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Sown temperate pasture decline - fact or fiction

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Abstract: Experimental evidence for the decline of sown pasture is reviewed. On-farm plant surveys provide useful indices of botanical status. However, the performance of grazing animals is the ultimate test for the reality *versus* the perception of pasture decline. Animal data are best provided by experiment rather than by survey, because many non-pasture decisions can affect animal production. To show the connection between sown species loss and animal production, we have summarised a 30-year study based on well-fertilised, sown temperate pastures set stocked from zero to 30 dse/ha. Long-term botanical changes were markedly non-linear and are explained as the joint effects of species competition, stress from severe drought, a reduced legume-based nitrogen economy, and disturbance from stocking rate and grazing preference. Reduced wool production and nutritional status were associated with loss of sown species, but the relationship was strongly dependent on stocking rate, where consideration of animal welfare, risk and utility and need for supplementary feeding are also important. Fertiliser input is also critical, and evidence is drawn from three major experiments based on sown pasture and combinations of superphosphate level and sheep stocking rate. Responses overall are remarkably consistent and provide a reminder that these two decisions are paramount for sustaining production. Legume presence also ranks highly. Claims for benefits from rotational grazing systems *versus* set stocking are noted. It is concluded that pasture decline, when assessed as loss of sown species, is not fiction. However, the causes and effects of such loss on production are inseparable from decisions on fertiliser, stocking and legume presence.

Playing the sceptic

Six years ago, Ken Archer and his colleagues addressed this question at your conference (Archer *et al.* 1993). In their widely ranging review they examined economic evidence, farm survey data, pasture pests and diseases and the impact of far reaching problems such as inadequate plant cover, soil acidification, and dryland salinity. We have narrowed the focus and directed attention to the experimental evidence for decline of our sown, temperate pastures, the processes that govern change in these communities, the importance of decisions on fertiliser and stocking rate, and the topical issue of benefits to be gained from grazing management.

Popper (1968) reminds researchers of the need to 'subject their ever tentative conclusions to ever renewed and ever more rigorous testing'. Thus, while the prevailing view is that our sown temperate pastures are in serious decline, an examination of experimental evidence may be timely. Is the decline just perception or is it a reality? Reports of change in pasture composition are consistent, but do these necessarily constitute production decline for the grazer and/or the grazed?

Measuring the production of grazed pastures is not easy. Herbage mass by itself is not a measure of pasture production because of the processes of growth, consumption, death and decomposition are continuous ones. What you record in a grazed pasture at any point of time is what the animals have **not** eaten and indeed may never eat; thus assessments can be biased against sown species which have high grazing preference. Also, some replacement species can be valuable and hence a loss of sown components does not automatically confer decline. Claims for loss of a plant species may not be upheld for long because of its potential regeneration from residual and migratory propagules. Sequences of good or poor seasonal conditions can either mask or inflate the perception of decline. Most importantly, apparent pasture decline needs to be backed by evidence of an accompanying loss in animal production, and here unconfounded data are in short supply. Finally, little effort has been devoted to studying the interplay of key factors and mechanisms that govern botanical change in our grazed temperate pastures under a range of manage-ments and hence our ability to predict the time course for pasture change is limited.

Temperate pastures of the high rainfall zone (HRZ)

The results of published surveys of the botanical status of temperate HRZ pastures have been tabulated by Wilson and Simpson (1993). The authors note that farm pastures rarely conform to the agronomic ideal and they calculate that large areas of sown temperate pastures are at least 25 years old, with their perennial grasses being replaced largely by annual species. However, the sowing of exotic perennial grasses was only one part of the pasture revolution of the fifties; the other important elements were the use of superphosphate and the sowing of exotic legumes. At that time, the value of native perennial grasses was largely dismissed on the grounds that natives would be less responsive to enhanced soil nutrient status (phosphorus, sulphur and legume nitrogen) and they were of low nutritive value with little winter production. In recent decades these assumptions have been vigorously and usefully debated. Currently however, the championing of native *versus* exotic grasses has become a distraction. Species origin should be irrelevant to the grazing enterprise and research must focus on evaluating potential contributions from either group to the enhancement of agroecosystem function. Here the key biological issues are plant and animal yield, their quality, seasonal distribution and persistence, soil cover, hydrology, the retention and biological recycling of nutrients and the needs for fertiliser. It should be recognised that sown legumes play a pivotal role by providing nitrogen input to sustain pasture production as well as a high-quality diet for grazing animals. Of course there is a downside to legume-dominated pastures; the development of soil acidification and bloat are examples, but such issues are not part of this review.

