THE ECOLOGICAL APPROACH TO THE WEED PROBLEM.

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I trust I will be pardoned if I both begin and end this paper with a quotation, and for the opening item I would like to quote the following translation of excerpts from a Statute of Alexander 11 of Scotland (1212 - 1249 A.D.): "If the tenant puts weeds in the land and will not cleanse it thereof he shall be punished by hanging;" and secondly, from the same source: "And if thy owner or his servant have filled the land with weeds, for every plant of it he shall give to thee or any other lord a wether sheep as a forfeit and notwithstanding this shall cleanse the land of the weed."

If I may comment, it is perhaps as well that the Statute does not apply at the present time in New Zealand.

When, some 12 months ago, I was privileged to address the Conference on Weed Control held in Christchurch, I chose to concentrate on the ecological factors responsible for weed invasion of grassland. I make no apologies for again addressing you on the same theme, since I feel very strongly that, in concentrating on the problem entirely from the viewpoint of control of weeds by chemical sprays and dusts of various sorts, we are inclined to become confused as the result of control of the effects without control of the causes. One hears a great deal these days of the use of various specifics for the control of this weed or that, from such apparently simple substances as special grades of kerosene for weed control in vegetable crops, to others such as 2,4 dichlorophenoxyacetic acid (2,4-D), and more with equally long and impressive names. Without doubt, in their respective spheres, all these substances are efficacious in eradicating specific undesirable plants, but to me the process always savours of the man who takes regular doses of aspirin to ease a pain which is merely a symptom of some underlying complaint that is not relieved by the treatment which alleviates the pain.

In other words, if, by the use of chemicals to eradicate the weed population of an established sward, we succeed in our object, we have merely removed the effect (the weed in the sward) and may not at all have affected the cause (the reason why the weed appeared in that sward). This being so, it is entirely probable that re-invasion of weeds will occur in a very short time, and the control measures will be largely wasted. The whole problem, immense as it is, boils down in the end to a problem of ecology. All plants, be they grass, crop, or weed, are responsive to various factors such as climate, temperature, soils, and competition from other species. A plant which in its seedling stage is capable of vigorous, rapid growth is assured, literally, of a "place in the sun", and this, no doubt, at the expense of its neighbours, whether they be useful species or mere weeds. Unfortunately, it does appear that most of the species which we regard as undesirables are capable of this quick early growth, and obtain an advantage over slower-establishing species of greater economic importance. The trend may be seen quite well in, say, a sowing of Italian ryegrass, as against the use of Cheving's fescue and browntop, for a lawn.

In the case of the ryegrass, growth in the initial stages is rapid and sufficiently vigorous to shade the ground surface and to overtop the establishing weeds.

The result is a clean, weed-free (or almost so) stand of ryegrass. With slower-establishing species (and the Chewing's fescue browntop has been chosen merely for the purposes of illustration), the less rapid initial growth and slow tillering, or spread, allows plenty of time for the developing weeds to reach the stage of overshadowing the grasses, and the result is that we have an area on which the undesired species gradually gain the ascendancy. Admittedly, in the case of lawn work, the areas are usually restricted in size; and it is therefore possible, and probably economic, to increase the seeding rate to a point where the grass stand which develops is so dense in the early stages that weeds are controlled by the competition.

Difficulty in establishment does arise, however, where land is cultivated and sown down in crop. Here, because sowing rates are comparatively light, in order that the developing crop plants may have room to attain their full size, there are of necessity large areas of bare ground, particularly in the early stages before the leaves of the crop have developed to the extent of providing ground shade. Weeds, therefore, are largely free to develop unhindered. I will content myself with mentioning the problem here and will leave the question of control to others better qualified than myself to speak on this aspect.

Perhaps the most satisfactory way of approach to a very brief review of the weed problem is to take an area in its natural state, so far as vegetation is concerned, and follow that area through a few of the stages as it is broken in and brought into permanent pasture. In doing this, within the confines of a short address, I would like to stress right away that no more than an outline and a bare statement of a few of the problems of weed invasion can be given. The question of control of the various weeds which establish could easily provide material for several bulky volumes, and cannot well be covered in one, or even many, papers. I would suggest, quite seriously, that this Conference could well give thought to the question of dealing in detail with several of the specific weeds which cause concern in New Zealand, a "symposium" on particular weeds, in other words.

