Wednesday, November 3rd.
Morning

APPLICATION PROBLEMS

Chairman: Mr. F. W. Morris

THE ROTATION OF WEEDKILLERS

A. L. ABEL, Pest Control Limited.

The first reference made in this country to the rotation of weedkillers was by Prof. Blackman in the inaugural Fernhurst lecture of 1950. As many of you may remember, he presented evidence of the relative toxic effects of growth regulating substances on parents and back crosses of a strain of Linseed, variety Royal, and instanced evidence that a single mass selection, by using a heavy dose of a growth regulating substance, had resulted in increased resistance. He went on to say, and here I quote, "While these results hold out a bright future for the breeding of resistant varieties, there is the reverse and grimmer prospect that repeated spraying with one type of herbicide will sort out resistant strains within the weed populations."

After quoting examples from the U.S.A. he went on: "The moral of this is twofold. Just as it is sound husbandry to practise crop rotation, it is also good farming to practise a rotation of herbicides. It is true that until new groups of selective herbicides have been discovered the choice of compounds is restricted, but nevertheless for some weeds and crops there are alternatives. The second moral is that although the mixing of two different types of herbicide may lead to the immediate killing of a wider range of weeds, there is the future risk of selecting types resistant to both compounds."

The continued and extended use of growth regulating weedkillers over the past 4 years has shown the "reverse and grimmer prospect" to have been realised in this and many other countries.

Resistance to weedkillers can arise in one of two ways: Firstly there is the development of resistance within a species as illustrated by Prof. Blackman's experiment on linseed. There is a segregation of those plants which by virtue of some character have survived, and with subsequent breeding a higher proportion will carry this character of resistance and will survive the treatment. This has, I believe, been demonstrated experimentally and in practice in the U.S.A. and there is increasing evidence from field experience in that higher dosages are now required to control certain weeds, e.g. creeping thistle (Cirsium arvense).

Secondly, there is the resistance which develops from a change in the botanical composition of the weed flora so that a weed not susceptible to the particular weedkiller being employed becomes dominant in place of the former susceptible weed. There are many examples of this type of resistance which have already developed. Typical cases are mayweed, corn marigold and chickweed which have become dominant in this way. Similarly, gramineous weeds have increased in importance, not only in this country but also abroad in such crops as rice and maize. The lack of competition from the broadleaved weeds, together with the abandonment of certain cultural methods of weed control, has led to their great increase. It has been mentioned to me by some farmers in East Anglia that the growth regulating weedkillers are partly responsible for the spread of wild oats. On enquiring why, I receive the following answer: "Before the use of these weedkillers became general, it was customary to send men spudding thistles and at the same time they removed any wild oats. The successful thistle control with chemicals has removed the necessity to spud them and the

men are not sent solely for wild oats."

A third possible way in which weeds might develop resistance would be by inducing a genetic mutation in some of the plants but there is no evidence, as far as I am aware, that this has happened.

It is by the second method that resistance is most likely to develop, and so necessitate a change in the choice of weedkillers. Most of the selective weed control carried out today is in cereals and it is in these crops in localised areas that we are finding the necessity for changing weedkillers. It is fortunate that there already exist alternative weedkillers for use in cereal crops - the growth regulating materials, the dinitro chemicals, and we must include sulphuric acid. These achieve their weed killing action in different ways and are effective against different weed species and, if they are used alternately in two successive cereal crops or other crops in which they can be used, a resistant weed flora is not likely to develop.

The grass weeds such as black grass and other gramineous weeds such as wild oats have not been so readily dealt with but the arrival of grass weedkillers such as TCA, IPC and dichlorpropionic acid have shown great promise. We have also had some indication recently that dinitro materials, applied in late autumn and early winter to established winter wheat, have been effective in controlling the seedlings of autumn germinating grasses including black grass (Alopecurus agrestis) but I would emphasise that these are the result of one season's work and conclusions should not be drawn. We intend following this line with further work and can only hope that it will be successful.

In a paper given at the "First International Conference for Plant Protection and Pest Control" in Rome 1950, Ripper, in dealing with this subject, expressed the view that, "for every weed of national importance in all crops, at least three weedkillers with totally different modes of action are required" and I emphasise the "totally different modes of action".

A glance at the Recommendations Committee Report for this Conference shows the range of crops in which it is now possible to employ chemical weed control, and the chemicals that can be used. The report makes firm and tentative recommendations for the various crops and they are briefly as follows:-

Cereals	MCPA, 2,4-D, DNC, Dinoseb and sulphuric acid.
Undersown cereals	DNC and Dinoseb; MCPA and 2,4-D for certain circumstances.
Cereal/legume mixtures	Dinoseb; MCPA under certain circumstances.
Linseed	MCPA and DNC (sodium).
Flax	" " "
Peas	Dinoseb
Field Beans	"
Lucerne	"
Sainfoin	"

Clovers (Direct sown)	Dinoseb
Kale	Sulphuric acid
Grassland and long term leys	MCPA and 2,4-D
Grasses for seed production	" " "
Onions	Sulphuric acid
Leeks	" "
Carrots	Vaporising oils
Parsnips	" "
Beet (Fodder, Red, Sugar)	Sodium Nitrate
Asparagus	MCPA
Potatoes	MCPA under certain circumstances.

As already mentioned, these are the firm and tentative recommendations for this year. It is probable that, for some of the crops, other chemicals than those listed may be equally effective but there is insufficient evidence available on which to base even tentative recommendations. New techniques in application such as pre-emergent treatment, as these following slides will show, and a re-examination of some of the older weedkillers for selective action will probably lead to new treatments being evolved: for example the use of sulphuric acid for weed control in kale. I should like to show you the next slides, again showing weed control in kale, this time with sodium arsenite. I am showing this to illustrate my point and not in any way to support the use of sodium arsenite on kale. There would appear to be a need for studies into the techniques of application of some of the older (and perhaps newer) materials to explore the possibility of selectivity being obtained by other than biochemical means, the aim being to obtain as many different weedkillers as possible for each crop.

The list just given reveals that we are quite a long way from the three per crop with totally different modes of action which Ripper suggested. However, in another section of the report, the Recommendations Committee have listed with brief notes eighteen new herbicides which have reached the development stage and in some cases are commercially available in this country. Extensive testing is required to assess properly their value for selective weed control in any of our crops but there is already evidence that some of them are finding a place and their commercial use extending.

There are vastly greater numbers of compounds in the research stage, some of which might fill the existing gaps and there would appear to be good prospects of extending the range of crops and weedkillers so that we shall have the required choice for each crop.

Someone will rightly ask, "What about cultivations as a measure of control of resistant weeds rather than rotate weedkillers?" Weeds do not develop resistance to implements! The trend over a long period is for costs of cultivation to increase with the rise in wages and there comes the time, as in many other industries, when new methods have to be introduced to reduce the labour bill. There comes a time when, apart from any increased efficiency in the degree of control obtained, economics dictate that chemical weed control should supplement or replace cultivations where they are employed solely for weed control.

We have the case of sugar beet in this country and Europe today - a crop traditionally weeded by hand or mechanically but one for which a good selective post-emergent weedkiller would be readily accepted. A further illustration is the use of dinitro materials as pre-emergent sprays for the potato crop in the U.S.A. The treatment is cheaper than the two or three cultivations that it replaces, but pre-emergent control is not the complete answer and later cultivations are needed in addition to the spray. In this country such advantages for the pre-emergent treatment of potatoes cannot yet be demonstrated while the present ratio of cost of chemical to cost of cultivations holds.

The control of weeds on agricultural land by means of chemical weedkillers should be considered in relation to all the crops in the rotation as a whole and not to any individual crop. The crops in the rotation should be selected, bearing in mind what weedkillers and what cultivation methods can be employed in each or between one crop and the next so that the most effective attack can be made on the particular weed or weeds.

This is not a new suggestion, for changes in crop rotation to suit a particular weed control programme have already been practised for cultivation and chemical weed control. Many will have read of and some experienced Mr. Tinney's seven course rotation for the eradication of wild oats by cultivations. For the control of many biennial weeds it is desirable to have two crops in succession in which growth regulating weedkillers can be employed. Prof. Blackman made this recommendation some years ago for the control of Hoary Pepperwort (Cardaria draba). More recently Dr. D. H. Robinson has reported the satisfactory control of docks in Staffordshire by sowing the field down to a pure Italian rye grass ley and by using 2,4-D together with cutting and fertilising in three successive years.

I believe that the much wider extension of this principle, together with the implied rotation of weedkillers, is desirable for the all round attack on the weed problem.

With the development of such grass weedkillers as TCA and dichlorpropionic acid it is possible to follow a broadleaf weed control in a cereal crop with a stubble application with a grass weedkiller and follow with a spring cereal or, if the treatment is made in the early spring, to follow with one of the resistant crops such as kale, potatoes, linseed and to a lesser extent peas and beans.

Other possible rotations of crop and weedkiller will suggest themselves and as the answers to more specific weed problems are found so the rotations may be modified.

If, for example, and I emphasise the "if", a chemical control of "wild oats" in let us say linseed were found, I feel sure that place would be found for this relatively unattractive crop in most rotations on farms where this weed is a problem.

The rotation of weedkillers is something of which we are likely to hear more in the future. It may be we shall hear one spraying contractor saying to another, "Say, Bill, what rotation are you following?".

In concluding these observations I should like to draw attention to the question of application. The tendency has been for the numbers of low volume spraying machines to increase much more rapidly than the high volume or all purpose machines. Most machines of the latter type are used in the areas where it is necessary to employ DNC or dinoseb sprays. Whether the selective weedkillers of the future will be such as to allow application in low volume we do not know, but it would seem to be increasing the difficulties if the choice is to be restricted

to weedkillers of this type. There is, for example, nothing on the horizon that is likely to replace DNC, and its use in cereals has increased over the past two years. The implication is that with the anticipated rotation of weedkillers, medium or high volume application will be required and there will be a greater demand for the all-purpose machine.

DISCUSSION

Dr. H. P. Allen: Our Chairman for this morning has just invited us to trail our coats and I feel particularly in a coat-trailing mood this morning so I will start the ball rolling. Obviously all of us here must agree with the principles put forward by Mr. Abel in his talk this morning. Although he lays much emphasis on the necessity for the whole question of the rotation of weedkillers being bound up closely with sound agricultural practice, I think even then he has not emphasised that point sufficiently.

I have three particular instances in mind where I think that the question of weed infestation is bound up inseparably with the method of farming which is practised. An obvious one, of course, is this five or six year continuous cereal growing, barley growing in particular. There we have, as Mr. Abel has said, two alternate weapons as chemical weedkillers. We can employ either the hormone or the DNC weedkillers while the cereals are growing and that produces a state of affairs where couch grass takes over, especially on lighter soils.

Yesterday, TCA was talked about quite a lot. Quite frankly, I do not believe that TCA can eradicate couch. It will control it but it will not eradicate it. If TCA is applied it may check the growth of the couch, but as likely as not, the fields under this long-term cereal cropping will eventually build up a tremendous grass weed problem. Here then is a case where rotation of weedkillers is not enough. Shorter term cereal cropping must be practised as well.