The 30-year Big Ridge site

The Big Ridge area (alt. 1050m) was sown to phalaris (cv. Australian) and white clover (cv. Huia) in 1958. In 1964 plots of 0.4 ha were set stocked with Merino wethers at 10, 20 and 30 dse/ha. In 1965 and 1980, there were two major droughts and post 1980 stocking rates were revised to 10, 15 and 20 dse/ha on ethical grounds. A fourth treatment of 40 dse/ha was abandoned in 1968 and left ungrazed for the next 30 years. A split-plot fertiliser rundown experiment was imposed on half of the experiment in 1978 but those results will not be presented here. Data (1965 to 1980) from the remaining grazed plots (3 stocking rates by 2 replicates) have been chosen to illustrate the impact of sown species loss on wool production from fine-woolled Merino wethers and the calculated values for their metabolisable energy intake (MEI) from pasture (Hutchinson *et al.* 1998). The plots were fertilised annually with 250 kg/ha of single superphosphate from 1963 and with 125 kg/ha of potassium chloride until 1988. The basal cover (BC%) of plant species was estimated as ground level hits of plant bases per 100 points using a vertical 10 pin frame (Levy and Madden 1933) with 800 points/plot/year. BC% was recorded in May 1964 and in the last week in September in all subsequent years until 1993.

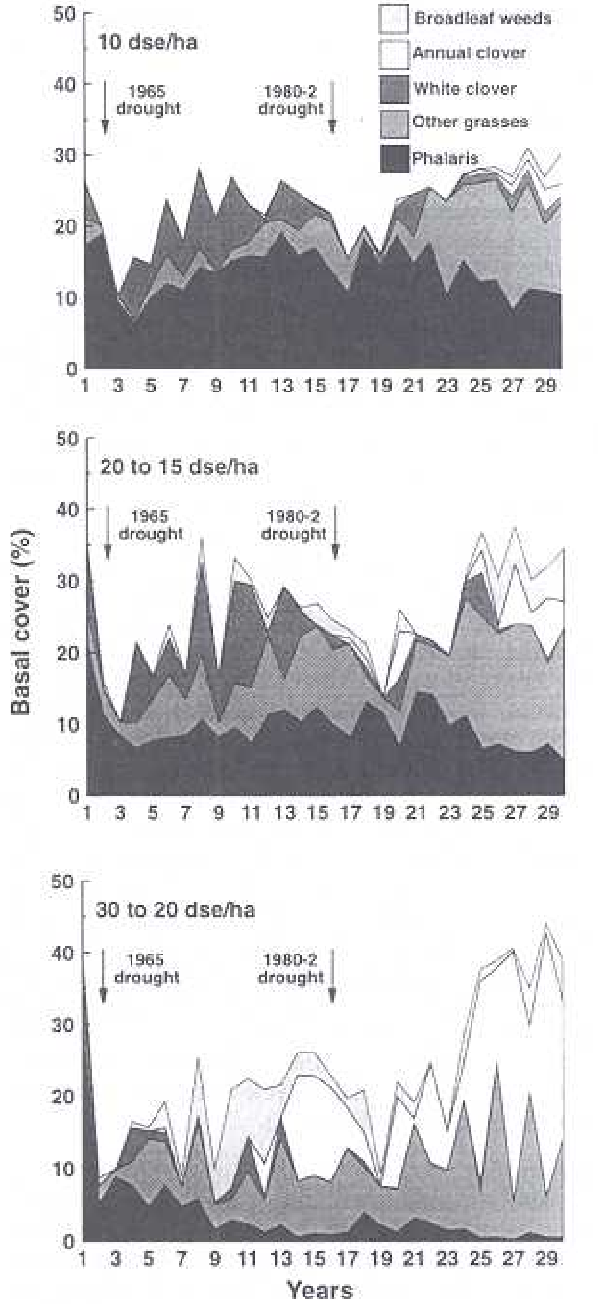

Figure 1. Area diagram showing changes over 30 years in spring presence of sown phalaris and white clover, annual clovers, other grasses and broad-leafed weeds (1964 to 1993). The pastures at Armidale NSW were well-fertilised, stocked at three levels and suffered two major droughts.

Spring measurements of BC% were chosen because the primary aim was to monitor the presence of cool-season species.