However, I digress. Much of our farming land in New Zealand, and in particular the bulk of our hill country, was felled in the early days out of native forest of various types. The felling and burning of this forest left the exposed soil carrying the high fertility resultant from centuries of forest cover. What was not realised however, was that this fertility was only temporary and not permanent. The seeds mixtures used in the first sowings contained such species as perennial ryegrass, cocksfoot, dogstail, timothy, meadow foxtail, and red and white clovers, providing a plant cover which grew vigorously only so long as the initial high fertility persisted. Once this fertility began to wane the pasture cover began to deteriorate, and since those species which could thrive under the lower-fertility conditions were not present, or present only in small amount, the decline was a progressive one.

Some danthonia and browntop did appear and thrive in most cases, it is true, but these plants were only the survivors of those originally present or the all-too-few "immigrants" brought in by stock. In the main, the space formerly occupied by the high-fertility species was occupied by mosses and weeds, especially on the damper and shadier faces. Although it was realised that deterioration had occurred, research had not yet shown the reason, and further sowings of seeds-mixtures similar to the first ones were made, with an even shorter lease of life and period of mediocre production.

It was at this stage, then, when initial fertility began to decline and the high-fertility species to weaken, that the weed problem became really serious. Truly, most areas had suffered some trouble with regeneration of secondary growth before this, but with the lower fertility the problem of manuka, bracken, or hard-fern on the one hand, and flat weeds on the other, became obvious. The casual observer would probably now say that, if lower fertility was the cause, then topdressing, either through increased stocking with its increased return of animal manure, or else fertiliser out of the bag, was the obvious answer.

Since the decreasing fertility was responsible for the weakening of the high-fertility species, increased stocking would have been of assistance, except that the decline of production was probably more rapid than could have been made up by the extra stock which could have been carried, particularly as the lower-fertility species were not present to provide bulk in the feed, and also largely because good strains of clovers were markedly absent. In the days of which we are speaking, fertiliser out of the bag was by no means such a simple problem as it appears today, availability, lack of means of transport, and lack of access all militated against its use.

At the same time as this problem of secondary growth and flat-weed invasion arose, well-meaning but misguided individuals were actually cultivating gorse plants in rows in nurseries with a view to its introduction and use as an ornamental and a hedge or fodder plant. How successful the scheme proved to be, and how ornamental the result, is plain for all to see.

We have, then, our original good pasture of high-fertility species deteriorated to a weedy sward with an invasion of shrubby second-growth. The eradication of this secondary growth is a problem in weed control which could occupy a Conference for years, as it has occupied for many years past the time of several individuals. I merely mention the problem and leave it at that for the present. Presuming that satisfactory control and eradication of secondary growth can be achieved, we are left with our weedy pasture. I can already sense a restlessness and eagerness among certain of those present - an eagerness to propose a sure and easy weed eradication by modern methods! But control that eagerness for a moment. You will remember that I stated earlier that our pasture, from the very nature of its early sowings and from the high initial fertility, does not contain in sufficient quantity those medium to low fertility species which can thrive under the existing conditions. What happens, then, if we dispose of the weed population with a wave of the chemist's magic wand? Our high-fertility species are past their peak and far along the decline, we have little or none of the species whose peak growth coincides with the lower plane of fertility, with the exception of the weeds. Should we be even successful to the unlikely extent of disposing of 100% of the weeds present by sprays or dusts, we are still left with bare spaces in the weak sward, spaces formerly occupied by weeds. None of our desirable species is vigorous enough to ensure a rapid cover of the bare areas, and re-invasion is certain from weed seed, either in the soil or carried by wind or other agency from the outside. Though we may by chemical means solve the immediate problem of weed control, in the ultimate we are little further ahead.

At first sight it might appear that an oversowing of the appropriate species shortly after the weeds were killed would be the answer, but such a sowing in itself is not a satisfactory solution. While each species will produce its optimum growth when the fertility conditions are at their optimum for that species, it must be

stressed that optimum growth for, say, browntop, would be considered very poor when judged by the best growth of rye grass under its particular optimum conditions. In other words, even if the fertility suits browntop growth, its establishment and early growth will be easily overtopped by re-establishing weeds. The only hope would be to have our lower-fertility species already present and growing in fair proportion in the sward, in which case growth and re-colonisation of bared areas would in most cases be sufficiently rapid to control re-invasion of weeds. The ideal, of course, would have been for such grasses to have been included in the first sowings. Had this been done, even though the lower-fertility species did not contribute much to production in the initial high-fertility period, they would have persisted and gradually increased their dominance as the fertility declined.