Turning over to grassland, there again, I think that before we can make very much progress with weedkillers we are going to have to alter the fixed management principle on which so much of our permanent pasture is farmed or ranched at the moment. Take rushes for instance: I think we all realise that if you are going to remove rushes you must get rid of the fundamental conditions which are responsible for rushes being there. I am fully convinced that we can do a lot of good merely by using chemicals to keep back the rushes for a period of two years, say, and to give the animals a chance to graze something better than Juncus for a change. However I do not think we should look at the problem with that attitude. I think we have got to become a little more fundamental and if we are going to improve our land and remove rushes we must remove the prime cause of them.

At the other end of the scale there is a very worrying possibility that broad leaved docks in temporary pasture may be encouraged by good farming. Firstly, the fertilisers which are applied benefit the docks as much as the grass and clover. Secondly, intensive cutting techniques will merely improve the stand of docks. Thirdly, when grazing, the cattle will normally not eat the docks. The result of all this is that the weeds may flourish and increase both in numbers and in vigour. Quite obviously, therefore, the removal of broad leaved docks will require amendment of farming techniques as well as the use of weedkillers. At the moment, unfortunately, there is no chemical which is really effective against the broad leaved dock.

Mr. C. V. Dadd: I would like to raise one or two points. Firstly, the use of arsenic in kale - I think we would all recognise the value of sodium arsenite as a total weed-killer and as a means of killing potato haulm. Used properly it is very efficient and quite cheap, but there is evidence that it is being used carelessly: I think if we are to continue to use it a warning ought to go out - a stronger warning than in the past - that it must be used very carefully. There are possibilities of cattle losses by leaving the stuff about, by emptying spraying machines close to ponds, and if arsenic is used for weed control in kale there would be the danger of cattle getting into a kale crop which had been sprayed. Let us all be very careful when we are handling such a dangerous chemical.

The second point concerns the rotation of weedkillers. If we follow up the suggestion that was made yesterday, that a partial kill or at least suppression of the weeds in favour of the crop is often good enough for practical purposes, then there may be a stronger case for rotation of weedkillers, if one accepts the evidence that resistant strains can develop. If you have got 100 per cent kill of a species, obviously you are not going to get much development of resistant strains.

Finally I would comment on a point that has come up once or twice. The statement has been made that barley is being grown as a one course rotation - that 6 or 7 crops of barley are being grown in succession. I don't believe that this is half as common as some people think and, in my opinion, it is certainly not as common as it used to be. I think most farmers in barley growing areas realise the inherent dangers of such a rotation full well, even if it was practised during the latter part of the war and just after the war.

Dr. E. Holmes: Arising out of this question of the control of weeds in brassica crops, may I just remind you that arsenical preparations were introduced into this country some three years ago solely for the purpose of killing potato haulms at a time when we were short of sulphuric acid. Subsequent work showed that this product could do a useful job in bulbs and recommendations are made there. Farmers and contractors found that, following the use of arsenicals for killing potato haulms, a considerable number of weeds were killed and the land was left cleaner. More recently we find that quite a number of farmers and contractors are using these products on food and fodder crops. Now, whilst we as manufacturers want to sell a lot of chemical, we do deprecate this widespread use of such a dangerous product unless or until we have good evidence of the lack of hazard in its use. I am referring particularly, of course, to the possibility of dangerous residues in the food and fodder crops, a question which is receiving a considerable amount of attention at the present time.

Dr. A. J. Lloyd: Mr. Abel pleaded for at least three methods of killing every weed, but he overlooked pentachlorophenol in his paper. This herbicide can be used selectively as well as pre-emergence. It can be used selectively in peas and beans in the same manner in which it is used in sugar cane and pineapples. I think that it is an alternative method of getting 100 per cent control of annual weeds. I would like to stress this possibility and ask him what he thinks of combinations of weedkillers. We heard Dr. Warren Shaw tell us yesterday that in one crop they were using a combination of 3 materials - TCA, pentachlorophenol and another compound. I would like to ask him what he thinks about getting out a total type of herbicide which will clean everything up at one go in possibly a number of crops.

Mr. A. Abel: I would like to give my apologies to Dr. Lloyd. The omission of pentachlorophenol is a complete oversight and the only excuse I can give is the time in which we had to produce this paper. I certainly agree that PCP can be quite effective as a pre-emergence herbicide but I don't know about the post-

emergence use. With regard to the mixing of more than two weedkillers, I think I should refer back to the quotation I took from Professor Blackman's paper. The use of two weedkillers together is much more likely to lead to a quicker development of species resistant to both chemicals. In other words, one will select out strains which are resistant to both chemicals at one and the same time. I don't think that for the overall picture of satisfactory weed control for a number of years there is anything better than the rotation of weedkillers. Now in this matter I am speaking without facts; this is only my opinion.

SPRAYING MACHINERY

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Introduction

At the 1953 Weed Control Conference papers on various aspects of spraying machinery were read by a number of eminent speakers who were well qualified for their task. Among these, Dr. Kearns and others discussed the aims and failings of spraying machine designers, while Dr. Ripper presented a paper dealing with such fundamental technical matters as the formation, size distribution and propulsion of spray droplets. Fundamental aspects of droplet formation and allied problems have been further dealt with in a paper by E. R. Hoare which was read to the Institution of British Agricultural Engineers.(1) Unfortunately, there seems to be some disagreement between the experts on certain matters of principle. For example, Dr. Kearns at the 1953 Conference is reported as having said "Large droplets .....have a greater chance of penetrating foliage than small droplets .....", whereas Dr. Ripper said " .....the growing point can be most easily reached by small droplets .....", and later indicated the necessity for high application rates in large crops because of the increased area to be covered, and also to obtain better penetration to the growing points of the weeds. Perhaps it is as well that Mr. Hoare's researches show that most spray patterns are made up of a mixture of large and small drops! There are several good reasons why I have decided to confine my remarks this year to practical problems, not the least important of these reasons being the fact that my knowledge of the more fundamental aspects is insufficient for my views to be of any value.

I have therefore chosen to review mainly such developments and difficulties as might be of immediate consequence to farmers and contractors, and I shall confine my remarks on future needs to such matters as require no deep knowledge of science for their understanding.

In preparing my paper I had to keep on reminding myself that I was concerned with spraying machines for weed control only; but I know you will agree that many farmers and most contractors have to think in terms of multi-purpose machines, so that in practice it is impossible to avoid considering also the requirements for such jobs as fungicide spraying, potato haulm destruction, and sometimes control of insect pests.

When asked to prepare this paper I thought that it might be helpful to look back over the way we have come during the past few years. I noted that in 1938 I wrote what was then a fairly up-to-date if brief account of field crop spraying methods and equipment. There was a reference to copper sulphate and copper chloride amounts and concentrations, a fairly lengthy essay on the new technique of using dilute sulphuric acid, and a nice picture of a horse pulling an axle-driven sprayer! We have come a long way since then, and I will not bore you by filling in the landmarks on the way, since they are familiar to most of you. My purpose in reminding you of pre-war days is chiefly to explain in advance why I shall make no dogmatic statements on spraying machinery needs. The machine must always be designed as far as possible to meet the requirements of the chemist, and any downright statements made about machines today are likely to be disproved as a result of further advances in the development of spray materials.

Technical Limitations of the Cheapest Sprayers

I would like to discuss first the question that we advisers are called upon to answer most frequently. It is, in a nutshell, "What are the

requirements of a multi-purpose sprayer?" or, conversely, "What are the limitations of a sprayer, described by the manufacturer as "low volume" (or alternatively "low-medium" or sometimes "low-high volume") and equipped with a gear pump?".

Some manufacturers of popular types of sprayers equipped with gear pumps take the view that if a farmer's chief need is to spray corn with a growth regulator type of weed killer and it is only very rarely or on a very small acreage that such a task as potato spraying has to be done, then it is quite reasonable to undertake such potato spraying with the machine designed primarily for use as a weed sprayer. He is usually advised to take care in the choice of chemical, and may sometimes be warned to expect a little wear on the pump. One old-established manufacturer has this to say in the instruction book of a machine that is in many respects well suited to tackle more than low-volume weed spraying:-

"Warning. Before using the sprayer for the application of a suspension it is most important that the chemical manufacturer's assurance be obtained that it is not of an abrasive nature, and will not damage the gear-type pump of the sprayer."

This is a clear enough warning, and farmers should realize that when abrasive suspensions are handled the rate of wear in gear pumps may be extremely rapid. Materials such as copper oxychloride and Bordeaux Mixture cannot for long be handled effectively by machines incorporating the commonly used types of gear pumps, even if it is possible to avoid trouble elsewhere such as blocked nozzles.

Report No. 23 of the Norwegian testing station[2] gives a figure for the rate at which a gear pump can fall off in performance. The pump in this test lost 25 per cent of its initial output at 100 p.s.i. after pumping a copper suspension of a usual kind for only 50 hours.

The remedy frequently sought is that of using spray materials that are not abrasive, or not so abrasive. There are certain proprietary copper sprays, for example, which the manufacturers will recommend for use in machines having gear pumps. The user then needs to ask "Is the spray application really effective as applied by the simple sprayer?". Here the answer is not a straightforward one. Generally speaking, the simplest sprayers are not as well equipped to give an effective cover of dense potato haulm as a more expensive all-purpose sprayer that was designed from the start to do this job. So it is then necessary to ask just how important the potato-spraying job is, and whether it is worth while to do a job that is not fully effective. One published report by Large and Taylor[3] on the cover achieved when spraying plants 15 - 18 in. high that did not meet across the drills showed the best results from machines using drop logs and spraying from below, as well as from above; but a report by Large and others on spraying trials at Torrington[4] shows that in the one year when it was tried, "top spraying" at low volume was almost as effective as any of the other treatments. The main point that I want to make, however, is well illustrated by this latter report, which shows substantial reductions of yield from spraying in two years out of six. I have probably said enough already to have convinced you that there is no one answer to this problem. The technical and economic aspects have to be weighed up for each individual case, and it is difficult, owing to such imponderable factors as the varying incidence of potato blight, and the range of jobs that may be better done at high volume, to draw up any table that will show when it pays to own a genuinely all-purpose sprayer or to hire a contractor to do either all the spraying or just the more difficult jobs. More will be said about economic aspects at a later stage. All that I need add now is my personal opinion that it seldom pays to do a job like potato spraying unless the work is fully effective. The damage done to haulm and tuber

development by the wheels of tractor and/or sprayer is indisputable, and can only be tolerated where the protective action of the spray is thorough.

If my argument up to this point is sound it now becomes necessary to know what are the characteristics of a fully efficient multi-purpose sprayer. One of the prime necessities today is undoubtedly a really good pump that is not seriously troubled by having to deal with gritty suspensions, and has a sufficient output to spray effectively at high volume when this is desirable. This generally means a pump output of the order of 15 gallons per minute at a pressure of 100-150 lb. per square inch for a smallish farmer's machine, or correspondingly more for a larger one. Types of pump that are designed for such duty include sturdy plunger pumps. Some modern designs incorporate easily replaced synthetic rubber plungers and porcelain-lined cylinders. A multi-stage centrifugal or "turbine" pump is also a suitable type. It must be appreciated that such pumps are somewhat expensive to make in comparison with the simple gear type; but they are generally built to last, and those of you who are contractors will need no convincing that it does not pay to buy the cheapest pumps where the amount of work to be done warrants a reasonable capital outlay. On the other hand, it is certainly the best policy for many farmers to buy a fairly cheap and simple low-volume or low-medium volume sprayer, and to arrange for a contractor to do the more difficult jobs, and also those that are potentially dangerous to the operators, owing to the toxic nature of the spray materials. Before leaving the subject of pumps it is perhaps worth recalling a point made by Dr. Kearns in his paper last year. He said that wear in gear pumps of spraying machines is often due primarily to wear in the bearings, which causes the shafts to get out of alignment and allows the gears to bite into the walls of the pump chamber. One manufacturer at least has gone to considerable trouble to avoid this by providing large bearings outside the pump chamber, where it is possible to lubricate them effectively; and this or other methods of construction that produce similar results might be worth study by other manufacturers.

