	44.4	42.8	46.8	48.0	46.6			
745		35.8	38.6	40.0	48.0	51.4	53.6	57.0		46.2	51.2	56.8	60.8	57.0		50.6	50.6	49.2	55.6	57.6	54.2		53.6	
746		34.8	39.2	40.0	46.8	47.8	52.0	54.4		44.0	51.0	53.0	52.8	48.8		41.8	45.0	44.4	51.2	48.8	46.8		45.2	
747		37.4	39.8	42.2																				
748		39.4	43.6	44.0	50.2	53.6	57.0	59.2		51.0	56.0	58.2	60.4	57.8		51.6	51.6	52.2	55.8	58.6	53.8		56.2	
665		29.8	32.4	33.8	41.6																			
688		28.6	31.2	31.2	38.8	41.6	43.6	45.8		35.6	42.0		47.2	45.6										
672		27.8	30.6	32.4																				
670		35.2	37.6	38.2																				
710										31.0	39.0	43.6	43.2	37.2		36.4	40.2	39.8	45.8	51.0	48.2			
711										42.0	47.4	51.8	55.8	53.4		47.0	46.6	46.8	51.2	54.6	51.4		47.8	
709										31.8	38.0	40.2	40.8	37.0		32.4	33.8	34.6	38.6	40.2	35.2		37.0	
721										45.0	51.8	55.4	57.8	55.4		48.2	49.4	49.2	55.2	59.0	53.4		52.2	

Date	30.8.73	5.10.73	14.11.73	7.12.73	15.2.74	4.4.74	14.6.74	7.8.74	12.8.74	16.10.74	13.12.74	6.2.75	28.5.75	22.7.75	22.8.75	10.9.75	14.11.75	16.1.76	30.3.76	2.7.76	24.8.76	18.9.76	23.8.77	23.8.77
Rainfall	shorn	73.2	26.2	63.6	348.2	16.9	53.3	0.4	shorn	69.9	69.5	68.4	116.3	34.9	shorn	19	19	220.2	26	28.2	18.2	shorn	616.2	shorn
712										31.0	38.6	41.8	43.9	43.6		37.2	40.2	41.4	47.2	49.6	45.2		48.4	
989																38.4	41.4	40.2	45.0	48.8	45.4		42.8	
Mean		33.6	36.5	37.8	44.1	47.1	49.7	51.8		40.4	46.5	50.1	51.4	48.7		42.7	44.1	43.8	49.1	51.3	47.7		47.1	
Count		16	16	16	11	10	10	10		15	15	14	15	15		15	15	15	15	15	15		11	
Eartag	Pdk 3	Mob 5																						
718		38.8	44.0	45.0	49.8	51.6	55.0	55.4		30.0	34.4		59.0	57.0		51.8	53.4	52.8	54.4	57.2	52.4			
719		38.2	41.6	42.2	44.8	47.4	53.4	50.0																
723		31.2	35.2	35.4	39.0	40.6	42.8	41.8		35.6	37.8		43.8	41.4		37.6	38.2	39.4	42.4	43.2	38.8			
725		31.5	36.4	36.8	40.8	44.0	47.2	44.0								37.2	40.4	42.0	47.0	46.2	42.8			
728		36.8	37.4	39.6	46.4	46.6	54.2	47.6			48.6	52.0	52.4	50.8		44.6	45.6	46.6	49.4	52.8	49.8		51.4	
730		39.8	44.2	44.2	49.0	50.2	53.8	51.8																
731		38.4	41.6	42.0	46.6																			
733		41.4	45.0	45.8	51.2	52.4	55.6	54.2		46.4	51.2	54.4	53.4	52.0		48.0	48.0	48.8	51.0	54.6	50.4			
695		40.8	47.2	48.4	55.8	49.6	60.8	62.4																
655		34.0	38.4	38.6	45.4	46.4	49.8	48.6									48.2	47.0	51.6	56.6	54.4			
656		33.4	35.6	37.0		42.0		39.6																
664		38.0	43.6	43.8	41.6		52.0	57.0								54.6	58.6	58.2	61.8	65.6	62.8		62.4	
661		32.6	35.8	37.2	42.8	46.0	49.6	46.2																
657		36.8	40.2	40.6																				
659		38.9	41.0	41.6																				
660		16.6	22.0	22.6	31.0		35.0	34.0																
477										46.0	51.0		58.1	57.2		52.2	53.8	51.8	57.0	61.0	58.4			
700										43.0	48.2	51.4	51.8	50.0		44.4	47.2	45.6	50.4	53.4	50.4			
799										37.0	42.4	45.4	44.8	44.6		39.0	41.6	41.2	45.0	47.0	42.4			
717										37.6	42.0		46.6	45.8		40.0	41.8	41.0	39.8	43.2	42.8			
600																	36.6	37.4	41.8	41.2	38.0			
694										41.8	45.4	48.2	49.2	46.4		41.6	39.8	43.6	48.4	46.8	43.6			
698										56.8	62.6		69.2	67.0		60.4	61.2	60.2	67.8	70.6	62.1			
699										42.6	47.4	49.8	50.0	51.2		47.2	49.2	45.2	49.6	53.6	51.2			
801											53.6		57.0	55.2		49.4	48.2	51.0	56.0	58.6	53.2		50.0	
Mean		35.5	39.3	40.1	44.9	47.0	50.8	48.7		41.7	47.1	50.2	52.9	51.6		46.3	47.0	47.0	50.8	53.2	49.6		54.6	
Count		16	16	16	13	11	12	13		10	11	6	11	11		13	15	15	15	15	15		4	
Eartag	Pdk 5	Mob 5																						
766		35.8	39.8	40.6	44.4	45.2	48.8	49.0																
768		30.8	35.8	37.4	43.0	41.8	46.6	45.6		40.0	45.0	47.2	48.2	45.8		39.0	42.2	45.0	47.4	49.0	47.2			
769		37.0	39.8	40.8	43.8	45.6	49.0	50.8		45.4	50.2	52.2	51.0	48.0		44.2	46.4	47.6	48.2	47.6	43.3		45.6	
771		32.2	36.0	37.8	41.8	41.8	43.8	46.0		40.0	43.0	47.0	46.6	46.2		40.0	43.6	44.4	45.2	45.6	43.0		44.6	
772		34.4	39.2	40.2	47.4	45.8	49.8	50.6		45.4	50.6	53.0	50.8	50.0		42.2	46.8	48.2	51.8	50.8	45.2			
774		40.4	46.0	46.8	53.4	52.2	57.8	57.2		51.0	56.4	59.6	60.1	59.6		52.0	54.2	55.6	58.0	59.2	56.0		58.2	
775		39.6	45.0	44.8	53.8	53.0	56.4	58.6		59.2	57.2	60.4	59.2	59.8		52.4	56.6	56.8	58.2	62.4	57.2		58.8	
776		37.2	41.6	43.2	46.4	46.0	52.2	52.0		46.0	49.6	54.8	54.6	51.0		45.4	47.8	50.8	52.0	52.2	49.8		47.2	
777		35.6	41.8	42.2	47.8	46.4	50.2	51.0		46.0	51.4	54.4	52.0	52.0		44.2	45.8	48.2	50.0	50.6	46.6			
778		37.6	42.0	43.0	48.8	49.4	52.0	54.8		47.6	53.0	55.0	53.2	54.6										
779		37.6	43.4	43.2																				
780		38.0	44.8	44.2	52.6	50.8	55.4	57.0		50.4	55.4	58.0	54.0	52.6		49.8	49.0	50.2	53.0	53.0	49.2			
693		34.4	38.6	40.2																				
663		42.6	46.0	47.3	49.8	50.4	55.4	56.8		48.0	53.4	55.2	57.0	54.6		47.2	50.0	51.4	53.8	57.2	52.4		53.0	
662		40.0	45.2	46.8	54.4	54.2	60.2	61.6		53.2	58.4	62.6	63.7	61.0		54.6	57.8	59.8	61.2	64.4	60.4		61.8	

Date	30.8.73	5.10.73	14.11.73	7.12.73	15.2.74	4.4.74	14.6.74	7.8.74	12.8.74	16.10.74	13.12.74	6.2.75	28.5.75	22.7.75	22.8.75	10.9.75	14.11.75	16.1.76	30.3.76	2.7.76	24.8.76	18.9.76	23.8.77	23.8.77
Rainfall	shorn	73.2	26.2	63.6	348.2	16.9	53.3	0.4	shorn	69.9	69.5	68.4	116.3	34.9	shorn	19	19	220.2	26	28.2	18.2	shorn	616.2	shorn
643		43.6	46.2	47.8	53.0		56.6	56.8		49.2	54.8	58.0	57.4	56.0		49.2	53.4	53.6	55.8	56.4	53.1		55.4	
719										44.0	49.0	51.4	53.2	52.4		43.0	45.8	48.2	50.0	50.2	47.2		48.2	
720										41.2	49.0	50.8	51.8	51.8			45.2	51.8	54.0	57.2	54.0		54.8	
755																32.2	34.2	35.6	38.4	40.2	39.4		43.2	
756																46.4	50.8	51.6	52.8	55.0	52.4		50.2	
Mean		37.3	42.0	42.9	48.6	47.9	52.4	53.4		47.1	51.8	54.6	54.2	53.0		45.5	48.1	49.9	51.9	53.2	49.8		51.8	
Count		16	16	16	14	13	14	14		15	15	15	15	15		15	16	16	16	16	16		12	
Eartag	**Pdk 4**	**Mob 5**																						
799		32.2	36.0	36.2	34.0	36.8	41.0	42.0																
700		35.6	39.2	40.2	44.8	46.6	50.4	51.0																
801		42.2	47.2	47.6	54.0	56.0	58.8	55.8																
477		34.8	40.6	39.6	44.0	47.6	52.6	52.8																
Mean		36.2	40.8	40.9	44.2	46.8	50.7	50.4																
Count		4	4	4	4	4	4	4																
Eartag	**Pdk 6**	**Mob 5**																						
699		35.0	39.4	40.8	43.2	46.4	46.8	47.0																
698		45.8	53.6	54.8	60.2	65.8	68.0	66.2																
694		35.0	40.2	42.0	44.4	46.6	48.0	46.2																
674		39.2	42.8	44.4																				
Mean		38.8	44.0	45.5	49.3	52.9	54.3	53.1																
Count		4	4	4	3	3	3	3																

Appendix 5.7 - Individual sheep liveweights (kg) for all mob 6 wethers (1977 – 1979) on all weighing occasions, listed within each paddock.