Long-term agronomic changes

A summary is presented of changes in the presence of major species and agronomic groups (Figure 1). Details of species succession, association and diversity under the four stocking levels will be published elsewhere. Sites were botanically diverse with more than 100 species being listed over the whole area.

White clover

The persistence of white clover in the northern temperate high rainfall zone (HRZ) is a major problem. Producers often refer to white clover as their 'fair weather friend'. Limitations of this species and potential for new cultivars have been summarised recently (Lane *et al.* 1997). Data presented here are from the Big Ridge study and show the dominant and interacting effects of stocking rate and drought on the presence of white clover in well-fertilised pastures (Figure 1). Detailed analysis of these data has shown the striking effect of moisture stress in late summer and autumn on white clover presence in the following spring (Hutchinson *et al.* 1995) and this is due to the death of white clover stolons (Archer and Robinson 1989). A high frequency of stolon death imposes dependence for regeneration on the white clover seed bank and its reserves can become limiting in the long- term, particularly under heavy stocking where annual clovers (prolific seeders) assume dominance (Figure 1). However, white clover is never extinguished and with a run of good seasons it can emerge and spread from patches with reserves of hard seed. Nevertheless, reseeding is often warranted to achieve a good cover quickly and at a relatively low cost. In kinder temperate climates, with a low frequency of stolon death, a cycle of clover-grass-clover dominance may occur (Turkington and Harper 1979), driven presumably by a build up of legume-derived soil nitrogen (N), and decline as a result of competition from the perennial grass. Between 1966 and 1980, a comparison of the timing of trends for phalaris and white clover suggests that part of such a cycle occurred in the low stocking treatment (Figure 2).

Australian phalaris - a model of persistence

The Australian cultivar is known for its resilience post-drought, but its recovery is strongly influenced by stocking rate (Figure 1). It is of interest that during the course of the 30-year Big Ridge experiment, observers have never noted any seedling-based regeneration of this cultivar. Its strategy for vegetative regeneration would seem to be based on the amount and distribution of rhizomatous meristem as a source of tillers. This resource is likely to be governed by the defoliation frequency of young tillers by grazing sheep. The status of plant reserves, influenced by drought and defoliation interaction, is clearly involved (Scott *et al.* 1997). Competitive and suppressive mechanisms and escape through low accessibility of meristem to the grazer may also contribute to the persistence of Australian phalaris in a diverse community. The likely interplay of these factors will be discussed later.

A drift towards 'annual' grasses - is this inevitable?

The main annual and short-lived perennial grass genera recorded at Big Ridge were *Poa, Bromus, Vulpia, Hordeum* and *Eleusine*. These appear to be common replacements for sown perennial grasses through the temperate HRZ (Wilson and Simpson 1993). Replacement of phalaris by 'annual' grasses was slower under conservative stocking (10 dse/ha) but it was substantial by the 23rd year of the experiment (Figure 1). Over the last seven years of the experiment, quasi-equilibria between phalaris and 'annual' grasses were achieved with approximate ratios of 1:1 for 10 dse/ha and 1:2 for the intermediate stocking rate. Over the same time period, the presence of sown phalaris at the highest stocking level was negligible. It is of interest that in the ungrazed sites (data not shown), phalaris had achieved virtually complete dominance by the mid-seventies and has sustained this dominance. It seems reasonable to conclude that the replacement of phalaris by 'annual' grasses is governed mainly by the effects of stocking rate and grazing preference acting interactively over time. Success-ional advantages for the cool season annual can be attributed to a preference ranking lower than phalaris, to an escape from grazing over the summer and early autumn, and to use a strategy (seed pool), which is less exposed to grazing than the vegetative regeneration of phalaris.

The dicots

Annual clovers, notably nodding (*Trifolium cernuum*) and clustered (*T. glomeratum*), became