A type of pump called the "roller-vane" has recently been introduced in fairly cheap machines by two well-known manufacturers. There has so far been too little field experience in farmers' hands to be sure how these compare with gear pumps, but they have many attractive features. Like gear pumps, they can be damaged by pumping water that contains particles of sand or similar materials. There is reason to believe, however, that the roller-vane type will usually outlive gear pumps working in similar conditions in spraying machines. After use, it is as well in the case of pumps made of steel to follow carefully the instructions regarding use of a rust inhibitor, in order to avoid sticking of the rollers.

It is satisfactory to record that the manufacturers of many types of pumps now offer a pump-replacement service at a price in the region of £10-£15. Such services should go a long way towards maintaining pump efficiencies at a reasonable cost to the user.

Some Points of Design and Specification

The following remarks concern a variety of design points which will be familiar to most of you, but which it may be profitable to mention in order that they may be more fully discussed.

Spray Tanks and Methods of Mounting

The mounting of the sprayer tank on the tractor itself in the case of the smaller machines has so many advantages that it has been rapidly adopted by manufacturers. The hydraulic lift is usually employed to raise the tank off its stand, and the latter is then locked firmly in position by mechanical devices,

so that the load is taken off the jack cylinder. This method of mounting works well until the point is reached where the load carried when the tank is full becomes excessive for the tractor concerned. A 100-gallon tank that is full is about the limit on flat land for a light/medium tractor, and steering difficulties may be expected on hilly land if the tank is filled. Some manufacturers provide for balancing the load by use of mid-mounted or forward-mounted tanks, but this solution is not usually acceptable to farmers on account of the extra time taken in attaching the machine to the tractor. The boom of a mounted sprayer may be dangerously near to the tractor driver on some mounted machines if toxic materials are handled, and it is worth noting that more than one manufacturer now offers a machine that can easily be converted to operate as either a mounted or a trailed machine.

It is interesting to note two opposed trends in regard to general construction of modern sprayers. On the one hand there are cheap machines with a chassis and a light tank that is only connected by flexible hose to the rest of the equipment. When the tank wears out the customer can throw it away and buy another cheaply. The manufacturer is sometimes even willing to sell the machine without a tank at all, and the user can provide his own! The reverse trend is soon where the spray tank forms the chassis on which the pump and boom assemblies are mounted, and in this case it must be sturdily constructed of welded steel plate, or similar materials, and must be especially well protected against corrosion, so that there is little risk of its wearing out before the rest of the machine.

Protection of spray tanks against corrosion is a subject of vital interest to the user, on which many manufacturers seem at present to be somewhat too reticent. There is nothing to complain at if the manufacturer states, as several do, that the tank is hot-galvanized after manufacture. At least, the buyer knows where he stands, and if the galvanizing is really thoroughly done, this treatment should generally be satisfactory for the handling of most of the common spray materials used by farmers. Unfortunately, however, even ordinarily reliable manufacturers do not seem able to ensure that their galvanized tanks will not corrode. I know of one sprayer, delivered new to a farmer this season, which has only sprayed MCPA and a little DNOC and already shows severe pitting of the galvanized layer, with pits that penetrate to the parent metal.

Some manufacturers keep secret their protecting process, and tell their prospective customers that the tank is "specially treated" to resist corrosion. In some cases the "special treatment" comes off, with disastrous results. The best advice that I can give on this point is to ask the manufacturers for details of their special treatments and to see the insides of similar tanks that have been in use for a few seasons. The use of ordinary paints invariably leads to trouble sooner or later, but some processes involving stove enamelling seem to be giving good results. Farmers who intend to use chemicals that are known to be corrosive, e.g. sulphuric acid, or materials that are known to be active solvents, should seek the sprayer manufacturer's advice when in doubt about the nature of their tank linings.

As a general rule, the satisfactory handling of sulphuric acid and other dangerous materials calls for specialized equipment and is usually best left to the contractor, who can employ acid-resisting compressor-type equipment. It has been surprising to me that a wider use has not been made of compressor type sprayers, especially as the compressor unit can be employed for a variety of other operations. Chief reason for this has undoubtedly been the great success and cheapness of the simple low-volume sprayers equipped with a gear pump when used for the simpler weed-control tasks. Nevertheless, a tractor-mounted compressor that is reasonably cheap can be such a useful device on many farms today that the compressor type machine may still be worth consideration.

especially where acid spraying is among the requirements. A disadvantage is that the tank itself is necessarily rather heavy for its capacity, and this means that on light tractors the tank of a mounted compressor-type machine cannot usually hold as much as 100 gallons.

Spray Nozzles

It does not seem likely at present that the work now in progress on air-blast spray nozzles for fruit tree spraying will much influence weed spraying in the near future. Conventional types of swirl nozzles seem to be well suited to high-volume work at moderate range, while various kinds of fan jets can do very good work at low and medium volumes. Nevertheless, I am not at all certain that we have yet seen the last of development of the low-volume air-blast field-crop sprayer. I have been told of satisfactory results achieved at low volume (25-30 gallons per acre) in the spraying of DNOC when using air-blast equipment; and it seems possible that if this type of equipment could be manufactured more cheaply it might have a definite if limited application in multi-purpose sprayers for areas where such jobs as potato spraying and DNOC and DNBP spraying are important. Such machines could clearly never be very cheap, and would inevitably have a rather high power requirement.

Practically all manufacturers of modern sprayers claim to incorporate an anti-drip device in their machines, but some of these seem to be more effective than others. Those who saw a grand parade of machines last summer will probably have noticed that at least one anti-drip device works exceptionally well - viz. one which incorporates just behind the spray nozzle a spring-loaded non-return valve which is set to close when the pressure in the line falls to about 20 lb. per square inch. If field experience proves that there are no additional cleaning problems with such valves, and that the life of the valves is satisfactory, the small extra expense will, I think, be considered warranted by many users. The anti-drip device is of less importance when nozzle blockage troubles have been overcome, and where a non-stop method of turning at the ends of the field is adopted.

Most manufacturers who employ fan jets now have them moulded or machined in such a way that the user can easily see whether the jet will be parallel to the spray-bar. Putting a pronounced flat piece on the nozzle to indicate the correct positioning is such a simple matter that farmers might well insist on it. It must, I think, be accepted that commercial low-volume nozzles of a given nominal size have an appreciable range in throughputs at a standard pressure. It is clearly desirable that there should be a reasonable limit to this range, ±10 per cent being probably the most that should be tolerated. A standard method of testing sprayers and their parts is being developed by the N.I.A.E., and includes a test of this variability, and also of the wear and of any increase in variability after use. Those who use sprayers regularly and are concerned to secure efficiency can check individual nozzle outputs by use of a simple measuring device, but with the cheapest type of nozzles it is probably best to exchange them for new when a check of the amount applied to a given acreage shows that the overall rate of application has changed substantially, since by that time the variability is likely to be excessive.

In the United States, complex batteries of jets with different characteristics are sometimes used simultaneously to secure a wide cover without using a boom. This method of application seems to have some value for the treatment of roadsides and similar areas that are inaccessible or accessible only with difficulty, but seems unlikely to be of much value for ordinary agricultural work. On the other hand, the multi-head jet in which any one of two or three different jets of different throughputs can be selected for use merely by rotating the assembly, may be attractive to some farmers and contractors. Multi-head jets

must, however, be more costly to manufacture than a similar number of interchangeable simple jets, and it is only where saving of time is very important that the higher capital cost seems likely to be justified.

Spray Booms

When weed control or other spraying operations are practised in row crops, questions of nozzle spacing inevitably arise, and the multi-purpose sprayer for use on this type of farm clearly needs adjustable nozzle spacings. This seems to be particularly desirable in the case of those sprayers which are attached to a specialized self-propelled tool carrier for work such as the spraying of onions or carrots. When spraying carrots with vaporizing oil the cost of the spray is considerable, and there is little to be gained by spraying the centres of the rows, which can easily be kept clean by hoeing. By setting the nozzle very low and spraying only 2-3 inches on each side of the row the saving in operating cost is considerable, since the quantity of spray applied per acre can be reduced appreciably.

The damage done to corn crops by tractor or sprayer wheels is frequently marked, and many farmers like to see it minimized by the use of wide booms. There have been some interesting developments in design, including the use of light wheels at or near the ends, and the employment of light steel pressings, to reduce the weight of wide booms.

Agitation of the Spray Fluid

It will be generally agreed that a good multi-purpose sprayer, which must be able to deal with heavy suspensions when necessary, needs more positive agitation of the contents of the spray tank than is provided by most of the methods of hydraulic agitation provided in the cheaper machines. Merely returning surplus spray from the pump to the tank in a "hit or miss" manner is largely ineffective, even when the pump has a much higher capacity than is required to supply the nozzles. In any case, suspensions are usually best applied at fairly high volume, when there is a minimum of fluid returned to the tank. It is therefore not surprising that most manufacturers of real multi-purpose machines prefer to employ mechanical paddles, and are prepared to accept the need to spend some money on providing a method of drive that is really sound. This does not mean, however, that hydraulic methods must necessarily be ineffective for those cheaper machines which are very seldom required to handle suspensions. More than one manufacturer has recently gone to considerable trouble to ensure that the liquid returned to the tank is sufficient in quantity, and is effectively used to impart a vigorous swirling motion to the whole of the spray liquid. A small point worth noting by some manufacturers is that it ought to be possible to provide agitation when the machine is being filled, as well as when it is actually spraying, so that suspensions which have collapsed owing to a long settling period can be effectively re-suspended.

The Problems of Spray Drift

It is satisfactory to record that farmers generally, as well as manufacturers, have become conscious of the difficulties that may arise from drifting of herbicides, and of the methods that may be adopted to minimize the trouble. There are today few machines being sold that cannot apply 15-25 gallons of spray per acre if necessary, and most farmers are becoming aware that the drift problem can often be reduced by applying the spray in a less concentrated form, and using pressures and nozzles that result in the formation of less very small droplets. Windy weather, however, continues to limit greatly the number of days on which satisfactory spraying can be done, and I personally have been interested in the reasons why the use of shielded booms has not been

developed to any appreciable extent, even by contractors whose livelihood depends on being able to get on with the work with as little interruption as possible. Reasons advanced include the extra cost, and the difficulty of folding up for transport.

Possibly the discussion will produce other explanations which I am unable to offer. It is realized that spray drift can occasionally occur long after the spray has settled, but I do not think that this is the reason for the apparent lack of enthusiasm for shrouded booms.

Methods of Varying Application Rates

Most manufacturers of low-volume sprayers provide for changes in application rates mainly by the fitting of sets of interchangeable spray nozzles, each of which is designed to operate at a standard working pressure - usually around 30-40 lb. per square inch. This is a sound policy, and one that does not present any real difficulty to a typical farmer-user, who can usually stick to one application rate for most of his work. A few manufacturers, on the other hand, encourage the use of a range of pressures, partly because variation of pressure is an easier and quicker operation than changing nozzles. It seems, however, to be generally accepted now that with typical fan jets, the low pressures generally employed are the most suitable for general work on weed spraying, and the use of appreciably higher pressures than 40 lb. square inch merely in order to increase application rate seems to be generally inadvisable.