Rainfall (mm) between weighings is also shown, as are shearing dates

Date	25.11.77	24.1.78	7.3.78	4.5.78	22.6.78	9.8.78	4.10.78	16.10.78	23.11.78	4.1.79	15.2.79	24.4.79	6.6.79	8.8.79	9.8.79
Rainfall	17	64.1	13	22.4	71.1	136.7	82.1	shorn	49.2	69.3	71	73.2	14.1	37	shorn
Eartag	Pdk 1	Mob 6	ROTATIONAL GRAZING - 4 sub-pdks, each 8 ac												
1701	21.6	20.0	24.8	27.4	28.2	24.8	27.8		29.8	27.2	28.2	36.0	34.8	37.8	
1702	22.4	20.4	26.2	26.8	26.6	23.4	26.0		29.0	25.4	26.8	31.6	30.8	32.2	
1703	25.8	21.8	29.6	31.2	31.0	28.2	30.2		33.4	29.8	31.0	38.6	37.4	39.4	
1704	22.4	20.8	27.4	29.8	31.2		37.6		39.5	42.4	40.8	46.0	44.8	47.6	
1705	19.0	16.8	21.4	22.4	23.4	20.8	21.2		24.4	23.0	24.2	25.6	27.0	29.6	
1706	22.4	21.0	27.0	29.4	30.4	25.8	27.0		31.6	28.4	32.4	35.4	36.4	36.6	
1707	18.0	17.4	22.2	23.2	23.8	22.0	23.0		23.0	21.0	22.8	28.6	27.4	30.6	
1708 D	18.0	18.0	23.2	24.6	26.8	23.8	27.0		30.0	25.8	26.0	35.2	32.8	35.2	
1709	23.2	20.2	27.4	28.4	29.0	25.0	28.2		32.5	28.0	29.2	37.0	35.0	37.8	
1710	21.4	19.0	22.8	23.0	24.4	22.6									
1711	20.8	20.2	26.0	27.0	27.8	24.0	26.2		28.5	25.8	27.6	34.6	33.2	34.8	
1712	25.6	23.0	30.6	32.2	33.2	27.8	31.5		33.4	30.2	32.8	40.4	39.6	40.6	
1713	20.8	19.2	24.8	25.8	28.0	25.0	28.4		31.0	28.8	29.8	36.2	35.4	37.6	
1714	21.6	19.6	25.0	26.6	27.8	25.0	28.2		32.4	29.2	30.4	30.8	30.2	32.4	
1715	18.4	21.8													
1716 D	22.8	21.6	27.8	29.6	29.8	26.4	28.5		32.0	29.4	29.2	38.6	36.8	40.4	
1717	21.2	19.6	25.4	26.4	27.0	23.0									
1718	20.2	17.2	22.8	22.4	23.6	21.4									
1719	20.8	13.6	24.6	26.0	25.8	23.0	26.0		26.2	24.8	25.2	32.4	31.8	33.6	
1720	21.4	19.0	25.2	25.8	27.8	23.8	27.2		28.6	30.8	30.0	35.2	34.2	34.8	
1721	17.8	17.6	23.0	25.2	26.8	23.8	26.0		29.2	26.4	29.0	32.2	33.2	35.4	
1722	23.0	20.4	27.2	28.8	30.4	26.2	29.4		34.0	29.8	28.8	37.8	37.2	41.6	
1723	18.4	17.6	21.6	22.2	23.2	20.4	24.4		25.6	23.6	24.6	30.8	29.6	30.6	
1724 D	22.2	19.0	22.8	23.4	23.6	20.2	21.4								
1725	22.6	20.4	26.6	27.4	28.8	25.4	27.8		30.0	27.0	29.2	35.4	35.0	37.6	
1726	18.2	17.6	22.8	23.6	24.8	21.4	22.2		26.8						
1727	20.8	18.8	24.4	25.8	25.8	22.8	25.0		28.4	25.2	26.8	33.8	32.4	33.2	
1728	20.2	8.2	23.6	24.8	26.4	23.2	25.6		29.4	26.4	27.6		32.4	35.4	
1729	21.4	20.0	24.4	26.2	27.8	24.4	27.8		31.0	28.4	28.4	29.6	31.6	35.8	
1730	18.8	16.4	22.2	23.4	23.2	21.0	23.5		26.8	24.8	25.8	31.8	30.4	31.8	
1731	22.4	20.0	24.2	26.2	26.8										
1732 D	22.0	20.0	25.8	28.6	30.4	25.6	27.8		31.5	28.4	30.2	38.4	36.2	39.0	
1733	19.8	18.8	25.6	27.4	27.0	25.6	27.3		30.0	26.2	27.4	36.4	36.2	37.2	
1734	20.2	18.6	23.6	23.8	23.8	21.6	21.4								
1735	23.2	20.2	25.2	26.4	28.2	25.4	28.9		32.8	29.8	31.6	36.4	36.2	35.8	
1736	21.2	18.6	26.0	26.8	27.4		28.2		31.6	29.2	30.4	34.8	34.2	35.2	
1737	25.0	22.2	27.4	29.8	30.2	26.0	29.0		33.6	30.4	32.2	38.8	40.0	41.8	
1738	19.4														
1739	20.6	18.8	24.4	26.8	26.8	24.6	26.8		28.6	27.2	28.6	35.8	35.4	35.8	
1740 D	22.8	20.8	25.4	27.6	20.2	25.4	25.2		27.0	25.0	26.8	32.6	32.2	34.8	
1741	19.6	17.6		24.2	24.8	22.6	24.0		26.8	24.8	27.0	31.8	30.8	34.0	
1742	22.4	19.4	24.8	24.8	24.8	22.4	25.0		27.2	26.4	28.2	33.4	32.2	34.0	
1743	23.0	20.8	27.6	28.8	29.2	25.8	26.0		30.8	27.8	29.6	37.4	36.8	38.4	
1744	20.0	18.0	23.0	24.2	25.2	21.6									
1745	21.6	19.6	24.8	26.6	27.0	23.4	26.8		29.4	27.0	29.4	34.8	32.8	35.6	
1746	18.4	16.2	21.2	22.0	22.8		19.0		22.5	21.0	22.4	27.0	26.4	28.4	
1747	20.0	18.0	23.8	25.6	29.6	23.8	27.0		29.2	25.8	26.8	33.2	31.8	34.8	

Date	25.11.77	24.1.78	7.3.78	4.5.78	22.6.78	9.8.78	4.10.78	16.10.78	23.11.78	4.1.79	15.2.79	24.4.79	6.6.79	8.8.79	9.8.79
Rainfall	17	64.1	13	22.4	71.1	136.7	82.1	shorn	49.2	69.3	71	73.2	14.1	37	shorn
1748 D	19.8	18.6	23.8	24.2	26.0	23.6	26.0		27.5	25.2	27.8	32.0	29.6	33.4	
1749	19.8	19.2	23.8	25.6	26.0	24.0	23.5								
1750	21.0	19.0	24.8	25.2	26.2	23.4	25.8		28.8	26.0	27.2	32.4	32.2	33.6	
1751	22.8		27.8	29.8	30.4	26.6	30.2		33.5	28.6	30.8	37.6	36.4	37.6	
1752	23.0	21.4	28.4	30.8	30.8	26.4	29.2		34.2	31.2	32.6	37.4	38.0	40.6	
1753	22.0	18.2	23.0	25.2	26.4	23.6	25.2		29.0	26.0	26.0	32.8	31.2	35.0	
1754	18.8	18.0	22.6	23.6	24.6	23.0	26.0		27.0	25.6	24.8	30.6	30.6	31.4	
1755	24.4	20.8	29.4	30.4	29.8	25.4	28.3		33.5	27.4	29.2	35.8	35.0	37.6	
1756 D	18.0	16.4	21.8	23.8	25.0	21.0	23.2		20.8	19.2	21.2	28.6	25.6	29.6	
1757	18.6	16.8	21.4	22.4	22.8	22.4	24.4		24.6	23.6	23.6	29.8	27.0	29.0	
1758	19.2	16.6	22.4	23.6	24.2	21.3	20.8								
1759	18.2	17.2	21.2	22.6	23.8	21.6	24.4		27.0	24.2	25.6	30.2	30.2	31.2	
1760	21.0	19.4	24.2	24.6	25.6	23.6	25.2		28.2	25.4	27.0	33.2	31.0	34.0	
1761	21.0	19.6	24.4	26.0	27.4		30.0		29.8	33.8	33.0	38.2	36.4	38.0	
1762	21.6	19.4	26.6	27.4	28.6	26.0	26.6		25.8	24.8	26.6	33.2	32.4	35.2	
1763	18.6	16.0	21.6	23.4	25.0	23.0	20.2		26.2	24.0	25.2	32.8	32.4	34.4	
1764 D	18.2	16.4	22.0	23.4	25.8										
2302												30.4	29.4	31.8	
2322												44.0	44.0	44.2	
2323												41.0	40.2	42.0	
2776									47.0						
2777									41.6	37.2	38.0		39.8	41.4	
2778									37.8	32.4	35.0	37.8	36.6	35.8	
2779									43.5	38.6	38.8		43.2	41.8	
2780									35.4	32.0	31.8	35.2	34.8	35.0	
2781									40.0	37.2	37.4				
2782									39.2	34.4	35.2	38.0	36.8	38.8	
2783									41.8						
2784									42.2	37.8	38.2	43.6	42.4	42.8	
2785									37.8	34.4	34.4	3.5	34.2	34.8	
Mean	20.9	18.8	24.7	26.0	26.8	23.8	26.2		31.1	28.1	29.3	34.2	34.1	36.0	
Count	64	62	61	62	62	56	56		62	59	59	58	61	61	
Eartag	**Pdk 7**	**Mob 6**	ROTATION -4 sub-pdks, each 8 ac												
7933	22.8	23.8	29.6	30.8	33.6	32.8	35.8		39.4	32.8	38.4				
7934	19.4	20.4	25.4	28.0	30.8	30.0	32.0		33.4	28.8	33.6	sheep died			
7935 D	20.0	21.8	27.0	30.0	33.2	31.6	33.8		35.2	31.4	35.4	This part of experiment			
7936 D	23.8	23.4	28.2	33.4	34.8	32.0	35.0		36.0	34.2	37.2	now discontinued			
7937	23.2	24.2	30.0	32.8	34.5	34.0	36.0		37.0	33.0	38.0				
7938	21.8	25.4	30.4	33.8	34.8	34.8	26.0		38.0	32.8	37.2				
7939	18.0	20.0	26.0	29.4	30.4	28.8	31.6		34.6	31.6	36.2				
7940 D	21.8	22.8	28.8	33.0	34.6	34.4	36.5		35.0	34.4	39.2				
7941	21.0	22.4	26.6	29.0	31.0	30.6	32.0		34.8	30.0	34.6				
7942	21.4	22.8	29.0	32.2	33.8	31.4	34.0		35.8	32.4	37.0				
7943	20.8	22.0	26.4	32.2	34.6	33.8	36.0		37.4	33.5	38.4				
7944 D	22.0	22.6	27.4	30.4	32.0	31.0	33.0		36.0	32.0	36.4				
7945	21.8	22.8	27.2	29.4	32.6	31.4	33.0		37.4	33.8	37.2				
7946	21.8	23.6	29.2	32.6	34.8	34.2	35.9		37.2	32.8	28.0				
7947	21.2	22.0	26.2	29.4	31.2	29.8	33.5								
7948 D	19.4	20.2	24.8	27.6	28.0	27.8	29.8		31.0	27.4	31.4				
7949	22.4	23.0	27.8	32.6	34.0	32.0	36.0		39.0	34.5	39.0				