On most of the more undulating to hilly country, cultivation by plough or discs was, and still is, impossible in the renovation of a run-out sward, and oversowings were the only available means of improvement, together with what small quantities of fertiliser problems of availability and labour made it feasible to apply. On the easier land it was possible to turn the weedy sward under and start again, though in many cases the fertility of the easier country was sufficiently high to maintain the better species for a longer period, and application of fertiliser was a simpler problem from the access point of view. Even on the easier country, however, success in control of weeds is not always just a matter of ploughing and resowing.

The same theme of competition between plant and plant, between desirable species and weed, applies just as much here as elsewhere. Competition for light, competition for moisture, competition for all the other factors of the environment which control growth and spread, all play a part. Survival of the fittest is no catchword in the development of a pasture sward, and the fittest is unfortunately not always the most desirable. What I do stress, and what I would like to repeat again and again, is that it is useless to wipe out an existing weed population in a pasture unless and until the species present, the fertility, and the management are such as to favour to the utmost the development of the desired species and to discourage re-development of the weeds. I had, perhaps, better make my position quite clear concerning weed control by chemical or other means. If the conditions which I have just stressed are fulfilled that is, if management and fertility and other factors favour the desired species, then by all means use any recourse available to remove the weeds, whether by cultivation, spray, dust, or any other method. So long as the balance is not swung against the development of the pasture plants by some feature of the weed control method used, then a clean sward will result, greater production will ensue, and we will have achieved our object.

And, in conclusion, I would like to say once again what I mentioned earlier: the few disjointed phases of the weed problem I have discussed are a mere skeleton of the whole. To cover the whole field would take volumes, in fact, has already taken volumes, as any review of the literature will show, and that is manifestly impossible in the space of one short address. I do feel, and I put it forward as a suggestion to those who may control any future Conferences, that a concentration of the control of a particular weed or weeds, a summing-up of our knowledge and suggestions for future work on such weeds, would, I am convinced, be of greater ultimate value than the more general type of discussion which, valuable as it may be, we have had up to the present.

Finally, one more quotation, this time from Shakespeare: "If we will plant nettles or sow lettuce, set hyssop and weed up thyme, supply it with one gender of

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herbs, or distract it with many, either to have it sterile with idleness or manured with industry, why, the power and corrigible authority of this lies in our wills". (Othello, 1, iii, 1604.)

GENERAL DISCUSSION.

Mr. D. A. Watkins - Mr. Harris is to be congratulated on his suggestions for future conferences. I have discussed the matter with people interested in good farming practices and the end use of these materials. If the conference followed Mr. Harris's suggestions we would get further. If a commercial compound will do a specific job it can be accepted as such. If basic chemicals do not get that result, farmers cannot use them.

Mr. Harris - Basic research and the application of research are two different problems. I was thinking more of basic research work than in the field. In the field we are concerned with the "why", and the man in the field is concerned with whether the treatment is effective. As far as pure substances are concerned I was speaking from the basic research point of view.

Mr. W. M. Horton - On the question of spraying-out weeds in a pasture where fertiliser is dropped, would it not be possible, by oversowing and raising the fertility, to gain benefit from the spraying; thereby using the fertility to reduce the acidity of the soil.

Mr. Harris - We certainly would have gained the benefit. The main point in spraying out weeds in turf and pasture is to have the pasture in such a way that the bared patches are covered as soon as possible after spraying. One of the main problems in a new turf is that grasses and clovers making initial growth have to compete with weed species. If you have pasture and turf growing well, then the areas bared by the spray are rapidly covered by clovers and the weeds are controlled. If the grasses are not growing strongly, the weeds may overtop the grasses and clovers and maintain themselves. I doubt whether, with low-volume spraying of hormones, there is enough hormone left to check future weeds. With five gallons to the acre, there is no great quantity of material left on the ground's surface to prevent re-establishment of weeds.

Q. - Is the time of the year important?

A. - Yes. I have concentrated on the turf side. Using the same concentration, etc., does not always make it possible to predict the results. One should spray when one expects to get optimum control. If it is a question of getting maximum cover, then those weeds which are growing strongly will be most effected by hormone sprays.

Q. - Has there been any experiment made whereby sprays were applied to the soil prior to sowing?

A. - I do not know. Perhaps a representative from the Department of Agriculture could answer that. We have undertaken control of weeds in experimental bowling green areas through pre-emergence spraying by hormones. The possibilities are good. We have done very little on the pasture side.