

Pest Control and the Helicopter

A DISCUSSION

*at a Meeting of The Helicopter Association of Great Britain
on Saturday, 28th January, 1950, in the Library of the
Royal Aeronautical Society, London, W.1.*

H. A. MARSH, A.F.C., A.F.R.Ae.S. (*in the Chair*).

Introduction by the Chairman.

Most of you probably know by now that our lecturer (DR. W. E. RIPPER) this afternoon has unfortunately been detained in the Sudan, and I must apologise, on his behalf, for letting us down. We, that is the Council of the Association, did not know ourselves until yesterday afternoon and were in a quandary as to whether we should cancel the whole thing or try and arrange an informal discussion on the subject of the lecture. Having decided that we could not possibly put off a number of those who would attend, we considered that the best thing to do was to try and arrange an informal discussion, which we have done. I have a list of names of gentlemen who had arranged to take part in the discussion following the original paper, and shall be calling on them, in due course, for their contributions, commencing with MR. HICK, of Plant Protection Ltd.

I am quite sure that the subject matter we are going to discuss is one which affects all of us to some extent, as obviously we are all interested in such matters as quality and quantity of food and health considerations.

Pest control in its various applications covers both of these subjects. Another interesting point, I am told, is that pest control could, if scientifically applied, save some £168,000,000 on food production in this country alone.

From the point of view of actual helicopter spraying I think I could rightly claim to be one of the first, if not the first, to have taken part in the early experiments in this country. In 1945, when some Sikorsky R.4 Helicopters arrived in this country two of them were sent to my station at Henley. In order to find out if these aircraft were suitable for crop spraying it was necessary that some preliminary experimental work should be carried out. Sample plots were laid out on the aerodrome and I well remember DR. RIPPER rushing up and down these plots, after the tests, to see the actual effect of the spraying experiments. We used a tractor to tow a liquid tank, which in turn was connected by a pipe to the helicopter spray gear. About three men were necessary to hold the pipe clear of the ground between the helicopter and the tank, and the helicopter itself brought up the rear travelling at about 3/4 m.p.h. Again, in 1946, my Company were lent (by arrangement with the Ministry of Supply) a Sikorsky R.4 to carry out further experimental work at Cambridge, for Pest Control, and in this case the flying was carried out by another member of our Association.

I will now call upon MR. HICK, of Plant Protection Ltd., to open the discussion.

Mr. E. Hick, M.A. (*Companion*) Plant Protection Ltd.

Crop Protection with the Helicopter in Canada.

During the next few minutes I shall try to describe some of the experiences I had while organizing and running a contract crop protection service in Canada with a helicopter. In a short time it is only possible to give a very general sketch of what happened but I hope it may be possible to amplify some of the detail in discussion afterwards.

My Company, the offshoot of a larger aircraft operating organization, was formed primarily on an experimental basis for the purpose of investigating the technical and commercial possibilities of the helicopter in agriculture. Such a project was part of a general scheme to explore as many potential uses for the helicopter as possible.

The Company consisted, apart from administrative staff, of a biologist, two salesmen/fieldmen with agricultural experience, one helicopter pilot, an engineer and an engineer's mate. Equipment consisted of 2 jeeps for the salesmen/fieldmen, a

car for the biologist, a lorry and a Bell 47 B 3 helicopter fitted with what I can best describe as prototype dusting equipment. No spray rig was available at the time.

In view of the fact that the project was designed to investigate the commercial possibilities of contract dusting with a helicopter as well as its technical performance, it was decided to send out salesmen/fieldmen during the winter preceding operations to line up contracts on as wide a range of crops as possible. (I might add in passing that these bodies were called salesmen/fieldmen because they acted as salesmen during the winter and fieldmen during the summer).

Firstly, however, discussions were held with a number of Federal and Provincial scientists, not only to ascertain from them the most suitable potential operating areas, but also to put them into the picture as to what we intended to do. Their reception was very sympathetic, particularly as regards the scientific approach which we were adopting towards the work we were going to carry out, but at the same time they did utter a number of warnings as to what we were letting ourselves in for. They pointed out that as the crop protection season was of relatively short duration in Canada, our project might not be commercially feasible unless other work could be found for the helicopter during the winter months or unless the season could be extended by working down in South America. We were also warned that a very great deal of hard, persistent and steady educational work would have to be put in before any reasonable volume of business could be attained and also, that as we were pioneering a new idea, we should receive a great many setbacks. Experience showed the accuracy of these warnings, particularly as regards finding winter work for the machine. In actual fact there was little that the machine could do during the winter, apart from the usual routine Father Christmas delivery stunts, and we came up against the currency problem when considering winter operations in South America.

However, acting upon the advice we received during these discussions, it was decided to concentrate upon vegetable crops in Kent and Essex counties of Ontario and accordingly a number of canning organizations and leading growers were approached in these areas. The number of firm contracts actually signed at this stage was relatively few which was not altogether surprising in view of the fact that we were trying to introduce a new technique with an untried equipment among a fairly conservative clientelle. The majority of people we approached adopted the not unnatural attitude that they would rather wait and see how the machine behaved on their neighbours farms before committing themselves. Furthermore, in quite a number of cases it was found very difficult to get the farmer to think as far as his next season's dusting or spraying programme. He apparently preferred to wait until he actually saw an infestation in his crop before considering any remedial measures. Careful planning with subsequent efficiency is very difficult under these conditions but despite the snags we did secure a sufficiency of firm orders to provide starting points on all the crops and in all the areas in which we were interested. We anticipated that once the season started further work would grow out from these nuclei, and this is in fact what did happen.