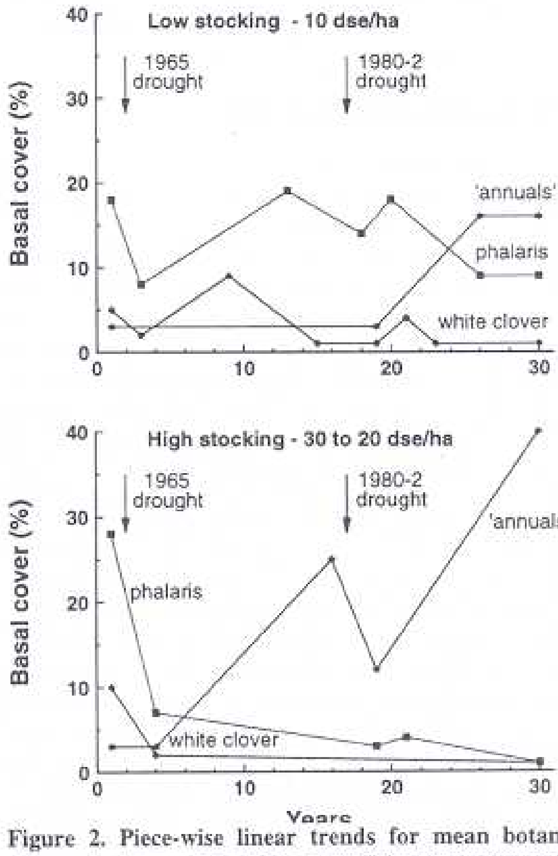

Figure 2. Piece-wise linear trends for mean botanical change in low *versus* high set-stocking treatments. The linear sections approximate least squares smoothing of data from replicated plots.

dominant in the high stocking rate treatments (years 12 to 30 in Figure 1). This was an important succession and plays a major role in the annualisation of these communities. There was also some late emergence of annual clovers (years 28 and 18) in other stocking treatments (Figure 1). These annuals have a relatively short growing season during the winter-spring (about 5 months), are highly preferred by sheep and other vertebrate fauna and are prolific seeders. There is also evidence of a short-term, cyclical dominance alternating with the annual grasses. This suggests that the annual clovers make a useful contribution to the N economy of these heavily grazed communities.

The main broad-leafed 'weeds' were *Hypo-choeris radicata*, *Paronychia braziliana*, *Cerastium glomeratum* and *Crassula peduncularis*. A weed is often defined as a plant in the wrong place; however wrongness can be a matter of subjective conviction. Broad-leafed 'weeds' appear to play gap-filling roles, but some could have significant forage value.

Explaining long-term change

Grime (1979) proposed a triangular ordination of grassland species based on their competitive ability, their tolerance to stress and their capability to cope with disturbance from fire, cultivation, treading and grazing. One aim of the Big Ridge study was to provide sufficient temporal data to evaluate

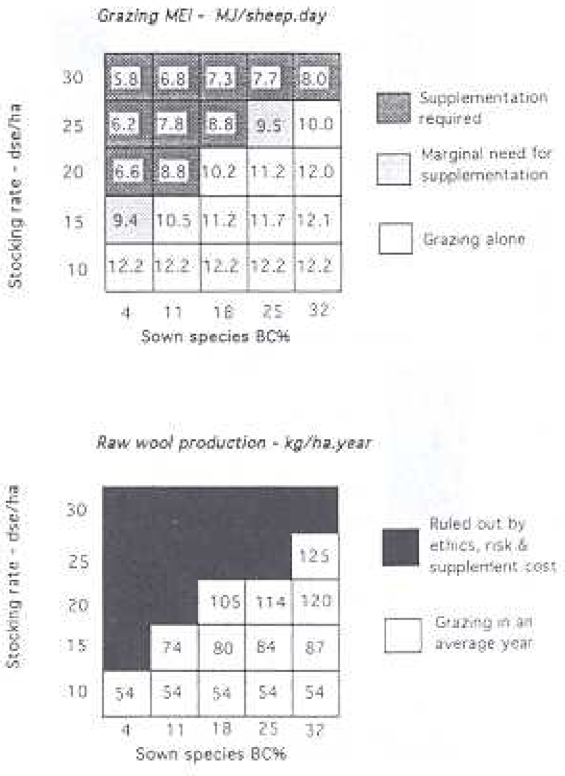

Figure 3. Metabolisable energy intake from grazing and annual wool production related to sown species presence and stocking rate in well-fertilised pastures at Armidale NSW (adapted from Hutchinson *et al.* 1998).

successional changes in temperate sown pastures subjected to a wide range of set stocking levels and subject to severe drought. Grime's model provides a useful starting point for explaining the joint and interactive effects of competition (C) between species, stresses (S) due to drought and poor clover presence (N economy) and disturbance (D) due to the combined effects of stocking level and selective grazing. Interactions are likely to be complex and long-term responses markedly non-linear. Trends are based on 30-year mean data for low and high stocking treatments (Figure 2). Linear approximations for fitted trends are presented and the following emerged:

- There was a major interaction between stocking rate and drought, shown by substantial differences in the recovery (resilience) of the two sown species and in the onset of 'annualisation'. At the high stocking rate 'annualisation' emerged in year 4; under conservative stocking this did not occur until year 19 and after two major droughts.
- At the low stocking level, difference in the timing of decline for white clover *versus* phalaris warrants comment. It suggests a short term cyclical dominance (years 3-13), which is followed by poor legume presence. This would reduce the legume N economy and could contribute to the subsequent decline of phalaris. Attention has been drawn recently to the association between ageing of sown grass pastures and production decline (Jones 1996). For the pasture community, age in a narrow sense could be viewed as a marker for time and it is important to identify the underlying cause of decline. For example, a substantial fall in cattle liveweight gain has been associated with the age of green panic pastures and then attributed to reduced mineralisation of nitrogen (Robbins *et al.* 1986). Of historical interest was a comparable view that decline in phalaris pasture with age was due to poor mineralisation of its organic residues, characteristically leaving the pasture sod-bound (White 1959).
- A major factor governing species change arises from the opposing influences of competitive dominance from the tall perennial phalaris with its suppressive litter mat (*e.g.* Leigh and Halsall 1994) *versus* increasing disturbance levels from the combined effects of selective predation and stocking rate. The latter increases the opportunity (gaps) for other species to establish. Pasture litter is an important resource, providing soil cover and a major food source for useful soil biota. The question of balance between litter levels and the degree of pasture utilisation is important.

The C-S-D interpretation (Grime 1979) provides a useful starting point, but additional influences could be added. Herbivory, for example, can also restructure grazed plant communities by a patchy redistribution of nutrients from animal excreta.

Animal production - does loss of sown species matter?

Choice of stocking level has a powerful influence on both animal production/hectare (McMeekan 1956) and the loss of sown species (Figure 1). Aversion to risk, utility, the cost of supplementary feeding, and commodity prices are also major factors in stocking policy decisions (McArthur and Dillon 1971). Consideration of the ethics of animal welfare and the cost of losing the sown pasture resource must be added. Given this complexity, we have reduced the data on sheep responses to sown species loss at Big Ridge, so that the question posed in the title of this review can be addressed. The maximum level for wool production per hectare has been set so that grazing alone provided maintenance energy to support a minimum body condition score of 3 for adult Merino wethers (SCA 1990) in an average rainfall year. In drier years, either some supplementary feeding would be necessary or sheep numbers would need to be reduced. The mean annual rainfall at the Big Ridge site was 888 mm for the years 1964 to 1979. The ability of wethers to harvest metabolisable energy (ME) was calculated from data on liveweight performance and appropriate energy conversion parameters. Wool production per hectare and ME intake (MEI) were then related to stocking level and a declining presence of sown species using published equations (Hutchinson *et al.* 1998). Responses have been reduced to two-dimensions with predicted values recorded in cells in a 2-dimensional matrix (Figure 3). This format has also been followed in Figures 4 to 6.

Values for grazing-based MEI in the hatched cells indicate levels of nutrition from pasture which failed to support the body condition of Merino wethers at an acceptable level (9.5 MJ/ha sheep/day). The need for supplementary feeding becomes progressively greater at the higher combinations of stocking level and sown species loss. Values for MEI and annual wool production per hectare show similar trends, both indicating substantial interaction between sown species loss and stocking rate. At low stocking rates (10 dse/ha), sown species loss did not influence production, whereas at high stocking rates (20 dse/ha), a 44% loss in sown species resulted in a 13% reduction in wool cut per hectare. Wool cuts above 100 kg/ha from 'agro-nomically ideal' pastures were a feature in exper-iments of the 1970's (*e.g.* Langlands and Bennett 1973). Two further points must be stressed. Firstly, the impact of sown species loss on prime lamb production, which is demanding of high nutritive value in pasture, would be expected to be greater. Secondly, the Big Ridge experiment received high and sustained fertiliser input. As is the case for stocking rate, fertiliser use can have major effects on production and pasture decline may also be involved.

