PART 5

SYNDICATE PAPERS

Weeds, Pests and Diseases of Grassland and Herbage Legumes – A Farmer's View

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Previous papers have been based on carefully observed situations and controlled experiments. By contrast, this paper represents the thoughts opinions and experiences of one farmer. Whilst little of it represents indisputable fact, I hope it does represent the experiences of many farmers and that the problems presented are those commonly encountered. I will also be concentrating on husbandry influences as previous papers have dealt in considerable detail with chemical control measures. Furthermore, this short paper will only be concerned with weeds in grassland, as that is the limit of my experience. If my grassland has been subjected to attacks by pests and diseases, then I have not been aware of it and long may this situation prevail! Weeds, however, do feature on my farm and I found no difficulty in finding suitable examples to illustrate my points.

Weed Problems in Grassland Establishment

Re-seeding is an expensive job. Failure to establish a fully productive new ley in a relatively short time can be quite disastrous. Not so much because of the high cost of the re-seeding and the possibility of having to repeat the process, but because of the disastrously high cost of losing at least a part of one year's production. For this reason it is appropriate to spare no trouble or expense to ensure, as far as one can, that a ley will not fail. Failure of a new ley is often associated with weed invasion of some sort: either weed invasion from a previous crop or invasion by chickweed and annual meadow grass where a patchy take occurs. To reduce the risks of failure and of weed invasion several points are important:

Husbandry to Avoid Problems

1. Time of sowing. I find that September re-seeding has the greatest chance of success and has the added advantage that land spends little time out of production.

2. Destruction of the previous crop, especially if it is grassland, is essential to avoid couch, Yorkshire fog, bents and meadowgrasses carrying over to the new ley. If there is sufficient growth and sufficient time, Glyphosate is always my first choice for this purpose as it achieves a more complete kill and is effective on

persistant weeds such as docks and couch. Paraquat is the alternative where there is little growth at the time of spraying and where there is no time for delay.

3. Ploughing remains my first choice of primary cultivation in spite of the cost.

It helps to break up any shallow pans.
It delays the emergence of annual weeds thus giving the new seeds a chance to get a head start.
Ploughing is less likely to be followed by pest attack.

4. Subsequent cultivations should be done very thoroughly to achieve the ideal, fine, firm seed-bed. I do not aim to make any economies in this respect.

5. Relative to the total cost of re-seeding the seed is not an expensive item. We use between 28 and 34 kg ha^{-1} for a perennial ryegrass ley using diploid varieties. To sow the seed we use a 4 m narrow-row seed drill, drilling in both directions, sowing the seed just into the soil. This is followed by a heavy roll. In the absence of a drill of this kind, I would broadcast onto a ring-rolled surface and then ring-roll again twice to cover the seed without harrows which, in my view, bury much of the seed too deeply.

Control

The above measures have been very largely successful in establishing new leys and chemical weed control has been necessary on only two occasions in the last 10 years. The first occasion occurred with a September re-seed after winter barley and following a perfect straw burn. An ideal seed bed was prepared without ploughing but the new seeds emerged with a great mass of chickweed seedlings. Spraying with Ethofumesate gave effective control of the chickweed and this was further helped by grazing with sheep which helped to remove the dense chickweed and encouraged the grasses to tiller. The second occasion was an autumn re-seed when the new seeds were not sown until 30th September when, understandably, the new seeds established very slowly and chickweed and annual meadowgrass were in strong competition. Again Ethofumesate was used and gave good control.

Weed-infested re-seeds may recover and eventually become good swards, but their production in the first year can be affected and clearly it is a case of prevention being better than cure. In particular the importance of keeping grass weeds out cannot be over-emphasised and here spraying out any weeds from the previous crop followed by good ploughing, still represents the best solution on many farms.

Weed Problems in Established Grassland

In my experience the ingress of *grass* weeds in established grassland is more important than all the broad-leaved weeds put together. Grass weeds are also the

most difficult weeds to keep out of grassland and the most difficult to control once they are there. There are some husbandry measures which can be taken to help delay the ingress of grass weeds and to a lesser extent, broad-leaved weeds.

Firstly we should briefly discuss the effect of grass weeds on total production. It has been shown that many grass weeds can be quite productive especially in fertile situations with adequate rainfall. However, I am convinced that weed grasses are markedly less productive than cultivated species in less favourable circumstances especially when there is a moisture deficit or when temperatures are low. At these times, when every bit of production is valuable, grassland containing a high proportion of grass weeds is often producing at an unacceptably low level and the decision is then taken to re-seed.

Management of Established Grass to Prevent Weed Ingress

Grazing management has a profound effect on the ingress of grass weeds. A good thick sward is very resistant to them. Unfortunately grazing management is usually far from ideal. In particular, lax grazing is responsible for aerial tillering and an open sward – the ideal medium for the weed grasses to gain a foothold. I am not an advocate of set stocking but there is little doubt that set stocked pastures, provided they are not over-grazed, are more dense and resistant to the ingress of grass weeds than pastures which are strip or paddock grazed. Rotational grazing using strips or paddocks is frequently lax because stock are put in too late and much grass is rendered inedible by trampling and soiling. Dairy farmers are the chief culprits in this respect and if only grass could receive the same attention as the sacred cow and a little more time was spent managing grass properly – particularly selecting paddocks at the right stage of growth for grazing – then grass could make a greater contribution to animal performance and there would be less sward deterioration.

Poaching is also responsible for sward damage, thus allowing weed encroachment. In these circumstances, in addition to weed grasses, docks are likely to become a problem. Sometimes a degree of poaching cannot be avoided but a great deal of poaching is severe and *can* be avoided. In this respect I would mention layout of paddocks, access to grazing, cow tracks and siting of water troughs. In the time available I can only say that I see very little thought and planning given to this important subject and what a pity it is that new tractors are so much more exciting to buy than new concrete cow tracks!

There is a tendency, once winter food is finished, to turn cows out on to grazing areas regardless of ground conditions. This can be disastrous and if it doesn't lead directly to the destruction of the sward, it will at least ensure damage leading to an invasion by weeds of all types. The cow is better off standing on bare concrete without food than standing up to her hocks in mud and inedible soiled grass. An hour's grazing once or twice a day with the cows shut in yards or cubicles with some straw for the rest of the day, is surely a better alternative to destroying the herd's future food supply. Cows *do* voice their objection to being shut in but ear plugs are a cheap solution to this problem and in the long term the cows must benefit from this seemingly harsh treatment!

Muck and slurry spreading, especially in the winter months, also bring weed problems. Why are docks associated with slurry? I am sure it is not just a case of the seeds being present in the slurry, but I cannot suggest a solution to this problem apart from the obvious one of keeping off the land when it's wet, to minimize the damage to the sward. *To me, grass is the sacred cow.*

There are of course other weeds such as thistles and ragwort, which I haven't mentioned so far. I am a dairy farmer and in the same way that docks aren't really a problem with sheep farmers, thistles are not a great problem with dairy farmers, no doubt due to the differing grazing habits of the animals. Furthermore, unlike the weed grasses and docks, I am not really able to blame bad husbandry practices for the presence of thistles and ragwort.

Chemical Control

I have to admit to no first-hand experience of controlling weed grasses selectively in established grassland. Maybe I am neglecting a tool in the armoury, but so far I have not been convinced that this technique is sufficiently effective to regenerate a jaded pasture. On the other hand I have found it necessary from time to time to spray docks and other broad leaved weeds, and although a good measure of control is often achieved, I am still disappointed to find that docks and thistles are persistent problems on many farms and spraying is not always effective. Coupled with this, many sheep and beef farmers have a proportion of clover in their pastures which is of value to them and they are reluctant to spray because:

a. they are afraid of damaging the clover;
b. if they use a spray which is 'safe' on clover they feel they are less likely to deal effectively with the broad leaved weeds;
c. they are reluctant to pull stock out of fields for 3–4 weeks in mid-season, after spraying.

I have found that the use of Mecoprop in March/April gives useful control of docks. However a follow-up spray the following year is nearly always necessary. To spray or not to spray is a decision frequently governed by the pride threshold rather than any economic factor. I subscribe to this entirely! There comes a time with docks, thistles and ragwort when one cannot stand the sight of them any longer, and even if they are not significantly reducing production, pride alone forces the decision to spray. Whether spraying is effective or not depends very much on:

1. stage of growth of the plant;
2. weather conditions;
3. subsequent management.

To illustrate the effect of weather, or perhaps I should say temperature, when spraying docks I have observed poor control after spraying at the beginning of the

day, improving to almost 100% control after spraying in the middle of the day when spraying conditions had improved.

The Future

There are many tools available to farmers and it may well be that more of them should be used to keep weeds at bay. Judging by the general standard of weed-infested grassland one sees on most farms, there is either a reluctance to use the existing techniques or they have been tried and, for a variety of reasons, have not been as effective as they might have been.

