Pastures without grasses: a speculative look at farming in the 80's

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Annual grasses—essential feed, or a nuisance in your cereal crops? For most farmers managing a wheat and sheep enterprise the answer is probably both!

On the positive side grasses provide early winter feed when clover apparently provides little. They contribute to the flush of pasture production in the spring and provide better erosion protection than clover or herbs.

On the other hand, grasses are often problem weeds in cereal crops. The staggered germination pattern of many annual grasses means that control often involves repeated cultivations and a delay in seeding—a double loss as tillage costs are increasing, and there is mounting evidence to suggest that later seeding reduces cereal yields:

In addition to their direct effects as competitors for nutrients and water in the crop, grasses also harbour the insidious root disease 'take-all', considered a major cause of yield reduction in the high and medium rainfall areas of Western Australia.

Even where in-crop herbicides are available, such as for ryegrass and wild oats, their use is a major cost to the producer.

Within an animal enterprise grass seed contamination can reduce the value of meat and wool, and annual ryegrass in particular is now also associated with the spreading problem of nematode-induced ryegrass toxicity.

For 150 years, grasses have been an integral part of our farming systems, being tolerated, or even encouraged in pasture; while reducing the profitability of the crop enterprise. What would be the consequences of totally removing them from our farming systems?

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'Spraytop' techniques—(the desiccation of pastures in spring before grass seeds can mature)—are used already to reduce the grass seed bank before cropping and to reduce the risk of ryegrass toxicity. But chemicals are now available to give complete control of annual grasses in pastures from germination onward with little or no damage to the legume component. What will be the consequences for our pastures, for animal production and for cropping if grasses are eliminated?

In this article we will speculate about the potential benefits and possible costs of a minimum grass farming system.

The boom spray could play an important part in removing grasses from pastures.
Comparing the systems
Consider first the possible benefits of removing grasses from the farming system:
1. Reduced grassy weeds in the crop.
2. Reduced crop loss from 'take-all'.
3. Earlier seeding.
4. Improved nitrogen supply to the crop through increased nitrogen fixation by the pasture legume, and
5. Improved prospects for animal production, through higher quality feed.
Against these possible benefits must be weighed—
1. Possible loss of pasture production, with detrimental effects on animal performance.
2. Increased risk of oestrogenic pastures.
3. Possible increased erosion risks from poor subterranean clover regeneration in dry seasons.

The potential benefits
1. Reduced grass weed competition in the crop.
Broadleaf weed control is both effective and relatively cheap in cereal crops, but the control of grassweeds is more difficulty.
The effects of weed competition on wheat have been studied most intensively with annual ryegrass (*Lolium rigidum*). Department of Agriculture studies (Figure 1) have shown that increasing ryegrass density reduced wheat yields. Even moderate infestations of 200 ryegrass plants per square metre reduced yields by 15-30 per cent depending upon the growing conditions.
Effective, but expensive pre-emergent and post-emergent herbicides are now available to control ryegrass and wild oats in wheat and barley crops. But for other grassweeds in crops including the bromes (*Bromus diandrus* and *B. hordeaceus*), barley grasses (*Hordeum geniculatum, H. glaucum* and *H. leporinum*) and silver grass (*Vulpia sp.*) control is not possible at the present time.

Fig 1: The effect of ryegrass density on wheat yield.

Fig 2: The effect of location on the expected incidence of take-all, based on six years' crop surveys.
An alternative is control by cultivation, but like the pre-seeding incorporation of herbicides, it delays seeding—probably incurring a yield loss and exposing treated areas to increased risks of wind erosion. Problems with these grasses also have become more prominent with increased use of minimum tillage. If the spray and single cultivation at seeding fail to achieve weed control, the weeds subsequently cannot be removed from the crop.

Moving the control of grasses to the pasture phase would allow the use of broader spectrum herbicides to achieve control of all grasses and also eliminate the delays and dangers of excessive cultivation before sowing a cereal crop.

2. Reduced crop losses from take-all
Take-all is the most serious root disease of wheat and barley in Western Australia. It is most common in the high and medium rainfall regions (Fig. 2). Along the south coast this disease may be so serious that cereal cropping is precluded. In other parts of the cereal growing areas the effects of the disease may be hidden and can go unnoticed except to the skilled observer.