Some multi-purpose sprayers which are capable of both high-and-low volume usage employ a two-position lever which gives an instantaneous change from a high-pressure range to low, and vice-versa; and this is clearly a desirable feature in such machines, since the higher range of pressure is essential for effective operation on high-volume work.

Is there a Need for a Marker for Spraying Machines?

The commonest operational difficulty with modern sprayers is probably still blocked jets, though the most experienced users can now avoid much trouble from this source. Another difficulty that occurs fairly frequently is inability of the driver to make accurate joins between adjacent bouts. This difficulty is obviously capable of solution in a variety of ways, and the problem seems to be to find one that is not too expensive. One experienced contractor always has a length of chain attached to each end of the boom, and he fixes to this a heavy piece of iron or an old sack, according to which of these makes a good mark without damage to the crop. Another possible method for short crops would clearly be to sow a line of a harmless white powder such as lime; but on wide machines where the need is greatest, there is a difficult mechanical problem in arranging for the mechanism to be placed in a position at the end of the boom - the only place where it will be really helpful. The spraying of a white or coloured liquid by a special nozzle at the end of the boom is also a possibility, but the additional equipment required to provide for this would possibly be rather expensive. My decision to raise this question of markers was reinforced by some information recently received from the Ministry's Agricultural Adviser in New Zealand concerning the papers read at the 7th Conference of the New Zealand Weed Control Association held in Dunedin from 24th - 26th August 1954.

I understand that in a paper entitled "A Marker System using Titanium Oxide", G. H. Blair(5) of the Canterbury Seed Company, a contract spraying firm, described a unit which they have evolved to assist the machine operator. The brief account so far received shows that a single marker nozzle with an output of 16 gallons per hour, is mounted at one end of the spray boom. This nozzle is adjusted to 6 inches above the crop or 12 inches above the ground and it is

set pointing forward and inwards so that the sprayed foliage will be in direct line with the operator's eye on the succeeding round. A slip clutch of rubber rings is incorporated in the marker nozzle stalk mounting on the boom to prevent damage. A chain is attached to the opposite end of the boom to drag over the mark made on the preceding run. A rubber hose connects the marker nozzle with a vertical cylindrical tank with conical ends, which is mounted on the tractor. To provide the pressure for both spraying the marker fluid and keeping the mixture in suspension in the tank, an important consideration as titanium oxide very readily settles and forms a thick sludge, a centrifugal pump, with an output of 1800 gallons per hour is used which feeds the nozzle at its capacity rate of 16 gallons per hour, the balance of 1784 gallons per hour being fed back into the tank through a one inch return hose. The concentration of mixture used is 1 lb. of titanium oxide in four gallons of water. The cost of the whole outfit is stated to be approximately £15 and the operation cost is less than 6d. per acre. Blair pointed out that experience has shown that for bare earth or for marking crops with glossy surface foliage, double concentration of titanium oxide is necessary and the wearing of polaroid glasses considerably assists the operator under conditions of bright sunshine. Blair also reported that he had tried many other soluble dyes mixed directly with the spray mixtures themselves but all were much inferior to this titanium oxide marker system.

It is perhaps unfair to comment in advance of a more detailed report, but it is difficult to see how equipment incorporating a pump with this high output could be so cheaply made. Moreover, for our normal methods of operation it would be necessary to change the position of chain and marker nozzle at the end of each bout. However, such difficulties could obviously be overcome, and the method seems to be worthy of some trial here. It might be particularly easy to arrange an independent feed to the marker nozzle on a compressor type of sprayer. The problem is obviously more important in the case of the wider machines. On machines with narrow booms a good tractor driver can soon achieve reasonably satisfactory joins in conditions where the tractor wheels leave a distinct mark.

Value of a Speedometer in Ensuring Correct and Regular Application Rate

It is a fortunate fact that there is a reasonable margin for error in application rates of weed-killing sprays, such as MCPA and 2-4D, within which the results obtained are more or less satisfactory. Nevertheless, it is possible to get bad results if application rates are seriously wrong, and the most common unknown factor with modern tractor-operated sprayers is the tractor's speed of travel. For ordinary farm work it is not essential to have a speedometer to check this, since a fairly simple check of time taken to go a measured distance will avoid serious errors. Nevertheless, a speedometer is a very useful device which assists in keeping speed correct where sloping land and other irregularities tend to alter the speed at a given governor setting. Other uses for a speedometer, that may help to justify its purchase, include drilling with a type of mechanism which does not have a positive feed. In the future, any development of the use of P.T.O.-driven fertilizer distributors will also make use of a speedometer desirable.

Testing of Field Crop Sprayers

As with most other types of farming equipment, with the exception of tractors, there have been few published reports on sprayers subjected to an official test by the N.I.A.E. From a farmer's viewpoint this is unfortunate, because a properly conducted official test can not only reveal any weaknesses to the manufacturer, but can also confirm a good performance, and through a published test report can assist in choice of a suitable machine.

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In the case of a sprayer, endurance tests on components such as the pump, when handling characteristic spray fluids, are obviously a desirable feature of a complete test, and it is worth reporting that the Institute has already established a suitable test rig for this purpose. The fact that all tests are strictly confidential to the manufacturer until the latter agrees to publication of results should encourage any who may be a little nervous about unbiased comparisons to make use of the service that is now provided.

Other points that are covered in a complete test include calibration of and rate of wear on nozzles, and the effects of subjecting various parts of the machine to conditions that might be expected to result in corrosion if the materials used in manufacture are unsuitable.

It may be necessary, as with the pump test rig, to provide for an intensification of the tests on corrosion resistance in order to obtain comparative results within a reasonably short time.

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DISCUSSION

Dr. Warren C. Shaw: Your Chairman assigned me this responsibility very early this morning and I must say that I have not had time to read all of Mr. Culpin's paper but I think we certainly are to congratulate him on an excellent presentation and the choice of some excellent visual aids in illustrating his talk.

The need for fundamental research on the requirements for highest efficiency of herbicidal sprays as influenced by droplet size and distribution was certainly demonstrated and emphasised in Mr. Culpin's remarks.

I am very much interested in his statement in quoting some earlier work in which he says that Dr. Kearns at the 1953 Conference is reported as having said "Large droplets ..... have a greater chance of penetrating foliage than small droplets", whereas Dr. Ripper said, "The growing point can most easily be reached by small droplets". Now he says there is disagreement: I don't think so. I have not talked to Dr. Kearns or Dr. Ripper about this but I'm quite sure that one was referring to systemic growth regulator herbicides and that the other had in mind contact non-translocated herbicides and that both are exactly correct

as far as droplet size is concerned. I dare say that if we had determined the maximum efficiency of droplet sizes they would vary for every single different molecule we're using to kill weeds. They would have to essentially, and therefore I don't think there's any difference here at all in these two statements.

In the United States we're often inclined to wonder why we haven't made more advances in some of our spraying equipment. The real reason is that the chemist and the plant scientist, who are developing these herbicides, don't know the particle sizes required for maximum efficiency. Mr. Culpin said that no dogmatic specifications for sprays is possible and that such specifications would not be available for a long time unless more effort was made to accumulate this information. Unfortunately, it is difficult to accumulate this type of information until it has been established just how far and under what conditions the chemical will be used in agriculture. It is very expensive research and is unlikely to be carried out until one is pretty sure it is going to have some practical application. I certainly should not like to comment on the specifications regarding the use of sprayers in this country, because I know your problems are quite different from our own and I am sure that of all the things I am supposed to be, I am not an agricultural engineer.

Dr. A. J. Lloyd: If the engineers and the plant breeders between them are going to give us single spaced, individual seed, row crops which do not require singling, then pre-emergence spraying will permit the growing of these crops to be totally mechanised. Dr. Warren Shaw, I think, said that in the United States they were spraying individual crop rows with a band of herbicide 3 inches wide. Such a technique would cost the farmers a quarter the amount he pays for spraying the whole field and he could cultivate in between rows post-emergence. I wonder whether this type of spraying is done in England at the moment? It presumably requires a machine for spraying the seed row at the time the crop is drilled, since subsequent spraying of the rows by following coulter marks would be very difficult.

Mr. C. Culpin: Strip spraying of crop rows is done in England by using the market garden type of tractor - the self-propelled tool chassis. Carrots are sprayed in this way with vaporising oil. Using a self-propelled tool bar with the nozzles right down to the individual rows it is possible to spray a band 4 or 5 inches wide and at the same time to hoe the row centres. This is a very much better proposition for the farmer than spraying the whole field.

THE ECONOMICS OF COMMERCIAL APPLICATION

R. E. LONGMATE - E. C. LONGMATE, LTD.

This subject could, of course, cover a very large field. It could include a valuation of the increased production of various crops due to the commercial application of weedkillers, and from this we could go to the greater availability of grain to those masses of the world population who, we are so frequently assured by our President and others, have an available food consumption only sufficient to maintain a level just above the starvation line. Although, on this, I must add that I know of, at least, one scientist who was unwise enough to marry a lady with farming interests and whose goal is making money and, who, whenever her husband puts over his facts and figures of the poorly fed multitudes in the world invariably deflates him with remarks such as "well my wheat is still unsold" or "my potatoes are still in the clamp". And the call for peace and plenty through efficient distribution is again echoed and how true it is.

However, this is by the way and my paper deals with such humdrum matters as "Does it pay to spray" and if so "Is it cheaper and better to do this spraying yourself or let a contractor do it".

I would make it clear I have worded this paper from the point of view of the application of weedkillers only.

Well! "Does it pay to spray?" - I think without doubt in every instance where weed infestation is sufficient to interfere with the development of a crop I cannot be accused of having a biased view if I say "of course it does".

I can think of only one possible argument that can be put forward against the case. Salesmen and advertisers glibly tell the farmer that if he sprays his pastures he will be able to graze twice the head of cattle he grazed before. Which the farmer no doubt realises is true. But! Many farmers are fully extended financially especially in view of the high cost of the constant improvements he feels he must make in order to remain up-to-date and thus he always farms to his financial limit.

If to obtain the full financial benefit from spraying his pastures he will require twice the head of cattle, where is he to find the money to purchase this additional stock? This fact, in my opinion, is holding up the putting into practice of measures for the improvement of pastures in many cases, the point being it is no use endeavouring to increase production unless the capital is made available to the farmer with which to do it.

On the second question which bothers the farmer "Is it more economical to apply these chemicals himself or shall he employ a contractor", there are a number of arguments for and against.

At the beginning of this year the Farm Economics Branch of the School of Agriculture at Cambridge issued a publication entitled "The Economics of Crop Spraying".* It contained carefully calculated facts and figures and conclusions and I think it is agreed by all who have studied it, is a document of a very high standard and a matter for congratulation to its editors.

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* The Economics of Crop Spraying. Farmer's Bulletin No. 16. Cambridge University Farm Economics Branch (1954).

I think it caused a certain amount of consternation in certain quarters but one must agree it is fair comment and I think the only adverse remark one can make of it in its entirety, is that, from the rather biassed point of view of some interests it would probably have been better if it hadn't been written at all. However, there was a demand for it and anyway you can't stop people working out things for themselves even if the results are not altogether beneficial to everybody.