There are some very good products available but in an ideal situation we could perhaps have the following:

1. a selective weed-killer that will completely kill established, persistent broad-leaved weeds e.g. docks;
2. sprays that can be used under a wider range of conditions and a wider range of plant development. A big problem at the moment is having to take grassland out of the grazing situation for 3 weeks or so at a time when the crop is growing fast and is required for grazing;
3. I understand there are some 1,700 herbicides on the market. In the minds of the vast majority of farmers there is complete confusion over chemical and product names. With this vast range of products available, there are few farmers who have sufficient knowledge to be able to choose the most cost-effective product without assistance. There are booklets available which are very useful but the choice generally is bewildering and I make a plea for some simplification in this connection together with a new attempt to steer farmers to the right spray for the job. Certainly the advertising material which pours through our letterboxes does little to help.

   I may be in danger of overstating the case, but I draw your attention to one indisputable fact, that the UK's grassland is still not only under utilized, but much of it is infested with weeds of all types to a level which we should consider unacceptable.

   Papers and posters at this Conferences have quoted remarkable responses to treatments for weeds, pests and diseases. Someone, somewhere has to put some cash values to these responses, and this means in terms of animal performance.

Weeds, Pests and Diseases of Grassland and Herbage Legumes – An Economist's View

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ABSTRACT

The difficulties of conducting economic evaluations of weed, pest and disease control in grassland are examined. The problem of valuing increases in herbage production from the use of herbicides and pesticides is discussed. The possibility of arriving at blanket recommendations for weed and pest control is questioned and instead the key to cost-effective control strategies is seen to be the derivation of threshold levels of weed infestation and pest damage, below which it is uneconomic to use chemical sprays. The necessity of considering both the immediate and long-term benefits of control measures is stressed, along with the need to consider the effect risk and uncertainty may have on decisions to use pesticides and herbicides. It is concluded that the problems of conducting economic evaluations of weed, pest and disease control in grassland are less conceptual and arise principally from a lack of data.

Introduction

While it is a relatively easy step to translate the yield improvements due to the control of weeds, pests and diseases into profits for arable crops, the process is so involved in the case of grass and herbage legumes that it is seldom attempted. Difficulties faced in evaluating the benefits of weed and pest control in grassland include:

i) grass and herbage legumes are not traded commodities. Apart from small quantities of dried lucerne and grass hay, little of these forage crops is sold off the farm. Hence, the value of grass and legume crops has to be imputed from its contribution to livestock production;
ii) as grass only has a value if it can be efficiently converted into marketable animal products, the value depends on the management skills of the farmer. Where the efficiency of grass utilisation is low, the extra grass production achieved through weed or pest control may be comparatively worthless. Thus, in contrast to arable crops, evaluation of the probable benefits of weed or pest

control in grassland needs to take into account both the effect on the crop (grass) yield and the utilisation of the crop by livestock;

iii) possibly because of the wide range of altitude, soil and climatic conditions under which grass and herbage legumes are grown, the response to a given dose of herbicide or pesticide varies considerably between sites (Goldsworthy *et al.* 1980; Clements *et al.* 1982a, b; Davies *et al.* 1982; Hill and Hood 1982). Often the observed variation between sites represents the difference between an economic and an uneconomic response (Doyle *et al.* 1984;), making it difficult to draw general conclusions;

iv) the evaluation of weed control strategies faces specific difficulties. Species commonly considered 'weeds' in grassland may not differ agronomically or botanically in any substantial degree from the crop itself. Thus, while the wild oats (*Avena fatua*), invading a field of spring barley are of no value to the cereal grower, the same is less obviously true of a 'weed' grass, such as rough meadow-grass (*Poa trivialis*), from the viewpoint of a livestock producer. This grass weed may depress the yields obtained from a predominantly perennial ryegrass (*Lolium perenne*) sward, but P. trivialis itself has a feeding value (Haggar 1976).

These complications underline the difficulty of preparing convincing economic arguments for weed, pest and disease control in grassland. Therefore the rest of this paper is concerned with defining a general framework for the economic evaluation of specific weed and pest problems and highlighting the data required for this. Because of the limitations of space, attention has been confined to evaluating the use of herbicides and pesticides. The problems of ascribing a value to increases in herbage production arising from weed and pest control are first discussed. This is followed by an examination of the factors which influence the cost-effectiveness of control strategies. Particular consideration is given to the effect which the time horizon and financial risk may have on decisions to use herbicides and pesticides.

Valuing Increases in Herbage Production

Valuing increases in grass production involves valuing the expected increase in livestock output associated with the extra grass production and subtracting known expenditures from this figure. The residual net income then provides a measure of the value of the extra grass output. Since the value placed on grass is a residual item, its apparent value will alter according to the livestock activity being considered and the specific use to which the gass is put. This is illuatrated in Table 1, which is taken from Doyle & Elliott (1983) after updating the values to 1984 levels. The Table shows the effect on the imputed financial value of grass standing in the field of using any extra grass production to (i) increase stocking rates, (ii) reduce concentrates, (iii) reduce bought-in hay and (iv) release land for alternative enterprises. The comparisons have been conducted at 3 different levels of grass utilisation. Where land is released for an alternative crop, the imputed value of grass is independent of the assumed efficiency of grass utilisation for reasons given in Doyle & Elliott (1983).

Table 1: Estimated value of grass in the field according to use in pence/kg d.m. at 1984 prices

Use of grass	%grass utilisation		
	50	60	70
To increase stocking rate:			
for dairy cows	3.4	4.1	4.7
for beef cattle	2.5	3.0	3.5
for lowland fat lambs	2.9	3.4	4.0
To reduce concentrates	1.7	3.2	4.7
To reduce hay purchases	3.6	4.3	5.1
To release land for other crops:			
for spring barley	5.0	5.0	5.0
for oilseed rape	4.8	4.8	4.8

Although there is a tendency for the values placed on extra grass production to cluster around 3–4 pence/kg d.m., the range is large (1.7–5.1 pence/kg d.m.). The effect that such changes in value can have on the apparent benefits of weed or pest control can be illustrated by reference to an experiment conducted by Goldsworthy *et al.* (1980), in which newly sown ryegrass (*L. perenne*) swards were treated with ethofumesate. Following the application of 2 kg a.i./ha of ethofumesate, the average increase in ryegrass production during the first harvest year at 7 sites was observed to be 1900 kg d.m./ha. At 1984 prices, the cost of the herbicide plus application would amount to £81/ha, so that the project benefits net of costs at grass values of 2.5, 3.5, 4.5 and 5.5 pence/kg d.m. would be −£33.5, −£14.5, +£4.5 and +£23.5/ha. Thus, the range of imputed grass values in Table 1 spans the zones of economic and uneconomic response in this specific case.

Cost-effectiveness of Weed, Pest and Disease Control

Relative to the value of the crop the use of herbicides and pesticides on grass and forage legumes tends to be more expensive than for cereals. On average it would appear that, expressed as a proportion of the crop value, herbicides on grassland are 2–3 times more expensive than the equivalent cereal weed sprays (Doyle 1982). One consequence of this is that in percentage terms, yield improvements from the use of herbicides must be larger in the case of grass than cereals to be economically justified.

Following on from this, it is unlikely that blanket recommendations for the use of herbicides or pesticides on grass or herbage legumes can be economically

justified. This can be illustrated by considering the results from 2 separate trials conducted at several sites in England and Wales. The first trial involved the application of ethofumesate to newly sown ryegrass (*L. perenne*) swards to control chickweed (*Stellaria media*) and annual meadow grass (*Poa annua*) at 7 sites (Goldsworthy *et al.* 1980). At 1984 prices the cost of the herbicide treatment including application amounted to £81/ha. Assuming a value for extra grass production of 3.5 pence/kg d.m., this implies a break-even incerase in grass yield of approximately 2300 kg d.m./ha; only if the increase in grass yield is greater than this figure would the use of the herbicide be justified. However, in only 2 out of 7 sites was the yield response to ethofumesate greater than the break-even yield. The second trial involved the application of chlorpyrifos to newly sown ryegrass swards at 7 sites to control pest damage (Clements *et al.* 1982a). At 1984 prices the costs of applying the pesticide would amount to £21/ha, implying a break-even yield of 600 kg d.m./ha, assuming a value for extra grass of 3.5 pence/kg d.m. In only 3 out of 7 sites was the yield improvement in excess of 600 kg d.m./ha.

Accordingly, to establish cost-effective control strategies for weeds, pests and diseases in grassland requires the determination of critical or threshold levels of weed infestation and pest incidence, above which the economic benefits of improved grass and legume yields outweigh the costs of spraying. Surveying the literature on weed control in grassland reveals that information on the economic threshold levels of weed infestation is scarce. In the case of pest control in grassland, this information is virtually non-existant.

