PASTURE DECLINE:

PASTURE DECLINE - REAL OR IMAGINED?

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Abstract: Pastures contribute about $8-12 billion each year to the Australian economy and are essential to the well-being of the whole community. There is evidence, however, of pasture decline and a fall in potential productivity during the past two decades with a 47% decline in the carrying capacity of non-crop areas between 1970 and 1984. More than 35% of farmers have a land degradation problem which equates to a $2055 million loss in the high rainfall zone alone. In south west Victoria, pasture composition was identified as a cause for decline in wool production and stocking rate which fell from 13 to 11 DSE/ha. On the Central Tablelands of NSW pastures were low in clover with high proportions of undesirable annual grasses (*eg.* vulpia). Low legume content limits animal production and does not maintain the soil nitrogen at adequatelevels. The high cost (>$150/ha) and the 5-8 year period needed to recovery investment costs preclude re-sowing as a feasible option. It is a concern that more than half of our cropping and grazing land requires treatment for erosion. Structural decline now affects about 28% of the cropping soils in NSW, dryland salinity affects many parts of Victoria and the slopes in NSW, and acidification affects productivity on more than 14 million ha in NSW alone. Declining fertility due to irregular fertiliser application may also contribute to general pasture decline. Drought in combination with excessive grazing pressure has caused a decline in the amount of legume and phalaris in pastures on the Northern Tablelands. Root rot diseases in clovers reduce clover persistence and along with insect pests which seriously affect pasture establishment contribute to insidious production losses in established pastures. The challenge is to understand these factors and apply management strategies that maintain pasture productivity and create a profitable return.

INTRODUCTION

Pastures are our most valuable natural resource, contributing around $8 - 12 billion per year to the national economy or over 60% of the value of all agricultural products. The direct contribution of pastures is through production of livestock - wool, meat and dairy products. Pastures also make a significant contribution to cereal crop production through nitrogen fixation by leguminous pastures grown in crop rotations, and play a critical role in sustaining the nation's soil and water resources. Where degradation has occurred, solutions to stabilise or reverse these processes will usually involve the use of pastures in combination with other management practices.

The sustainability of the productive capacity of our pastures and grasslands is therefore essential to the benefit of the whole community, both rural and urban. The issue of pasture decline, and whether it is fact or fiction, must be seriously addressed, and if proven, must be overcome.

EVIDENCE FOR PASTURE DECLINE

Direct evidence for pasture decline is not readily available or documented. Rather, the case for decline tends mostly to be anecdotal, a composite of widespread observations by producers, advisers and scientists. Detailed measurements over the last three decades are simply not available or are fragmented. However, on the balance of evidence available, we believe that production from a significant proportion of our pastures has declined over the last couple of decades.

Economic evidence of pasture decline.

Results of a study by Vere and Muir (1987) have provided evidence of a declining trend in overall productivity of pastures on the central and southern tablelands. Their long-term economic analyses showed a decline in both carrying capacities and wool production from pastures in the region during the 1970's and early 80's. Subsequent trends have yet to analysed. Wheeler (1986) cites BAE data which indicates that the carrying capacity in non-crop areas of NSW fell by a massive 47% between 1970 and 1984. Between 1973 and 1983, the average carrying capacity was reduced by 0.9 dse/ha or 25%.

Hall and Hyberg (1991) reported results of a 1984 ABARE survey designed to collect production and financial data in relation to degradation. A total of 37% of farmers indicated they either had a problem or a potential problem. By comparing the financial situation of this group with a control group of farmers who considered that they did not have a problem, it was estimated that the loss in production due to perceived degradation was 6.2% or $4835 per farm. In the high rainfall zone, this loss was estimated to total $2055 million. It was concluded that "other things being equal, farms whose operators believed that they had a land degradation problem tended to produce less output than that of other producers." It is axiomatic that pasture decline is associated with land degradation.

A problem with this type of analysis is to differentiate cause from effect. In other words, was pasture decline the cause of lower farm income or were unfavourable economic factors *(eg.* lower prices and higher costs) responsible for the pasture decline in the first place? In the latter case, lower profitability would contribute to pasture decline due to reduced inputs and changed grazing conditions (*eg.* reduced fertiliser application and higher grazing pressures).

Botanical evidence of pasture decline.