Just before the season started our whole unit moved up from Toronto to an airport which was more or less in the centre of our main area of operations. This type of base was chosen as it enabled us to concentrate hangarage and maintenance facilities for the helicopter, office space and chemical storage facilities in the one place.

Working out from this base, one of the biggest problems which had to be overcome was that of bringing about an efficient co-ordination between the actual flying side and the supporting ground work and with this end in view a number of different operating methods were tried out.

In the first instance, a lorry containing a load of dust in 50 lb. bags and a jeep containing a fieldman proceeded to the given field to be treated. The helicopter followed them, settled alongside the field and was loaded up from the lorry. Meanwhile the fieldman ran to a point mid way up the field from where he could move across flagging the helicopter onto its correctly spaced flight lines. The only snag to this method of flagging was that the fieldman had to lie flat each time the machine passed over him, but it was more economical than having two flagmen, one at each end of the field. The whole of this technique was far too slow because the helicopter could move from field to field very much more quickly than could the ground party. Much valuable time was therefore wasted while the helicopter sat on the ground waiting for the other vehicles to catch up with it by road. A very much quicker method was therefore devised as follows: The lorry went round some days in advance dumping the correct number of bags of dust at suitable loading areas alongside each

field to be treated. These loading areas could be annotated onto a map, or air photograph, and all that was then necessary was for the fieldman and helicopter pilot to fly to the first field, settle down alongside the bags of dust and load up. Then the pilot treated the field, relanded to pick up the fieldman, and moved on to the next field. Such a technique would not lend itself of course to spray application.

So much for the actual operating drills. A much greater problem with which we were confronted was bound up in the fact that we were only operating one helicopter. This is alright when one is conducting a purely experimental project but it is quite hopeless for an efficient paying contract service. Apart from financial considerations of having the entire overhead of the organization centred upon the limited acreage which one machine can handle, it is not good business to have one's sole machine grounded for inspections and maintenance when a particular infestation is rapidly ruining a crop. Farmers don't want to be told that the equipment is undergoing overhaul and therefore unable to operate at such times and if they are told that, they will tend to deprecate both the equipment and the contractor for some considerable time to come.

So far I have said nothing at all about the biggest problem connected with the helicopter in agriculture and one of which we were acutely conscious by the end of the season. This problem is one of cost. Even with the maximum practical utilisation of the machine in a given year, the cost per flying hour is still high and it is therefore necessary, in order to arrive at a reasonable cost per acre, for the machine to cover the greatest possible number of acres per flying hour.

The conditions under which we were working, conditions of small, often widely dispersed fields which were often obstructed by trees or telephone wires on the perimeter, did not favour the attainment of a high acreage per flying hour. As a result, it became increasingly clear to us that, except on a few crops where the use of ground equipment was not entirely suitable, we were in no position to compete with ground contractors.

I shall return to this question of cost in my conclusions but meanwhile you will probably wish to hear something about the various crops which we treated. Potatoes constituted the largest acreage and a combination of DDT/Copper dust was applied against Colorado Beetle, Flea Beetle, Leafhopper and Blight. The effective period of control appeared to be in the nature of seven to ten days and up to four applications per season were carried out. The first two applications could have been applied with ground equipment perfectly satisfactorily, but the helicopter was very popular for the last two applications when the haulm was heavy as it caused no wheel damage. This question of mechanical damage arose again with peas which we treated with a $\frac{3}{4}$ % Rotenone dust to control pea aphid. The vines were very dense and the canners did not favour the use of ground equipment. Successful treatment had been carried out in previous years on peas with fixed wing aircraft at very much cheaper rates than we could quote with the helicopter but the helicopter did seem to score in certain areas in that it could treat with safety those smaller obstructed fields which were hazardous for the fixed wing aircraft.

Other crops we handled successfully were beans, where a 3% DDT dust completely controlled Leaf Hopper and corn on which a good control of European Corn Borer was obtained, also with a 3% DDT dust. Protective applications of a copper dust were given to tomatoes, but as blight did not develop in the crop, it was not possible to assess the biological value of the treatment. Hornworm control on Tobacco was attempted and was 100% effective using a 3% DDT dust. The one crop on which results were not satisfactory was the onion crop on which attempts were made to control thrip using a 5% DDT dust. This was rather disappointing as workers in the States had claimed 100% thrip control on onions using a 5% DDT dust applied from fixed wing aircraft.

Onions apart, the growers and canners with whom we worked appeared to be well satisfied and in fact enthusiastic over the results of the technique, but tended to be doubtful as to its future on the score of cost which they claimed to be too high.

This cost factor leads me to certain general conclusions which were forced upon us as a result of our work in Canada. They are not unique and other people who have had practical experience with aircraft in agriculture or who have thought about it at any length have reached the same conclusions. They can be summed up as follows :

Firstly, commercial success in aerial spraying and dusting is inevitably bound up in the long run in the availability or otherwise of cheap and efficient methods of ground application. It is most likely to succeed under those conditions where the

use of ground equipment is impractical due to the type of crop, method of cultivation, topography and other factors.