Short- and Long-term Economic Considerations

For a perennial crop like grass the economic threshold levels of weed infestation and pest incidence will be influenced by the farmer's time horizon. This is well illustrated by a study undertaken to evaluate the short- and long-term effects of using asulam to control dock (*Rumex obtusifolus*) infestation on a long-term grass ley (Doyle *et al.* 1984). This showed that for a sward in which docks initially accounted for 20% of the ground cover, only about 40% of the increase in grass production arising from a single application of 1 kg a.i./ha of asulam might be expected to occur in the first year. Rather more than 50% is realised in the second and third years. Thus, the danger of confining attention to the costs and benefits of weed control in the immediate year is that an unnecessarily high threshold level of infestation will be set. For instance, in the study on dock control, it was found that if only the first year following the herbicide application were to be considered, then ground cover by the docks needed to initially exceed 15% before spraying was economic. On the other hand, if a 10-year time horizon was considered, the economic threshold was lowered to a dock ground cover of 2.5%.

In considering the long-term implications of weed and pest control, the issue of repeated applications of herbicide and pesticide may have to be confronted. In particular, choices may have to be made between frequent but small doses of chemical and fewer but heavier applications. These 2 strategies are likely to involve very different threshold criteria for spraying as illustrated by the study on dock control previously mentioned. Table 2 shows the frequency with which 2

contrasting doses of asulam have to be applied over a 10-year period if dock infestation is to be contained within specified limits. In each case the initial dock infestation was equivalent to 1% ground cover. The corresponding discounted net benefits are also shown. Where asulam is applied at the rate of 0.5 kg a.i./ha, the economic threshold is at around 5% dock cover. However, the adoption of the same threshold level where asulam is applied at 2 kg a.i./ha would be clearly uneconomic. At 2 kg a.i./ha the net benefits are maximised by using a threshold level of dock infestation for spray decisions of 15% ground cover.

Few experiments, however, have documented the impact of weed and pest control measures beyond the first 2 years. Equally, information on the population biology of many grassland weeds and pests is limited, so that it is difficult to even use mathematical modelling techniques to simulate the long-term impact of control measures. As a consequence, it is difficult to give recommendations on the level of weed infestation or pest incidence above which the use of herbicides or pesticides will be economically justified.

Table 2: Long-term discounted net benefits of various application strategies designed to control dock (*Rumex obtusifolius*) infestation on grassland within specified limits

Target ceiling on dock infestation, % ground cover	Application rate of asulam, kg a.i./ha			
	0.5		2.0	
	FS+, % of years	NDB§, £/ha	FS+, % of years	NDB§, £/ha
5	80	26.1	40	−22.4
10	70	25.5	30	6.2
15	50	23.3	20	23.0
20	30	11.5	20	4.8

+ FS, frequency of spraying § NDB, net discounted benefit

Considerations of Financial Risk

So far no consideration has been given to the fact that farmers must take decisions concerning the use of herbicides or pesticides without being certain about the outcome. At the time a decision is made to spray against pests, there is likely to be considerable uncertainty about the future growth in pest numbers and the percentage kill of the pesticide. In this situation the farmer can only weigh up the possible costs of reduced yields from not spraying against the costs of spraying unnecessarily.

Guesses can be made at the probable incidence of pest or disease damage and an estimate of the expected pay-off from spraying arrived at. Suppose there is a probability that 1 year in 4 there will be a 25% reduction in the first-year yield of

Table 3: Possible pay-offs and expected pay-offs/ha from either spraying or not spraying given 2 possible pest levels, £/ha

Control measure	Pest incidence		Expected pay-offs
	Serious	None	
Apply chlorpyrifos	329	329	329.0
No chlorpyrifos	280	350	332.5
Probability of event	0.25	0.75	

a ryegrass ley due to pest damage during establishment, if the sward is not treated with clorpyrifos. In the absence of pest-damage annual grass production is assumed to be 10 000 kg d.m./ha. Assuming a value for grass of 3.5 pence/kg d.m. and a typical cost for applying chlorpyrifos of £21/ha, Table 3 shows the possible pay-offs/ha according to whether a pesticide is used and whether a pest outbreak occurs. Weighting the possible pay-offs by the probability of a pest outbreak gives the expected pay-offs from spraying and not spraying. In this case, the higher expected profit is associated with not spraying.

However, whether or not an individual farmer accepts this recommendation will depend on his attitude to the risks involved. The expenditure of £21/ha on a pesticide may be seen as a small price to pay for the avoidance of the risk that 1 year in 4 the value of the grass crop will be reduced by £70/ha. Because the attitudes of individual farmers to risk vary signficantly (Webster 1977), it is impossible to generalise, however. Instead the objective of economic evaluation should be to provide a table of the possible pay-offs and the likely incidence of pest damage and leave the farmer himself to judge the risks. With a few exceptions, this information is not available for most grassland weeds, pests or diseases.

Conclusions

As a group livestock producers are probably much less aware than cereal growers of the depressive effect of weeds and pests on crop (grass and legume) production. Consequently, if herbicides and pesticides are to be used more widely on grassland, it will be necessary to clearly establish the economic benefits. Arguably the principal constraint to achieving this is lack of data, although there are conceptual difficulties, such as how to value increases in grass production. Particularly, more information is required on the grass and legume yield losses associated with given levels of weed infestation and pests. A clearer understanding of the apparent differences in the efficacy of herbicides and pesticides between sites also seems necessary. Only then will it be possible to

define economic threshold levels of weeds and pests, above which the use of control measures will be cost-effective. Finally, more information is required on the population biology of individual weeds and pests, so that through the use of computer simulations it should be possible to simulate the long-term effect of control measures and devise appropriate long-term control strategies.

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Weeds, Pests and Diseases of Grassland and Herbage Legumes – An Advisory View

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The Use of Pesticides on Grassland

A survey of nearly 500 farms by Sly (1984) gives some indication of the area of grassland treated with specific pesticides.

Table 1: Grassland and pesticides – area treated 1982 survey

	Ha	Tonnes a.i.
Insecticides	2,048	0.99
Molluscicides	7,095	4.90
Seed treatment	4,441	0.07
Fungicides	24,423	19.14
Herbicides	2,815,679	998.57

(from Sly 1984)

From the figures in Table 1 the information obtained by Sly suggests that 10 times the area of grassland is treated with fungicide compared with pesticide, and more than 100 times the area is treated with herbicides compared with fungicides. Herbicides therefore are far and away the most common agrochemical input into the grasslands of this country. A similar increase applies for active ingredients in use, as about one thousand times the amount of herbicide active ingredient is used in comparison with the insecticides. Further data from Sly (1984) shows an interesting comparison in the frequency of use of pesticides on grassland.

Table 2: Pesticide usage on farm crops – 1982 survey

	Grass	Cereal	Major arable
Area (m ha)	6.1	3.4	0.6
% treated	42.5	99.8	98.5
Times treated	1.0	5.2	6.5

(from Sly 1984)

Of the 6.1 m ha of grassland only 42.5% are treated and it is only treated once. The 3.4 m ha of cereals, however, are virtually all treated, and treated some 5 times in the course of a year and a similar set of figures apply for the other major arable crops. Clearly if a pesticide is to be effective on grassland its efficiency must be very high. The figures emphasise the programme approach used on cereals and arable crops in comparison to the rather one-off nature of the single applications to large areas of grassland. The figures in Table 1 show 998 tonnes of a.i. were used on grassland; the figure for cereals is 16,700 tonnes.

Interestingly the figures from Sly (1984) show an increase in use of active ingredient on cereals from 9,090 tonnes in 1977 to the 16,700. Over a similar period the active ingredient used on grassland has gone from 946 to 998 tonnes. To some extent this is a reflection of the area of new reseeds put down each year in comparison with the area of cereals.

Autumn Weed Control

Papers at this conference have mentioned the problems of clover establishment (Haggar *et al.* 1985) and the problems of clover-safe autumn weed control (Cooper & Jackson 1985). I think the questions often asked of advisors are: what do we gain or lose by controlling the weeds; just how important is clover safety; when we do remove weeds and what is the effect on yield?

Table 3: Effect of weed removal on crop composition and yield – December sprayed; harvested 25 April

	% by separation			d.m. yield
	PRG	Clover	BLW	t/ha
Treated	94	0.2	6.1	3.5
Untreated	58	0	42.0	4.3

(Cardiff 1984)

The figures in Table 3, which have been incorporated into the paper given by Cooper and Jackson at this conference, show several things. Firstly, they give some indication of the typical level of clover in autumn reseeds. 0.2% is by no means unusual and our trial work in Wales has shown autumn reseeding to be the worst time to get effective clover establishment (Anon 1983). At clover contents like this, the benefits to livestock and to sward nitrogen fixation will be low, even accounting for increases the following summer. What value therefore is clover safety? The second point which clearly emerges is the effect of spraying at the December date on the amount of perennial ryegrass and broad-leaved weed harvested. Clearly on the basis of ryegrass and broad-leaved weed content, treatment has been worthwhile. However, the d.m. yield taken at the end of April lost 800 kg d.m. ha^{-1} as broad-leaved weed material. Harvesting later undoubtedly would have increased the perennial ryegrass contribution.