A major aim of the report is to calculate in terms of facts and figures whether it is more economical and wiser for a farmer to purchase his own machine - either low volume or high volume - or whether it is better for him to employ a contractor.

I do not think the report emphasises sufficiently the limitations of a low volume sprayer. Low volume sprayers are cheap to buy and can be afforded by farmers with only a few acres - but, although this is an obvious atrraction, it is largely offset by the limited number of uses for which a low volume sprayer is suitable. For instance, if the farmer has an acreage of cereals in which cleavers are not present he will be alright; but if he has cleavers spraying by low volume by which he can only apply MCPA or 2,4-D will, in the long run, do him more harm than good for, although he may destroy other weeds, the very fact of removing the competition of these other weeds will result in him having even bigger and better cleavers.

Again, supposing he is offered an atrractive contract to grow peas next year. He won't be able to destroy the weeds in his peas with a low volume sprayer, or incidentally obtain a sufficiently good coverage with DDT to combat aphis attacks and pea moth. So he will have to employ a contractor to do this work by high volume whilst his own capital outlay stands idle in his yard.

For the reduction of Charlock infestations and the spraying of grassland low volume sprayers are of use but for little else. It is true a large number are now on the farms in this country but the statisticians should bear in mind they are only operating within their limited ability.

It is, of course, far wiser and more economical for a farmer, if he is to purchase a machine at all, to buy one which will apply materials at both high and low volume but in this case his outlay will be considerably greater.

The Cambridge report recommends that on a purely cost basis 30-acres of spraying a year will justify the purchase of a low volume machine. If you take into account, convenience, I should place this at 20-acres. It similarly states that a high/low volume sprayer is justified for the spraying of 66-acres per year. Again I would place this at 50. But if you take into account the vast number of farm holdings in the British Isles where certainly not 50-acres and in many instances not even 20-acres will be sprayed and thus according to the report it would be financially foolish to purchase a machine, - what an obvious market there is for the spraying contractor.

It can be argued that the cost of purchase of a machine may be offset by the farmer carrying out spraying for his neighbours, but there are substantial pitfalls. Apart from such matters as sufficient know-how and the complications associated with the work generally (especially when applying the toxic chemicals) it does not appear to be generally known that the farmer who employs his neighbouring farmer to do his spraying is himself responsible if damage is done to surrounding crops and not the farmer carrying out the work. Very few farmers carry this type of insurance cover although claims may be for considerable sums. For that matter I should estimate that very few farmer/contractors themselves carry this insurance cover.

And now to consider the well organized contracting business. I am only too well aware tbat there are a number of contractors who cannot be called well organized. The chief reason for this is that to start in business, as a spraying contractor, a considerable amount of capital is required (quite often difficult to obtain) and in some cases some piece of machinery has to be omitted and efficiency suffers.

We hope, in the National Spraying Association, that, in such cases, the new concern will either rapidly go out of business or that hard endeavour will achieve success and that greater experience will be attained with the spraying of larger acreages and another efficient contract spraying organization will come into operation.

I do not propose to say anything further on insurance as it is being dealt with more fully in other papers. Suffice it to say that nobody should employ a contractor who is not insured to cover damage to the sprayed crop and damage to neighbouring cropping. This insurance is, of course, a costly item in the spraying contractor's budget.

What are the essential points to take into consideration to ensure an efficient and economical spraying job.

Firstly, as with anything, you must achieve your particular aim. In this instance the destruction of particular weeds in the crop. To make sure of this you must above everything know what you are doing. So the first thing the farmer must make up his mind about is whether or not he has had enough experience or knows enough about the job to do it himself. Now spraying in many instances is not simple. Often there is only a small margin between a successful result and costly failure.

Surely it is better to employ a firm of contractors who have had many seasons of experience than to take a risk. If the farmer thinks the contractor will cost him more than he could do it for himself, he must not lose sight of the fact that he is paying for this experience, experience which has undoubtedly been quite expensive for the contractor to acquire.

Incidentally this item - concerning the gaining of experience - is not taken into account in the costings in the economics review to which I previously referred. Perhaps the authors could not trust themselves to put a value on it!

On the matter of which weedkiller to use, can the farmer be quite sure about this? We know the advertisements and leaflets make it scund simple but don't forget their aim is to sell the product and once sold anything you do with it - well its up to you! You have only to look through the Report of the Recommendations Committee of this Conference to see the wide range of susceptibilities of both crops and weeds to certain materials and also to note that a considerable number of the recommendations are labelled 'tentative'.

This again points to the great need for experience in the use of these products, experience which it is almost impossible for a farmer to have but can only be the prerogative of the fieldman of a contracting firm confronted as he is each season with these problems.

Again, in the matter of "When to Spray", that is, "When the crop has reached what height?" "When the weed is at which stage of growth?" "Is it best to spray following rain or dry weather?" All these points can be ascertained from books and leaflets but how much easier it is to ask somebody who has the answers all ready. Anyway when the time comes and the machine is

waiting in the field the odds are something will have been forgotten it is imperative to know.

So if the farmer decides for these reasons to employ a contractor instead of buying a machine and doing the work himself he must be prepared to make an additional contribution to cover the cost of (1) The Laboratory work which brought the material in the first instance to the notice of the interested parties. (2) The field trials and research that convinced the commercial users of its value and taught them how to handle it. (3) The cost of tutoring the fieldmen and supervisors who are responsible for the correct result.

His payment will also have to contribute to the cost of the insurance already mentioned, the cost of the machine and maintenance staff and the research work that went to making the machine efficient for its purpose.

What does he get for his money?:

(1) He can be sure he is using the correct material.

(2) He can be sure he is using the most suitable machine - often a specialised machine which only a contractor could afford.

(3) He can be sure he is using the machine in the correct way.

(4) He is saving himself capital outlay and the interest on it.

(5) He is relieving himself of the responsibility and expense of looking after a machine which will rapidly deteriorate if it is not competently looked after.

(6) He can be sure he is spraying at the correct time.

(7) He can be fairly certain of a correct result or he has the right to "know the reason why".

(8) He is insured against his legal liability in respect of damage to his own or his neighbours crops.

(9) Above all he has peace of mind - freedom from having to swat up the job and take the responsibility for the result himself.

All surely worth a great deal more than the cold L.S.D. of costs per acre and I am quite sure worth more than the addition the contractor has to make to cover such things as transport costs, idle labour and bad weather.

To sum up, I do not contend that in terms of L.S.D. it is not cheaper for a farmer to purchase his own machine if he has a considerable acreage to spray, tut I do contend that in terms of wise responsibility it will pay him to think again before he makes his decision.

The case for purchasing a low volume sprayer is weak so far as many farmers are concerned, owing to its severe limitations. The case for purchasing a high volume sprayer, as is pointed out in the Economics Review, falls down save in the case of the largest farms on the point of cost and in any case the potential saving is slight. As the review also emphasises there is no point in purchasing a high volume machine unless you are going to do all your own spraying which will mean applying many chemicals, such as DNOC, DNBP and other toxic chemicals, which can be dangerous to human life and require great care in their use

necessitating special clothing and instructions for the operators in order to comply with government regulations.

It is also a fact, which is also pointed out in the review, that many types of high volume spraying require more specialised knowledge than that necessary for the spraying of hormone weedkillers.

It may be felt that many of the arguments I have advanced are psychological as opposed to money saving but how will it benefit a man if he has saved shillings per acre on his spraying and lost pounds per acre on his crop yield, and probably made bad friends of his neighbours in the process.

The essence of the matter seems to me to be as the report says "The cost of spraying is low and can be covered in most cases by a very modest increase in yield". Spraying contractors, the specialists in this branch of science, are available and farmers can afford to ask for their assistance.

DISCUSSION

Dr. E. Holmes: In opening the discussion on Mr. Longmate's paper, I also must refer to this famous Cambridge report. Last year, at our first National Weed Control Conference, I stuck my neck out as usual and gave some figures for possible costs of spraying by the farmer himself; I was very interested to see from this report that their figure of 6/5d per acre corresponded with the 7/4d I mentioned last year. I am still waiting for the apology from Mr. Longmate and his friends, but I am afraid I shan't get it! Quite seriously, however, I think contractors have sometimes felt that we, as chemical manufacturers, have been working against their interest. I don't see it that way. I think all of us want more necessary spraying done efficiently and cheaply; we, as manufacturers, want that and I feel sure that contractors and farmers themselves want that, and if it is done there will be a lot more work for all of us. But there is one basic difficulty in Mr. Longmate's arguments. As I see it, the people who need contractors most are the very small farmers who could never justify buying their own equipment. But I know from our experience in spraying potatoes against Colorado beetle for the Ministry that those tiny patches stuck all over the place are the most costly to treat and, therefore, I imagine the least profitable to the contractor.

There is another point I would like to raise, the handling of dangerous chemicals. Now I will go all the way with the good contractors who really know what they are doing; they use good equipment and they do the job efficiently and safely. But I would submit that the poorer contractors, and you will have to admit that there are some of them about, don't really know what they are doing. I would say they are more dangerous than the farmer for this reason - although the farmer doesn't always know much of what he is doing with the dangerous chemicals, his people are only working for a relatively few hours during the year and the human frame is pretty recuperative. The poor spraying contractor is different; I have known them work up to 17 hours a day 7 days a week and that is where the trouble comes in.

Again I would agree with Mr. Longmate in that the good contractor knows the best stage of the weed, the best stage of the crop, the best state of the weather and all the rest of it to do the best spraying; but I think he skated round this question of timeliness. You see, a contractor must obviously keep his machinery working a fair number of weeks and months in the year to make it pay, and I defy him to do the job at the right time for every farmer.

Finally, I would congratulate Mr. Longmate on a very nice piece of special pleading on behalf of the contractors.

Mr. G. E. Barnsley: I think Mr. Longmate gave a very balanced picture of the contractor versus farmer spraying in relation to well established spraying techniques. Carrying this a stage further it would be interesting to consider the relative merits of the contractor versus farmer in relation to the newer pre-emergence spraying technique, of which we have heard so much at this Conference.

Mr. R. E. Longmate: Well, Mr. Barnsley, I don't know if I am quite correct, but I think some people think this is developing into a racket in which spraying contractors hope to have a go pre-emergence and again post-emergence. I don't think that is correct; but the obvious answer to Mr. Barnsley is, of course, that if we can carry out pre-emergence spraying to stop weed growth we are relieving the pressure on post-emergence spraying. We shall have more time and fewer acres to spray post-emergence, or that is the likelihood. We have, of course, been carrying out pre-emergence spraying for the last twenty years or more.

One of the points Dr. Holmes raised was about small farmers. This opens a very wide field of discussion. I cannot help feeling that perhaps the solution may be found in some form of co-operative effort by the small farmers themselves. I know there are very many reasons why co-operation should not be adopted as a remedy, neighbours do not always get on well together but I cannot help feeling that in the interests of economic farming that is the solution, both with regard to such matters as spraying and the use of costly and efficient farming equipment.

Mr. A. G. Strickland: I would like to make some observations on the last speaker's remarks on the improvement of pasture by spraying.

If a chemical manufacturer has made a statement that by the spraying of old pasture with a hormone type weedkiller one could expect immediately the double up of the stock numbers, and if a farmer falls for this line of talk he needs his head examined. There is no doubt by sound pasture management following spraying one should be able to carry more stock and of course money must be found for slightly increased numbers. (Not double the number.) There is, of course, always the question where is the money coming from for this purpose.