Secondly, a high proportion of aerial spraying and dusting can be handled very successfully by the fixed wing aircraft at costs far below those of the helicopter. The helicopter, however, has one big advantage over the fixed wing aircraft, and that is its greater manoeuvrability. This important factor allows it to operate under conditions which would be totally impractical, or at the best, very hazardous for the fixed wing aircraft. These conditions exist where crops are grown in relatively small fields surrounded by trees, on hill-sides and in narrow valleys. Unfortunately, under these conditions, the helicopter often has to expend more flying time in manoeuvring than it does in actual spraying and dusting. This means that relatively few acres are covered per flying hour with a resulting high cost per acre. This brings me back to the cost factor again and my main conclusion which is that whereas the helicopter has a tremendous potential in crop protection work, that potential is prevented from becoming reality on the grounds of cost, and will continue to be so prevented until operating costs are drastically brought down to a more commercially competitive level.

Mr. A. L. Abel (*Visitor*), Chief Entomologist of Pest Control Ltd.

I would like to endorse the Chairman's remarks regarding DR. RIPPER's unavoidable absence—he must be extremely disappointed that he cannot be with us.

With regard to the remarks that I would like to put forward in such a discussion as this, I would explain that they are connected with the use of the helicopter as a spraying instrument in this country during the past season. The Chairman has outlined the early development stages, and last year Pest Control Ltd. went out into the field with a contract helicopter spraying service operating in this country.

Firstly, a few basic considerations, many of them familiar, to put the whole thing in perspective. The helicopter as a *spraying machine*, as opposed to dusting, depends on the principle of using a large volume of air, taking the chemical to the place where it is needed. This principle is established not only for helicopters but also for certain types of ground equipment, many different types of which are manufactured in the States and one or two in this country. So that the question as to the principle involved—using the air stream—is not one into which we need go further. The question turns on the use of the helicopter as being the means of locomotion of such a machine and at the same time producing the required air stream. The first point that arises is that a technique of operation is required. To have the machine given one and told to “Get on with the job” is not sufficient. Our experience has been that a rigid technique has to be evolved, and this has largely been evolved through trial and error. A big problem, and it is one which Mr. Hick has elaborated on, is the organizing of the work in such a way that one has the chemical supply and the ground crews ready on site for the helicopter to arrive and stay with it during operation; yet at the same time the ground equipment should be moving ahead, to be ready at the next place of work, because the helicopter can do larger acreages in the matter of minutes. The method that was finally evolved was to have two tanker supply units.

The pressurized system of spraying chemical is one which requires some means of re-charging the helicopter tank with compressed air. We found it was better to have two such units with one helicopter, so that no time whatever was lost, either spraying time or helicopter flying time, and the machine was working continually. That of course does put up the cost of operations, but we are confident that it is the method of operation to bring the ultimate cost down as low as possible by getting every available acre per flying hour.

In organizing the work, the radius of operation is important, and by that I do not mean the radius from the re-fueling site; it is possible to bring your re-charging unit practically alongside the fields that are being sprayed. The question is how far is the machine to fly out in the morning and have to fly back in the evening, and at what distance apart should one have servicing stations. That question is not completely answered, but at present we are operating on 35-40 miles direct flight, we do not know whether this is ideal. The movement of the helicopter over this distance entails the movement of the ground crews travelling by road. Ground crews must be out earlier, and of necessity they return later in the evening. These are problems from a contracting point of view, and increase considerably the expenses of operation.

Now as to the operations. The results and the success that we had last year depended largely on what sort of job we were doing, on the chemical, and on the

formulation, and I would like to say that, granted that the helicopter is a suitable spraying machine, fresh problems have turned up for the chemist in that questions of formulation must be considered from the angle of formulating them for helicopter spraying. The distribution of the spray by the helicopter is, of course, important; even distribution is what one aims at. The question of particle size comes into it. It has also been shown by many workers that particle size plays a very great part in the effectiveness of a chemical, either an insecticide against pest, or a herbicide against weed. Then there is the drying out of the spray when the particles are too small and in many cases, *e.g.*, weedkilling, particles in a dry state are not so effective. We have done a considerable amount of nozzle research. I would say that experience obtained from one year's contract spraying has turned up more problems in that direction than what we had first thought possible, and considerably more work must be done in that direction.

Another problem, that of drift, is a familiar one and there is no need to enlarge on it, but operating with a helicopter spray, drift is certainly much more controllable than with a fixed wing aircraft. I do not think there is any future at all for fixed wing aircraft in the field of pest control in this country. The drift problem is tied up with the terrain operated upon, and also with the type of chemical used. For this problem chemicals may be divided into three classes (1) non-poisonous (to human beings and animals) and non-phytotoxic; (2) non-poisonous but phytotoxic; (3) poisonous but non-phytotoxic. The first group includes such chemicals as D.D.T. insecticides, certain copper fungicides, etc., and drift of these materials does not constitute a great hazard. The second group includes the selective weedkillers used on cereals and one or two other crops. With these chemicals drift constitutes a serious problem as susceptible crops in neighbouring fields may be irrecoverably damaged. Another point to consider is the decrease in selectivity that occurs when certain of these weedkillers are applied at high concentration. Double application through too great an overlap can cause damage under these circumstances but this can be avoided by using ground markers. We find that two markers are required to maintain a perfectly regular spraying with the work properly matched up. With markers it is possible to obtain effective results even when wind interferes with the spray pattern. The third group of chemicals are those which are poisonous but not phytotoxic. Here we have the problem of drift spray falling on livestock, fish, birds, etc., and on adjoining crops which may be for human consumption. But the danger is not the same as with drift from weedkillers where the crop may be killed. Provided adequate precautions are taken that adjoining crops are not being consumed within prescribed periods, depending on the chemical used, then no harm is done.