A big problem in an advisory context with autumn spraying is the poor weather conditions prevailing at that time of year, and the consequent likelihood of ineffective spray due to applying in adverse conditions. Although spraying is desirable in terms of producing clean swards, the practical application of late autumn/early winter spraying can lead to problems, particularly in the wet and windy west.

Perhaps the major problem in grassland weed control in livestock areas is the decision on whether to use livestock or to spray. If livestock are to be used the sward needs to be relatively well established and yet if it is left too long the weeds will get an even tighter hold and probably result in large areas of dead sward.

Grazing autumn reseeds growing into the winter is not without problems. Sward damage by poaching can allow weed ingress and reduce yield in the spring. However, trials have shown that poaching in the autumn needs to be really very severe before sustained substantial crop loss occurs in the spring and summer (Anon 1970). When grazing with sheep, very severe poaching is quite difficult to obtain in practice.

Weed Grasses

Poaching in the autumn typically leads to the ingress of annual meadow-grass. Work at the Weed Research Organisation has shown that *Poa annua*, if not in too large an amount in the sward, does not necessarily reduce yield (Wells & Haggar 1974). However, because of its ephemeral nature, it does represent in some situations an unstable sward which can lead eventually to deterioration and weed ingress of more serious weeds. In the newly established sward, ethofumesate offers effective control of *Poa annua*. Unfortunately, control of *Poa annua* in a mature sward is more of a problem. Unless proportion of *Poa annua* is very high, say in excess of 20 or 30%, then I think it's a weed grass that should be lived with. However, if its presence indicates sward deterioration and lack of stability in sward composition then some action is required.

Choice of Herbicides

Herbicides are chosen on the basis of what weeds appear to be problems. The paper by Hopkins & Peel (1985) at this symposium shows docks to be a perceived problem by 50% of farmers. The values from Sly (1984) in Table 4 would support this.

Totalling the products other than MCPA, we find that herbicides for the control of docks and bracken make up the major group of use. The percentage area treated with the third and fourth products in the lines of the table is three times the percentage area receiving glyphosate. This suggests a desire to control perennial weeds without a full reseed. Effective control of perennial weeds in grassland without recourse to ploughing remains one of the major challenges in grassland weed control. Unfortunately, the impact of triclopyr on the market is not shown in these 1982 survey values.

Selective application has shown some potential for clearing perennial weeds in

Table 4: Major grassland herbicides

	% of area
MCPA	28
Asulam	16
2,4,5–T; 2,4–D; dicamba	7.5
Dicamba, mecoprop, 2,4,5–T	7.5
Glyphosate	4.9

(from Sly 1984)

grassland, but sadly problems of its operation in practice can often leave much to be desired, rather like the application of herbicides in the autumn. The commonest fault is too rapid a forward speed through the crop, and other drawbacks can be lack of height differential, irregular terrain, and a desire to obtain effective control with just one pass. In many trials of the technique of two passes seem to give a better result (Anon 1983).

However, the technique of selective application has a lot of potential, perhaps as part of an integrated weed control programme. The techniques currently available do lend themselves to the development of weed control strategies for perennial weeds although at present such strategies tend to be rather hit and miss affairs. Label recommendations are complex enough as it is, and it would seem unlikely that it will be ever possible to encapsulate such strategies for perennial weed control on product labels.

Bracken

Effective control of bracken involves the suppression of vast underground reserves in the rhizome system. Much of the land occupied by bracken has a deep soil and is potentially quite fertile. Bracken has been shown to have carcinogenic properties in a wide variety of conditions (Cooper & Johnson 1984). As an advisory problem its control with herbicides presents few difficulties: products available at the moment are effective and can reduce this vigorous weed to virtually nothing in the course of a season. However, the rhizome mass under the soil is capable of regeneration and the principal advisory difficulty is ensuring that a bracken control programme contains an effective follow-up management package to ensure fronds do not return. A problem with bracken eradication is the great variety of swards that exist beneath the fronds, ranging from reasonable grassland to a rather deep litter.

Direct Reseeding

The herbicides for this operation have been around for some time now and they offer very effective control of the sward and in most cases a total kill can be achieved. In some cases too much material remains and in others the drilling is

done when soil moisture conditions are far from their best. Fortunately much of the drilling is done by contractors with a wide experience and generally a reasonable standard is achieved. Yet despite this expertise it is interesting to observe that frequently cross-drilling is not practised unless specified. Although an additional cost, the benefits in terms of quick ground cover and effective weed suppression are well worth the extra time and money (Newcomb 1985).

Seed rate is a little considered aspect of weed control in reseeding, although some of its potential has been mentioned at this conference (Parr 1985). Table 5 shows the effect of two different grass seed rates on clover establishment at a relatively clean and a weedy site.

Table 5: Effect of weeds and seed rates on clover establishment

	Clover: % cover	
Clover/grass seed rate, kg/ha	Clean site	Weedy site
4.8/11	36	25
4.8/22	33	31

(ADAS Wales)

From a much larger trial (Anon 1984b) the figures show the difference obtained in clover cover when 22 or 11 kg of grass were used. At the clean site there was relatively little difference, but at the weedy site less clover was obtained at the lower grass seed rate. This weed suppressing effect of grass is missed by the use of low grass seed rates to ensure a vigorous clover sward. In this context the ability to forecast weed populations from soil seed reserves and weather conditions would be a great asset.

Grazing Management

The main aim of a grazing system must be to ensure optimum livestock output from the area of land utilised. By and large the differences between well managed systems under different techniques of management are small (Ernst *et al.* 1980). Paddock grazing of dairy cows has produced some very creditable results, notably from Northern Ireland (Gordon & Crawford 1984). However, grass growth varies considerably throughout the UK and in some areas other systems may be preferred. Continuous stocking has benefits in terms of avoidance of poaching and the generation of dense relatively weed-free swards.

The new grazing techniques being advocated by the HRFO based on herbage mass are dependent on very high tiller populations (in excess of 30,000/m^2) being produced by continuous grazing of sheep (Grant & King 1984). This system generates very high quality weed-free swards and produces very good livestock output. Clearly continuous grazing has a vital role to play in the preservation of sward quality, density and weed-free status. It may be that more skill is required

to obtain maximum output per hectare, but when this is available the yields differ far less than may be expected from rotational grazing.

Slurry application is another area of management where livestock producers find difficulty in obtaining the best from their grassland. The relatively low fertiliser value of slurries and farmyard manures emphasise the need for efficient spreading of the bulky material and the avoidance of sward damage. Winter applications give a poor return on the nutrient value but offer an effective way of slurry disposal, and if followed by a spring harrowing damage to the sward is minimised.

Pests and Diseases

The major problem with pests and diseases is their lack of visual symptoms. Most requests for advice occur when bare patches have appeared in the sward or where reseeds have failed to establish properly. The diagnosis of leatherjacket or frit fly is relatively straightforward and treatment presents no problems. Forecasting pest damage would appear a useful service, however in practice this can be rather difficult. ADAS does put out forecasts of frit and crane fly activity, but the industry does not appear concerned about acting upon such forecasts.

Fungal losses in grassland are even more rarely presented as advisory problems than those due to pests. However, I suspect we are at the tip of an iceberg with this problem and those advisory queries relating to rejected herbage by grazing livestock represent a very small proportion of the herbage lost due to fungal activity. Many papers at this conference have highlighted the benefits to be gained by the control of pests and diseases, particularly during the establishment period. It would seem likely that some of the treatments mentioned could emerge as routine over the next few years, perhaps more so in direct drilled swards.

Future developments

We are now starting to understand the problem of pests and diseases in grassland. Whether this understanding leads to developments in the husbandry of grassland will depend on the actual frequency and severity of losses. If these are judged significant by the farming sector, undoubtedly products will come along at prices suitable for their general use.

We still do not know accurately whether there is a widespread demand for some of the potential developments outlined at this conference.

Some mention has been made of the use of growth regulators but their role is yet unclear. At present they are available for use on amenity swards and on herbage seed crops. They have possible uses in the control of weeds, the establishment of swards, the manipulation of sward composition and the matching of seasonal growth to livestock demand. The suppression of normal grass growth is, however, not without its problems. Table 6 shows the effect on sward composition obtained by using propyzamide to reduce normal grass growth and so encourage clover.