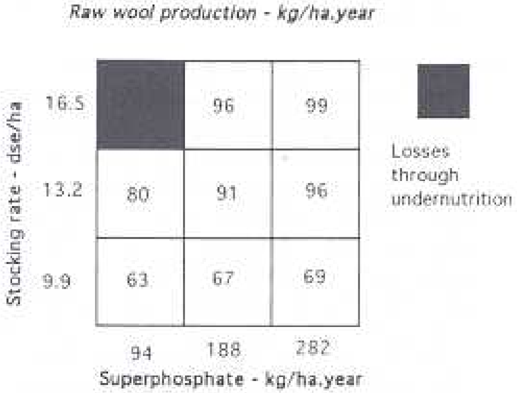

Figure 4. Annual wool production per hectare related to superphosphate levels and stocking rate for sown pastures at Kangaroo Island SA (adapted from Carter and Day 1970).

Fertiliser - a major decision

Superphosphate, Species (notably sub-clover) and Stocking rate (the 3 S's) was the catchcry for the sown pasture revolution of the fifties. With the low prices for wool and meat in the nineties, research attention turned away from fertilisers to

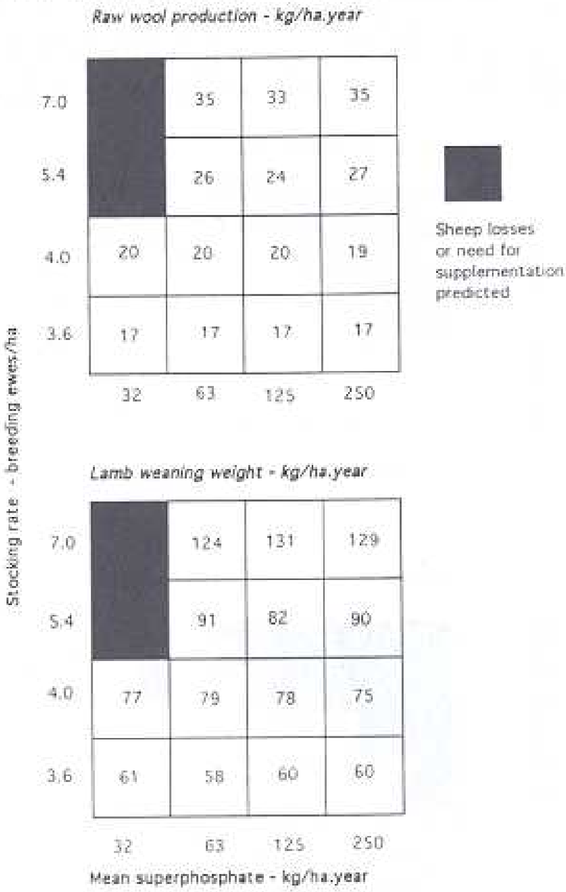

Figure 5. Annual wool production and lamb weaning weight per hectare related to mean superphosphate levels and stocking rate at Stuart Town NSW (adapted

grazing management in a search for a low-cost solution to the perceived decline of our temperate pasture resource. However, from time to time the valid question has been raised as to whether a lowered use of fertiliser may itself be a major cause of pasture decline. Hence it is timely to summarise findings of three major experiments which have investigated responses involving levels of fertiliser input.

The joint effects of superphosphate and stocking rate on production from strong-woolled Merino wethers were investigated in a three-year grazing experiment at Kangaroo Island, SA (Carter and Day 1970). Prior to the experiment, three tonnes per hectare of superphosphate had been applied. The mean annual rainfall for the three years was about 500 mm. The species sown were perennial ryegrass and subterranean clover. However, there was a substantial presence (53%) of other grasses and dicots in the pastures. Single superphosphate rates ranged from 94 to 282 kg/ha/year and set stocking rates from 9.9 to 16.5 dse/ha. There was no association between fertiliser input and species composition over the three year period There were significant responses to both superphosphate and stocking rate and the data showed that a combination of high rates of stocking (16.5 Merino wethers/ha) and superphosphate produced about 100 kg/ha of wool (Figure 4). Wool production responses from the Big Ridge experiment, which received 250 kg/ha superphosphate per year, were comparable.