Date	25.11.77	24.1.78	7.3.78	4.5.78	22.6.78	9.8.78	4.10.78	16.10.78	23.11.78	4.1.79	15.2.79	24.4.79	6.6.79	8.8.79	9.8.79
Rainfall	17	64.1	13	22.4	71.1	136.7	82.1	shorn	49.2	69.3	71	73.2	14.1	37	shorn
7950	17.2	19.4	26.4	30.6	32.8	31.2	35.4		40.0	35.0	39.0				
7951	21.8	23.6	28.6	33.2	33.6	32.8	32.8								
7952 D	19.6	20.2	25.4	37.2	29.2	29.6	36.0		33.4		36.4				
7953	21.6	22.6	27.4	31.0	33.2	31.8	35.8		38.2	35.6	40.6				
7954 D	20.8														
7955	21.2	22.6	26.6	28.8	30.8	29.2	33.0		35.2	32.2	38.8				
7956 D	19.8	20.2	25.2	28.9	31.0	30.0	33.2		35.4	33.0	37.2				
7957	22.0	20.8	28.6	33.6	34.6	34.6	24.2		30.4	27.4	31.5				
7958	21.4	21.8	26.6	31.0	33.2	31.6	34.0		38.0	32.4	38.2				
7959	18.8	21.2	26.2	30.2	31.0	29.8	34.0		37.4	33.2	38.9				
7960 D	21.6	23.0	26.8	29.8	31.2	30.4	34.0		35.2	32.2	34.8				
7961	19.0	17.6	21.2	24.3	25.8	25.0	28.0		30.5	28.2	31.4				
7962	16.4	17.0	21.4	23.6	24.4	23.8									
2745									37.4	33.8	37.2				
2746										38.0	40.4				
2747									32.8	30.6	37.4				
2748									43.8	38.4	42.0				
2749									47.4	42.0	47.6				
2750									33.4	29.0	32.0				
Mean	20.8	21.8	26.9	30.6	32.1	31.0	33.2		36.3	32.8	36.9				
Count	30	29	29	29	29	29	28		31	31	32	0	0	0	
Eartag	**Pdk 2**	**Mob 6**													
7917	19.4	24.4	30.0	32.6	32.2	33.0	38.0		37.8	36.8	37.4	43.6	44.4	43.2	
7918 D	15.8	19.8	25.0	27.2	27.0	28.6	29.0		31.5	33.5	33.0	40.0	39.2	37.4	
7919	23.0	24.2	33.2	34.0	34.2	35.6	42.6		43.0	40.4	41.4	49.2	50.4	48.4	
7920 D	18.8	23.0	28.4	31.4	29.4	31.0	37.8		37.0			35.4	40.2	42.4	
7921	17.8	21.2	26.0	28.8	29.2	30.0	36.0		35.4	34.8	35.2	38.6	41.4	40.6	
7922 D	20.4	24.2	29.2	29.4	30.0	32.0	37.0		37.2	36.4	37.2	42.0	41.8	41.6	
7923	20.2	26.0	34.0	35.4	34.6	31.8									
7924 D	19.2	24.6	31.8	35.0	33.6	33.8	40.0		41.4	41.2	42.2	46.8	47.0	46.0	
7925	21.6	25.0	30.4	34.0	33.0	35.2	40.0		41.2	39.2	39.6	47.0	48.6	47.8	
7926 D	22.6	27.2	35.2	36.2	35.2	36.2	43.0		41.8	40.4	41.4	50.8	51.6	49.4	
7927 tg	18.4	23.2	28.8	30.8	30.0	33.8									
7928 D	15.8	20.4	25.2	28.4	27.6	28.4	32.5		32.6	31.2	32.0	38.4	39.2	38.8	
7929	18.6	21.6	28.8	32.4	31.0	32.8	39.0		41.0	38.4	39.0	47.4	48.2	46.6	
7930 D	16.2	20.8	27.0	23.6	27.1	29.0	34.0		35.4	33.6	36.0	42.4	43.0	42.4	
7931	21.8	22.8	28.2	32.2	31.2	31.4	36.0		37.7	35.8	35.8	41.8	43.6	42.6	
7932 D	17.0	19.2	23.6	26.6	26.2	28.4	32.0		30.8	31.0	32.2	36.2	38.2	36.2	
2738									37.0	38.8	39.6	49.2	51.8	50.4	
2739									41.0	37.2	38.6	44.8	45.6	45.2	
Mean	19.2	23.0	29.1	31.1	30.7	31.9	36.9		37.6	36.6	37.4	43.4	44.6	43.7	
Count	16	16	16	16	16	16	14		16	15	15	16	16	16	
Eartag	**Pdk 8**	**Mob 6**													
7901	22.8														
7902 D	23.0			34.4	35.6	33.6	25.0		34.0	30.4	35.1				
7903	16.8	19.2		31.8	32.4	33.2	39.5		38.6	34.4	38.2				
7904 D	23.4											all died from thirst			
7905	23.0						38.5		47.0	42.2		or escaped			

Date	25.11.77	24.1.78	7.3.78	4.5.78	22.6.78	9.8.78	4.10.78	16.10.78	23.11.78	4.1.79	15.2.79	24.4.79	6.6.79	8.8.79	9.8.79
Rainfall	17	64.1	13	22.4	71.1	136.7	82.1	shorn	49.2	69.3	71	73.2	14.1	37	shorn
7906 D	24.2														
7907	17.4			30.8	33.4	31.6									
7908 D	21.0														
7909	20.6	23.6		35.2	36.0	35.0	40.8		39.8	36.8					
7910 D	18.4														
7911	20.2														
7912 D	21.8	23.6		35.2	35.6	34.8	34.0		38.8	36.0					
7913	22.2														
7914 D	22.8														
7915	19.2						42.0		40.4	38.4	40.8				
7916 D	23.6			34.2	36.6	35.4	40.2		40.4	38.0					
1782				31.8	32.4	31.2	37.5		33.2	31.4					
1786					30.8	30.6	35.2		35.5	31.8	33.8				
1787				34.2	34.2	33.8			39.3	37.0	36.8				
1788				30.0	31.2	32.2			26.4	24.0					
1789				36.4	37.6	36.6	42.5		38.4	36.0	41.3				
1790				37.2	38.0	36.0			42.6	38.8	41.4				
1791				35.2	36.8	34.6	41.0		40.2	38.2					
1792				30.4	31.0	30.4	42.0								
1795									40.4	37.0	38.4				
no tag	21.3	25.2		39.0	37.2	35.8	40.8		39.2	36.1					
Mean	21.3	22.9	mix	34.0	34.6	33.7	38.4		38.4	35.4	38.2				
Count	17	4	11	14	15	15	13		16	16	8	0	0	0	

Eartag	Pdk 3	Mob 6													
1781	22.4														
1782 D	18.4	21.4		31.8	32.4	31.2	37.5								
1783	21.6		running in												
1784 D	19.6		Pdk 8 as												
1785	22.8		got boxed												
1786 D	18.2		and some		30.8	30.6	35.2								
1787	20.8	21.6	lost;	34.2	34.2	33.8	38.5								
1788 D	18.8	19.2	no	30.0	31.2	32.2									
1789	25.0	25.0	data	36.4	37.6	36.6	42.5								
1790 D	22.2	24.0	this	37.2	38.0	36.0									
1791	20.8	21.6	pdk	35.0	36.8	34.6	41.0								
1792 D	17.4		this				42.0								
1793	20.2		date												
1794 D	19.8	20.6		30.4	31.0	30.4	32.0								
1795	21.0														
2726									38.2						
2727									44.8	42.8	all died from thirst				
2728									51.6	45.2	or escaped				
2729									46.6	40.6					
2730									38.8	35.6					
2731									42.4	39.8					
2732									40.6	35.0					

Date	25.11.77	24.1.78	7.3.78	4.5.78	22.6.78	9.8.78	4.10.78	16.10.78	23.11.78	4.1.79	15.2.79	24.4.79	6.6.79	8.8.79	9.8.79
Rainfall	17	64.1	13	22.4	71.1	136.7	82.1	shorn	49.2	69.3	71	73.2	14.1	37	shorn
2733									40.2						
2734									36.6	33.4					
2735									42.4						
2736									35.2	31.0					
Mean	20.6	21.9	mix	33.6	34.0	33.2	38.4		41.6	37.9					
Count	15	7	0	7	8	8	7		11	8	0	0	0	0	
Eartag	**Pdk 5**	**Mob 6**													
1765	20.6	24.4	30.4	34.2	36.4	36.0									
1766 D	16.8	20.4	26.4	31.0	33.0	33.6									
1767	18.8	20.8	25.8	29.2	30.9	32.0	37.2		36.2	35.6	35.8	40.8	40.8	41.0	
1768 D	16.6	19.0	26.0	30.2	31.2	31.6	37.0		36.4	38.0	37.6	41.6	40.6	42.8	
1769	20.2	22.8	28.6	31.4	33.8	34.6	36.0		36.2	37.2	37.8	44.4	43.6	44.4	
1770 D	21.0	23.4	30.8	33.8	35.0	34.8	39.2		42.2	42.5	41.8	49.0	50.4	50.8	
1771	22.4	25.4	33.2	36.8	39.0	39.6	47.2		48.4	47.0	46.8	53.0	50.6	55.0	
1772 D	20.8	23.4	29.8	33.0	34.1	33.6									
1773	19.4	20.6	27.6	30.8	32.4	34.0	40.0		39.0	39.8	39.6	41.2	41.6	42.4	
1774 D	23.2	25.2	32.6	36.6	39.6	40.4	48.4		49.6	50.0	50.6	55.8	56.4	57.8	
1775	18.4	21.8	29.6	32.6	34.8										
1776 D	21.4	24.0	29.2	32.0	33.4	34.2	42.0		40.8	41.4	42.4	46.4	45.6	47.2	
1777	20.4	23.0	29.8	34.4	35.6				45.6	48.0	47.6	54.0	52.8	55.8	
1778 D	17.8	21.4	27.8	31.6	33.2	34.6	48.0		41.6	41.0	41.4	45.0	46.0	45.6	
1779	19.4	22.4	27.2	30.0	32.8	33.4	41.2		42.8	41.4	40.6	46.8	38.2	45.4	
1780 D	22.4	26.0	33.8	37.6	38.8				45.6	47.0	47.8	54.6	53.8	54.8	
2740									46.8	46.2	46.2	51.4	50.0	50.2	
2741									44.8	45.6	44.8	48.6	49.6	50.6	
2742									46.4	46.4	46.8	51.8	52.8	53.6	
2744									43.5	43.4		48.0	47.6	47.8	
Mean	20.0	22.8	29.3	32.8	34.6	34.8	41.6		42.9	43.2	43.2	48.3	47.5	49.1	
Count	16	16	16	16	16	13	10		16	16	15	16	16	16	

Appendix 5.8 - Individual sheep liveweights (kg) for all mob 7 wethers (1980 – 1982) on all weighing occasions, listed within each paddock.

Rainfall (mm) between weighings is also shown, as are shearing dates.

Date	22.2.80	21.5.80	13.8.80	13.8.80	7.10.80	11.2.81	10.4.81	24.6.81	13.8.81	27.8.81	27.8.81			13.10.81	10.12.81	11.2.82	19.3.82	26.5.82	17.8.82
Rainfall	177	86.3	77	shorn	12.6	145.4	106.2	167.5	84.1	0	shorn			10.6	129.2	94.4	96.3	25.3	15
Eartag	Padk 2	Mob 7											orange tag						
2201	30.0	30.8	33.6		29.2	26.0	34.2	38.6	38.6	34.8		*2201*	O113	41.6	44.8	52.2	47.2	50.6	44.6
2203	33.5				31.2		36.0	36.6	37.4	31.0		*2203*	O110	36.4	33.8	42.8	35.8	41.2	38.8
2216	27.0	29.0	31.0		26.6	27.4	33.4	34.6	34.8	31.4		*2216*	O111	38.6	41.4	47	44.8	45.6	40.8
2218	33.0	31.6	31.8		22.4	24.4	33.0	33.6	32.2	27.6		*2218*	O109	37.8	41.8	49	45.6	50	44.2
2219	37.5	37.2	37.6		31.8	27.0	38.2	40.0	38.2	34.8		*2219*	O114	43.4	47.2	53.4	50.6	54	48.8
2222	27.5	28.2	31.2		27.0														
2334	30.5	30.4	33.2		29.2	26.4	33.8	36.8	37.4	33.2		*2334*	O102	41.8	44.6	49.6	48.2	52	46.6
2338	32.0	32.2	32.4		28.0	23.4	33.0	32.2	32.6	32.2		*2338*	O108	38.4	42.2	48	43.2	49.2	44.4
2340	25.0	27.0	27.4		24.8	20.8	28.4	29.8	30.4	28.4		*2340*	O105	35.4	38.8	46	42.8	44.8	38.4
2342	30.0	30.8	32.6		27.2	25.0	32.8	34.4	35.4	31.0		*2342*	O104	37.4	41.8	47.4	44	46.6	42.4
2346	33.0	31.8	33.6		28.8	25.2	33.8	35.6	35.8	33.6		*2346*	O106	42.0	43.5	51.8	46.8	52	48
2347	35.0	34.0	35.8		29.2	25.6	34.6	35.4	29.0	24.4		*2347*	O103	22.4					
2350	36.5	38.2	36.8		30.4	29.0	37.8	37.0	33.8	27.0		*2350*	O101	37.6	43.2	50.8	48.4	52.2	46.4
2677	32.5	31.4	32.6		26.0	24.0	29.2	31.4	32.4	30.0		*2677*	O112	35.2	38.6	47.4	41.4	45.4	41.8
2681	31.0	31.0	32.0																
2688	29.0	31.0	32.8		27.2	24.4	33.8	37.6	37.4	34.2		*2688*	O107	41.8	44.8	51.4	47.6	52.8	49
2696	25.5	26.6	26.4		22.4														
576										38.2		*576*	O115	39.4	43.2	47.6	45.2	46.8	41.2
579										49.2		*579*	O116	51.4	53.8	57.8	54.2	56.8	50.8
2694												*2694*	G128				50.2	53.4	48
Mean	31.1	31.3	32.6		27.6	25.3	33.7	35.3	34.7	32.6				38.8	42.9	49.5	46.0	49.6	44.6
Count	17	16	16		16	13	14	14	14	16				16	15	15	16	16	16
Eartag	Pdk 8	Mob 7											yellow tag						
2223	26.5	29.4	32.6		28.4	26.4	33.0	37.6	36.8	32.2		*2223*	Y108	37.8	41	46.4	46	45.4	45
2224	33.0	34.3	38.2																
2326	33.0	34.2	36.8		30.8	27.4	36.6	43.4	34.2	36.2		*2326*	Y102	42.0	45.6	53.6	51.4	50	47
2327	35.0	36.4	40.2		36.4	33.2	38.9	43.6	43.8	37.8		*2327*	Y113	43.6	47.6	51.2	49.6	48.2	48.2
2333	29.5	31.4	34.0		29.4	25.2	34.2	40.0	40.2	34.8		*2333*	Y109	42.4	42.8	49.6	48.8	47.8	47.2
2337	38.0	37.0	41.0		35.8	33.4	39.0	45.8	45.8	40.2		*2337*	Y112	44.2	48	54.4	53	53.6	51.4
2341	37.0	38.2	41.8		34.6	32.2	41.2	48.0	39.2	45.8		*2341*	Y103	50.4	49.4	55.6	54	54.8	54
2344	30.0	32.0	34.8		29.0	29.0	37.0	42.8	42.4										
2348	33.0	33.8	32.2		30.8	30.6	38.6	44.6	44.4	38.8		*2348*	Y111	46.2	48.2	54.2	52.2	51.4	49.4
2349	28.0	28.0	37.2		28.2	27.0	32.2	36.0	35.4										
2682	30.5	31.0	34.4		29.8	28.4	35.4	40.6	39.6	36.6		*2682*	Y106	41.2	43.2	50.2	49	49.4	48.6
2684	31.0	31.6	33.8		28.8	26.0	34.4	40.6	39.8	36.2		*2684*	Y110	43.2	45.8	51.4	50.2	48.6	47.4
2685	25.5	27.0	30.2		25.8	23.8	32.0	38.0	36.4	33.8		*2685*	Y104	38.6	41	47.2	46	44.4	40
2687	31.0	34.8	37.4		34.0	31.6	41.2	28.6	31.8	34.4		*2687*	Y105	44.4	47.4	56.6	54.8	52.8	50.4
2693	28.5	28.0	29.8																
2699	27.0	28.6	32.0		27.2	28.0	34.4	39.2	39.0	32.8		*2699*	Y107	39.0	43	48	45	44.2	43
578										42.0		*578*	Y114	46.8	48.4	51.6	49.8	45.2	42
599										38.2		*599*	Y101	47.2	50.4	57	56.4	52.8	49
600										36.8		*600*	Y115	41.4	42.4	47.2	45.8	44.2	43.8
694										47.8		*694*	Y116	49	49	50.8	48.2	45.2	35.6
Mean	31.0	32.2	35.4		30.6	28.7	36.3	40.6	39.2	37.8				43.6	45.8	51.6	50.0	48.6	46.4
Count	16	16	16		14	14	14	14	14	16				16	16	16	16	16	16