The new systemic insecticides, such as Pestox 3, fall in this third group. They are of particular interest in that complete cover of the crop foliage is not essential. The material is absorbed into the plant and ultimately renders it toxic all over to aphides.

These remarks are based on my experience of using the helicopter as one machine amongst a fleet of ground machines, and the problems are those which have turned up during the past year. A brief review of the jobs we are undertaking this season might be of interest.

Pollen Beetle on turnips, swede, broccoli, etc. Satisfactory results last year using D.D.T. emulsion, spraying 5 gallons concentrate per acre. The job is very attractive to the growers due to damage done by ground machines.

Mustard Beetle on mustard. D.D.T. emulsion proved quite satisfactory.

Aphides on Sugar Beet and Mangold Seed. This past year we had rather a bad outbreak of black aphid on sugar beet, and every available ground machine was employed to full capacity. It was decided to put the helicopter into operation, and we used both Pestox 1 and 2 where we were absolutely sure that no drift on to other crops could take place. We had very good results and in one case a comparison of yields showed that where we had left off spraying through difficult terrain the yield was 1½ cwt. of Mangold seed per acre, whereas the portion treated yielded 18½ cwt. seed per acre.

Copper spraying on potatoes and on celery has been carried out in Lincolnshire, the Eastern Counties and the West Midlands. The problem here is one of maintaining a copper fungicide in suspension at high concentration and our chemists have solved it satisfactorily.

Weeds in corn. We are undertaking that this year, although a word of warning is necessary. We were rather optimistic last year, and the problem of drift at the time when sugar beet seedlings are coming through is a very serious one. It is not possible to detect the drift by ordinary observations. Very fine particles can be taken over by convection currents and it is necessary to take extra special precautions where crops to be sprayed are neighbouring to sugar beet. The helicopter would seem to be the ideal tool for destroying weeds in certain grass marshes in some parts of the country where we have long straight stretches, anything up to 600 or 800 yards wide, all infested with thistles and many other weeds. The chief problems here are the apathy of the owners and the cost of treatment bearing in mind the low value of the land.

Pea Moth on peas. A very satisfactory campaign was carried out with the helicopter, using D.D.T. emulsion, spraying quantities of 5 to 10 gallons per acre. The helicopter is so much more attractive to the pea grower for this operation that we have deliberately made a differential in price so as to avoid too many people requesting the helicopter to the complete exclusion of any ground equipment.

Such is the experience of a person who merely accepts the helicopter as a spraying machine, together with the problems which the experience of one season's operation has thrown up.

P. M. van Bommel (*Visitor*), Shell Petroleum Ltd. ("Delft" Laboratory, Holland).

The work I have been doing in Holland has been only work on the development of spray equipment for aeroplanes and helicopters, so I cannot say very much, of course, about the commercial possibilities, and I would like to say only some words about the possibilities that there are and the difficulties that we had with different machines. For spraying, the first thing that we need is a small droplet in order to get a good coverage, but small droplets give a very high drift, and that brings us always the difficulty of getting the right droplet for the purpose. The difficulty has been to find apparatus that would give a good coverage and a good distribution. For some cases the droplet size has not a very great influence, for example when you have a leaf of a plant and you want to fight Colorado beetle, then one or two droplets will be enough. If he does not reach it today, then he will reach it tomorrow. If the pest to be controlled is stationary, you must touch the pest, so you want many very fine droplets, and that is the main difficulty there is in spraying. There is one more difficulty, and that is the penetration between plants. If the insects live on the upper side of the leaf, then making the droplets fall down by their own weight might be enough, but if the insects are on the under parts of the plants then very much better coverage might be needed, and perhaps the helicopter might be of very much use because it gives a downward air stream and so causes the liquid to cover a far greater part of the plant than when applied with fixed wing aircraft. I said I was working on the technical side, and I have no experience of what the entomologist can say about this. That is what I would like to ask a specialist: in which case might the helicopter prove to give better penetration than the fixed wing aircraft, and so for which plants or for which pest must we use a helicopter? For other cases, the fixed wing aircraft is much cheaper, so we should not lose sight of that much cheaper method of application.

Dr. Swarbrick (*Visitor*), Development Department Royal Dutch Shell Group.

Most of you know that I am a little critical of some of the statements that are frequently made about the helicopter, and so if I am critical in the absence of DR. RIPPER please do not think I am trying to be rude to him. The use of any kind of spraying machine is merely a means of applying pest control material to the plant. We have ultimately to determine which is the best method. Is there a best method? There is a best method for a particular application. Helicopters, fixed wing machines, and even hand-operated apparatus, will continue to find a use in pest and disease control. In Holland, two years ago the Government purchased a Sikorski Helicopter and we collaborated with the Ministry of Agriculture Army, Navy and Post Office in trying to find out if this machine could be used. We put it to a great deal of work, on its use for pest and disease control and we have acquired a great deal of knowledge. About two-thirds through the season, while we found we could control pests or disease, but we could not control them at an economic level. I am still very interested, and I still want to meet the man who can make a helicopter pay, spraying crops. I was in the United States in the Spring of this last year, but it was the same