There is evidence that reduced farm inputs may have at least contributed to pasture decline. Schroder *et al.* (1992) conducted a botanical and production survey of farms in SW Victoria during 1988-90. Although the potential productivity of pastures in this region was considered to be 95 kg wool per hectare per year, average wool production on the farms surveyed was only 44 kg/ha. While this figure had not actually changed for 20 years, stocking rate dropped from 13 to 11 dse/ha. Poor pastures were considered to be the major reason for the low levels of wool production. Pasture growth varied from 4.4 to 9.3 t DM/ha/year, and only 5% of paddocks contained a minimum of both 20% subterranean clover and 30% improved perennial grasses. The three highest ranked farms spent $6.50/ha (60%) more on their pastures, stocked them at 2.0 dse/ha (19%) higher and spent $10.40/ha (31%) less on supplementary feed in comparison with the three lowest ranked farms. This suggests that pasture condition and livestock production can be maintained at high levels if economic circumstances allow.

Kemp and Dowling (1991) conducted a survey of the botanical composition of pastures on the central tablelands of NSW during spring of 1988 and 1989. Their results were strikingly similar to that found by Schroder *et al.* (1992), with pastures containing on average only 21% improved perennial grasses and 36% annual grasses. Average clover levels in the NSW study were 42% (both white and subterranean clovers) compared to 22% in Victoria. Kemp and Dowling (1991) suggested, that because many pastures in the high rainfall areas did not exceed 30-40% legume during relatively favourable spring conditions, the quality of these pastures is much less than desired for maximum animal production and is minimal for maintenance of the nitrogen economy of the pastures. A concern in both studies was the high proportion of annual grasses, much of which was Vulpia spp. Results from a further survey in Victoria led Quigley *et al.* (1992) to conclude that it is incorrect to assume that the foundation of pastures in SW Victoria is perennial grasses and subterranean clover. The results of Kemp and Dowling (1991) would lead to similar conclusions for central NSW despite the fact that these pastures were sown to and would have originally contained higher proportions of the desirable species.

One of the most serious effects of pasture decline is the cost involved in resowing degraded pastures. On the central and southern tablelands, the area of improved pasture has not changed since 1972 (about 1.2 m hectares) so that all pasture sowings since then must have effectively been to replace existing pastures. Pasture establishment costs range from $150 - 170 per hectare, and it may take 5-8 years to recover the initial outlay (Vere *et al.*, 1993). The need to frequently resow pastures therefore has serious implications for farm profitability.

CAUSES OF PASTURE DECLINE

Many factors are obviously implicated in pasture decline including the loss of desirable species, reduced vigour and weed invasion. By their very nature, grazed communities are inherently unstable and dynamic, and tend to move between different equilibrium states. The transition phases are due to combinations of many natural or imposed forces. The likelihood of significant transitions from one state to another is greatly increased if man intervenes in combination with natural stresses, for example, overstocking in drought (Hutchinson 1992). Unfortunately, most changes are to a lower production state, but improvement of pasture condition can also occur.

Burton (1989) lists the causes of land degradation to be soil erosion and compaction, salinity both under irrigation and dryland conditions, and acidification. These would obviously lead to pasture decline, with additional factors being declining fertility, inappropriate grazing management, changing climatic patterns and incidence of disease and insect pests. The cause of pasture decline may therefore vary from situation to situation, and will most likely be due to a complex combination of factors.

Soil physical degradation.

Burton (1989) reported that a national survey conducted in the mid 1970's indicated that more than half the nation's cropping and grazing lands were in need of soil erosion treatment at a cost of $2 billion in today's values. The extent of erosion in permanent pastures however is usually small. Murphy and Harte (1992) suggested that 28% of all cropping soils in NSW are affected by soil structural decline costing $144 million, and that grazing may also result in structural decline by stock compaction particularly in wet soils, although the extent and cost of the problem is not well defined. Hutchinson (1992) reported a decline in the biological and physical structure of soils under continuous high stocking rates on the Northern Tablelands, and this was associated with pasture decline in these treatments.

Dryland salinity

Burton (1989) indicated that dryland salinity is now widespread in Northern Victoria and is rapidly extending along the western slopes of New South Wales. This problem is a consequence of tree clearing and loss of deep rooted perennial grasses in recharge areas on upper slopes causing increased amounts of water entering water tables resulting in outbreaks of salinity in lower areas. The on-farm consequences of this problem were described by Barber (1992) who indicated that over the last 30 years salinity has increased from small pockets to about 100 hectares on his farm. The alarming feature of this situation is that the problem has intensified in the last five years. Barber (1992) also reports that this has had serious effects on both pasture and livestock production.