Table 6: Sward manipulation

	% cover			
	Propyzamide, 1.5 kg a.i. Oct 23		Control	
	Oct 83	Oct 84	Oct 83	Oct 84
Perennial ryegrass	27	44	26	72
Broad-leaved weeds	1	29	5	13
Clover	12	21	8	16

(ADAS Wales)

The clover was increased to an amount higher than that due to the normal increase during the summer. Unfortunately, the suppression of the perennial ryegrass allowed the development of the resistant broad-leaved weeds as well as the clover. The best and cheapest change in sward composition was that obtained simply by its enclosure from the field management of heavy sheep grazing!

Environmental constraints will figure in future developments and there is a clear need for a wider education about the realities of agrochemicals. In the long term, biological and genetic developments should elad to very safe products with high target specificity. Certainly such products would be attractive for the control of perennial grassland weeds and the removal of the problem weed and no others would be an ideal. Minor weeds, either grass or broad-leaved, can contribute to the stability of the sward; they can help to even out the seasonal growth pattern; in some instances they can be a useful source of energy and trace elements (Barber 1985).

Grassland farmers are generally quite capable of producing very productive monoculture swards of Italian or perennial ryegrass. Keeping such swards for several years is the problem. From an advisory point of view the widespread demands for this type of grassland appear small. The maximising of livestock output always comes first, and grassland husbandry advisory problems are clearly centred on this need, and likely to remain so.

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Weeds, Pests and Diseases of Grassland and Herbage Legumes – An Industry View

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The Market

Britain has the reputation of being a green and pleasant land, but for livestock farmers it must a green and productive land. If 'industry' is to help in this productivity it must have a close knowledge of the market which is: the area of grass and legumes, both herbage and arable, influenced by: the current farm expenditure; the future available cash and the 'on farm' fixed and variable cost balance. An evaluation of the influences shows that the farmers' costs are increasing, whilst his returns are often constrained or reducing.

The total area of grass declined from 1980 to 1984 (Table 1) especially short term grass: the very area that is the lifeblood of the agrochemical industry, the seed industry and many others.

Table 1: Area of grass, ha^{-3}

	1980	1982	1984	1980–84
Temporary grass	1,966	1,860	1,807	−8.0%
Permanent grass	5,142	5,099	5,126	−0.3%
Rough grass	6,335	6,199	6,199	−3.4%
	13,443	13,158	13,052	−2.9%

Source: MAFF Returns

Ninety percent of the national usage of agrochemicals is on arable crops, *i.e.* about 25% of the land area. But the 70% grassland area receives only 2% of the agrochemicals. Hence one of the agrochemical industry's problems is: will there be a justifiable return on investment and in what are we investing?

If we turn to Psalm LXXV we find that:

'In the morning it is green
And Groweth up
But in the evening,
It is cast down
Dried up and withered'

Some people may say that this sums up the farmer's achievement with clover, but the psalmists amongst you will know that it referred to grass, so maybe we have progressed!

Besides taking evidence from history, we have to look forward. From two papers given at this Symposium (Table 2) there is a conflicting evidence of potentials.

Table 2: Re-drilled grass

Estimate 1 : 0.45 m ha
Estimate 2 : 0.40 m ha

Difference 0.05 m ha

	Available market – difference of 50,000 ha		
	£/ha	£m p.a.	Ratio
MCPA	3.05	0.15	1:1
Benazolin 2,4–DB MCPA	24.85	1.24	8:1
Ethofumesate Bromoxynil Ioxynil	40.35	2.02	13:1

A turnover ratio of 13:1 and a cash value variation of £0.15 m to £2.02 m must have a considerable influence on industry's decisions with regard to investment, particularly research and development! Research into the accurate assessment of potentials is, therefore, vital. It is the potential profitability after research and development costs that counts, coupled with the farmers' willingness or ability to spend.

Herbage Legumes

What potential do herbage legumes offer to industry? (Table 3)

At these levels of legume use it would be difficult to justify much development on sanfoin or lucerne, not only in terms of agrochemicals but also other inputs as well such as seed, machinery and research. But improvement and developments have to come from somewhere, hence the value of a high quality crystal ball.

Table 3: Herbage legumes 1983–84 – Industry recorded seed sales

	Herbage legumes, %	Seed sold, Tonnes	Total seed Tonnes	Herbage legumes grass, %
Red clover	19.5	246		
White clover	71.1	896		
Alsike	8.0	100		
Sanfoin	0.9	11		
Lucerne	0.5	6		
	100.0	1259	1,259	6.3
Grasses			18,662	93.7
			19,921	100.0

Market Changes

A shift in any of the following areas can considerably affect market potentials: grass/clover balance; nitrogen cost and utilisation; grass/concentrate balance; conserving and utilisation efficiency of herbage.

While on a more mundane level, what are we talking about? We have the words: 'fodder', 'forage' and 'herbage'. They seem to be rather inter-changeable in their use, I think we need a clear definition of each so that we can talk a common marketing and advisory language.

Farmer and Industry Risks

What are the risks that can threaten a farmers' investment and about which *they* may need information and assistance? They include, weeds, pests, diseases; fertilizers, seeds; soil type; drainage, incident light etc.; utilization and storage waste; re-seed *v.* re-furbish benefits; establishment of crop.

Out of these factors, utilisation may often be weak, but establishment is the one most often treated in a cavalier fashion on the farm. For example, the farm benefit of agrochemicals would be much greater if target 'grass' were better quantified and husbanded.

What are the risks to industry?

Farmers – will they change their systems or their spend?
Politicians – what new constraints will they impose in times of surplus?
Farmer margin pressure – how much will they be able to spend?
Investment decisions – will be challenging for farmer and industry in the future scenario!
Governmental regulations – what will they be, with what impact?

Industry Contribution

What has or is industry going to contribute to?

Clover safety of herbicides – here considerable work is being done.
Screening of new varieties – to ensure crop safety.
Evaluation of husbandry systems – to find the benefits and constraints.
Evaluation of input benefits – a difficult and long-term investment.
Pests and diseases – what is the future benefit and potential of control?

Where might 'industry' invest?

Will Lucerne, sanfoin, peas or lupins have a future as forage legumes?
Will fodder crops, such as fodder beet, take up some area currently down to grass, if so which crop has the greatest industry potential?

Changing Systems

Changes introduced by alternative cropping systems could give rotational benefits, but they may also create new weed problems and alter feeding and utilisation patterns. In turn this may result in much more slurry, and so have an effect on the efficiency or timing requirements of agrochemicals. You can't change one factor, without changing 'the system', as Professor Spedding rightly emphasised. So what safeguards or assistance does a farmer have or need when looking at his systems now and in the future?

Seed beds and sowing – education is certainly needed here!
Optimum sward life – if stocking density is reduced will it change?
Optimisation of fertiliser benefits with agrochemicals!
Retention of target species in swards. Currently it is not well done, it is too often a question of panic late, instead of protect early!
The target plant distribution must be improved – it is no use saying that spraying gives bare patches. Researchers and advisers should be helping farmers avoid them, not wingeing about them!
Pest and disease control – probably the area of potential for industry and the farmer.
Fodder conservation and utilisation – will both need better organisation, timeliness and choice of chemical and other aids?

Agrochemical Safeguards

Out of 199 active ingredients in the 1985 list of *Approved Products for Farmers and Growers* there are relatively few available for grassland use. (Table 4)

This Table graphically illustrates the relatively low number of aghrochemicals availability for our enormous area of grass. So it is important that advice on available products gets to the farmer easily, and in a way that he can understand.

Table 4: Current farmer safeguards

'A' agrochemicals – 1985 – Number of available active ingredients

Grass type	General weeds	Perennial weeds	Pasture destruction	Pests	Diseases
Established	8	6	4	2	0
Leys	9	0	6	2	0

Advice

Where will this advice come from in these times of financial constraint: ADAS, MAFF, companies, consultants, farmer investigation groups, co-op agronomists.

How will the information be communicated to the end user, by means of, literature, audio, computer, prestel or ATB? Will any of these be suitable for the small farmer and how much will farmers and industry have to pay for advice received and given?

Production Optimisation

An important part of the information supplied to farmers should relate to production optimisation: what is the optimum soil, seed, fertiliser, agrochemical interaction? And what is the best timing relation of grazing/conservation with inputs? This brings us to the recurring symposium theme of who will find out, and who will pay?

It seems to me that there is the need for a central research clearing house that takes all the good research elements and puts them into a 'system development programme' to get something of value to the farmer. In this way we won't just have PhD theses on a library shelf, we will be getting value for the research spend.

Agrochemical Contribution

If the market potential *and* farmer uptake justifies it, the agrochemical industry contribution can move towards:

Increasing potential yield and utilisation
Retention of target swards
Aiding palatability and seasonality – perhaps with plant growth regulators
Aiding digestibility
Pest and disease control
Improving weed control capabilities

All of these potential benefits demand that supplies and suppliers are available. What about the supply industries?

Whither bankruptcies – farmer and supplier?
How many farmers and suppliers will be left in the market?
How good will delivery services be?
How much 'advice' will be affordable without payment?
Will the pressures lead to 'cash and carry' supplies?