tale all over which MR. HICK put across to you, that you could do the job but you could not make it pay. That raises the question : can you do it with a fixed wing plane?—and I do not agree with DR. RIPPER's colleague that there is no possibility of using fixed wing planes in this country. I would perhaps go further and say there is not much hope for fixed wing planes or helicopters in a big way, in this country, but just as much hope for the fixed wing plane. The situation all turns on the farmer. He ultimately wants to know how much this job is going to cost. MR. VAN BEMMEL was very modest in his claims. We are now designing an efficient spraying apparatus for a fixed wing plane lent to us by the Prince of the Netherlands, and in co-operation with the Dutch Government officials, we are hoping, this coming summer, to put these two machines into competition—the fixed wing and the Sikorski—and see which comes out with the best results.

J. Harper, A.F.C. (*Founder Member*), Chief Pilot, Pest Control Ltd.

We have heard strong comment in favour of condemning the helicopter this afternoon, and I am in a position to confirm MR. ABEL's remarks. We consider that the helicopter is more efficient as a crop spraying machine than the airplane. We quite recognise that the airplane can do a job such as attacking locusts, and indiscriminate spraying in which coverage has not to be so accurate. The problem of the helicopter appears to be economical, and at this present stage we are finding it very difficult to make it a paying proposition. Our costs are increased to a large degree in development work, in which DR. RIPPER has a very great interest. From the operations we have done to date, I would like to answer one question regarding normal aircraft, and that is, in which areas one could use it in this country and Europe. There are limitations in the spraying of insecticide chemicals through drift, and weed-killer needs very careful application close to the ground. There are very few areas in which the airplane could be operated at such low heights, and therefore it would seem to me that the airplane, as a means of spraying insecticides, would not be effective. The economics would be immediately eliminated by the fact that claims from farmers would be fantastic. There is a big advantage in that helicopters operate directly from the sites, whereas fixed wing aircraft would have to fly back after each load.

With regard to the introduction of new types of chemicals which are toxic to human beings and animals, and require very close and precise flying, I do not feel the ordinary airplane could undertake this. We operated last year in Normandy where we had one Bell helicopter and one Piper Cub, and we found that the Piper Cub had great difficulty in finding landing sites, and if such an aircraft as this Piper Cub has difficulty in finding landing sites, I think this would apply very much to this country, and in many cases considerable reduction in daily acreages would be involved.

In the Sudan, we have used helicopters for cotton spraying, and we have reached 800 acres per day. It would be possible to reach 1,000 acres per day. There is no doubt that the acreage per hour is the controlling factor. We have reached a total acreage of 45,000 acres. We have also operated on tobacco in Rhodesia.

We have had little experience to date of tree spraying, but it is quite obvious that if a helicopter is not economical on crops it will not be on trees. We hope to have experience of that this year. We have reached 148 acres at 30 m.p.h. in the Sudan. As to experimental night flying on the spraying of crops, there is a question of its being more tiring for the pilot. We could reach an acreage of 200 acres per pilot. We are developing night flying as we feel it will be feasible and an advantage in certain areas.

Colonel H. J. Holman (*Member*), Colonial Insecticides, Fungicides and Herbicides Committee.

DR. SWARBRICK has referred to the inefficiency of the helicopter, and although I do not entirely agree with what he has said, I do feel that there has been too much optimism about the use of helicopters for insecticide purposes. Many extravagant claims are made for the helicopter, but it is at present extremely difficult to operate it economically.

I would like to outline some of the possibilities of the helicopter, not only in this country but overseas. We have spoken so far about agricultural crops, and here pest control involves not only insects and diseases of agricultural crops, but the use of weed-killers, arboricides and defoliants. There is also the control of insects affecting man and animals, such as the mosquito and the tsetse fly, and many others.

I would now like to indicate some of the differences between pest control in this country and overseas. In the United Kingdom comparatively small acreages of restricted and awkward sizes often occur, and I can appreciate that it may be more efficient and just as economic to use a helicopter. This is particularly so on high priced crops, such as seed crops, where the crop can stand the high cost of insecticide. Overseas, particularly in the Dominions, there are large areas where the use of fixed wing aircraft will very obviously be desirable, perhaps not more efficient, but undoubtedly at the moment very much cheaper than the helicopter. Even so, there are certain forest areas, ravines and rivers which may have to be treated, and in these areas the helicopter will undoubtedly play a very valuable role. In the Colonies, where you have not only plantation crops but small holdings under native agriculture, the problem is still more complicated. Fixed wing aircraft may be effective for plantation crops, but in the case of tea or rubber the steep terrain may render their use extremely hazardous, and the helicopter may here have considerable possibilities. In the case of cocoa, high shade trees may make the use of fixed wing aircraft difficult. I am, of course, talking about efficiency and not cost of operation. With regard to cotton in Africa, grown by small native growers, you are up against an awkward economic problem in that you cannot go round to each grower and ask him to pay you to treat his small holding. How long it will be before one can use helicopters or fixed wing aircraft in such areas it is difficult to say, but it may eventually be possible to do so on a co-operative basis, or under Government auspices.