Date	22.2.80	21.5.80	13.8.80	13.8.80	7.10.80	11.2.81	10.4.81	24.6.81	13.8.81	27.8.81	27.8.81			13.10.81	10.12.81	11.2.82	19.3.82	26.5.82	17.8.82
Rainfall	177	86.3	77	shorn	12.6	145.4	106.2	167.5	84.1	0	shorn			10.6	129.2	94.4	96.3	25.3	15
Eartag	Pdk3	Mob 7																	
2202	27.0												green tag						
2217	27.5																		
2221	30.0	34.8	41.2		37.2	38.6	41.2	46.8	48.6	42.8		*2221*	G131	47.8	49.2	55.4			
2225	30.5																		
2328	33.0	36.2	45.0		40.8	41.3	44.8	49.8	52.2	43.8		*2328*	G133	51.2	52.6	57.2			
2330	30.5	35.2	42.8		39.4	41.2	43.8	47.8	50.2	42.6		*2330*	G138	49.2	49.8	55.4			
2343	38.0	42.4	53.2		46.8	47.6	47.2	44.0	54.0	46.6		*2343*	G137	58.8	58.2	67.6			
2345	25.5	34.0	37.0		33.6	37.4	40.1	44.0	46.4	40.6		*2345*	G134	44.8	47.2	53.6			
2678	29.0	30.2	36.6		34.8	36.2	39.2	42.6	44.8	38.6		*2678*	G139	42.2	43.2	48.6			
2686	31.5	34.2	41.4		38.6	39.8	41.6	46.6	49.8	43.4		*2686*	G136	49.0	50.6	56.6			
2689	33.5	36.8	44.8		40.4	42.4	45.6	48.4	51.0	43.3		*2689*	G127	49.8	51.0	56.0			
2690	34.0	38.0	47.4		42.2	43.6	46.4	49.4	50.0	42.8		*2690*	G135	51.4	56.2	58.0			
2694	25.0	33.6	37.8		34.6	39.0	43.0	47.2	47.8	41.6		*2694*	G128	48.8	49.0	55.0			
2695	36.0	35.0	42.2		38.6	41.0	43.0	45.8	48.0	41.8		*2695*	G126	47.6	48.8	51.6			
2698	31.0	31.8	40.4		37.2	39.6	43.2	46.8	49.2	41.2		*2698*	G141	45.4	47.4	55.0			
2700	32.0	35.0	41.6		36.4	36.2	40.2	46.8	49.2	42.0		*2700*	G130	45.6	47.8	53.8			
2701					33.6	36.8	39.4	44.8	47.2	40.6		*2701*	G132	45.0	47.6	50.6			
2723	33.5	39.0	41.8		33.2	38.2	41.8	47.4	50.8	43.4		*2723*	G129	50.6	53.0	57.6			
2724			45.0		42.2	42.2	44.8	50.4	51.8	43.8		*2724*	G140	50.0	51.2	56.0			
Mean	31.0	35.4	42.5		38.1	40.1	42.8	46.8	49.4	42.4				48.6	50.2	55.5			
Count	17	14	15		16	16	16	16	16	16				16	16	16	0	0	0
Eartag	Pdk 5	Mob 7																	
2214	26.5	28.2	33.6		31.6								Blue tag						
2215	29.0	30.4	37.2		34.0	35.8	39.0	41.2	33.6	31.0		*2215*	B53	39.4	43.2	49.6	49.4	47.8	48.4
2220	30.0	30.2	36.4		32.8	35.2	38.0	41.4	43.4	37.2		*2220*	B54	43.6	44.8	49.0	48.4	46.2	45.6
2329	32.0	33.8	41.6		38.6	41.0	43.6	49.2	51.4	43.0		*2329*	B58	50.8	53.4	60.2	58.2	58.2	59.8
2331	31.0	32.8	40.0		37.0														
2332	33.5	35.2	42.2		39.4		43.4	49.2	52.6	44.8		*2332*	2332	51.0	53.0	58.0	56.2		
2335	31.5	34.6	42.6		38.4	41.8	44.0	48.0	50.6	42.4		*2335*	B61	50.8	51.8	57.2	55.2	53.0	54.6
2336	28.0	27.0			32.2		39.0			40.2		*2336*	B56	43.4	46.2	51.0	49.6	47.0	
2339	26.0																		
2676	25.0	27.2	34.8		32.4		39.4												
2679	31.0	35.2	43.2		38.4	41.4	45.4	49.6	52.6	45.0		*2679*	B57	53.2	53.6	59.8	59.2	58.4	58.2
2680	30.0	29.2	36.0		35.0	36.8	40.4	42.2	44.8	38.8		*2680*	B55	45.6	46.4	50.4	49.4	49.2	49.4
2683	36.5	34.8	41.8		37.6		43.0			42.2		*2683*	B59	48.6	49.4	55.0	53.0	50.6	50.2
2691	33.0	34.2	39.6		36.4		40.8												
2692	30.5	32.2	40.8		37.6		42.6	47.0	49.6	40.8				48.4					
2697	35.0	35.2	41.6		39.2		47.0	51.4	53.8	46.8		*2697*	B51	52.0	53.6	57.8	57.0	54.4	53.0
2725			36.2		34.0	36.4	39.8	43.8	46.2	36.4		*2725*	B62	43.0	46.6	47.8	49.4	49.6	48.4
577										40.0		*577*	B65	44.4	46.0	49.4	49.6	48.0	48.4
580										37.2		*580*	B66	41.8	42.2	48.0	47.0	47.6	
1759										48.8		*1759*	B64	54.6	56.0	59.8	57.8	55.8	52.0
2225										44.6		*2225*	B60	50.8	52.6	56.0	53.8	52.4	51.2
2501												*2501*	B63		50.0	55.2	54.4	52.8	51.8
Mean	30.5	32.0	39.2		35.9	38.3	41.8	46.3	47.9	41.2				47.6	49.3	54.0	53.0	51.4	51.6
Count	16	15	15		16	7	14	10	10	16				16	16	16	16	15	13

Appendix 6 - Table of faecal crude protein and phosphorus concentrations recorded in all 4 phases.

Paddocks 1 and 7 1.25 sh/ha; Pdk 3 and 5, 2.5 sh/ha; Pdks 2 and 8, 5 sh/ha; Pdks 4 and 6, 10 sh/ha. Samples said to be dried at 75° or 65°C depending on batch, it seems

Crude Protein %		1967-68								
Pdk	13/12/67	10/01	7/02	6/03	4/04	7/05	28/05	19/06	24/07	21/08/68
1	16	17.8	13.3		13.2	17.9	14.0	13.1	12.0	14.2
7	15.4	16.4	13.7	12.9	12.3	16.5	13.2	12.1	10.4	12.7
3	14.5	17.9	12.5	14.5	10.8	17.1	14.4	13.6	10.7	13.1
5	16.8	18.1	13.7	13.7	13.4	17.3	14.0	12.4	11.2	11.7
2	13.7	17.0	12.0	14.7	11.6	18.4	14.2	12.7	10.1	11.4
8	13.7	18.2	12.4	13.3	11.1	18.7	14.3	13.5	11.0	11.8
4	11.9	19.0	11.6	15.5	10.2	17.5	11.1	9.3	6.9	6.7
6	11.5	16.5	11.2	14.0	11.6	14.7	9.5	7.0	5.7	8.7
Phosphorus %										
Pdk	13/12/67	10/01	7/02	6/03	4/04	7/05	28/05	19/068	24/07	21/08/68
1	0.73	0.95	0.53		0.50	1.06	0.95	0.74	0.67	0.81
7	0.74	0.97	0.34	0.55	0.45	1.11	0.80	0.70	0.67	0.61
3	0.73	0.97	0.57	0.62	0.48	1.10	0.94	0.78	0.71	0.71
5	0.93	0.87	0.63	0.69	0.57	0.97	0.90	0.77	0.61	0.72
2	0.80	1.02	0.51	0.77	0.49	1.38	1.03	0.72	0.60	0.69
8	0.81	0.92	0.61	0.68	0.49	1.05	0.96	0.88	0.73	0.57
4	0.72	1.07	0.42	0.82	0.41	0.87	0.79	0.51	0.38	0.37
6	0.69	0.97	0.49	0.61	0.47	1.22	0.52	0.30	0.30	0.47