A 10-year experiment at Stuart Town, NSW (Davies *et al.* 1998) was based on combinations of superphosphate use (annual equivalents of 32, 63, 125 and 250 kg/ha/year) and stocking levels of breeding ewes with lambs held to weaning (3.6, 4.0, 5.4 and 7.0 ewes/ha). About 1 tonne/ha of superphosphate had been applied prior to the experiment. Mean data for 2 three-year periods (1984-6 and 1987-9) have been extracted for this review and the mean annual rainfalls for these two periods were 648 and 629 mm respectively. There were no effects from fertiliser or stocking rate on spring pasture composition (sub-clover 49%, phalaris 5% and other grasses and dicots 46%) and lambing performance. Data for wool production and weight of lambs weaned per hectare (assuming 80% lambing) are given in Figure 5. The main result was a linear response in animal production to stocking rate, which suggests that the stocking levels used were below the technical maximum production per hectare. However, most producers choose to operate at a conservative level on the basis of risk and utility (McArthur and Dillon 1971). Wool and lamb production did not respond to additional super-phosphate, but data for available soil phosphate indicated that this level of production could be sustained with a modest input of superphosphate (equivalent to 63 kg/ha/year).

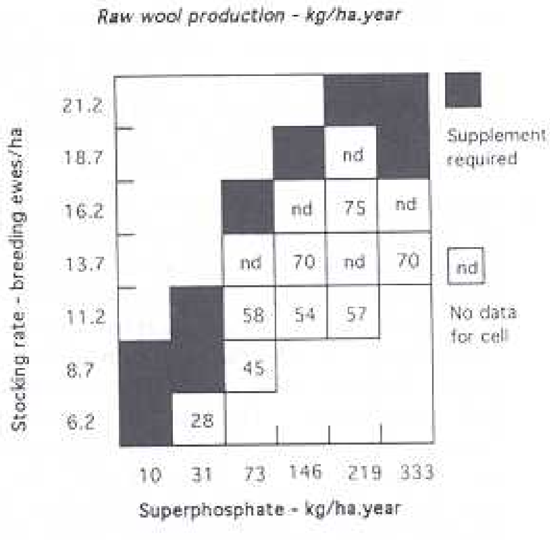

Figure 6. Annual wool production per hectare from breeding ewes related to widely ranging but incomplete combinations of superphosphate levels and stocking rates at Hamilton Vic. (adapted from Saul 1994).

The third major fertiliser by stocking experiment is referred to as the Long Term Phosphate Experiment (LTPE), located at Hamilton, Victoria, and now in its 21st year. Results have provided the stimulus for the current Grassland Productivity Program which has been extended through that state and beyond (Saul 1998). The widely ranging combinations of stocking and superphosphate levels used in the LTPE were selected on the reasonable ground that increased levels of superphosphate would be unwarranted and certainly unprofitable without a commensurate increase in stocking rate. For this review, we have blocked the stocking treatments into 2.5 breeding ewe classes to provide a consistent format. Cells in which winter supplementary feeding was required (Saul 1994) have been blacked out in Figure 6 in order to present responses in wool production from grazing alone. Production responded to both superphosphate and stocking, with maximum wool production at levels of 14-16 breeding ewes/ha and about 200 kg/ha of superphosphate. Allowing for reduced wool production from breeding ewes (*versus* wethers) due to the nutritional demands of gestation and lactation, this peak response is comparable to the Big Ridge result. Valuable auxiliary data have been provided for the effects of long-term superphosphate use on the nutritive value of pasture species biomass (Saul 1998). The largest increase in estimated digestibility occurred in subterranean clover and values for several commonly occurring annual grasses were comparable to perennial ryegrass.

In summary, the evidence from the four major experiments that have been reviewed is consistent and provides a reasonably secure basis for resolving the importance of the 3S's for sustaining the production of sown, set stocked and continuously grazed sheep pastures. The value of managing the grazing process remains to be examined.

Continuous *versus* intermittent grazing.

The early argument for intermittent grazing was based largely on the shape of the logistic relationship between leaf area and pasture growth rate and the assumption that management of the grazing process should aim to maintain leaf area within the near linear range of response. A recent review provides a more detailed perspective (Lemaire and Chapman 1996). This includes the influence of leaf lifespan, senescence and the internal N economy of the plant, along with animal factors such as stocking rate and the proportion of the sward grazed each day. The authors conclude that differences in pasture growth between continuously and intermittently grazed pastures will be small. Since most studies have been based on 'agronomically ideal' pastures, we could add further effects on mean pasture growth from the wide range of growth rates, patterns and grazing preferences in species-rich 'degraded' pastures. The issue is complex and, hence, it is important to evaluate animal data from experiments that have compared continuous with rotational systems. Two major Australian experi-ments are noteworthy: both were conducted in sown pastures in southern temperate HRZ and both were soundly designed and continued over a four year period (Moore *et al.* 1946; Morley *et al.* 1969). Neither provided any evidence for an increase in animal production from their rotational sequences.