The problem of extensive development in the use of helicopters for pest control will largely resolve itself into one of economics. We, who are anxious to use these machines, would make an appeal to the manufacturer. We say that the cost of the helicopter as a spraying instrument is far too high. The manufacturer replies that he can only make a limited number of these aircraft, and therefore must charge say £20,000 each, but the potential buyer cannot afford one at this price. Thus there is a vicious circle and until this is broken helicopter operation for pest control will not extend widely and will be restricted to special conditions.

The second problem is maintenance of helicopters, which is far more costly and difficult than that of fixed wing aircraft. It is said that one of the advantages of the helicopter is that you can land anywhere. But if you are operating over a jungle area, say in Africa, you may be able to put down your helicopter anywhere, but if anything goes wrong it is going to be extremely difficult to get to it on the ground. The advantages of an easy landing may therefore be negated if it is impossible to repair your machine in an inaccessible place. Manufacturers must concentrate on standardisation and simplicity of spare parts, and hence easier and cheaper maintenance.

I would draw the attention of the manufacturer to three points :—

- (1) The cheapness of the machine.
- (2) Ease and comparative cheapness of maintenance.
- (3) Design of accurate equipment for spraying or dusting.

As regards the third point, extravagant claims were made for spraying and dusting equipment, particularly in the United States, before anybody had carried out proper tests. I think DR. GALLEY will agree with me that, although thousands of acres of crops were sprayed or dusted, no one knew just what was happening. If you are going to do the job economically, you have got to use the minimum amount of chemical in the right droplet size and in the right formulation. If you are operating over large areas, say for example over many square miles against tsetse fly, the cost of operation of the aircraft is small compared with the cost of insecticide. By using the minimum amount of the most effective insecticide you will be making very great economies. The manufacturers should not be content with the present equipment. What we do want is equipment carefully designed so that it can be sold to potential operators who will know that it can produce exactly the right type of spray or dust required for the particular pest and conditions. I do not believe we have reached that stage yet.

Dr. R. A. E. Galley, (Visitor), Agricultural Research Council.

While the experts have been speaking on this matter, I have made a few notes, and I propose to use those as a basis for some remarks on certain aspects of the question we have been discussing today.

In the first place I should like to enlarge upon a statement which our Chairman made, concerning the cost of the damage caused by crop pests and diseases. The

figures vary from year to year. During last year I attended two international gatherings, one in London, the Second International Congress on Crop Protection, and the other in the United States, the U.N.S.C.C.U.R.* At the first, it was obvious that very many efficient methods of crop protection had been devised, some of them embracing new insecticides, fungicides and plant growth substances. At the second, emphasis was given to the colossal amounts of food which are lost as a result of attack by insect, fungus and weed pests. Even in advanced countries like our own and the United States, those losses are enormous, and much could be done to save food by the use of the proper protective measure. If the losses in the advanced countries are so high, the losses in the more backward countries both of the growing crop and the stored food, are just unimaginable.

The helicopter may or may not be a machine for helping us to achieve this saving of food, and the claims of the helicopter and fixed wing aircraft have been advanced by different speakers. I would like to say a word about the accuracy of spraying by both helicopters and fixed wing aircraft. It requires high skill on the part of the pilot, whether in a helicopter or fixed wing aircraft, to get the spray where it is wanted. On the North Saskatchewan River in 1948, experiments were being carried out to control the larvae of *simulium arcticum*. The insecticide solution was dyed red. There was a space of about 40 yards between the edge of the river and a row of houses, and on the 8 or 10 occasions that the pilot flew over the river he got the spray into the river every time, but not once did he spray a house with it. He was flying a 'Dakota' aircraft at 150 feet, at 150 miles per hour. The fixed wing aircraft can put down spray fairly accurately, but it has not got the manoeuvrability of the helicopter.

As regards the work which the Council is sponsoring in connexion with helicopter development as a spraying machine, we are concentrating upon the problems associated with producing a uniform swath of particles of predetermined size, the importance of which has been stressed previously.

We are, therefore, obtaining basic data on the types of nozzles, the pressures at which they function, the spacing of the nozzles on the boom and the position of boom in relation to the rotor and to give different particle sizes at different rates of application. I think the basic data will be extremely useful and will dovetail in with other information obtained on the biological control achieved in the spraying of various crops.

Mr. Alan Bristow (*Member*), Helicop-Air Ltd.

I would say my agricultural experience is limited. I have been dusting, not spraying, and I find in a month of hard work in Africa enough to criticize some of the experts. First of all, referring to MR. HICK'S paper: I think he was correct in taking Organisation as the key factor, but the displacement time is the factor that put his costs up, and costs are killing a business which has great prospects. You cannot expect to give efficiency unless the organisation of all your ground unit is absolutely faultless. The aircraft should not be flown from site to site. The only way to get an aircraft at a given spot at a given time is to get it there by road: put the helicopter on a lorry, choose your operating zone for the day, deposit the helicopter there the night before and establish your operating base.

These remarks apply to what MR. ABEL had to say. He cannot transport his helicopter by road. There is not enough "rolled up sleeves" in this agricultural business; by that I mean that pilots cannot stay in the best hotels. They have to get down to sleeping where they work—in a caravan where they are working, and so reduce the costs and make the radius of operation considerably larger.

As to COLONEL HOLMAN'S remarks on maintenance, the helicopter to which I refer is not only the simplest helicopter in the world, it is also the easiest to maintain. Designed as an agricultural machine, it carries no surplus weight. The pilot can do the maintenance himself in an emergency.