Crude Protein %			1968- 69								
Pdk	20/11/68	15/01	12/02	12/03	27/03	10/04	6/05	11/06	2/07	30/07	4/09/69
1	11.1	9.6	16.5	12.9	13.5		9.6	10.6	10.8	10.1	9.4
7	12.3	10.4	15.0	11.0	14.2	13.8	10.2	9.4	9.5	8.9	9.4
3	10.3	8.7	15.6	10.1	14.1	14.1	10.6	9.5	9.5	7.9	7.4
5	10.4	9.5	17.2	11.4	14.5	15.1	10.2	9.6	9.8	8.9	7.8
2	8.8	6.6	16.8	7.0	14.8	15.4	9.4	8.6	9.0	6.8	6.1
8	8.3	6.5	16.1	8.2	15.7	15.4	9.4	8.0	8.2	7.1	6.1
4	10.8	6.0	12.5	12.3	13.8	14.4	6.7	6.7	9.5	8.9	8.7
6	10.4	6.1	9.6	13.2	11.6	11.2	7.2	8.5	8.1	12.6	8.8
Phosphorus %											
Pdk	20/11/68	15/01	12/02	12/03	27/03	10/04	6/05	11/06	2/07	30/07	4/09/69
1	0.41	0.18	0.81	0.46	0.07		0.42	0.41	0.37	0.25	0.24
7	0.34	0.08	0.67	0.43	0.17	0.63	0.49	0.31	0.42	0.15	0.22
3	0.37	0.17	0.88	0.45	0.22	0.64	0.53	0.39	0.37	0.18	0.22
5	0.36	0.16	0.83	0.44	0.15	0.73	0.48	0.42	0.37	0.18	0.21
2	0.31	0.12	0.99	0.23	0.13	0.62	0.34	0.29	0.29	0.21	0.18
8	0.32	0.11	0.83	0.26	0.14	0.62	0.47	0.31	0.29	0.18	0.19
4	0.62	0.19	0.87	0.59	0.21	0.72	0.32	0.22	0.39	0.32	0.28
6	0.56	0.17	0.65	0.68	0.22	0.71	0.55	0.38	0.45	0.45	0.20

Crude Protein %		1969-70									
Pdk	15/10/69	13/11	10/12	7/01	11/02	5/03	1/04	29/04	28/05	25/06	23/07/70
1	9.1	15.0	13.0	13.0	20.9	13.7	13.8	10.4	10.6	9.4	9.3
7	9.5	13.1	13.2	13.1	19.7	13.5	10.9	10.3	10.1	9.7	9.6
3	6.6	14.3	11.0	12.6	19.9	13.8	11.6	9.4	9.1	7.3	7.2
5	6.2	15.3	12.4	13.3	21.3	12.7	14.8	11.5	9.8	8.4	7.8
2	6.9	13.8	7.3	12.9	23.0	13.7	10.7	7.4	6.7	6.8	6.1
8	6.0	13.6	6.5	12.8	22.3	12.9	11.1	7.3	6.3	5.7	5.7
4	13.3	12.1	10.6	10.8	11.5	12.6	11.2	12.4	15.6	10.5	9.9
6	15.6	12.3	11.5	13.9	9.7	11.1	9.2	10.6	13.4	10.6	10.0
Phosphorus %											
Pdk	15/10/69	13/11	10/12	7/01	11/02	5/03	1/04	29/04	28/05	25/06	23/07/70
1	0.21	0.45	0.46	0.46	1.02	0.55	0.62	0.38	0.38	0.26	0.27
7	0.20	0.64	0.44	0.47	1.09	0.59	0.6	0.32	0.29	0.29	0.26
3	0.20	0.53	0.46	0.46	0.98	0.57	0.47	0.39	0.34	0.26	0.23
5	0.21	0.46	0.42	0.48	1.27	0.51	0.59	0.37	0.26	0.24	0.20
2	0.18	0.54	0.22	0.44	1.15	0.62	0.46	0.20	0.23	0.17	0.20
8	0.19	0.74	0.21	0.48	0.54	0.60	0.59	0.29	0.21	0.23	0.20
4	0.57	0.67	0.50	0.58	0.66	0.47	0.82	0.76	0.77	0.67	0.44
6	0.69	0.78	0.43	0.56	0.50	0.29	0.70	0.60	0.69	0.62	0.49

Crude Protein %		1970-71							
Pdk	13/11/70	10/12	6/01	11/02	10/03	7/04	6/05	4/08	24/08/71
1	15.3	15.0	19.3	13.6	19.4	12.4	10.2	8.9	11.2
7	16.8	15.1	17.8	13.8	18.5	12.6	8.8	8.5	9.7
3	13.5	14.1	19.1	14.7	20.4	12.2	9.6	6.6	9.2
5	15.6	14.9	19.4	13.8	20.1	12.5	10.8	7.1	11.7
2	13.0	12.8	18.7	14.3	17.6	9.4	7.7	9.1	9.0
8	11.2	13.3	18.9	14.3	19.2	11.6	6.1	5.1	6.4
Phosphorus %									
Pdk	13/11/70	10/12	6/01	11/02	10/03	7/04	6/05	4/08	24/08/71
1	0.70	0.45	0.62	0.59	1.16	0.29	0.28	0.18	0.53
7	0.74	0.44	0.75	0.60	1.11	0.27	0.40	0.19	0.50
3	0.68	0.44	0.81	0.73	1.02	0.49	0.30	0.17	0.45
5	0.90	0.46	0.70	0.60	1.15	0.39	0.28	0.17	0.44
2	0.62	0.54	0.81	0.66	1.04	0.32	0.23	0.39	0.50
8	0.79	0.61	0.79	0.80	1.08	0.34	0.22	0.16	0.44

Crude Protein %		1971-72									
Pdk	22/10/71	19/11	15/12	12/01	8/02	2/03	13/04	27/04	2/06	22/06	19/07/72
1	12.2	13.7	9.7	17.8	11.1	13.7	14.4	13.3	13.7	10.0	8.4
7	13.6	12.4	9.5	16.1	11.6	13.7	14.9	12.8	11.6	9.1	8.8
3	12.4	12.3	8.0	17.3	11.4	12.0	14.3	11.8	11.1	8.3	7.1
5	12.3	14.2	8.9	20.0	10.8	14.8	15.5	13.4	12.4	10.0	8.4
2	10.4	11.7	8.6	17.2	9.5	11.9	13.1	11.8	8.1	6.8	6.0

8	10.0	11.1	6.8	16.6	10.5	11.9	14.3	12.0	9.7	7.5	6.6
4						13.4	12.6	12.1	11.7	10.4	
6						13.1	13.3	11.9	12.9	10.1	8.1

Phosphorus %

Pdk	22/10/71	19/11	15/12	12/01	8/02	2/03	13/04	27/04	2/06	22/06	19/07/72
1	0.63	0.58	0.37	1.29	0.38	0.45	0.42	0.38	0.34	0.30	0.23
7	0.63	0.55	0.37	1.43	0.35	0.40	0.45	0.88	0.29	0.22	0.20
3	0.71	0.60	0.38	1.29	0.84	0.37	0.42	0.32	0.29	0.28	0.25
5	0.76	0.58	0.44	1.28	0.37	0.41	0.46	0.37	0.33	0.20	0.17
2	0.44	0.57	0.43	0.71	0.39	0.35	0.39	0.34	0.26	0.29	0.24
8	0.58	0.82	0.31	1.64	0.39	0.43	0.46	0.39	0.32	0.22	0.25
4						0.29	0.36	0.28	0.26	0.22	
6						0.50	0.39	0.33	0.31	0.18	0.26

Crude Protein % **1972-73**

Pdk	28/09/72	27/10	5/12	21/12	28/02	13/04	10/05	6/06	4/07	2/08	29/08/73
1	8.40	8.00	19.20	14.50	17.20	13.10	12.60	13.60	8.70	8.30	7.70
7	7.80	8.50	22.20	14.70	16.60	16.30	12.10	13.70	9.30	8.80	6.80
3	6.90	6.90	20.20	15.50	15.50	13.80	14.30	15.60	9.50	7.80	6.90
5	8.10	7.40	23.30	14.80	16.20	13.20	15.80	11.20	8.60	8.10	7.40
2	5.70	5.60	19.00	15.00	17.60	12.00	15.10	10.90	7.80	6.50	5.80
8	6.30	6.10	19.30	14.20	16.60	12.60	14.00	10.40	7.50	6.20	5.70
4	8.70	7.90	17.90	13.00		13.70	15.20	12.70	9.20	8.60	6.50
6	7.50	7.60	18.30	13.90		14.90	12.60	12.60	10.50	9.10	8.80

Phosphorus %

Pdk	28/09/72	27/10	5/12	21/12	28/02	13/04	10/05	6/06	4/07	2/08	29/08/73
1	0.21	0.19	1.10	0.54	1.00	0.70	0.70	0.57	0.46	0.39	0.23
7	0.17	0.23	1.22	0.67	1.06	0.75	0.73	0.64	0.52	0.20	0.22
3	0.16	0.16	1.30	0.55	0.85	0.67	0.65	0.78	0.52	0.45	0.25
5	0.23	0.17	1.40	0.55	0.98	0.77	0.84	0.59	0.42	0.34	0.27
2	0.18	0.17	1.20	0.49	0.86	0.61	0.72	0.47	0.35	0.40	0.21
8	0.15	0.20	1.10	0.60	0.98	0.77	0.70	0.61	0.44	0.23	0.20
4	0.22	0.20	0.97	0.71		0.72	0.65	0.50	0.41	0.35	0.24
6	0.10	0.16	0.88	0.46		0.6	0.63	0.54	0.37	0.39	0.28

Crude Protein % Dates uncertain **1973-74**

Pdk	5/10/73	14/11	7/12	15/02	4/04	4/06	14/06	7/08/74
1	12.8	12.2	14.9	11.7	9.7	10.2	11.0	15.7
7	15.6	12.0	15.3	10.6	8.7	9.6	10.7	15.2
3	15.6	11.2	16.3	11.8	9.2	13.8	9.9	14.2
5	15.0	11.8	15.3	12.2	9.2	9.1	11.5	16.1
2	16.0	10.4	16.5	11.6	10.3	9.1	10.9	10.5
8	13.5	10.7	16.1	11.6	8.4	8.6	11.0	15.5
4	13.5	11.1	15.6	12.1	10.4		11.2	
6	16.7	13.7	14.2	12.0	9.4	9.4	11.9	15.4

Phosphorus %								
Pdk	5/10/73	14/11	7/12	15/02	4/04	4/06	14/06	7/08/74
1	0.75	0.86	0.67	0.61	0.26	1.14	0.68	0.32
7	0.97	0.86	0.75	0.57	0.31	1.09	0.72	0.29
3	0.64	0.75	0.74	0.55	0.35	0.84	0.56	0.82
5	0.90	0.82	0.73	0.55	0.28	1.03	0.58	0.38
2	0.88	0.70	0.91	0.67	0.28	0.36	0.44	0.23
8	0.73	0.86	0.77	0.56	0.27	0.97	0.52	0.27
4	0.76	0.52	0.81	0.57	0.27		0.59	
6	0.65	0.61	0.58	0.54	0.26	0.84	0.43	0.30

Crude Protein %	**1974-75**				
Pdk	16/10/74	13/12	6/02	28/05	22/07/75
1	15.7	11.1	10.2	8.5	8.7
7	15.2	10.4	10.5	8.5	9.7
3	14.2	10.3	11.5	7.9	7.9
5	16.1	9.7	10.1	8.6	8.0
2	10.5	9.3	10.1	8.1	8.7
8	15.5	9.2	11.3	8.3	8.8

Phosphorus %					
Pdk	16/10/74	13/12	6/02	28/05	22/07/75
1	1.14	0.61	0.43	0.47	0.56
7	1.09	0.58	0.44	0.45	0.46
3	0.84	0.49	0.40	0.46	0.37
5	1.03	0.62	0.55	0.41	0.38
2	0.36	0.53	0.46	0.41	0.51
8	0.97	0.55	0.53	0.53	0.29

Crude Protein %			**1975-76**				
Pdk	17/09/75	14/11	15/01	30/03	2/07	24/08	25/10/76
1	8.3	6.4	12.5	14.3	8.1	6.8	6.8
7	9.1	8.8	12.5	11.8	7.7	6.4	6.4
3	7.0	6.4	12.8	12.5	7.4	6.2	6.2
5	7.7	7.3	13.0	13.4	7.9	6.6	6.6
2	6.5	5.7	14.1	14.7	7.4	6.6	6.6
8	7.0	5.8	14.0	15.3	8.1	6.6	6.6

Phosphorus %							
Pdk	17/09/75	14/11	15/01	30/03	2/07	24/08	25/10/76
1	0.45	0.24	0.76	0.72	0.35	0.19	0.19
7	0.39	0.41	0.80	0.78	0.31	0.20	0.20
3	0.32	0.23	0.74	0.74	0.30	0.16	0.16
5	0.37	0.28	0.86	0.80	0.32	0.18	0.18
2	0.30	0.18	0.80	0.66	0.26	0.17	0.17
8	0.30	0.21	0.94	0.83	0.27	0.16	0.16

Crude Protein % **1978-80**

Pdk	24/01/78	7/03	4/05	9/08	4/10	18/12	9/01	19/02	24/04	6/06	11/06	10/08	10/06/80
1	20.5	7.3	5.4	7.1	10.7	10.3	13.0	19.2	6.1	5.6	13.0	6.1	
7	16.9	9.9	7.3	8.5	14.9	10.3	15.4	20.9			15.4	6.7	
3												8.4	10.8
5	18.1	10.5	9.4	12.7	13.0	9.1	12.9	22.4	10.0	7.2	12.9		9.7
2	17.3	11.2	8.0	11.1	11.5	8.9	15.7	23.0	9.6	7.3	15.7		8.1
8	17.2			10.3	13.1	9.1	14.7	22.7			14.7		9.0

Phosphorus %

Pdk	24/01/78	7/03	4/05	9/08	4/10	18/12	9/01	19/02	24/04	6/06	11/06	10/08	10/06/80
1	1.04	0.44	0.26	0.34	0.89	0.58	0.63	1.66	0.41	0.21	0.63	0.24	
7	1.10	0.61	0.40	0.36	1.00	0.90	1.41	1.76			1.41	0.23	
3												0.24	0.47
5	0.83	0.57	0.62	0.65	1.06	0.87	0.94	1.28	0.69	0.27	0.94		0.52
2	0.99	0.51	0.36	0.56	0.92	0.69	1.25	1.76	0.33	0.25	1.25		0.50
8	0.92		0.53	0.46	1.03	0.80	1.29	1.58			1.29		0.47

Appendix 7. - Clean wool production rate (mg/sq cm/d) details for Phase 1, mobs 1 to 4.