In addition 'the industry' may be more controlled by legislation. For example, what will the new 'Pesticide' bill bring forth? Will it affect:

The random use of uncleared products
Unapproved tank mixes
Clearance of off-patent products
Minor crops, like grass.

The Future Challenges

Some of the challenges that the next year or two hold out for industry and the syndicates are:

Predicting the horn/corn balance?
What will human feeding trends be?
What type of meat and milk will the public want?
What sort of sward will be needed to produce it?
Will *Bromus willdenowii* be important?
The environmentalist and conservationist pressures!

Are these really new? Shakespeare was very perceptive and in Henry V recognised the conservationists view:

'The even mead,
That erst brought sweetly forth
The freckled cowslip
Burnet and green clover'

He also presented what I would call a destructionist view of a pasture which:

'Conceives by idleness,
And nothing teems
But hateful docks,
Rough thistles, Kecksies, Burs'.

So I guess little has changed – the 'even mead' must have had the hedges taken out and the ditches filled in.

But the industry challenges still carry on. What will the vegetarian lobby be? Will we want grass or livestock much longer? Will mycoprotein take over from the livestock that make such a nasty mess on the roads; the mess that urban village dwellers complain about; or will they decide they can't do without 'pretty' cows in the field? Maybe Milton Keynes, with its concrete cows, was more perceptive than we give credit for.

Back to reality, what, where and at whose cost will chemical and variety screening be done? What will the science of silage be? How about a silage intake booster, a sort of molecular clover? What will be the impact of genetic engineering; or that of integrated biological control? How can the seasonality of grass be improved? Will clover-safe herbicides be produced for adverse weather conditions or will breeding produce herbicide-safe clovers? What will be the impact of slurry seeding?: It could change the way that we might or might not be able to use agrochemicals. Will slow release pesticides be the best and easiest way forward in grass crops? Is there a place for a harvest shock inhibitor? Would a plant growth regulator help with a quicker recovery of grass after a conservation cut?

Whatever happens there will have to be: much more co-operative development of products and systems; better communication to the end users; ensurance that the products and services are affordable by the farmer.

I would like to sum them up in the Christopher Society motto:

'It is better to light one candle than curse the darkness'

As the syndicates go forth they will no doubt light many candles and if they are feeling particularly inspired, they may be able to bring out the sunshine over our green and pleasant land.

PART 6

SYNDICATE DISCUSSIONS

SYNDICATE DISCUSSIONS

Delegates were divided into six syndicates and each syndicate was composed of a complete cross-section of the delegates present. Syndicates were asked to discuss the following questions, each question being considered in relation to WEEDS, PESTS and DISEASES.

1. what important points have come out of the Symposium for:
   - the farmer?
   - the adviser?
   - the agrochemical industry?
   - the future R & D?

2. What areas have not been covered or covered inadequately?

Following syndicate discussions, each syndicate chairman made a brief report to the Symposium and these reports are summarised on the next few pages.

After the reports had been given a general discussion was led by R.J. Wilkins.

Report of Syndicate 1 (R.J. Haggar)

The syndicate felt that it was important to gauge the magnitude of weed, pest and disease problems in comparison with other constraints on grassland enterprises. Such an approach was in line with Professor Spedding's opening challenge: also it could be associated with Doyle's model, which showed it was likely that the level of dock infestation justifying economic control was greater than that permitted by Richard Newcomb's 'pride level'.

In order to resolve any imbalance in the work of pathologists, entomologists and weed scientists, it was suggested that multivariate experiments be carried out to determine relative effects.

Weeds

There was an assumption that in the future farmers will cut back inputs into grassland, leading to a concerted effort to grow more clover for sheep and beef production. From this it was concluded that weeds of tomorrow could well include indigenous grasses, particularly those that prevent clover from spreading and surviving.

There was need for more appropriate applicators for applying herbicides to weeds growing in patches, rather than overall spraying.

Pests

There is adequate information on the effects of frit-fly and leatherjackets on yield losses, but much less is known about the damage caused by slugs, wireworms and nematodes. On the question of frit-fly damage, it was felt that serious damage was regional in nature and risk levels could be predicted from knowledge of larval populations.

Diseases

There is a real need for pathologists to quantify yield losses caused by specific diseases. Farmers need to be made aware of such quantification and there is the possibility of pathology becoming of great practical value in the future.

Gaps

Funding will become a problem in the future. At present AFRC seem to favour long-term research and the agrochemical companies can afford only short-term investigations. This means that the necessary R and D is very much at risk unless a new system of funding can be devised. Any such new system should involve active farmer participation in use of funds.

Other points were:

- a need for improved education and communication of research findings
- simplification of advice
- concern for environmental issues

Report of Syndicate 2 (C.K. Mackie)

Weeds

Several papers emphasised the role of good husbandry in keeping weed problems in check and this was re-emphasised by Richard Newcomb. This is a message that needs promotion and a suitable video-tape on the subject was proposed. Is clover important in grassland? The group were concerned that time, money and effort were going into the protection of 'conscience clover'. Are clover-safe herbicides justified if:

- most of the clover in an autumn reseed dies before spring?
- in the first year clover is swamped by at least 300 kg ha^{-1} of N?
- the clover that remains in the sward does not fix N but utilises fertiliser N?
- the clover content is so low that nutritive value of herbage is not enhanced?

If clover is important, then a spring reseed could eliminate the need for other protective measures.

Environmental considerations are important and mention was made of trial schemes in which farmers are paid a grant of £2–£6 ha^{-1} $year^{-1}$ for each wild flower species present in old grassland above a threshold of 20 species. Greaves referred to biological control and use of aerial spraying of 'Collego', a biological herbicide. It is likely that environmentalists will see use of such 'natural' products as potentially harmful to the environment as chemical products.

Richard Newcomb criticised much of the current marketing promotion of agro-chemicals. Rewriting literature is out of date. An interactive system for the farmer is desirable, for example, wider use of Prestel.

Pests

Farmers would find accurate forecasting of likely problems a great advantage. At present, routine use of insecticides against frit-fly should be used for August or later sowings. Leatherjacket populations can be estimated and Mowat's paper was of interest. The population dynamics of nematodes should be better understood and also the likely contribution of tolerant varieties of grass and clover. Bibionids, sub-surface feeders, might be important.

Diseases

NIAB evidence from Priestley has shown both a yield response to fungicides and a range of resistance to disease amongst recommended varieties. The reported yield response of 0.55 t ha^{-1} of d.m. to fungicides might be economic, but this was the average response of all varieties, irrespective of their degree of resistance.

Also, it is essential that work on disease is conducted on herbage mixtures, as nearly all grassland is established with mixtures.

The syndicate was surprised at the scale of losses due to various diseases.

Gaps

Dibb posed the question as to why newly sown swards produce their highest yields in their first full harvest year. Suggestions were:

- compaction limits full root development after the first year
- nematode damage
- N is locked up in organic matter
- virus diseases limit production

Allan asked 'who will pay for future research?' It is hoped that Government agencies and industry will work more closely to use limited funds to the best advantage.

Report of Syndicate 3 (R. Newcomb)

Weeds

At establishment farmers should pay more attention to seed-bed preparation and be prepared to sow above-average seed rates if seedbed condition is poor. Chemical weed control should not be a substitute for good husbandry at establishment and low levels of weed can be controlled by grazing and cutting management.

Weed grasses are not important in grazing situations until weed populations are at a high level, but weed grasses can be more serious in cut areas, particularly under drought conditions.

Dock control is often for cosmetic rather than economic reasons, but this is not criticised as uncontrolled dock problems do get progressively worse.

Pests

It is known that some areas are more prone to frit-fly attack than others and work is needed to pinpoint geographical areas of high risk and also timing of maximum damage. It seems likely that late August sowings are most susceptible and use of seed dressings as a means of control looks promising. If such dressings combine appropriate fungicides as well, it could be a satisfactory alternative approach to spraying and one that might be more acceptable environmentally.

There is need for more information on the biology of pests and the effect of pesticides on plants and non-target insects.

Nematode damage needs further quantification, but some attacks are devasting: effective sampling methods for identification are lacking.

Slugs were nearly ignored in the papers but are likely to be important when grass is direct-drilled or where clover is established. Damage by rabbits and pigeons is of great significance in some areas, the latter being very damaging to legumes.

Breeding for resistance should be encouraged.

Diseases

Farmers should accept that some loss of production through disease is likely, although disease symptoms may not be obvious. Use of resistant varieties looks promising, but breeding objectives need setting up.

Work on fungi, reported by Lewis, should be followed up in a wider range of experiments.

The widespread occurrence of BYDV in grass was a surprise and further evidence on yield losses is important.

Gaps

There is urgent need for data on the animal performance from 'weed' species in grassland.