The fungus (Gaeumannomyces graminis var. tritici) which causes take-all infects wheat, barley, oats and volunteer grasses. It oversummers on residues from these hosts. Barley grass and brome grass are particularly good hosts for this disease. Take-all does not infect non-grasses such as subterranean clover, medics and capeweed. During the pasture phase the fungus will grow on the roots of grasses in the pasture. The density of the fungus in the paddock will increase as the grass content in the pasture increases. When the pasture is broken up for cropping the fungus remains dormant on grass crown and root residue until it infects the crop seedlings’ roots as they grow over this residue.

The present recommendations for control include the use of cleaning crops such as rapeseed, lupins or linseed sow in the year before the cereal. If these crops are grass free the take-all fungus is left without a host and its survival is greatly reduced. Removing the grass hosts early in the pasture phase makes the pasture itself a cleaning crop, as there will be little or no undecomposed root material to carry the fungus over.

3. Earlier seeding
Grass dominant pastures not only affect the crop through direct competition and the carry over of take-all, but also indirectly by enforcing a delay in the seeding date.

There is mounting evidence that wheat yields can be increased substantially by earlier seeding. Figure 3 shows the yields of Egret wheat obtained since 1973 in the Department's cereal variety trials in the high rainfall (greater than 450 mm) region.

Results of a trial at Beaufort River in 1979 (Table 1) confirm the variety trial results. In this particular trial, neither take-all nor Septoria leaf spot caused yield losses. Later planting reduced yields because the crop formed fewer grains per square metre (i.e. fewer and smaller heads) and each grain weighed less.

<table>
<thead>
<tr>
<th>Date sown</th>
<th>Yield kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 24</td>
<td>4.172</td>
</tr>
<tr>
<td>June 12</td>
<td>3.446</td>
</tr>
<tr>
<td>July 6</td>
<td>2.590</td>
</tr>
</tbody>
</table>

Fig 3: The yield response of Egret wheat to seeding date in the high rainfall region.
Using the variety trial results, the loss of yield through delayed seeding is 27.7 kg/ha/day and for the Beaufort River trial 36.7 kg/ha/day. Thus delays caused by additional cultivations to control grasses or for control of take-all may be costing producers far more than the visible costs of the extra fuel and labour required.

4. Nitrogen fixation by the pasture
Legume based pastures have long been an important source of nitrogen for cereal crops. The widespread sowing of subterranean clover for wheatbelt pastures in the 1940's and 1950's was a major factor in arresting declining cereal yields and soil fertility.

The last decade, however, has seen a declining interest in legume pastures due to poor seasonal conditions and lower profitability of livestock enterprises relative to cropping. The ready availability of manufactured nitrogen and subsidies on its use have further eroded the role of legumes as sources of nitrogen for cereal crops.

Whether these trends can continue is debatable. Figure 5 shows the increase in cost of nitrogen fertiliser since 1969. In the last 12 months for example, the cost of nitrogen has risen from $350 per tonne to $525 per tonne, reflecting the rising cost of energy. Further substantial increases are likely in the future.

The effect of legume based pastures on soil nitrogen and cereal yields has been demonstrated in several long term experiments. Figure 4 shows the changes in soil nitrogen and crop yields for various terms of clover based pasture, starting from virgin scrub, at Wongan Hills Research Station. The major point to be drawn from this research is that under the pasture, an annual average of 64 kg/ha of nitrogen was added to the top 7.5 cm of soil. Cropping reduced soil nitrogen with the biggest loss in the first year.

In this experiment, between 1966 and 1972, wheat yields increased 1000 kg/ha after only two years of subterranean clover based pasture (Figure 4). A further five years of pasture, although substantially increasing soil nitrogen, only returned an extra 170 kg/ha above the yield obtained after two years of pasture. The most probable explanation is that at Wongan Hills (325 mm annual rainfall) water rather than nitrogen was limiting further yield increases when averaged over the seasons studied.

The annual increment of 64 kg/ha of organic nitrogen per year gained in this experiment is typical of many similar measurements made on legume pastures throughout southern Australia. Such figures are the net result of big gains and losses of nitrogen over a series of years.

How long a pasture phase is required?
In the experiment at Wongan Hills, two years of pasture gave near maximum grain yields. Researchers did not attempt to crop after a single year of pasture because at the time the experiment was started in 1956, even cropping after two years pasture was considered a radical step.

In the second phase of the experiment, started after all plots had been in crop for four years, the plots were re-sown to subterranean clover at 11 kg/ha and a wheat crop grown after one, two, three or
four years of this pasture. After the single year of pasture the wheat yield still depended on the length of the original pre-crop pasture phase, varying from 1 900 kg/ha for the seven-year pasture plots to 1 600 kg/ha for the two-year pasture plots. This suggests that at Wongan Hills a single pasture year is not enough to over-shadow the effects of the previous pasture cycle.