Now I submit that it is not a shortage of money that will allow our dairy farmers to feed their milking herds at approximately 3½ lb. of concentrates (home and purchased) for nearly every gallon of milk produced. By practising maintenance and 600 gallons off the farm they could save approximately £20 - £25 per cow in concentrate feed. This saving surely should pay for the greater (not double) stock increase brought about by the spraying of pasture plus better general grassland management.

Mr. E. J. N. Cakebread: I would like to join with Dr. Holmes in the comments and remarks he had made and at the same time cross swords with Mr. Longmate on one particular point. He made a very definite statement that practically all a chemical manufacturer wants to do is write booklets, publish leaflets, sell chemicals to the farmer and then it is up to the farmer and heaven help him! I think Dr. Holmes will agree with me that after-sales service by the manufacturer is a very important point. This service is given to the farmer by the manufacturer and I would also like to add that our sales service is also extended to the spraying contractor.

Mr. O. G. Williams: I wonder how many pastures will pay for spraying? If we are considering first class pastures of ryegrass and white clover which are used for feeding cattle we have got to bear in mind that the returns per annum of these pastures are extremely low. Such areas will yield three or four cwts. of beef per annum and the return on that beef is very small when you consider that

farmers may have to pay £8 to £8.10.0d. per cwt. for stores in spring and sell these out at £6 to £7 per cwt. in the autumn. The margin left for rent, labour, fertilizer and spraying must be very small. If the poorer pastures are infested with weeds, such as rushes, ragwort, thistles and dock then there is probably a very definite cause why those weeds are present. I think it is very much more important to endeavour to remove those causes rather than try and kill the weeds. Obviously if the cause of the infestation is not removed, there will be a very rapid return of the trouble.

Dr. W. E. Ripper: Mr. Longmate has done well in putting the contractor's point of view, but there are two important points which he has not made. One is that the spraying contractor in this country has introduced many new spraying techniques which otherwise would have found their way into farming very much more slowly. The educational benefit of the spraying contractor's work has never been measured but it is true to say that annually 350-400,000 acres have been sprayed by contractors, many of whom have technically qualified field men and supervisors. 350-400,000 acres well sprayed by contractors form a demonstration of a size which I think must be a valuable supplementary help to the work of the N.A.A.S. This educational effort is not complete; Dr. Shaw has shown in his paper yesterday that there are many new specific remedies coming along for the control of specific weeds. Specialised knowledge and careful attention by technical staffs of contractors will help to introduce these new techniques.

Secondly, despite all the cracks about inefficient contractors levelled against Mr. Longmate, extensive travel has shown me that the standard of British contractors is higher than in any other country. Would it therefore not seem worthwhile for the Ministry of Agriculture to consider whether it would not be wise to improve the standard of those few inefficient contractors to whom reference has been made by Dr. Holmes by a licensing scheme similar to the one which is operated in California or other States of the U.S.A? In other words, if a minimum knowledge by the contractors was a condition to the granting of a licence, I am sure the well qualified contractors would not be troubled by this requirement, and those few poor types which supplied Dr. Holmes with his demonstration material would improve their knowledge or disappear. A licensing scheme requiring a certain amount of technical knowledge, annual inspection of the efficiency of the equipment, and safety precautions might also assure the farming fraternity and the community as a whole that spraying with biologically active compounds is carried out to the best professional standards.

References concerning spraying of crops at the incorrect time and forcing of growers to suffer the contractors at the wrong time because of shortage of equipment are unfair because they are very much the exception compared with the good and timely services by the majority of the contractors. In fact, contractors have made large investments in capital plant which is lying idle for the greater part of the year for the specific purpose of having the equipment available for the farming community at the right time.

Mr. R. E. Longmate: Perhaps the best answer to Mr. Strickland is to instance an example. Take the fertiliser subsidy; as soon as it was removed, what happened? The usage of fertilisers as estimated from the sales figures, fell right down to something quite phenomenal. The farmers would have obtained the increased yield from the fertiliser as they did when the subsidy was in existence, but they didn't because they hadn't the money.

Mr. Cakebread is feeling upset because I was unkind to the manufacturer. I must admit I had my tongue in my cheek; we all appreciate very much the way in which manufacturers help. They put up a front of disclaiming responsibility

and insert a disclaimer clause on their labels which is pretty horrible. Although the label disclaims all possible responsibility, the manufacturer is usually most helpful to anybody who runs into trouble. As far as Mr. Williams is concerned, I agree with everything he's said.

THE APPROVAL SCHEME

DR. R. de B. ASHWORTH.
(Plant Pathology Laboratory of the Ministry of Agriculture and Fisheries)

In speaking of the Approval Scheme, I think it must be obvious that one cannot speak about its application to weedkillers without telling you something about how it works. Of the importance of the Scheme I have no doubt. The farmer is frequently not in the position to evaluate pesticides himself; in fact, in the case of a weedkiller it is frequently said that differences in efficiency of 20 to 25 per cent are essential before they can be spotted by the farmer.

History

After several attempts, the Approval Scheme finally saw the light of day in 1943, as the result of a very considerable effort on the part of the late Sir John Fryer and Mr. H. J. Jones. Dr. J. T. Martin was appointed its first Secretary and the survival of the Scheme is largely a measure of the exact, careful, patient work he put in and perhaps, even more important, the high standards which he laid down.

To begin with the Scheme was restricted to approving insecticides and fungicides, but was subsequently enlarged to include weedkillers. Fairly recently Dr. Martin took up another appointment and I took his place not only as secretary to the Scheme but also as chemist to the Plant Pathology Laboratory. This has resulted in my accepting some responsibility for a wide range of plant protection problems on the chemical side.

Before leaving the history of the Scheme I should like to pay tribute to the voluntary work put in by members of the Advisory Committee, Joint Panel, and the A.B.I.M. In the days when one could afford to pay someone to paint the kitchen, it might be argued that one sacrificed little by undertaking voluntary work. That is not the case to-day. Those doing voluntary work dip increasingly into their meagre reserves of leisure for the public good; that is a very considerable sacrifice.

How the Scheme works

The Scheme is a voluntary one, i.e., the manufacturer may or may not apply for approval of his product. This is very important as it gives all concerned a certain amount of room for manoeuvre. Thus the manufacturer can and does, if the whim moves him, refrain from applying for approval of his products, while the Ministry is not placed in the awkward position of having to make up its mind quickly as to whether it should or should not approve of a new group of products on what the manufacturer fondly and hopefully believes is satisfactory scientific evidence. This is a good thing for all concerned.

If the Scheme were compulsory, the Ministry would have been forced to set up extensive and expensive testing stations, as indeed has happened in Germany where as many as 600 products a year are tested. This would appear to be an unwarranted expenditure on what, after all, is a slightly negative procedure. We have devised here the much more satisfactory plan of getting the manufacturer to supply the evidence as to the soundness of his product. This, of itself, is a very salutory process as we all know from having to write reports on work we have done.

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Now as to the actual functioning of the Scheme, which is perhaps best illustrated by a diagram:-

HOW THE VOLUNTARY CROP PROTECTION PRODUCTS APPROVAL SCHEME WORKS

ADVISORY COMMITTEE

Prof. J. W. Munro. Chairman	
Mr. C. T. Gimingham	Plant Pathology Laby.
Dr. C. E. Foister	D.O.A.S.
Mr. A. J. Holden	A.B.C.M.
Dr. J. T. Martin	Long Ashton Res. Stn.
Dr. M. H. Moore	East Malling Res. Stn.
Mr. W. C. Moore	Plant Pathology Laby.
Mr. W. H. Read	Cheshunt Res. Stn.
Dr. I. Thomas	Plant Pathology Laby.
Dr. E. K. Woodford	A.R.C. Unit of Exp. Agronomy.
Mr. D. W. Wright	Vegetable Res. Stn.

MANUFACTURERS AND OTHER BODIES

Mr. H. J. Jones. Vice Chairman	Hemingway & Co. Ltd.,
Dr. J. R. Booer.	F. W. Berk & Co. Ltd.
Dr. J. E. Hardy	Shell Petroleum Ltd.
Dr. E. Holmes	Plant Protection Ltd.
Mr. J. King	Government Chemist
Mr. A. G. Ponton	Pan Brit. Ind. Ltd.
Sir E. Salisbury	A.R.C.
Mr. H. Cole-Tinsley	N.F.U. of Eng. & Scot.

JOINT PANEL

The Opening of a New Group of Products

JOINT PANEL

Approval under Section 6 †
Joint Ministry-A.B.I.M. Cttee. to draw up chemical specifications

Approval under Section 7 *
Sub-Cttee. to advise the J.P. on Schedules for a new group of products

ADVISORY COMMITTEE

FIRM OF MANUFACTURERS WITH A NEW PRODUCT

APPROVAL OF A NEW PRODUCT BY THE ADVISORY COMMITTEE NOT J.P.

PRODUCTS APPROVED UNDER

† Section 6 Chemical Specification (Tech.Bull.No.1)

* Section 7 Where formulation & performance is important and a Chemical Specification is not possible

On the left, the Advisory Committee, consisting of representatives of research stations, government departments, etc., while in the centre we have the Joint Panel, the membership of which is made up out of the Advisory Committee together with representatives of the A.B.I.M., N.F.U., of England and Scotland, Government Chemist's Laboratory and the A.R.C.

On a request being received for the opening of a new Group, it is put before the Joint Panel and, if acceptable, it is next, where possible, decided whether the product should be placed in Section 6 or 7 of the Scheme. Products are placed in Section 6 when there is a direct relationship between their biological activity and their chemical or physical properties. In Section 7 when no such relationship is at present known, e.g., when wetters and spreaders etc., influence efficacy.

In the case of Section 7, the Joint Panel appoints a sub-committee with powers to co-opt and with instructions to draw up a schedule which will set out the requirements for approval, such a schedule requires a statement as to amount of active ingredient, guidance as to biological efficacy, stability etc.

If, under Section 6, the Joint Panel recommends to the parent bodies that a joint Ministry - A.B.I.M. committee be appointed, this committee then draws up a specification and method of analyses for the particular compound. When the schedule is finally approved by the Joint Panel, it is passed to the Advisory Committee who may then declare the 'Group' open. At this stage the manufacturer is in a position to submit his product for approval to the Advisory Committee, using the schedule as a guide to filling in the necessary application form.

It will be noted that the Joint Panel is a most useful device for allowing the Industry and other bodies to have a say, in drafting the specifications and schedules or on any other matter on which they care to express an opinion. At the same time, all confidential information is submitted to the Advisory Committee so that no other manufacturer is in possession of the secret information of others. A further important advantage is that in function the Advisory Committee is essentially judicial. It considers all the evidence submitted then reaches a decision on the facts of the case, unswayed by the fashion of the moment. I think this is very important and perhaps other bodies might with advantage study this aspect of its workings.

Information on products

It is important in any approval scheme that a minimum standard should be adopted. Thus all compounds above this standard are approved: those below it not approved. A second job we do is to vet the labels and eliminate any pleasing but unsubstantiated claims that the product has practically supernatural powers. The manufacturer with an alert research team is frequently wishing to revise the claims made, and where we consider there is still some element of doubt we require some such phrase as "has been found useful for".