The 10 sh/ha data are omitted after mob 2 because they were supplemented regularly with lucerne hay.

	Stocking rate (sh/ha)				
Time interval	10	5	2.5	1.25	l.s.d.
1967/68					
15/11/67 - 10/1/68	0.85	0.71	0.80	0.85	n.s.
10/1 - 6/3	1.21	0.89	1.01	0.97	0.16
6/3 - 7/5	1.22	0.79	0.90	0.85	0.14
7/5 - 19/6/68	0.91	0.88	1.00	0.92	n.s.
1968/69					
14/10/68 - 15/1/69	0.72	0.61	0.59	0.65	n.s.
15/1 - 12/3	0.88	0.91	0.93	0.95	n.s.
12/3 - 6/5	1.06	1.15	1.12	1.05	n.s.
6/5 - 2/7	0.55	0.95	0.85	0.76	0.11
2/7 - 11/9/69	0.33	0.59	0.70	0.65	0.088
1969/70					
15/10/69 - 10/12		0.55	0.56	0.66	n.s.
10/12 - 11/2/70		1.10	1.06	1.03	n.s.
11/2 - 1/4		1.47	1.20	1.20	0.2
1/4 - 27/5		0.77	0.91	0.98	0.14
27/5 - 22/7/70		0.29	0.50	0.65	0.094
1970/71					
15/10/70 – 6/1/71		1.42	1.34	1.32	n.s.
6/1 - 10/3		1.39	1.22	1.21	0.16
10/3 - 6/5		0.61	0.67	0.63	n.s.
6/5 - 30/6/71		0.55	0.67	0.85	0.23

Appendix 8 - Wool fibre diameter (μ) details- Phase 1, mobs 1 to 4.

The 10 sh/ha data are omitted after mob 2 because they were supplemented regularly with lucerne hay.

	Stocking rate (sh/ha)				
Time interval	10	5	2.5	1.25	l.s.d.
1967/68					
28/09 -15/11/67	19.9	20.4	21.4	21.5	1.08
15/11 - 10/1/68	19.1	21.2	22.0	22.4	1.07
10/1 - 6/3	20.8	22.6	22.8	23.3	1.16
6/3 - 7/5	21.8	21.9	22.9	22.4	n.s.
7/5 - 19/6	19.7	22.2	22.7	22.5	1.21
19/6 - 21/8/68	16.5	22.5	22.6	22.4	1.08
1968/69					
14/10/68 – 20/11	16.8	17.4	18.4	19.1	1.14
20/11 - 15/1/69	16.1	16.9	18.8	19.5	1.21
15/1 - 12/3	17.4	19.6	20.7	21.8	1.19
12/3 - 6/5	18.7	21.5	22.0	22.8	n.s.
6/5 - 2/7	15.1	19.7	20.1	20.4	n.s.
2/7 - 11/9/69	13.6	17.4	20.0	19.8	1.31
1969/70					
25/9/69 - 15/10		16.2	16.3	17.5	n.s.
15/10 - 10/12		17.9	19.3	20.0	1.22
10/12 - 11/2/70		21.1	21.6	21.6	n.s.
11/2 - 1/4		21.9	22.1	21.9	n.s.
1/4 - 27/5		18.4	20.4	20.8	1.56
27/5 - 22/7/70		14.4	17.8	19.2	1.33
1970/71					
15/10/70 – 13/11		15.8	18.7	20.0	1.30
13/11 - 6/1/71		19.6	22.0	22.0	1.56
6/1 - 10/3		21.3	22.6	23.2	1.30
10/3 - 6/5		19.8	21.6	22.4	1.90
6/5 - 30/6/71		15.5	18.6	21.1	1.60

Appendix 9. Greasy Fleece Wool production (kg/sh) of each treatment mob during the entire trial period. Rainfall received (mm) during each mob's time is also shown

Mob	S/rate (sh/ha)	GFW (kg/hd)	GFW (kg/ha)	Propn of 68/69 on per ha basis	Mob Days	Mob rainfall
1967/68	1.25	4.6	5.7	1.11		
	2.5	4.6	11.4	1.17		
	5	4.3	21.4	1.26		
	10	3.1	30.8	1.37		
Mean/ha-2.5and5			**16.4**		**327**	**470**
1968/69	1.25	4.1	5.2	1		
	2.5	3.9	9.8	1		
	5	3.4	17.0	1		
	10		22.5	1		
Mean/ha-2.5and5			**13.4**		**356**	**168**
1969/70	1.25	4.1	5.2	1.00		
	2.5	3.9	9.8	1.01		
	5	3.1	15.4	0.91		
	10		22.0	0.98		
Mean/ha-2.5and5			**12.6**		**366**	**265.3**
1970/71	1.25	4.1	5.1	1.00		
	2.5	3.9	9.7	1.00		
	5	3.0	15.2	0.89		
Mean/ha-2.5and5			**12.5**		**379**	**439.8**
1971/72	1.25	5.0	6.2	1.21		
	2.5	4.7	11.7	1.21		
	5	4.6	23.0	1.35		
	10	4	10.0	0.44		
Mean/ha-2.5and5			**17.4**		**349**	**411.5**
1972/73	1.25	4.9	6.1	1.19		
	2.5	4.8	12.0	1.23		
	5	4.4	22.0	1.29		
	10	5.3	13.2	0.59		
Mean/ha-2.5and5			**17.0**		**369**	**569.4**
1973/74	1.25	4.8	6.0	1.17		
	2.5	4.7	11.7	1.21		
	5	4.7	23.5	1.38		
	10	5.4	13.5	0.60		
Mean/ha-2.5and5			**17.6**		**365**	**624.5**
1974/75	1.25	5.1	6.4	1.24		

Mob	S/rate (sh/ha)	GFW (kg/hd)	GFW (kg/ha)	Propn of 68/69 on per ha basis	Mob Days	Mob rainfall
	2.5	5.1	12.8	1.31		
	5	5.1	25.5	1.50		
Mean/ha-2.5and5			**19.1**		**375**	**395.5**
1975/76	1.25	4.5	5.6	1.09		
	2.5	4.5	11.2	1.15		
	5	4.4	22.0	1.29		
Mean/ha-2.5and5		**5**	**16.6**		**393**	**586.6**
1976/77	1.25	3.4	4.3	0.83		
	2.5	3.5	8.7	0.90		
	5	3.4	17.0	1.00		
Mean/ha-2.5and5			**12.9**		**340**	**640.9**
1977/78	1.25	2.6	3.3	0.64		
	2.5	3.5	8.9	0.91		
	5	3.6	18.3	1.07		
Mean/ha-2.5and5			**13.6**		**419?**	**466.5**
1978/79	1.25	2.8	3.5	0.68		
	2.5	4.3	10.7	1.10		
	5	4.1	20.5	1.21		
Mean/ha-2.5and5			**15.6**		**296**	**328.5**
1979/80	2.5	3.7	9.2	0.95		
	5	3.4	17.0	1.00		
Mean/ha-2.5and5			**13.1**		**384**	**390.3**
1980/81	2.5	5.1	12.9	1.32		
	5	3.9	19.5	1.15		
Mean/ha-2.5and5			**16.2**		**366**	**527.1**
1981/82	2.5	4.8	11.9	1.22		
	5	4.9	24.7	1.46		
Mean/ha-2.5and5			**18.3**		**356**	**398.9**

A summary of above data shows no correlation below between fleece growth and rainfall received

Year	Mob	Mid-range mean	Rain
1967/68	1	16.4	470.0
1968/69	2	13.4	168.0
1969/70	3	12.6	265.3
1970/71	4	12.5	439.8
1971/72	5	17.4	411.5
1972/73	5	17.0	569.4

1973/74	5	17.6	624.5
1974/75	5	19.1	395.5
1975/76	5	16.6	586.6
1976/77	5	12.9	640.9
1977/78	6	13.6	466.5
1978/79	6	15.6	328.5
1979/80	7	13.1	390.3
1980/81	7	16.2	527.1
1981/82	7	18.3	398.9

Appendix 10. - Example from Pdk 3 sheep (2.5 sh/ha) in 1975-76 of the variation between sheep and over time within a growing fleece of (A) wool fibre diameter (μ) and (B) rate of clean wool growth (mg/sq cm/day)

(A) **Diameter of wool fibre (micron) grown by individual sheep over sequential periods**

Band	1	2	3	4	5	6			
Dates	10.9 - 14.11	14.11- 15.1	15.1- 30.3	30.3- 2.7	2.7- 24.8	24.8- 17.9	Mean	StDev	SD%
Interval									
Eartag #									
699		25.4	28.1	27.5	25.0	24.7	26.14	1.55	5.9
733		24.9	27.7	28.4	25.9	23.5	26.08	2.01	7.7
728		23.3	25.5	27.6	25.1	20.5	24.40	2.66	10.9
723		22.1	25.3	26.3	23.2	18.9	23.16	2.90	12.5
694		18.6	21.5	24.7	21.5	17.6	20.78	2.80	13.5
799		19.0	21.8	22.6	19.9	18.0	20.26	1.92	9.5
477		21.8	23.8	23.5	22.4	20.1	22.32	1.48	6.6
700		24.4	27.5	30.0	28.2	22.5	26.52	3.02	11.4
698		23.2	26.6	27.3	24.1	21.7	24.58	2.34	9.5
Mean		22.5	25.3	26.4	23.9	20.8	23.8	2.30	9.7
StDev		2.42	2.48	2.40	2.49	2.46	2.33		
SD %		10.8	9.8	9.1	10.4	11.8	9.8		

(B) Rate of clean wool growth (mg/sq cm/day) by individual sheep over sequential time periods

Band	1	2	3	4	5	6			
Dates	10.9 - 14.11	14.11- 15.1	15.1- 30.3	30.3- 2.7	2.7- 24.8		Mean	StDev	SD%
Eartag #									
699		0.72	0.67	0.81	0.60		0.70	0.09	12.6
733		0.97	0.97	1.10	0.76		0.95	0.14	14.8
728		0.79	0.82	1.06	0.72		0.85	0.15	17.4
723		0.94	0.94	1.16	0.84		0.97	0.14	13.9
694		0.62	0.87	0.93	0.58		0.75	0.18	23.4
799		0.57	0.66	0.77	0.50		0.63	0.12	18.7
477		0.33	0.88	0.80	0.46		0.62	0.26	42.8
700		0.84	0.76	0.99	0.68		0.82	0.13	16.2
698		1.16	1.35	1.51	0.97		1.25	0.23	18.7
Mean		0.77	0.88	1.01	0.68		0.84	0.16	19.8
SD		0.25	0.21	0.23	0.16		0.20		
SD %		31.9	23.5	22.9	24.1		23.9		