Costs: I would like to say that in the United States the costs have been got down and agricultural service is being offered at an economic figure now. There is no reason why this cannot be done here.

Dr. D. L. Gunn (*Visitor*), Anti-Locust Research Centre.

My experience of aircraft spraying has been gained on behalf of the Anti-Locust Research Centre with fixed-wing aircraft against locusts in Africa. I have never

* United States Scientific Conference on Conservation and Utilization of Resources.

been in a helicopter or had any experience of using one ; that information will help you to assess what I have to say.

As an aircraft target, locusts have a number of peculiarities. They are found in remote places, often far from normal bases and supplies ; each locust has a target area of about an inch, so that fine sprays are unnecessary and coarse sprays can be used ; a small swarm covers 100 acres when roosting and a large one several square miles ; since swarms commonly fly away a few hours after sunrise, only a very short time is available for spraying a large area. These facts are responsible for our present choice of methods. Using Anson aircraft flying at several hundred feet above the ground and with the Porton technique of spraying without any jets or pumps, in 1947 we repeatedly produced complete clearances of Red Locusts at an area dosage of less than a gallon of 20% DNOC solution per acre and at rates of between 5 and 10 acres per minute. In one operation we virtually cleared 11,000 acres in 100 minutes. That disposes of most of the advantages claimed by helicopters for this particular purpose. On the other hand, a helicopter does not need a 1,000 yard runway and can land almost anywhere. In Central Africa, however, it may be easier to fly your poison from an airfield 50-100 miles away than to truck it in country with no roads or only inferior ones. Even allowing for the flying time so used up, an Anson with this technique can cover acreage more quickly than any existing helicopter can with the spray boom technique.

There are therefore very considerable advantages in fixed wing aircraft for this particular purpose, and in our present locust strategy it does not seem that helicopters can compete with fixed wing aircraft, even leaving out all questions of price. We are keeping in very close touch with the developments, especially the experiments of the Ministry of Supply, to see if the helicopter will fit in, not in the place of the fixed wing aircraft, but perhaps somewhere else. We might be very interested in a helicopter with the following properties : an endurance of 5 hours at a cruising speed of 150 m.p.h., a load of one ton of insecticide, easy maintenance, and low insurance rates.

J. S. Shapiro (*Founder Member*), Cierva Autogiro Co. Ltd.

I have very little experience of pest control, apart from having been an interested onlooker at the past trials of spraying from a helicopter in this country. I think the background of these trials could be profitably reviewed to remove some confusions which seems to exist when commercial spraying is discussed.

The idea of spraying by helicopters arose mainly out of the belief that the helicopter is a form of spray-gun which produces more effective spraying due to the existence of a slipstream which improves the distributions and throwing power of spray-particles and agitates the foliage of the crop simultaneously so as to improve coverage, particularly underneath.

I do not know whether this belief in the improved quality of spraying by helicopter has been vindicated as it appeared to have been during those first trails but most contributors this afternoon seem to take it for granted that spraying by helicopter is merely equivalent to pushing down a given weight of spraying material over a given area. The helicopter then becomes not a spray-gun as originally conceived but substantially a load carrying vehicle.

Now, I do not wish to quarrel with such a conception ; though it is difficult to believe that it is the only valid criterion. I expect to see the ultimate value of the helicopter is spraying precisely in the fact that it can *combine* the function of carrying and shooting.

When we come to evaluate the helicopter as a load carrier we must immediately recognise that we are not in a position yet to judge the *ultimate* economics of pest control by helicopter until a new generation of machines become available of which *perhaps* there are some forerunners already in existence.

Whilst admitting the present weakness of helicopter economics it would be a complete fallacy to conclude that the helicopter is inherently inefficient as compared with fixed wing aircraft. This is not so from a purely aerodynamic point of view. If a numerical criterion, such as ton-miles per h.p.hr., is applied, rotating and fixed wings are of the same order of efficiency at speeds of around 100 m.p.h. The fact that fixed wings are better at much higher speeds is irrelevant here because all spraying takes place below that speed. Perhaps a still better criterion is ton hours per h.p.hr. where the helicopter scores over the fixed wing taking each at its optimum speed.

The reasons for high costs of helicopter operations in this application are the high first cost of helicopter, low pay load, high cost of maintenance, high insurance rates and high cost of crew per unit of pay load.

It is part of our faith in the future of helicopters that continuous improvements are taking place in all these factors and will continue to take place. The pest control operator can however only partially contribute to this development and then only when he is prepared to carry some of the development costs, or order helicopters in substantial quantities.

But there is another avenue for improvement wherein the operator has a major part to play. This is bound up with the conception of co-ordination of organisation technique, and design which, as every operator knows, are powerful means of economic improvement.

To achieve co-ordination a great deal of experience is necessary and present-day helicopters give ample scope to gain that experience.

The helicopter designer is particularly interested in a number of problems which, I fear, have not received much attention this afternoon. First there is the problem of spraying versus dusting both of which seem to have their adherents. Second the optimum position of the discharging device in the slipstream. Third the effect of speed of spraying, less fuel is consumed to sustain a given load at 50 m.p.h. than at 10 m.p.h. and payload can be improved. Fourth the effect of weight spraying; can the ground cushion be utilized under certain circumstances? Fifth take off and landing standards; can a running or "hovering" take off be accepted as a rule to allow overloads? Sixth, weather limitations; is it practical to prohibit spraying under exceptionally turbulent condition so as to reduce flight load function to increase overloads? Seventh, optimum width of swath; could not payload be gained by reducing the weight of supporting structure and flying faster. The helicopter designer is also interested in the broad outline of spraying or dusting equipment, provision of auxiliary power and other details.