Sources of information available to us are the very considerable personal experience of the Advisory Committee, scientific evidence submitted by the firms, data submitted by the research stations, the N.A.A.S. trials and work investigated either at our own laboratory or at our request. In addition, industry has always been prepared to undertake additional work when it has been required.

We do not carry out routine analyses of products already approved, and it is of interest that here and on the continent where compulsory approval schemes are in being, it has been found that there are very few cases of fraud encountered. Where lowering of standards has occurred it is usually traceable to ignorance and lack of resources on the part of the manufacturer.

Toxic Weedkillers

As a result of the report of the second Zuckerman Working Party an Inter-departmental Advisory Committee has been set up with Professor Zuckerman as chairman. This committee is guided by a scientific sub-committee with Mr. W. C. Moore as chairman, while the secretariat of this sub-committee is stationed at Harpenden with Dr. Miller as Secretary.

It is planned that we shall form a single chemical unit so that there shall be the closest possible collaboration between those interested in residue and application hazards and those concerned with the effectiveness of pesticides.

It is further planned and agreed (on a voluntary basis) that before a new chemical comes on to the market, full toxicological data shall be submitted by the manufacturer on the toxicity of his product. In order not to hold up unduly the sales of a new product it is suggested that the manufacturer approaches us in confidence sometime before he wishes to sell his product. In most cases this should give time for any additional toxicity work required to be carried out.

From this brief description it will be seen that a clearance on the toxicity side will in no way hold up approval of a product. The stages as I see it are:-

(1) Toxicity clearance.

(2) A pause of a year or so for sufficient data on pesticidal efficiency to accumulate.

(3) Consideration for approval.

With regard to the application risks involved in the case of toxic weed-killers, we all feel that we do not know enough about them yet.

Weedkillers and the approval Scheme

Having now cleared away some of the undergrowth, I feel it desirable to tell you something of the work of our Joint Ministry - A.B.I.M. Committees which have been working in recent years on weedkillers.

Our chief standing committee on herbicides is a committee and not a working party, yet, even so, with Dr. Woodford as chairman, much good work has been done. We have recently been concerned with a method of analysis for dinoseb, which is now practically agreed, and a method of analysis for MCPA together with the requisite schedules.

This MCPA schedule of requirements has involved us in a good deal of work, because chlorocresols, which are impurities of technical MCPA, are liable even in small amounts to cause taint to tomatoes. The difficulty we faced here was that no one really knows what is the maximum amount of chlorocresol which can be permitted in the concentrate and yet will not involve us in unreasonable taint risks. I will be frank - we still don't know. However, we have attempted to get at it from the other end. Namely, what is the least amount of chloro-cresols which the manufacturer can get away with without increasing the cost of manufacture too much. Well, we have agreed on a figure, and we have yet to see how it works.

Joint Committees

I think I should now tell you how these Joint Analytical Committees go about their work.

As might be expected they consist of Ministry and A.B.I.M. nominees. At their first meeting the various methods of analysis available are reviewed and discussed in detail. When two or three methods have been agreed, homework in the shape of samples of known content of active ingredients are distributed. At the next meeting each member reports the results he has obtained and his views on the methods used. As a consequence the methods are revised and the process repeated. In the case of MCPA we adopted a chromatographic method of analysis and in the course of time arrived at a rather amusing impasse. Excellent results were obtainable when members had personally instructed each other in how to do the job at each others laboratories. But when a fresh analyst was called in to carry out an analysis from the written word the results were usually bad.

However, on the receipt of personal instructions in the laboratory of one in the know excellent results could again be obtained.

I don't know what the moral of all this is except that art seems to play a large part in analytical methods. It may well be that it would pay to have instructional films made of complicated and difficult methods of analysis. Certainly we have all come across similar cases.

The methods when completed are approved by various bodies and printed in the Ministry's Technical Bulletin No.1 and are then available to anyone and have in fact, been accepted in many parts of the World.

Well, so much for the work of our Joint Committees. We have a good many of these Committees in being and functional.

I think I have given you a picture of the Scheme and how it applies to weedkillers. We shall have to move with the times and be prepared to adjust the Scheme to meet new conditions.

The future may see new competition from abroad and one way to deal with this is to depart from the principle of approval on the basis of minimum efficiency. If so I would make a plea for realistic support from the A.B.I.M. to do so. It has also been suggested that, at least for MCPA and 2,4-D the percentage of active ingredient should be stated on the label. Now that we have a satisfactory method for distinguishing between the isomers of MCPA this should be possible and I understand there is a considerable support for the proposal within the Industry.

Better biological evidence from the firms, especially with new products would enable the Advisory Committee to proceed more rapidly with the opening of new groups, and this is something they are very anxious to do. This evidence could, with advantage, be supplemented by the results of trials carried out on a national basis, of new and interesting compounds.

There are considerable difficulties inherent in this suggestion, but the idea is well worth pursuing, and it would certainly have the advantage of giving the Ministry's Advisers in the field an opportunity to gain experience of new products before they came into general use.

Finally, I should like to refer to the fine collaboration we have always had from Mr. Williams, Secretary to the A.B.I.M. Without that generous and unselfish help the Scheme would not work as smoothly as it does. We, in the Ministry, greatly appreciate it.

DISCUSSION

Mr. N. K. Smith: It would have been interesting if the discussion on Dr. Ashworth's paper had been opened by someone from overseas, who could compare the practical effectiveness of our voluntary system with that of the compulsory approval of products required by some countries before sale was permitted. It is to the credit of British industry that a voluntary system can function with great benefit to those concerned with the manufacture, approval, recommendation, sale and use of crop protection materials and that compulsion is not required to protect users against inefficient products, since the number of such appears to be negligible. Certain legitimate criticisms can be made against the british scheme, but these are relatively minor. Industry played its part in the founding of the scheme and has supported it actively. The efficient functioning of the scheme depends on full technical co-operation between industry and the Ministry. This has led to pooling of knowledge and trial results, collaborative work in analysis, etc. Specifications and final methods of analysis are thus agreed, not imposed. Most of the recent advances in the field have come from industry itself, which, therefore, desired to have a voice in the control of its own products. Knowledge is not the prerogative of any one section and more can be achieved by co-operation than by compulsory control measures imposed from outside. This spirit of co-operation and joint work for the common good is the most valuable feature of the Approval Scheme and it is to be hoped that it will not be weakened by excessive legislative zeal. Much credit for the success of the scheme is due to the work and personalities of Dr. J. T. Martin, its first Secretary and Dr. Ashworth, its present Secretary.

Mr. F. W. Morris: I would like to re-emphasise the point which has already been made concerning the lack of publicity given to this scheme. It is deplorable that after the amount of work that has gone into this scheme, the only people that really know about it are the people in the industry. It is the customer, the user of the material, that matters, and I am certain that there's not one in a hundred that is aware of the scheme. I do urge the people concerned with this scheme really to consider tackling this most important aspect.

Dr. R. de B. Ashworth: Publicity costs money and that is the basic reason why we've not had it. The Ministry of Agriculture and Fisheries is going to call a meeting shortly between the A.B.I.M., ourselves and their publicity working party to discuss this problem. Although it is permissible for firms to use our approval mark in advertisements of approved products, they have taken very little advantage of this opportunity.

THE LEGAL ASPECTS OF SPRAY DAMAGE

J. HENNIKER SMITH, (J. Henniker Smith & Co.)

I wish to make it quite clear in reading this paper that I am not a Lawyer but a Claims Adjuster and Investigator who has specialised in dealing with claims arising from damage to crops, on behalf of Insurers, not only involving the liabilities of the Spraying Contractors but also of the Manufacturers and Suppliers of the Chemicals and Insecticides. Because I am not a Lawyer I shall not indulge in Legal phraseology and Latin tags but will attempt to deal with the Legal positions arising as I have learned them from practical experience.

Different issues arise which affect the liabilities of the various interested parties and questions of those which are purely Legal Liabilities should be clearly distinguished from commercial considerations where goodwill or matters of commercial policy arise.

I feel it is very necessary first to make the point that Manufacturers and Spraying Contractors are dealing with chemicals and insecticides in which utmost care both in manufacture and in the instructions and recommendations of the Manufacturers should be exercised. Further that claims which are ambiguous should not be made for the products, for example that a certain chemical may be used for the treatment of some cereal when in fact there is risk of damage to certain varieties. It would also seem that some of the chemicals on the market are virtually still in the experimental stage and Manufacturers have, therefore, to revise their instructions as to use in the light of experience gained. I must be careful not to particularise, lest I incur the wrath of some manufacturers. These are matters of course for the experts, but I seek to draw attention to these points in view of claims which have arisen, thereby incurring liabilities on the part of Manufacturers.

I will now deal with the position as I see it between the Manufacturer and the Contractor. The Manufacturer supplies chemicals or insecticides to a Contractor and there is a straight Contract which is governed by conditions and terms which are usually specified, generally accompanied by pamphlets or literature giving advice and instructions as to use.

The Manufacturer is liable for breach of conditions and terms of the Contract, to the Contractor. For example, where a Manufacturer supplies goods which are not up to specified standard.

It is rarely that the issue of negligence arises independent of Contract.

As I see it, a Manufacturer has a duty to ensure that the product which he markets is fit for the purpose for which he sells it and that it will not cause injury or damage when properly used and applied.

There is a duty to warn customers and users against any dangers inherent in the use or application of the products.

Most Manufacturers seek to protect themselves against their liabilities under their Contracts of Sale by what is known as "Contracting out" or by restricting their liabilities either under Contract or at Common Law. "Contracting out" or limiting or restricting of liabilities on the part of the Manufacturers is not confined only to those dealing in chemicals but is common to many trades.

I personally consider that Manufacturers are well advised to do so, since they have no control over the mixing or application of the chemicals, and if they have marketed a product which if used in accordance with their instructions will control the weeds or kill the bugs, then I feel this is all that can be expected of them. Manufacturers cannot be expected to guarantee the yield of any crop sprayed with their products.

There may be cases where a Farmer might have a right of action direct against a Manufacturer whose chemical or insecticide has caused damage to crops by reason of the negligence of the Manufacturer, but such cases I feel may be considered as rare.

So frequently, however, I find that as a result of over-keen salesmanship, claims are made for the chemicals which are never intended by the Manufacturers, and Farmers or Contractors use the chemicals on some verbal and often very loose assurance on the part of the sales representative. This is greatly to be deprecated for it should always be remembered that we are dealing with crops and food, so vital to the life of the Community.

It could well be, therefore, that Manufacturers may find themselves liable because their Servants or Agents have given wrong or misleading advice, though unintentional.

Manufacturers should be very careful to see that their terms and conditions of Sale and their Instruction pamphlets and labels, whether issued separately or on drums or other containers, agree, and that the Purchasers' or Users' attention is clearly drawn to such terms and conditions. In this connection Manufacturers have a duty to see that clear warning is given as to any dangers which may arise out of the use of the chemical.

It is surprising when one considers the very considerable liabilities that Manufacturers may well incur in connection with the sale or the supply of a large batch of one particular chemical, which may be below standard or be wrongly mixed or labelled, that they do not all avail themselves of the facilities at their disposal in the Insurance market. In America particularly, it is common for all Manufacturers to insure their liabilities in respect of their products. In fact many customers insist on confirmation that the Manufacturer is adequately insured.

Some illustrations might be helpful as to the type of incidents giving rise to claims where Manufacturers would not be able to seek the protection of their terms and conditions of Sale or supply or of any warranties.