Appendix 11. - Table used to convert sheep liveweight at the start of a period and rate of weight change during the period into Dry Sheep Equivalents (DSE) for that time period

1 DSE = 50kg and no change in weight during the time period. Source framework from Farm Table (2019)

	Rate of weight gain (g/d)								
LWt (kg)	-100	-50	-20	0	20	50	75	100	150
15		0.26	0.30	0.35	0.40	0.50	0.57	0.65	0.80
16		0.27	0.31	0.38	0.43	0.53	0.60	0.67	0.84
17		0.29	0.33	0.41	0.46	0.55	0.62	0.69	0.87
18		0.30	0.35	0.43	0.48	0.57	0.65	0.72	0.90
19		0.31	0.37	0.45	0.50	0.59	0.68	0.75	0.93
20	0.20	0.32	0.38	0.47	0.52	0.62	0.70	0.79	0.96
21	0.21	0.33	0.39	0.49	0.54	0.64	0.73	0.82	0.99
22	0.22	0.35	0.41	0.51	0.56	0.67	0.76	0.86	1.02
23	0.23	0.36	0.42	0.53	0.58	0.69	0.78	0.88	1.06
24	0.24	0.37	0.44	0.54	0.60	0.72	0.81	0.91	1.10
25	0.25	0.38	0.45	0.56	0.62	0.74	0.84	0.94	1.13
26	0.28	0.42	0.48	0.59	0.65	0.76	0.87	0.97	1.17
27	0.31	0.46	0.52	0.62	0.68	0.79	0.89	0.99	1.20
28	0.34	0.49	0.55	0.65	0.71	0.81	0.91	1.01	1.23
29	0.37	0.53	0.59	0.68	0.73	0.83	0.94	1.03	1.26
30	0.40	0.57	0.63	0.71	0.76	0.85	0.96	1.06	1.29
31	0.43	0.58	0.64	0.72	0.78	0.87	0.98	1.08	1.31
32	0.45	0.59	0.65	0.74	0.79	0.89	1.00	1.10	1.33
33	0.46	0.60	0.66	0.75	0.80	0.91	1.02	1.13	1.36
34	0.48	0.61	0.67	0.77	0.81	0.92	1.04	1.16	1.39
35	0.50	0.62	0.68	0.78	0.83	0.94	1.06	1.18	1.41
36	0.52	0.63	0.69	0.79	0.85	0.96	1.08	1.20	1.43
37	0.54	0.65	0.70	0.81	0.86	0.97	1.00	1.22	1.45
38	0.56	0.66	0.71	0.82	0.88	0.99	1.11	1.23	1.47
39	0.58	0.67	0.72	0.83	0.90	1.01	1.12	1.25	1.50
40	0.57	0.68	0.73	0.85	0.92	1.02	1.14	1.27	1.52
41	0.59	0.69	0.74	0.86	0.94	1.05	1.16	1.30	1.55
42	0.61	0.70	0.75	0.88	0.96	1.07	1.19	1.33	1.58
43	0.62	0.70	0.76	0.89	0.98	1.09	1.22	1.36	1.62
44	0.64	0.71	0.77	0.91	1.00	1.12	1.25	1.39	1.66
45	0.65	0.72	0.78	0.93	1.02	1.14	1.28	1.42	1.70
46	0.66	0.72	0.79	0.94	1.03	1.16	1.30	1.44	1.74
47	0.67	0.73	0.80	0.96	1.05	1.18	1.32	1.47	1.77
48	0.68	0.74	0.82	0.97	1.07	1.21	1.35	1.49	1.80
49	0.69	0.74	0.83	0.98	1.09	1.23	1.38	1.52	1.83
50	0.70	0.75	0.85	1.00	1.11	1.25	1.40	1.55	1.85
51	0.71	0.77	0.87	1.02	1.12	1.27	1.41	1.56	1.86

	Rate of weight gain (g/d)								
LWt (kg)	-100	-50	-20	0	20	50	75	100	150
52	0.72	0.79	0.88	1.03	1.13	1.28	1.43	1.58	1.88
53	0.73	0.81	0.90	1.05	1.15	1.30	1.44	1.60	1.90
54	0.74	0.83	0.91	1.06	1.16	1.32	1.46	1.61	1.91
55	0.75	0.85	0.93	1.07	1.18	1.34	1.48	1.63	1.93
56	0.76	0.86	0.95	1.09	1.20	1.36	1.50	1.65	1.94
57	0.77	0.87	0.96	1.10	1.21	1.37	1.51	1.67	1.96
58	0.78	0.88	0.97	1.12	1.23	1.39	1.53	1.68	1.97
59	0.79	0.89	0.99	1.13	1.25	1.41	1.55	1.70	1.99
60	0.80	0.90	1.00	1.15	1.26	1.42	1.57	1.71	2.10

Sources:

Farm Table (2019) RCS table at https://farmtable.com.au/build/lsu-dse-tables/

NSW Dept of Ag (2015)

https://www.dpi.nsw.gov.au/agriculture/budgets/livestock/sheep-gross-margins-october-2015/background/dse

Appendix 12. - Example of the calculation method to convert sheep liveweight and growth rate to Dry Sheep Equivalents and then to grazing pressure as DSE/ha

Weighing	Shp /ha				Avge (kgs)				Rain	Days	Chg (g/d)				DSEs				Grz press DSE /ha			
Date	10	5	2.5	1.25	10/ha	5/ha	2.5/ha	1.25/ha			10/ha	5/ha	2.5/ha	1.25/ha	10/ha	5/ha	2.5/ha	1.25/ha	10/ha	5/ha	2.5/ha	1.25/ha
29/09/1967	16	16	16	16	28.6	29.7	28.6	28.6	2	0												
15/11/1967	16	16	16	16	31.3	32.3	33.4	32.7	75	47	57	55	100	87	0.85	0.85	1.06	0.95	8.4	4.2	2.6	1.2
13/12/1967	16	16	16	16	25.2	28.8	30.5	31.4	39	28	-219	-125	-102	-49	0.25	0.35	0.42	0.57	2.5	1.7	1.0	0.7
10/01/1968	16	16	16	16	26.0	30.6	33.5	33.7	45	28	31	66	105	83	0.65	0.9	1.07	1.05	6.4	4.4	2.6	1.3
7/02/1968	16	16	16	16	31.0	35.5	37.2	37.7	25	28	177	172	133	143	1.25	1.5	1.25	1.4	12.3	7.4	3.1	1.7
6/03/1968	16	16	16	16	30.2	35.0	37.1	37.3	122	28	-28	-16	-3	-15	0.65	0.7	0.8	0.75	6.4	3.5	2.0	0.9
4/04/1968	16	16	16	16	33.6	38.2	40.0	40.3	19	29	119	110	102	103	1.1	1.2	1.25	1.25	10.9	5.9	3.1	1.5
7/05/1968	16	16	16	16	30.0	38.2	40.2	40.2	61	33	-110	0	4	-3	0.45	0.81	0.85	0.85	4.4	4.0	2.1	1.1
28/05/1968	16	16	16	16	30.5	39.8	41.1	42.1	60	21	22	78	45	91	0.77	1.15	1.04	1.3	7.6	5.7	2.6	1.6
19/06/1968	16	16	16	16	30.3	42.1	43.7	43.4	0	22	-6	105	118	58	0.71	1.33	1.42	1.15	7.0	6.6	3.5	1.4
24/07/1968	16	16	16	16	26.6	43.3	45.3	44.7	60	35	-105	34	44	39	0.3	1	1.12	1.09	3.0	4.9	2.8	1.3
21/08/1968	16	16	16	16	26.0	43.3	45.1	45.4	0	28	-24	0	-5	24	0.47	0.87	0.91	1.05	4.6	4.3	2.3	1.3
Paddock																	Mob 1	Avg	6.7	4.8	2.5	1.3
Areas (ha)	1.62	3.24	6.47	12.95														Max	12.3	7.4	3.5	1.7
																		Min	2.5	1.7	1.0	0.7
14/10/1968	16	16	16	16	28.5	28.1	28.5	29.2	0	0												
20/11/1968	16	16	16	16	29.0	30.0	32.6	33.4	6	37	14	50	109	114	0.7	0.83	1.06	1.1	6.9	4.1	2.6	1.4
15/01/1969	16	16	16	16	26.0	28.2	32.8	34.8	2	56	-54	-32	5	24	0.53	0.65	0.73	0.85	5.2	3.2	1.8	1.1
12/02/1969	16	16	16	16	24.5	27.3	32.0	33.3	59	28	-54	-32	-31	-54	0.42	0.62	0.66	0.6	4.1	3.1	1.6	0.7
12/03/1969	16	16	16	16	26.0	28.6	36.3	37.0	17	28	54	47	156	135	0.76	0.77	1.41	1.3	7.5	3.8	3.5	1.6
10/04/1969	16	16	16	16	28.5	31.2	36.4	36.5	122	29	86	91	3	-17	0.92	1.06	0.8	0.7	9.1	5.2	2.0	0.9
6/05/1969	16	16	16	16	29.0	35.4	39.6	40.4	2	26	19	161	122	147	0.73	1.36	1.4	1.46	7.2	6.7	3.5	1.8
11/06/1969	16	16	16	16	29.5	36.2	39.9	40.7	20	36	14	23	9	10	0.74	0.85	0.85	0.86	7.3	4.2	2.1	1.1
2/07/1969	16	16	16	16	27.0	35.6	40.5	41.5	13	21	-119	-28	28	35	0.4	0.7	0.93	0.94	4.0	3.5	2.3	1.2
30/07/1969	16	16	16	16	26.0	34.6	42.1	42.9	11	28	-36	-37	58	50	0.5	0.68	1.04	1.05	4.9	3.4	2.6	1.3
11/09/1969	16	16	16	16	25.0	30.4	37.8	39.9	0	43	-23	-98	-100	-70	0.47	0.45	0.57	0.6	4.6	2.2	1.4	0.7
																	Mob 2	Avg	6.1	3.9	2.3	1.2
																		Max	9.1	6.7	3.5	1.8
																		Min	4.0	2.2	1.4	0.7

Appendix 13. - Notes taken from the annual reports of the trial highlights each year

- 1967

Site fenced and infrastructure erected. Final approvals in June. Sheep added Sept '67. Pasture DMY and Basal area recorded 21 Sept. Regular sheep weighings, faecal sampling and dyebanding commenced.

- 1968

First year/mob of sheep (Sep-67 to Aug-68) have been monitored. No data presented

- 1969

Second year (Sep-68 to Aug-69). Restocked 25 Sept with weaner ewes off-shears. Sheep supplied by Gall family of 'Eastwood'. 4 sheep/ac Paddocks hand-fed lucerne hay supplement all year.

- 1970

Third year. Paddocks 4 and 6 (4 sh/ac) fed hay all year. Paddocks 2 and 8 (2 sh/ac) supplementary fed for last 2 weeks before shearing. Mixed woolled and newly-shorn sheep used at start of this period. Some fly-strike deaths. Oestrus cycling recorded – Stocking Rate effects noticed on cycling. Animals lose liveweight on abundant hayed-off pasture. Optimal S/Rate 0.5-1ac/sheep. By end of Jun'70 there was a good body of hayed-off feed in Paddocks 1,3,5 and 7 with some green shoot on closely grazed tussocks near water points in Paddocks 1 and 7. No green shoot evident in Paddocks 3 and 5 (1 sh/ac) and only old dry stem in Paddocks 2 and 8 (2sh/ac). Even less dry stem in Paddocks 4 and 6 (4 sh/ac +hay). Paddock 2 got hay supplement until mid-Nov.

- 1971

Fourth year. New ewes in on 9th Oct. Paddocks 4 and 6 destocked. A few deaths. Paddock 8 gets extra run-off water from storms. Supplementary hay to 1 sh/ac Paddocks Jun-Aug. Paddock 2 performing differently to its Paddock 8 'duplicate'. Seeding and seedling regeneration of buffel grass noted often but not in Paddocks 3 and 5. Poor rainfall year but well distributed. Pilot trial of moving exclosures for pasture dry matter yield (DMY) estimation was instigated but proved unworkable because hard to find adjacent matching 'open' and 'closed' pasture biomass areas.