Apart from these there are many purely practical aspects of technique and organisation which require study by the operator. I have no doubt that with present day machines method and experience will render two or three times better cost than those prevailing at present. The promise of the next generation of helicopters goes much further than that. Systematic operational experimentation is essential to make these promises come true.

Group Captain G. V. Howard (*Companion Member*).

In view of the discouraging things which have been said this afternoon concerning the helicopter as a spray vehicle, I am grateful to MR. BRISTOW for telling us of the useful purpose to which it is being put in N. Africa.

We have heard the view expressed that the helicopter is uneconomic for this type of work, but surely this is a question of organisation? The great advantage of this type of aircraft is the accuracy with which it can spray or dust combined with its speed of delivery. The Americans claimed originally that they could spray at the rate of 192 acres an hour and I believe that the experiments carried out in this country last year indicated that 80 to 100 acres per hour could be covered provided that the ground staff is adequate to maintain the supply of chemicals and have them available at the points selected for refilling the hoppers. Ground organisation must therefore be the determining factor.

As regards the usefulness of the helicopter as a spray vehicle; in the early days of aviation, it was considered fortunate if you could achieve a bombing accuracy with aircraft of .5% hits and as a result the Pongos of those days despised aircraft as a military weapon. Had we accepted that view we should not have reached the degree of bombing accuracy achieved. Many people may think that this would have been a good thing, having regard to the ghastly effect of bombing to both sides in the late war, but the same reasoning cannot apply to spraying or dusting—after all our insect enemies have not devised a means of hitting back with poison gas!

If we are to develop the helicopter as a spray vehicle, we must be more indulgent concerning the allegedly high costs, although I do not believe that these costs are as high as they are represented to be. I understand that the farmer was paying as much as £5 per acre for certain types of spray by ground rig. I went into the costings fairly thoroughly two years ago and as a result of my investigations, I am quite certain

that spray by helicopter does not cost anything like as much as this. In addition, it gives you the advantage of not treading the soil to be sprayed and above all, speed.

One speaker this afternoon referred to the high cost of flying the helicopter to and from the areas to be sprayed. But the helicopter, in this case should not be regarded as a means of transport. It should be used purely as a spray gun and conveyed to and from the areas of operation on suitable transport in a way similar to the transportation of A.A. Artillery.

COLONEL HOLMAN expressed the view that difficulties might be experienced in maintaining helicopters operating over jungle and forest areas and that the virtue of their ability to land in confined spaces might add to these difficulties, were ground transport unable to reach them. If one can land, however, so can another and the obvious remedy is to have repair unit helicopters.

I do ask everyone to view the development of the helicopter for this type of work more indulgently. I feel so certain that the helicopter will be used as the spray vehicle of the future—maybe only after the expenditure of a great deal of energy and money. It is a fact, I believe, that our own troops, the Americans and the Japanese, suffered more casualties in deaths alone, in addition to the enervating effect on those who recovered from malaria, than to each other's bullets. Consequently, we might have saved a large number of lives had we had an efficient means of fighting the mosquito. Having regard to these factors and the menace also of the tsetse fly and locust, surely such efforts are justified.

Mr. O. L. L. Fitzwilliams, B.A. (Eng.) (*Founder Member*),
Westland Aircraft Ltd.

I would feel rather depressed if this were a formal meeting at which future policy were to be decided, but as it is only a discussion I am glad that the various criticisms have been brought into the open. I am aware that the helicopter is not impressive economically in its present state but, in common with others on the design side, I have paid careful attention to criticisms raised at this and previous meetings concerning the high purchase and operating costs of the helicopter.

I do not agree that we have entered a vicious spiral which would result in the end of either helicopter development or of the use of helicopters for crop spraying. I think present criticisms reflected merely certain difficulties associated with the early development of the helicopter and of the technique of using it. On the one hand the development of the helicopter was progressing rapidly and I have been much relieved to be able to see some light on the problem of meeting operator's criticisms regarding costs. On the other hand it is clear to me that effectiveness in the killing of bugs was not the direct concern of the helicopter manufacturer but of people who have a detailed knowledge of bugs. I am much impressed by the extensive knowledge possessed by such people but they have not yet been able to tell the helicopter manufacturer exactly what it is that they want the spraying gear to do. When this is correctly specified I do not think that properly qualified engineers would have any great difficulty in supplying suitable gear with the helicopter.

I think the present difficult position was the result of considerable ignorance on both sides but that adequate solutions would be forthcoming in the quite near future, after which we could expect a very large expansion of this particular side of the industry.

Dr. A. P. Thurston (*Member*).

With regard to the pressure at which spraying should be undertaken, it may be of interest to note that I spray at 500 lbs. pressure. The one point that we ought to concentrate on is how to get the poison and the blow in at the right time.

THE CHAIRMAN, summing up, said: 'a lot of questions still remain to be answered but I consider it has been worth while holding this discussion, which has revealed a widespread interest in the agricultural applications of rotary wing aircraft. It is particularly pleasing to have had so many guests here to-day and I hope we have made some converts. I wish to thank all those who have participated in the discussion, especially those who have prepared statements at such short notice.'