Soil acidification

Soil acidification is probably one of the most serious causes of pasture decline. Helyar (1991) estimates that nearly 14 million hectares of land in New South Wales has a pH less than 5.0. The southern and central tablelands have a particularly high proportion of acid soils and are also particularly vulnerable to increased rates of acidification. While many soils are naturally acid, processes associated with pasture improvement can further reduce pH (or increase acidity). This occurs where nitrogen is fixed in soils and subsequently leached leaving behind an excess of hydrogen ions. As a result, increased levels of aluminium and manganese are released which are toxic to plants causing reduced growth and vigour. Rates of acidification can be as high as the equivalent neutralising effect of 300 kg lime/ha/year (Helyar 1991).

Species vary in their tolerance to soil acidity, but most show some decline at pH levels less than 5.0, especially legumes. Lucerne is particularly sensitive. The spread of vulpia, which tolerates high acidity, may have been assisted by increased soil acidification. However, Leys and Dowling (1992) found no obvious relationship between the incidence of vulpia and soil pH.

Helyar (1991) indicates that the use of perennial pastures will reduce rates of acidification because they utilise summer rainfall, thereby reducing nitrate leaching, and more effectively cycle nutrients due to deeper root systems.

Declining fertility

Although the area of improved pasture on the central and southern tablelands of NSW has remained relatively stable since 1972, annual fertiliser application has varied considerably and was especially low during a three year period 1983-86, when only 31 kt/year was applied to pastures in the area. This contrasts with applications of 86 and 69 kt/year for the three year periods before 1983 and after 1986, and with an average of about 68 kt/year for the 1960's and 70s (Vere, personal communication). Periods of reduced fertiliser application have led to the broad assumptions that declining soil fertility level is likely to be a key cause of pasture decline (Wright 1993).

We also believe that in many instances, declining fertility is likely to be a factor, but there is evidence that pasture decline has occurred where fertility levels appear adequate. For example, Leys and Dowling (1992) indicated that vulpia invasion was not associated with soil P levels. Pasture decline of phalaris/white clover pastures on the northern tablelands occurred under "well fertilised" conditions (Hutchinson 1992, see below). The study of Schroder et al. (1992) in Victoria indicated that while 40% of farms surveyed had adequate soil P levels, only 5% had acceptable pasture composition. These issues obviously require further detailed analysis.

Climatic influences

Hutchinson (1992) reported on findings of Hutchinson and King (unpublished) who provide evidence of lack of stability and decline in white clover/phalaris pastures on the northern tablelands over 28 years. Selective, year-long, uncontrolled grazing of phalaris in combination with drought greatly reduced its budbank, and hence its ability to regenerate. At high stocking rates, phalaris was almost entirely replaced by annual species after drought leading to instability and loss of production. At low stocking rates, phalaris was relatively stable and even showed a recovery after severe drought. The fact that some pastures have remained productive after 28 years indicates that pasture decline is not inevitable.

In another study on the northern tablelands, Archer and Robinson (1989) showed that the proportion of white clover in pastures was also closely related to grazing management in combination with soil moisture and temperature. White clover was particularly vulnerable to heavy grazing during extended dry periods in summer. Although white clover was subsequently able to recover, this was much slower and more risky if dependent on seedling re-establishment compared with recovery from surviving stolons. The impact of suggested trends towards drier, hotter summers on the northern tablelands could therefore have serious effects on persistence of current white clover cultivars in pastures of the region.

Grazing management

Individual paddocks on farms may be set-stocked or grazed on an irregular basis by either sheep or cattle, with intermittent and variable periods of rest. These differences in time, type of stock and intensity of grazing between paddocks will almost certainly affect species composition. It is only necessary to look along fence lines to conclude that differences in stocking regime between similar pasture types can have dramatic effects on pasture composition, and that these differences are likely to be reflected in livestock performance.

These effects are poorly understood but we believe they have contributed significantly to the decline in the content of desirable species and increase in the weed content of pastures. The development of an understanding of the ecological processes involved could provide a powerful tool to enable pasture managers to manipulate species composition in a positive direction. An example of this is the use of heavy summer grazing to control *Aristida* (wiregrass) in pastures on the northwest slopes (Lodge and Whalley, 1985). Kemp (1991) has also described beneficial changes in the grass : legume balance in pastures on the central tablelands due to differences in seasonal grazing and resting.