- 1972

Fifth year. Change from ewes to wethers – fill-in mob of ewes grazed 26/8/71-8/2/72. Wethers shorn 8/2/72 and entered into Paddocks. Suppl. feeding Paddock 2 Aug-Dec '71 and Paddock 8 in Dec '71. Many losses and escapes of sheep. Paddocks 4 and 6 restocked in Feb '72 @ 2.5 sh/ha (1 sh/ac) after 18 months spell. Other data collection continued as usual. No rain Jun-Sept. *Salsola* and *Flaveria* crops in heavy S/Rate Paddocks. Big faecal N and P fluctuations and sometimes cross-overs of result trends.

- 1973

Sixth year. Same wethers used. Shorn 30/8/73. Some deaths in all treatments and escapes from Paddocks 2 and 3- water shortage related. Best rain received since trial began. Buffel seedling regeneration in all Paddocks.

- 1974

Seventh year. Same wethers continue. Significant fly strike rates and a number of deaths. Some sheep escape from Paddock 3. Small worm burden in 2 Paddocks in Feb '74 - 1st time of note since trial began. Shorn 12 Aug '74.

- 1975

Eighth year. Trial continues. Sheep shorn 22 Aug '75. Pasture basal area recordings done but no pasture DMYs. No intestinal worms. Faecal N and P levels generally low. No treatment effects on wool growth or sheep liveweight. Low, even rainfall during year.

- 1976

Nineth year. Paddocks 4 and 6 no longer used in the trial from now on. Good rain especially in summer. Pasture basal areas done but no DMY recorded. Worms detected. Shorn 18 Sep '76 - no fleece weight differences due to treatments. High S/Rate sheep varied more in liveweight and other faecal parameters. Faecal N and P often lower when good rains because of DM dilution.

❖ 1977

Tenth year (76'-'77). No animal data during this year. Shorn 23/8/77; have fleece data. Many missing sheep at shearing. Plans to start a rotational grazing experiment discussed and approved. Use Paddocks 1 and 7 @ 5 and 2.5 sh/ha respectively and compare with set stocked Paddocks 2,3,5, and 8. Rotation aims to reduce bulky DM accumulation and graze pasture more evenly spatially.

❖ 1978

Eleventh year. Began rotations Nov '77 using weaner wethers. 64 sheep in Paddock 1 set and 32 in Paddock 7. Did Basal area recordings Nov '77. Dyebanding and mid-side clipping data reported; fleece data will be in '79 annual report. Individual faecal N and P and sheep LWt recordings presented. High worm burdens required drenching. Dry summer, wet winter. Few Paddock 8 fleeces available.

❖ 1979

Twelfth year. Shows when Paddocks rotated. Very poor data year. Fleece data for Paddocks 1,2 and 5; has LWt data but lost Paddock 3 sheep. Paddock 7 sheep died after Feb '79.

❖ 1980

Thirteenth year. Has LWts for Paddocks 2,3,5 and 8 and B/area data. New wethers in Feb '80. Lwts start 22/2/1980 and go to 7/10/80. Has fleece weights

❖ 1981

Fourteenth year. Has LWt data. No site rainfall data but generally a dry summer and wet winter. B/area done Oct '81.

❖ 1982

Fifteenth year. All Paddock 3 sheep perished from thirst in March '82. Trial terminated after shearing in Aug '82. No final basal area recording done.

Appendix 14. - Transcriptions of itinerant field and trial observations held on file about the 'Eastwood' Grazing Trial

Ex Small notepad labelled "Eastwood Paddock Yields"

15/8/1968 Paddock 6 all dead stalk with short green shoot that was too short to cut. Every sandalwood tree eaten.

10/12/1969 by R.G. Silcock

Almost no feed, dead or green, present in paddocks 4 and 6.

In Paddocks 2 and 8 there was very little green shoot and no green leaf. A fair amount of tough dead stalk remains. The DMY results seem a little high but this may be due to the weight of the basal parts of the plants.

In Paddocks 3 and 5, as in 1 and 7, there has been a green shoot following the October rain (1") but this has now been burnt off by the heat. There is still a great deal of dry feed in these paddocks but much is very old and stalky.

No flowering occurred after the rains. Grasshoppers bad in Paddock 7 especially and some in Paddock 1.

Sandalwood trees being defoliated, in Paddock 7 especially. It is a chewing defoliation. No grasshoppers seen on trees but there were leaf-hoppers and ants. The leafhoppers were ovipositing in the branches causing some damage, some leaves turning black before falling. Ants seem associated with the secretion of resins after the leafhoppers have oviposited.

Paddocks 1,3,5, and 7 look very good but 3 and 5 just eaten down a bit more. Paddocks 2 and 8 look in a bad way.

11/2/1970 by R.G. Silcock

Small green shoot in Paddocks 4 and 6. All speedie weed eaten in paddocks; probably pulled out by the roots.

Sheep had begun eating it at 4-6" height early in January but none left now. A new crop of weeds is just emerging after the rain and not being touched yet. Numbers high for new crop.

Paddock 2 has fair response to 175 pts of rain which fell 1 week before. Paddock 8 slightly better response with many new seedlings growing.

Paddocks 1 and 7 have plenty of feed but a lot of old dry stalk still.

Paddocks 3 and 5 have stacks of feed but response to rain rather slow and plants haven't elongated their stems yet.

Gavin Graham's summary in 1970 from earlier project files that he read when he started at Blackall - 29/9/67 to 10/1/68, says site spelled between April fencing and sheep introduction in September. Useful June rain with rapid pasture response but short-lived due to frosts. At end of Sept '67 good quantity of standing dry feed. Good pasture response to Dec-Jan rain. Nov '67 pasture sampling showed buffel dominance (mono-specific?). Coeff of Variance of DMY samples comparable in all Paddocks. No green pasture available in Sept or Dec pasture samplings.
Feb'68-Apr'68 comments - Feb-Mar rain promoted good buffel growth. Buffel seeding Jan-Mar and seed fallen by April. Good green feed until late March. Hot days caused rapid drying off of pasture.

Chemical analyses of pasture samples show reduction in nitrogen during Sept-Dec and increase in Dec-Jan.
Apr'68 to Aug'68 - Feed reached critical level in heaviest S/rate Paddocks by April with browsing of sandalwood shrubs. Remaining 3 treatments have feed in excess of needs.

1970-71, Gavin did several tests of the spatial variability of the Point Quadrat cover results and drew a map of the layout of the traverses done across the paddocks. This sampling pattern differs from the one proposed by Silcock the previous year. His graphs seem to show that to achieve a statistical significant $P<0.05$ with 2000 points you need >1.0% Basal Area difference around 3% BA, 1.5% diff around 6% BA and 1.75% around 9% BA.

11/3/71 - Gavin acknowledged the size of operator differences that can occur when determining hits under the point frame method and did a comparison of results achieved by himself compared to Graeme Lee. They did the same nominal 4 traverses of a Paddock with a 5-pt frame taking the same randomly predetermined 10 positions (fence panel numbers) and then 10 placements of the frame around each of those positions. They did this in Paddocks 2, 3, 7 and 8 which equates to 1 for each Stocking rate. At the time (Thurs) the buffel was very green and actively growing after a previous cloudy, drizzly weekend (50 mm).

In Paddock 7, GR Lee had 169 hits while TWG Graham had 320. The next day (12/3/71) someone or group assessed Paddocks 5, 8, 3 and 2.

In brown, bound ruled book labelled "Eastwood – Bkl P50 WR"

This book has lots of notes about the sampling methods used between Jan '71 and Mar '72. DMYs were done using exclosure cages, 3 exclosures per Paddock.

7/1/1972 good buffel seedling regeneration in all paddocks; speedie weed in all Paddocks [after 120 mm of rain at Xmas]

11/1/1972 other species in Paddocks include *Portulaca oleracea, Tribulus terrestris, Urochloa panicoides, Euphorbia drummondii, Sporobolus caroli, Boerhaavia diffusa, Bassia quinquicuspis, Chloris virgata*

In **Paddock 6** the proportions from the Point Quadrat test (2000 pts) were - Buffel 42 hits, *Salsola kali* 31, *Sporobolus caroli* 11, *Flaveria* 9, pigweed 6, *Tribulis terrestris* 4, *Euphorbia* spp. 2, *Boehaavia diffusa* 2, *Bassia quinquicuspis* 1 and *C. virgata* 1. Total 109 hits or 5.45% basal cover.

For **Paddock 4,** hits were - buffel 121, *S. kali* 14, *Flaveria* 4, *T. terrestris* 2, *B. quinqui* 2, *S.caroli* 1, - giving a total of 144 or BA of 7.2%

For **Paddock 2,** hits were buffel 73, pigweed 1, *Flaveria* 1, total 75 or 3.75% BA

For **Paddock 8,** hits were buffel 80 and no other species for 4.0% BA

For **Paddock 7**, hits were 126 for buffel and no other species, BA 6.3%

This shows that the pasture is virtually monospecific buffel under continuous grazing unless cover is very drastically reduced for a long time.

17/3/1972 Notes on buffel seedling regeneration and the main extra weeds and pasture yields from cage exclosures.

Paddock 1 good buffel seedling regeneration; some speedie weed. DMY 7831 – 10,860 kg/ha

Paddock 2	profuse speedie weed growth; not eaten. DMY 4371 – 6256 kg/ha
Paddock 3	good buffel seedling regen; little or no speedie weed. DMY 7471 – 16,155 kg/ha
Paddock 4	dense *Salsola kali* [Sheep back in after 18 mths spell]
Paddock 5	DMY 3702 – 7708 kg/ha
Paddock 6	dense *Salsola kali* [Sheep back in after 18 mths spell]
Paddock 7	good seedling regen; some speedie weed. DMY 10,467 – 13,572 kg/ha
Paddock 8	DMY 4948 – 7791 kg/ha

Ex Sheep and Wool branch Rept for Qtr ending 31 Dec 1974

Good Nov '73 rain produced green growth and buffel seed was maturing in mid-Dec 1973 in all paddocks.

274 mm of rain in 17 falls in Jan '74 caused deaths from blowfly strike and buffel seedling regen in Paddock 5.

Scattered rain in autumn kept pastures green until heavy July frosts damaged pasture quality.

At end of October, all pasture just standing hay.

Ex Annual report 1975/76

Pasture growth began mid-December '75 and continued until end of March 1976.

All paddocks carried a large body of feed, particularly the lightly stocked ones.

Buffel seedling establishment was very low, probably due to severe competition from existing plants.

Light falls of rain and frost during June, July and August affected pasture quality.

Ex battered, bound field results book 1977 – 1982 [mostly sheep liveweights - LWt]

1977	Nov	7	Commenced rotational grazing phase; Paddock 1 and 7 began in sect 1; mostly wethers but a few ewes
1978	Jan	24	Paddock 1 sheep moved to Sectn 2
	Mar	7	Paddock 1 sheep to sectn 3 and Paddock 7 to sectn 2
	May	4	Paddock 1 sheep to sectn 4 and Paddock 7 to sectn 3
		4	Some Paddock 3 sheep got mixed up with Paddock 8
	Aug	9	Paddock 1 sheep moved to section 1 and Paddock 7 sheep moved to sectn 4
		9	No dyebands put on Paddock 3 sheep
			A few flystruck sheep noticed at shearing
			Some Paddock 5 sheep bled for national bluetongue survey sometime in 1978
	Oct	4	Paddock 1 sheep moved from section 1 to section 2 and Paddock 7 sheep moved to their section 1
1979	Jan	4	Paddock 1 sheep moved to sect 3 and Paddock 7 sheep to their sect 2
	Jun	6	All sheep drenched and branded
	Aug	8	Last weighing before shearing
			Re-stratified all sheep on LWt into Paddocks 2,3,5 and 8

1980	Feb	22	All sheep drenched with Thibenzole
	May	3	worm counts from faecal samples low (3 <40 and 2@200 eggs/gram epg) so did not drench again
	Jun	6	most sheep got out of Paddock 3 into lambing paddock; returned 21/5/1980?

Most recorded weighings are accompanied by cryptic notes about losses, struck sheep, drenchings and dipping if carried out.