From the plant viewpoint, there is undeniable evidence that grazing management can affect pasture composition, at least in the short term. The evidence has been reviewed recently (Fitzgerald and Lodge 1997) and advice given on seasonal periods when valuable species are most vulnerable to grazing pressure. Given a range of land capabilities and pasture types on many farms, implementation of these modest proposals seems feasible. However, advocacy for cell grazing systems is at a different scale. Unconfounded comparisons are difficult and lengthy time periods are needed to demonstrate claimed ecological changes. At the present time, advocacy for cell grazing appears to be based on 'subjective conviction', whereas 'scientific object-ivity must be the path of science' (Popper 1968). This is not necessarily a criticism. Subjective conviction is the basis for the management of many enterprises and is often associated with success; however, the underlying reasons for such success can remain undefined.

Summing up

The following points summarise the evidence that has been assembled:

- A decline in sheep nutrition and wool production can be attributed to loss of sown species (phalaris/white clover) in well-fertilised pastures. Losses increase progressively with set stocking level and with time. However the trend is non-linear and temporal change can be influenced by drought and a decline in the legume N economy.
- Successional change is consistently directed towards annualisation. This can be attributed partly to poor climatic adaptation of the species sown (*e.g.* Kemp and Dowling 1991). However at any one site, the loss of sown and palatable perennial grasses can be primarily explained as a balance between their strong competitive ability under conservative stocking *versus* their vulnerability to increased levels of disturbance from the combination of high stocking rates and grazing preference. Gaps produced provide the opportunity for replacement species to establish.
- Well-adapted, sown legumes have a pervasive influence on both pasture and animal production. It is difficult to estimate the total contribution of legumes. Firstly the nitrogen economy of Australian temperate pastures is legume-based. Secondly, legume decline in the Big Ridge experiment was associated with a subsequent decline of the sown perennial grass. Finally, the very high nutritive value of legumes *per se* has been confirmed in many studies.
- The effect of loss of the sown perennial grass on production is also difficult to isolate. The presence of sown perennial grasses has been linked to rainfall and altitude (Kemp and Dowling 1991), adding to the difficulty. There was low presence of sown perennial grass in both the Kangaroo Island and the Stuart Town experiments, but sub-clover was abundant and the wool production responses were reasonably consistent with the Big Ridge and Hamilton data. Beneficial processes attributed to deep-rooted perennial grasses could include a lengthening of the pasture growing season, a better hydrology and an enhanced nutrient uptake. A contribution to production of 25% from the sown perennial grass appears feasible.
- There is a long Australian history of research on the phosphorus (P) and sulphur (S) needs of pasture, involving the traditional use of single superphosphate (9% P:10% S). Evidence shows the value of building a superphosphate application history (*e.g.* 1 tonne/ha), and then sustaining pasture response with maintenance additions (63-125 kg/ha/year). The Stuart Town experiment provides an example of this low-input option, which needs to be supported by a persistent legume such as subterranean clover (Rossiter 1964). A different option would be a high input fertiliser regime, which produces a good gross margins outcome (Saul 1998). This may require land of high capability and a reliable climate, preferably with a long growing season. Response would appear to be based on

better winter growth of the sown species, a higher nutritive value of those species as a result of the high fertiliser input, and scope for some grazing management and limited supplementary feeding.

- Grazing management, which is targeted at reducing grazing disturbance at critical times, may promote the persistence of sown species. It is a truism that the botanical composition of any one portion of the pasture resource can be improved by grazing management involving 'putting and taking' from the farm animal pool. However, the feasible use of this practice depends on the diversity of the soil-pasture-animal resource of the farm enterprise and this can be ignored in 'put and take' experiments.

The verdict

Sown temperate pasture decline is fact not fiction, although some 'facts' can be illusory. The status of sown, temperate pastures is driven by management decisions on stocking type and level, long term fertiliser strategy, and the extent to which management of the grazing process can stabilise the grazing resource without compromising animal production. When these decisions are combined with other physical, biological, economic and social constraints such as climate, land area and capability, diverse on-farm pasture and animal resources, risk and utility, environmental and regulatory issues, commodity prices, debt to equity ratio and externals such as income stability to be gained from off-farm investment, then a substantial choice of management strategies for providing stable and productive grazing enterprises must emerge The ultimate challenge for research and development is to pack-age information on these issues so that managers can make better choices.

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