A Manufacturer, say, breaks down a 40 gallon drum into smaller containers, to use an illustration, DDT Emulsion, and through some error or negligence on the part of employees, the Emulsion is poured into smaller drums which had previously contained a hormone. In other instances drums have been wrongly labelled.

I have had experience in other cases where a Manufacturer has had to admit that the product was not up to standard and contained, for example, too much oil. This was confirmed by the Manufacturers' own analysis after a complaint had arisen.

In another instance a firm supplied an Insecticide but the crop showed signs of hormone damage and subsequent analysis showed the presence of hormone in the insecticide.

These are a few illustrations of cases where a Manufacturer might well not be protected by any restricted terms and conditions which he might seek to impose on his customers.

There is another aspect of Manufacturers' liabilities which is not always realised, namely, the risks of contamination or damage to other property which may arise during transit or storage owing to faulty containers.

There is also the case of the Manufacturers, anxious to sell a particular product for the spraying of a crop, and who instruct their representatives to visit farmers and persuade them to give the product a trial. The Manufacturers may also recommend the farmer to engage the services of a Contractor, who the Manufacturers may nominate to carry out the work, and the farmer then agrees to give the necessary order to the Contractor.

What is the position if in any event damage to the crop results? Would the Farmer's rights lie against the Manufacturer or only against the Contractor, or both? This, I believe, raises questions with which only Lawyers are competent to deal.

The Farmer under such circumstances might well find himself in the position of having to proceed against both the Contractor and the Manufacturer, with the prospect of incurring heavy costs which might not be recoverable.

A Contract of a different nature exists as between Contractor and Farmer, that is that the Contract is for work to be performed, and the Contractor has to decide what chemicals he advises to be used and in fact uses. He does the mixing and provides the equipment and applies the chemical. Therefore his position is much more vulnerable than that of the Manufacturer. He realises that he cannot pass on any claim made against him to the Manufacturer, except where he can prove negligence.

The Contractor holds himself out as a Specialist in the use of chemicals for spraying and insecticides and for the treatment of crops generally. He is, or should be, the adviser to the Farmer, and he should decide what spray to use, how to apply it, in what quantity and also the proper time to spray and the suitable weather conditions.

If he fails in his duty in these elementary points, he has an undoubted liability to the farmer and it is no use the Contractor blaming the chemical under such circumstances.

The Contractor's liability therefore, falls in the main under two heads - (a) in respect of advice given, and (b) in respect of work carried out.

A Contractor also, who takes a chance and fails to comply implicitly with the Manufacturer's instructions and directions is failing in his legal obligations to the Farmer. Equally a Contractor who takes a risk, even though perhaps persuaded to by the Farmer, may well still be liable for any damage which arises to the crop which has been sprayed.

I have often met the case where the Contractor has said "I warned the farmer of the risk of damage and he told me to go ahead" and unless therefore before spraying commences, and I emphasise before, the Contractor obtains in writing from the farmer an acknowledgment that he has been warned of the risk, but nevertheless requests the Contractor to carry out the spraying and that he, the farmer, will not make any claim against the Contractor, the Contractor could I think under most circumstances, be held to be liable, for any damage resulting.

I have no doubt at all that every Contractor should avail himself of the cover afforded him by Insurance and that he should see that he has adequate cover to indemnify him in respect of his liabilities.

Every Spraying Contractor, I am sure, realises the great responsibility that is placed upon him, to see that he uses the utmost care and skill and that he carefully observes the Manufacturers' instructions.

In this connection I have formed the view that not sufficient care is taken by Contractors to acquaint themselves with the conditions prevailing prior to carrying out the spraying. For example, in investigation I have found it to be very important to go closely into questions of soil conditions, source of seed, date of sowing, and as to what fertilisers have been used, and further, as to the state of the crop and whether there are any signs of disease.

It seems to me that Contractors should in many instances take very much more care to go into such questions prior to spraying. I fully realise the practical difficulties with which Contractors are met but this does not detract from the importance of using proper care.

These points all have a bearing on Contractors' liabilities and it is for this reason only that I mention them.

I am firmly of the view that Spraying Contractors should very seriously consider making their terms and conditions of Contract more stringent and explicit than they are, so as to protect themselves against the many unjustified and unreasonable claims which farmers are all too ready to make, especially in seasons such as we have experienced this year.

My experience shows that farmers are not slow to make claims against Contractors, in some instances without any foundation. They also have the erroneous impression that Contractors are really Insurers of their crops and guarantors of their yields, and I am of the view that Farmers should be brought to realise that they must themselves accept a measure of responsibility in very many instances for the damage that may subsequently occur to crops.

Often before a Contractor is asked to carry out work for a Farmer, the crop itself is in a very indifferent state, apart altogether from the weed infestation or from attacks by insects, and it is problematic whether the crops would mature in any event, and certainly only a small yield could be expected.

In very many cases of claims with which I have dealt, I blame the Contractors for not making their position very clear where incidents of this nature occur, and I maintain that Contractors should carefully consider any such cases, informing the Farmer that they are only prepared to carry out the work on the Farmer's express instructions and solely at his own risk.

When claims arise in these cases the farmer expects to be paid on the basis of 100% yield and protests when he is requested to take into account the condition of the crop and of the field prior to spraying.

To minimise their liabilities, Contractors should take steps to investigate claims or complaints immediately there is the slightest suggestion of damage, and not to wait until the crops have grown on, or until the time of harvesting.

So far as the Insurers of their Legal Liabilities are concerned, there is a duty on Contractors to comply with such a requirement as it is essential where potential liabilities exist for the necessary evidence and enquiries to be made in early stages.

An important aspect of a Contractor's Legal Liability is in respect of drift damage. This I think should be considered from two aspects.

1. Actual spray drift.

2. or what is termed "blow off", for example where there has been no drift at the time of spraying but the residue of the spray remaining on the crop subsequently through change of weather conditions gets blown on to an adjacent crop whether the property of the farmer or of his neighbour.

Primarily, I believe that drift damage, or cases of "blow off" rests with the Farmer whose crop is being sprayed, though of course under practically all circumstances, but not in all cases, the Farmer would have a right to be indemnified by the Contractor.

If a Farmer were to stipulate the chemical to be used and the date and time of spraying and requests the Contractor to carry out the work, then I consider the Farmer might have difficulty in the event of a claim for damage from a neighbouring Farmer in placing the onus on the Contractor. It must again always be remembered that the Contractor is the expert and he can refuse to carry out the work if he is not prepared to accept the risks.

Some examples of the types of claims for which Contractors may be held liable irrespective of their conditions of Contract may be given.

I would draw Contractors' attention to the necessity for the most careful storage of chemicals and marking of containers. I have had instances where chemicals, because they have not been properly marked, labelled or stored, have been used on crops with disastrous results and have also resulted in loss of cattle. This in my view is inexcusable and it is doubtful whether any terms and conditions could properly protect a Contractor in respect of any claim made against him on these grounds. Also I find that Contractors often undertake to spray with a certain chemical which they designate, and in fact do not use that chemical but use a mixture. In such cases again no terms and conditions could protect the Contractor.

Failure properly to cleanse plant and equipment and thus resulting in damage to crops, is another instance of a liability which could not be repudiated.

A Contractor who advises a Farmer as to the type of chemicals to be used on his crops would I think have a duty in law to warn the Farmer of possible damage to adjoining crops, whether his own or that of his neighbours.

This may surprise some Members present, but I believe it is a fact that the Farmer in law is looked upon as the person who has allowed the noxious chemical to escape from his land, and if he either injures the passer-by or cattle or damages his neighbour's crops, he would have to meet that liability. Few Farmers, if any, realise their position in this respect.

Therefore the observance of weather conditions, temperatures and a full knowledge of surrounding crops is of the utmost importance before spraying takes place.

In the case of damage by "blow off", I am of the opinion that though the Farmer would still be responsible to his neighbours, he would have difficulty in recovering from the Contractor, subject to the point as to whether the Contractor should have advised the Farmer of the potential risk. I do not know of any case that has been contested on these grounds, but it seems quite clear that a Contractor cannot be responsible for weather changes after his work has been completed, although I can see arguments that could be used against the Contractor on the grounds that the farmer relied on the skill and judgement of the Contractor and that the Contractor would not use chemicals capable of damaging surrounding crops.

It is quite obvious that many Farmers who do their own spraying have no real conception of the risks and liabilities in which they may involve themselves, apart from when they do spraying for neighbouring Farmers. I do not know whether the National Farmers' Union have given any advice on this subject to their Members, but it may well be that they have.

There is one final point, I think both Manufacturers and Contractors might well consider, and that is the pooling of information, season by season, of their experience of claims made against them arising out of the use of sprays and insecticides, and that such information should be made available to all Manufacturers and Contractors in such a form as to be of general help and interest in respect of both the Manufacturer of Chemicals and the Contractors' operations.

DISCUSSION

Mr. Cameron Gifford: I think this particular paper should lead to a very lively discussion because we all find farmers can be very, very hard task masters. It is a pity that more of them could not have heard Dr. Ripper's remarks about the British contract sprayer being the most efficient in the world and Mr. Longmate's comments on the cost of spraying. In connection with cost one item should be added to those listed and that is cancelled accounts. It is an item that can amount to several shillings an acre in certain seasons and I don't think that Dr. Holmes made proper allowance for it in his estimates.

Mr. Henniker Smith has mentioned a very important point in connection with the damages that can be caused by the application of insecticides which contain 'hormone' weedkiller impurities. If it is remembered that contractors can carry out work for farmers at a cost of a few pounds which may ultimately lead to claims of several hundred pounds then I think it will be realised that our charges are justified.

Mr. J. R. MacDonald: I want to put a plea for more work to be done on the residual lethal properties of weedkillers with particular reference to drift, and contamination of surface water which may ultimately be used for irrigation.

Many of you probably know that the N.F.U. is much concerned with complaints that arise out of consequential damage. I'm thinking particularly of neighbours' crops. We've found that in a number of these places, both the farmer and the contractor have in fact carried out all the instructions that were available, but some unknown factor has arisen which has produced quite unexpected damage. I feel that not enough work has been done by manufacturers and research organisations to obtain the maximum amount of information on potential damage and to ensure that this information is distributed and readily available. We have had the greatest difficulty in obtaining accurate information.

Unidentified speaker: We have not yet had sufficient emphasis on the contractural relationships that may exist between the distributing agents and the farmer. During the past season we have run into considerable embarrassment because it was not clear how we stood concerning spray damage when we sold weedkillers to a farmer who does his own spraying.

Mr. J. Henniker Smith: Wherever there is a contact between seller and purchaser then the seller must incur the liabilities attaching to him. It is, of course, not possible to answer a question like the last very specifically. I can imagine for instance a distributing agent passing on to a farmer certain advice or making assurances as to the efficacy of the chemicals which the manufacturer has made and that might land the manufacturer and not the distributor with the liability.

Mr. S. C. Jary: In legal phraseology, one occasionally hears that such a thing is an 'act of God', occasionally the Queen's enemies are involved. Are there not certain circumstances, such as when the spray which has dried on the crop and is then blown on to a neighbour's field, which may be called acts of God? Nothing that the farmer or the manufacturer could reasonably have done would have prevented this.

Mr. J. Henniker Smith: I have yet to find a case where damage is not due to the action of man in the first place.