Environmental implications of chemical treatments should be better documented. Too little is known about the effects of pesticides on non-target species; Mr Choe drew attention to damage to soil micro-organisms in Korea caused by some chemical applications.

Report of Syndicate 4 (J. Johnson)

Weeds

The agrochemical industry sees main justification for chemical control in the establishment phase, but would like to see more of a market in established grassland. At present it has not been proved that weeds necessarily lower animal output from grassland and such economic information is overdue. The emphasis on the role of good husbandry to minimise weed problems in the establishment phase has been welcome, and the concept of a 'pride factor' influencing farmers' decisions on use of chemical control has blurred the potential impact of economic data.

The need to sow clover with grass needs re-thinking: either white clover is not needed or clover could be introduced after grass has been established and weeds controlled cheaply. So much grassland currently sown with clover contains too little clover to be of real value.

Pests

At present farmers see only severe damage and there is an urgent need for accurate forecasting of pest incidence and likely yield losses. The agro-chemical industry does not see a big market in pesticides for grassland and there is much interest in seed dressings.

Research should study pest problems in true field situations and not in 'set-up' situations or small plots.

Diseases

Farmers will find it difficult to recognise and assess disease problems and also the likely effects of disease on yield, persistance and animal intake of herbage.

Use of resistant varieties or seed dressings both seem attractive, as is the possible development of biological methods of control.

It is likely that use of grass seeds mixtures and regular close grazing will reduce the harmful effects of disease.

Gaps

Good economic data is scarcely available.

Environmental consequences of wider chemical use on grassland must be ascertained.

Report of Syndicate 5 (A.J.H. Carr)

Weeds

The symposium has re-emphasised the central role of good husbandry at establishment and questioned how many farmers really need clover safe herbicides. In the future more farmers may become dependent on clover, but a swing to spring establishment of grass/clover swards could alleviate costly chemical control and the high risk of clover loss.

Where spring sowing is not possible, the introduction of clover after a successful establishment of weed-free grass should be studied. This will lead to lower demand for clover-safe herbicides and allow wider development of grass-safe herbicides to completely control perennial weeds such as docks.

Many farmers and advisers lack information on economic thresholds for control and the availability of cost-effective products. There is need to speed-up the present Approval system and simplify product ranges on Company lists. More emphasis is needed on animal aspects – intake and production – to follow up the work reported by Barber.

Pests

If grass is sown after grass in August or later, then prophylactic control against frit-fly should be used. For leatherjackets, Mowat's report of July control measures should be studied on a wider scale; more emphasis should be given to farmer-operated testing kits (e.g. Newbold's poster). Slug damage is much more serious on clover than grass and also where direct-drills or slit-seeders are used.

Bibionids are not controlled by chlorpyrifos and nematode populations need monitoring (it was reported that some Humberside farmers use nematicides regularly at grass establishment.) Sitona weevil and flea beetle attacks on clover are seen as localised problems.

Diseases

The NIAB data from Priestley made an impact: is this size of response widespread? Will animal production be similarly (or even more markedly) affected? Diseases are more likely on grass cut for silage and it is suggested that further work is needed in field situations where grass is cut for silage and then the silage is fed to stock.

Pathologists should look beyond foliar diseases, e.g. study Fusarium, Pythium and other early or stem-based diseases.

Breeding for disease resistance should continue; disease resistance should feature more when new varieties are recommended.

Further investigations into the prevalence and effects of virus diseases is needed, as are methods of economic control.

Where appropriate, wider use of seed dressings should be studied.

Gaps

There is need for improved communication so that the farmer and adviser are aware of current thinking and recommendations.

Environmental aspects need consideration, particularly in relation to increased use of herbicides, fungicides and pesticides.

Professor Spedding was right in pinpointing need for an integrated approach to control, based on systems analysis.

More work is needed on the possibilities of genetic manipulation.

Report of Syndicate 6 (R.O. Clements)

Weeds

There was not a lot of new information presented at the seminar, but the manner of its presentation emphasised the need for the integration of cultural and chemical control methods. Farmers need more information on weed forecasting and the relative merits of undersowing compared with establishment without a cover crop.

As the agrochemical industry sees grass as a minor crop, it may lack the incentive to develop new grassland herbicides. The role of (and need for) clover-safe herbicides must be resolved, but this is part of a much wider concern over the future role of clover in British grassland.

Future R & D should look at the place for low-dose herbicide applications and the development of biological control methods.

Pests

Response to pest control measures are seen as variable and the uncertainty of response predication is a problem. Are molluscicides needed as often as they are used?

Frit-fly damage needs more publicity, as does the use of seed treatments for control if it is proved that these are cost-effective.

More work is needed on nematode problems and threshold levels for leatherjackets.

Pesticide use should be studied in relation to biological control possibilities and better use of sound husbandry techniques. The possibility of resistance through breeding should be investigated.

Diseases

The widespread occurrence of BYDV on grass was noted: the possible effect of this disease on yield, herbage quality and response to N should be quantified. Differences in varietal resistance should be measured and any link with cereal levels of disease should be noted.

Good seedbed conditions may minimise fungal development and there was concern lest widespread use of fungicides on grassland would lead to more fungicide resistance in cereals as well as grass (and wider environmental implications).

Gaps

There has been too little reported on the effect of disease on water-soluble carbohydrate levels in grass and the impact of this on silage (fermentation quality, intake of product and subsequent animal performance).

More research is needed on foot-rots and root diseases in grass.

Considering legumes were mentioned in the title, too little information was given on legumes.

Summary of Syndicate Discussions

The following gives main points raised by at least two syndicates (each asterisk indicates the point was mentioned by one syndicate).

Weeds

Is consideration of legumes important when considering herbicides for grassland?	* * * * * *
Good husbandry at grass establishment minimises the need for herbicides	* * * *
Greater farmer awareness of weeds and information on economic thresholds are needed	* * * *
There should be developments in biological and integrated control	* *

Pests

Need for developments on forecasting attacks	* * * * *
Use of seed dressings for control	* * *
More information on autumn sowing dates and frit-fly damage	* *
Treatments for leatherjackets	* *
Quantify nematode problems	* *

Diseases

Further need to quantify effects	* * * * * *
Potential role of resistant varieties	* * *
Study disease problems in mixtures	* *
Possible use of seed dressings for control	* *
Importance of BYDV in grass	* *

Gaps in Material Presented	
Data on economic thresholds	* * * * *
Future funding of necessary R & D	* * * *
Need for improved communication from research-to-industry-to-adviser-to-farmer	* * *
General Points	
Need to consider environmental aspects	* * * * * *
Inter-relationship of work on weeds, pests and diseases	* * *
Change of autumn sowing date to spring will alleviate some weed, pest and disease problems	* * *

CONCLUSIONS

Contribution to Concluding Discussion (J.H.D. Prestcott)

A new situation is faced by all of us; farmers, the ancillary industries, the extension and R & D services.

In order to make the best use of reduced resources and to adapt to these changes, we need a more dynamic approach to stimulate, co-ordinate and foster the distinctive contributions of individual specialists in both public funded organisations and industry. The dispersed geography of our centres of activity should no longer be a major problem in this age of Information Technology. Research, development and extension work will need to be more sharply focussed for practical application, and in order to achieve this there must be improved feed-back from practice. The needs of both the grassland farmers and the interests of the wider community must be reconciled in defining objectives for R & D and Extension. Linked with this we must find an acceptable way to generate financial support from both farmers and the ancillary service industries to sustain priority research and development as Government funding is progressively reduced.

In our R & D the new dimensions that must be accommodated are an effective follow-through to economic appraisal and due account of environmental considerations. We need to quantify the incidence of weeds, pests and diseases – not just in terms of mean effects, but also in terms of the critical conditions that influence their timing, location, frequency of occurrence and intensity. We need to define these effects not only in terms of physical performance but also in terms of economic consequences.

An approach to the valuation of grass and forage as indicated by Chris Doyle must take into account its seasonal availability, efficiency of utilisation and value to the animal. This must extend beyond estimates of crude chemical composition and digestibility to include characteristics influencing intake and ultimately nutrient supply to ruminant animals.

Evidence of the difference between forages in nutrient supply to cattle and sheep has already markedly altered our perspective on the role and potential of legumes, especially white clover in beef and sheep production. We have measured a 40% higher nutrient supply from white clover than ryegrass. Similar consideration could well apply to the influence of weeds, pests and especially foliar diseases not just on yield of dry matter from the sward but on its utilisation for animal production as affected by intake and nutrient supply.

CONCLUDING REMARKS

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Weeds, pests and diseases of grassland must be considered in the context of a changing pattern of requirements from agriculture and the land. Consequently, these remarks deal initially with possibilities for changes in the intensity of production from grassland, before discussing (i) some specific impressions from the Symposium papers, (ii) an appraisal of the current state of knowledge and opportunities for controlling loss, and (iii) procedures to facilitate information transfer and research efficiency, particularly in relation to initiatives by the two Societies.