In a higher rainfall environment at Kojonup, E. R. Watson (1963) found that increasing the pasture ley from one to five years gave only a marginal increase in wheat yield (Table 2). These yields, averaged over the years 1956-58, were obtained from pastures sown at 168 kg/ha of clean seed. This gave a dense stand of clover in the first season, similar to those expected in the Kojonup area.

At Bakers Hill, in 1977 Watson and his fellow workers showed that a rotation of one year of crop and one year of pasture maintained soil nitrogen and could produce grain yields equivalent to a crop grown after six years of pasture. The clover content of the short rotation pasture was higher also, probably due to the frequent cropping keeping the soil mineral nitrogen at a lower level, thus discouraging the invasion of grasses and broadleaf weeds.

All of these trials were started on new land sites. Generally the grass content of the pastures was low. Although the evidence is still scanty, one year of pasture may be enough to support a cereal crop in the higher rainfall wheatbelt at least.

5. Improvements in animal production

Changing the pasture composition from grass to legume dominance should have a number of beneficial effects on the productivity of a sheep enterprise.

Bodyweight:

As the legume component increases in the pasture, the nutritional value of the feed will be improved. G. W. Arnold and co-workers (1970) found that spraying paraquat onto a mixed pasture changed the botanical composition from 55:45 to 25:75 per cent grass:clover. The Sprayed pasture had more than 50 per cent more nitrogen and phosphorus in the herbage due to the higher proportion of legume in the material. Weaner merinos on the sprayed pasture maintained their bodyweights for the first two months of summer while those on the control plots lost 4 kg per head. Thereafter the feed supply on the sprayed plots was limiting, and at the end of summer there was no difference between the two groups.

Wool growth:

Wool growth is slowest in autumn and fastest in spring. In the experimental work above, wool production per head over summer was 20 per cent higher on the paraquat-sprayed pasture, compared to the control. This was due, almost certainly, to the better nutritional quality of the pasture arising from the greater legume component.

If total production could be maintained with a high (80-100 per cent) legume proportion, the increased nutritional value of the pasture should increase total wool production.

Grass seed contamination:

Grass seeds may cause problems through facial infections and eye damage to sheep, accentuate sheep losses after dipping, and reduce carcass value at slaughter. In addition, vegetable fault in the wool clip reduces grower returns and is of major concern to wool processors. All of these problems would be virtually eliminated in grass free pastures.

Ryegrass toxicity:

Annual (Wimmera) ryegrass infested with the nematode *Anguina loli*I and an associated bacterium (*Corynebacterium spp*) becomes toxic to both sheep and cattle and frequently causes death. The grass usually does not become toxic until the heads are mature and drying off.

At present, attempts to control the disease have focussed on removing ryegrass in cereal crops and 'spraytop-grazing' pastures in spring to reduce seed heads. Complete control of grasses in the pasture phase represents an alternative strategy that must be evaluated for its effects both on the disease and on pasture production in the specific situations where the disease is most serious.

Lamb production:

Improving the quality of summer pastures by shifting the balance from grasses toward legumes may enable producers to fatten lambs on pastures over the summer period.

What do we lose?

To set against the advantages of grass free pastures, we must consider the possible detrimental effects of removing grasses, both on pastures and on subsequent animal production.

1. Pasture and animal production:

The complex effects of reducing or eliminating one component in a competitive mixture of pasture species is illustrated in Table 3. In these three pilot trials carried out during 1980, the selective annual grass herbicide pronamide caused a major increase in the proportion of clover in the pastures and in one case actually increased winter dry matter production.

No firm conclusions can be drawn from these limited experiments but the effects of suppressing grasses on pasture production may not be as severe as first appears, even in the year the pasture is treated. Further, if the legume component

| Table 2. Wheat yields following 0-5 years of mixed subterranean clover/grass/broad leaf pasture at Kojonup. (from Watson, E. R., 1963). |
|-----------------|----------|--------|--------|--------|--------|--------|
| No clover       | 1 year   | 2 years| 3 years| 4 years| 5 years|
| Wheat yield     | 1 057    | 1 824  | 1 623  | 1 928  | 2 034  | 2 260  |
of the pasture is increased, the nutritional value of the paddock feed will be improved. This may compensate for any decrease in total production.