Diseases and pests

Little work has been done on diseases affecting pastures in NSW. The role of grasses in carrying over soil-borne diseases to subsequent cereal crops has received most attention, but the effects of such pathogens as the fungi that cause take-all, crown rot and bare patch have on productivity of pasture grasses is unknown. Several pasture grasses are also alternative hosts of some cereal rusts and the viral disease barley yellow dwarf.

The effects of pasture diseases are best known in subterranean clover (Murray *et al.*, 1993). Productivity and persistence of subterranean clover are reduced by several diseases. The foliar diseases scorch and rust are presently controlled with resistant varieties, but root diseases continue to reduce herbage and seed production, and persistence. The main root disease is taproot rot caused by *Phytophthora clandestina*. The disease is favoured by early breaks with high soil moisture followed by moisture stress when diseased plants die. Recent releases have included varieties with improved resistance to this disease. Other root rots are caused by the fungi *Pythium* spp., *Aphanomyces euteiches* and *Rhizoctonia* sp. (Eskdale and Murray 1991). Several virus diseases such as stunt virus occur in subterranean clover. These seem to be more important on the coast and tablelands and less important in the inland.

A similar range of diseases affects white clover (Nikandrow, 1992). Rusts can seriously defoliate plants and reduce growth. As in subterranean clover, pepper spot can occasionally be severe but its role in affecting production is not clear. Several root rotting pathogens are known, but again their role in reducing herbage and persistence is unknown. Stolon rots caused by *Sclerotinia trifoliorum* and *Sclerotium rolfsii* are sporadic under cool wet conditions. Further work is needed to determine the diseases present and their causal agents before appropriate controls are sought.

It is also unclear as to the total impact that insect pests have on pasture production and their role in pasture decline. Pests such as red-legged earth mites and snails and slugs can have devastating effects on pasture establishment. The impact and damage caused to established pastures by other pests such as lucerne aphids, wingless grasshoppers, scarab grubs, sitona weevil *etc.* is also quite obvious during outbreaks of heavy infestations. However, at less obvious levels of infestation, these and other pests can have a more insidious impact on pastures which almost certainly contributes to pasture decline. This level of impact has not been effectively quantified.

CONCLUDING COMMENTS

The evidence strongly supports the case that pastures have declined to the extent that botanical composition and production of many pastures is now far from a desirable optimum, and almost certainly does not reflect the composition at establishment. The reasons for pasture decline probably vary and may be a complex combination of factors, both biological and economical. While pasture decline is difficult to measure and its effects on livestock production difficult to quantify, the indicators all point to a continuing decline in pasture production and persistence and consequently to lower livestock production. This is supported by the Identification Report for the Meat Research Corportion Key Program on temperate pasture sustainability, which states that "the real crunch is yet to come (because) to date the pastures have degenerated in terms of their composition and the soils have degenerated with increasing problems of acidity and salinity without yet showing dramatic decline in carrying capacity".

It is however, reassuring that despite these pressures, some pastures have been maintained in highly productive states, particularly where maintenance has not been limited by economic pressures. Thus, decline is not inevitable and can probably be managed, given dollars and application of the correct technology. Finding the key for each situation and implementing appropriate and timely management practices is the challenge. In other words, we must give more emphasis and commitment to pasture management and to learn to 'read' our pastures for early indicators of decline and then to implement appropriate remedial practices. This will require greater knowledge and understanding of the processes involved in the changing states of pastures.

One of the key factors in fighting pasture decline is the establishment and maintenance of vigorous legumes and perennial grasses because these are essential to control erosion, compaction, salinity and acidity and to maximise pasture quality and animal performance. Vigorous perennials also reduce weeds and invasion of annual grasses, such as vulpia. The challenge is to develop total management systems which achieve these objectives at minimal cost rather than to opt for expensive renovation. The emphasis should therefore be to develop appropriate grazing management systems together with better fertiliser and liming strategies to economically maintain desirable species composition, production, soil nutrient status and pH. This will in turn facilitate the production of higher value livestock products better targeted to market requirements thus improving the economic flexibility to maintain pastures. Having developed these systems we must find better ways to have these technologies adopted through innovative, community supported, extension programs.

Burton (1989) makes the point that conservation must be profitable. The data of Schroder *et al.* (1992) indicates that it should be possible to combine moderate to high production and profit levels with pasture sustainability given correct application of technology. We believe that unless these dual objectives can be achieved, the status of pastures will not be improved because economic pressures will not allow remedial management to occur. This should be possible for grazing systems based on both low input natural pastures and high input improved pastures, as long as we develop an understanding of the management requirements of each system. This is our challenge for the next decade.

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