Intensity of Production from Grassland

The potential for large increases in the output from grassland is well-recognized and was discussed by Wilkins *et al.* (1981). There is also, however, general agreement that the National consumption of ruminant products is unlikely to increase, with the consequence that large increases in National production from grassland will probably not be required. For the future, there are the possibilities of either (a) reduction in the area of agricultural grassland or (b) reduction in the output per ha of grassland, or a combination of these two effects. Much will depend on the development of economic demand for land for purposes other than food production. The outstanding possibilities are for forestry (every EEC country is a net importer of timber and timber products) and for amenity or conservation, with financial incentives being provided for non-agricultural purposes.

If, as seems quite probable, these alternative demands for land increase, the required rate of output from the remaining 'agricultural' grassland could increase. In contrast, if the existing area of grassland remains in agricultural production, then there will be a need to develop lower input systems, probably reliant on white clover. Thus, although the future pattern of requirements for grassland is unclear, there does appear to be a need, as was done in this Symposium, to consider both intensive systems based on high inputs of fertilizer-N and more extensive systems involving legumes.

Impressions from Symposium

Note is made here of three topics to which the Symposium returned on many occasions, each of which had some contrasting and paradoxical features.

Availability of Crop Protection Chemicals

In reflecting views from Extension and from Industry respectively, Garstang and Allan both stressed that grassland is a minority crop in relation to crop protection

chemicals, with the quantity of active ingredient used on grssland being only around 5% of that on cereal crops. It was pointed out that new chemicals will not be developed specifically for grassland use. It is surprising in these circumstances that a large number of chemicals are available with recommendations for use on grassland, and it is particularly notable that the first of the Crop Protection Handbooks published by the BCPC on specific crops deals with grass and clover swards (Williams 1984). Thus, despite being a minority crop, there is a range of chemical treatments available for use in many problem situations.

Perception of Problems

Difficulties in the perception of weed, pest and disease problems and the identification of threshold levels at which treatment is economically justified, was a recurring theme of the Synmposium.

The use of herbicides is much greater than that of insecticides or fungicides, with much herbicide being used for the control of docks, which are obviously widely perceived as important weeds. However, the data of Courtney on the influence of docks and dock-control methods on herbage yield indicate that treatments may not be economic until there are very high levels of dock infestation, and Newcomb indicated that he treated docks for 'pride', in order to avoid being considered a negligent farmer rather than in the belief that he would receive economic benefit from the treatment. In contrast, farmers rarely perceive problems in pest and disease damage at grass-establishment, and in pest damage to established swards. Consequently, control measures are not taken, although economically consequential losses in yield may be taking place. Physical size seems to be of the essence, with large perennial weeds such as docks, thistles and bracken warranting consideration for treatment, whilst damage by micro-flora and micro-fauna, perhaps of greater consequence, will not be recognized or treated.

There is need for much more work on weed, pest and disease levels in relation to economic loss, in order to establish threshold levels for treatment, and on encouraging appreciation by farmers of situations where treatment is justified. It was encouraging that several papers dealt with economic aspects of control. The problems of making appropriate economic evaluation with an 'intermediate' crop such as grass are well recognized and it was interesting that most of Doyle's paper related to grass valued at £35/t d.m. whereas Newbold and Stewart ascribed a value of £85/t d.m. to grass. This is not a criticism of the analyses used, but illustrates that the real value of grass will vary much between different farming situations and different seasons of the year. The main deficiency is in the availability of biological data on crop response to a particular challenge. Once such information is available, then economic appraisals for candidate control measures can be made appropriate to particular circumstances.

Herbage legumes

Much attention was given to herbage legumes in this Symposium, particularly in

relation to clover – safeness of herbicides and the effects of nematodes, Sitona and Sclerotinia on clovers. It must be recognized that at present legumes are of little significance in British grassland. Although white clover is included in the majority of seeds mixtures, management is geared to grass rather than clover, with the result that surveys indicate few of our swards to contain sufficient clover to affect either plant growth or animal performance. Thus, at present, for crop protection in grassland there is little sense in restricting the use or development of technical chemicals to clover-safe materials.

The development of clover-safe materials will be important for the future because of a possible increased significance of legume-based production, as discussed earlier. Effective crop protection procedures are likely to be even more important in the development of reliable legume-based than in grass-based systems. All aspects of legume production and utilization were reviewed in a recent BGS Symposium (Thomson 1984).

Current Knowledge and Opportunities

This section reviews briefly the availability of technical solutions for the control of weeds, pests and diseases in grassland and our understanding of the situations where such treatments may be required. The discussion centres on grass (rather than grass – legume) swards, and considers firstly the establishment phase and then established grass.

Grass establishment

Several promising developments to protect grass at establishment were presented at the Symposium. Chemicals should be used to aid rather than replace 'good husbandry'. Lewis reported on fungicidal seed treatments, and this approach was extended by Paul and by Mathews with information on insecticidal seed treatments. The possibility of effective nematicide treatments at establishment was indicated by van Bezooijen. Recommendations for selective herbicide treatments pre- and post-emergence are available, and Whitehead indicated ways in which the spectrum of activity of ethofumesate can be further widened.

Only general guidance can, however, be given to situations in which chemical control of weeds, pests and diseases is needed for successful establishment. For example, there is a greater risk of insect damage when grass follows grass, or where direct-drilling rather than full cultivation techniques are used (Clements and Bentley) and risks of fungi reducing grass establishment are increased when seeds are sown in dry conditions (Lewis).

The potentially low costs of seed treatments, however, promise that it may be possible to use seed protection against fungi and insects as an 'insurance' treatment negating the need for research to give more precise guidance on responsive situations. The dose rate of the chemicals should be sufficiently low to avoid adverse environmental effects. The cost of effective weed control treatments is likely to be higher. This has led, for example, to recommendations

to use ethofumesate post-emergence, after the magnitude of the weed challenge has been assessed, rather than as a routine treatment prior to grass (and weed) emergence. The research reported by Haggar *et al.* is beginning to indicate threshold levels for the major weeds of grass establishment.

Established Swards

Likewise, with established swards the availability of crop protection measures is probably in advance of information on crop losses and threshold levels, although the range of satisfactory control measures is not as wide as that for establishing grass. Chemical control of docks, thistles, bracken and other broad-leaved weeds is available, although the ability to control 'weed' grasses is limited. Techniques for controlling frit-fly and leatherjackets are available, although the timing of applications may be restricted somewhat in grazed swards. There are fewer options for the chemical control of nematodes, fungi and viruses, and for these attention to cultural methods and the use of more resistant varieties and species, as discussed by P.W. Wilkins, gives the best prospects for limiting loss. The prospects for biological control of weeds, pests and diseases of established grass probably warranted more discussion at the Symposium. The use of mycoherbicides, as outlined by Greaves, is an exciting possibility, but I feel that such materials are more likely to be successful in the control of annual weeds in annual crops than in the control of perennial weeds, usually with substantial storage organs, in a perennial grass crop.

Although much more information on threshold levels is required, progress is being made, as indicated in papers at the Symposium on weeds in establishing grassland (Haggar *et al.*), docks (Courtney), thistles (Oswald), frit-fly (Clements) and leatherjackets (Newbold and Stewart). Information on the incidence of nematodes, fungi and viruses, particularly BYDV, on grass production and utilization is still sparse. Research reported by Dibb should, within the next few years, clarify the need to control the incidence of 'weed' grasses.

Information Transfer, Research and the Societies

Crop protection in grassland is very much a multi-disciplinary business and the Societies are to be complimented in bringing together the various interested parties at this Symposium to review the 'state of the art' and possibilities for the future in a way to complement the information on the BCPC Handbook. Newcomb commented on the difficulty of obtaining information on appropriate control measures, and Forbes noted in a study of ragwort control that some 50% of the attempts made for chemical control were not in accord with the guidelines supplied with the chemical. These points illustrate limitations in either the current procedures for transfer of information or that the control packages now provided cannot easily be applied in practical farm conditions. The prime responsibility for action to remedy these defects probably rests with Industry and the extension services, but the Societies should review whether there are further initiatives that they should take.

With reduced budgets, the need for effective co-operation in research, both in the public and the private sectors, probably has never been greater. With on the one hand the Institutes having much expertise with the grass crop and its management and evaluation in the widest sense, and on the other hand Industry having expertise in chemicals, formulation and application technology, there must be much scope for more projects involving partnership between the public and private sectors than has occurred previously. The encouragement being given by MAFF in the form of 'open contracts', in which extra support is provided to a project because of matching resource input from Industry, is to be commended, but many forms of co-operation can be envisaged, ranging from discussions in areas of mutual interest through to confidential contract research. It is to be hoped that this Symposium will have provided stimulus to the development of such co-operation.

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Reference is made in the text to numerous papers from the present Symposium which are not listed here.