Even if decreases in pasture production do occur in the first year, the long term effects of grass suppression on pasture production in the rotation are more important. Watson and co-workers (1977) compared a 1:1 crop: pasture rotation with a longer rotation of six years pasture: one year crop at Bakers Hill. In the short rotation, pasture production was less than that on the six year pasture for the first two cycles. However, in the third cycle of 1:1 rotation, pasture production was greater than on the continuously grazed pasture. The clover content of the short rotation also reached 80 per cent after three cycles compared to 40 per cent in the continuous pasture.

Although the evidence is limited, this experiment does suggest that in some circumstances at least, clover dominant pastures can remain productive in short rotations.

The possible loss of animal production associated with the removal of grasses will be of major concern to livestock producers and is undoubtedly the most contentious issue in any discussion of minimum grass farming systems.

Grasses make up the bulk of early winter feed, and a grass-free pasture could accentuate the autumn decline in sheep body weights and wool growth. Although we have argued that the effects on total pasture production may not be as severe as first thought, and that improved pasture quality may offset any production losses, the autumn feed gap remains a critical issue. The extent to which improved legume regeneration, aided by better seed set, can compensate for the absent grasses will require investigation.

2. Other losses

In areas where highly oestrogenic clovers have been sown, removing the grasses may mean a return to oestrogenic pastures as the proportion of legume is increased. Such situations would mean re-seeding pastures to newer cultivars selected for low oestrogen content. An additional benefit from re-seeding to newer subterranean clover cultivars will be higher levels of hard seed, which will assist pasture regeneration if rotations should continue to shorten.

Conclusions

Whatever the long term future, the role of research will be to increase productivity and to contain costs. The ideas that we have outlined in this article may seem radical at first sight but they could contribute substantially to both of these aims.

Removing grasses from degenerated pastures containing less that about 30 per cent legume may result in bare patches subject to erosion. Otherwise, broadleaf weeds may fill the niche left by the grasses. In both cases, re-seeding may be necessary before one attempts to control grasses.

There are very strong arguments that minimum grass systems will increase the productivity of a cropping enterprise through reduced weed competition, earlier sowing, reduced disease levels and improved nitrogen nutrition. Costs also may be reduced through reduced tillage and herbicide expenditure.

We also have argued that the loss of pasture production due to the absence of grasses in the pasture may not be as serious as many producers believe. Indeed, improved legume growth should largely compensate for the absence of grasses, and the overall improvement in pasture quality should help to offset any losses in total pasture production.

Bands of darker green indicate pure medic stands resulting from strip-spraying with grass-killing herbicides.
In this case, the density of pasture legume was relatively low. Bare ground can be seen between the broadleafed plants after grasses have been killed by sprays.

To speculate even further, should grain feeding of young sheep for meat production become economically feasible, clover dominant pastures would have major advantages over stubbles or grass dominant pastures. This is because cereal grain diets do not provide enough protein for the growth of young sheep. Clover (and capeweed) dominant pastures could change the economics of grain feeding completely by providing extra protein.

How might minimum grass pastures change our overall farming systems? Over the last decade, economic pressures have favoured crop production over livestock.

Some authorities believe that the trend toward increased cropping will continue indefinitely. Others, however view the flexibility of two complementary enterprises as particularly valuable as a buffer against price, and therefore income, fluctuation.

One year crop, one year pasture rotations look attractive as the most effective and efficient systems for maintaining minimum grass pastures in the high and medium rainfall areas as least.

Removing grasses and broadleaf weeds from the pasture will stimulate clover growth, improve the prospects for better clover seed set and increase the soil nitrogen buildup. Following the grass free pasture with a cereal crop will utilise this nitrogen quickly and thus forestall the invasion of nitrogen-hungry weeds when the paddock is returned to pasture.

The improved seed set in the grass-free pasture phase will help to ensure adequate regeneration of pasture following the crop. Longer pasture phases would encourage grass and broadleaf re-invasion while multiple cropping would run down the legume seed banks essential for pasture re-establishment.

Such is our theory. Most of the technological factors we have discussed: earlier seeding, take-all control, weed seed carry over and soil nitrogen build up have been investigated—to a greater or lesser extent—in other contexts.

We know relatively little about the effects chemical manipulation could have on pasture growth and composition, or on subsequent animal production. Similarly, is a one year legume pasture: one cereal crop rotation the most productive mix? These are important questions which active research must answer.

References


