good result. All I can suggest is that the copper is capable of being leached out by water and small quantities which we may not be able to detect are redeposited over the leaf. Indeed, that copper may be leached out with water can be shown by the fact that dilute hydrochloric acid will remove all the copper from the deposit.

Dr. Hartley added:

It is possible that the low volume spray protected from evaporation may convey more very small (satellite) drops to the leaf, which drops would be lost from a normal spray.

SESSION X

TRANSLATION OF RESEARCH INTO PRACTICE - THE INTRODUCTION OF INSECTICIDES AND FUNGICIDES INTO AGRICULTURAL PRACTICE AT HOME AND OVERSEAS

Chairman: E. E. Cheeseman
Agricultural Research Council

THE TRANSLATION OF RESEARCH INTO PRACTICE - AT HOME

by M. Cohen
National Agricultural Advisory Service

The foregoing Proceedings have ranged over a wide field of activities covering both research and practice in the fields of development and usage of insecticides and fungicides.

The present paper is an attempt to look at the process of translation of research into practice and narrowly at that, since the terms of reference of the writer were defined in that the area to be covered was to be restricted to the U. K. Even so the covering of the subject in an area where science and practice have worked together, more or less for a long time, is made no less difficult by this very fact. Generally speaking the speed and thoroughness of the adoption of new ideas and advances is very dependent on the enthusiasm of those who make the advances and the receptiveness of those who are supposed to benefit by them. Those who make the advances may be divided very broadly into two groups. First there are those whose sole interest is in the solution of a problem so as to enable the user of the information to obtain better results in terms of quantity and/or quality of yield at an economic cost. The other group has the same object in view but additionally there is the added aspect of financial gain through the sale of products developed to bring about these results.

So far as those who are to benefit are concerned the speed of adoption of the results of research is dependent on a number of factors of which a few will be briefly considered. Thus the size and effectiveness of advisory services, whether they be independent or ancillary to the commercial interests involved, must be of great importance. Again the level of education of the users must influence the rate of acceptance and the thoroughness of practice of new ideas and developments. The agricultural and horticultural communities cover a very wide spectrum of levels of education. They are no different from those engaged in industry in this respect and it is not suggested that they are in any way exceptional. This factor of variability in ability to receive and absorb new ideas is inherent in mankind and in the less well developed countries of the world the task of the adviser is made more difficult by the need to pitch the advice at a level suitable perhaps to peasant agriculture and horticulture where both the development of husbandry practices and education are at a relatively early stage.

The practicability of integrating the results of research into commercial agriculture and horticulture, the activity of governments and agricultural organisations in supporting the adoption of new developments in the interests of nations and individuals, the economic climate of the industry are other factors influencing the process of translating research into practice that will not be considered further in the present context although they are clearly of varying degrees of importance.

Having considered some of the generalities affecting the topic it is necessary to examine it in more detail in respect of insecticides and fungicides. One way of attempting this would be to recount the progress of development of new materials. Briefly the story would proceed as follows. Sometimes a compound of promise is found by accident or is revealed as a result of screening tests in the laboratory. Following on laboratory trials, toxicological work, small plot work and more or less widely distributed field trials together with notification of intention to introduce and possibly approval, it is launched on to the market, sometimes at very great cost and often with considerable effort to impress potential users and advisers with its superior attributes. Consideration could then be given to a number of compounds to illustrate this process which would cover the topic so far as research by commerce is concerned. Reference could be made to examples of developments arising from research in institutes, universities and by independent advisory services and this would cover the remit to deal with the translation of research into practice.

Alternatively the work of the official advisory service - the National Agricultural Advisory Service, the Experimental Farms and Horticultural Stations in taking the results of research to the agricultural and horticultural communities could be described and this too would satisfy the terms of reference of the writer. But both these approaches are well known at least in outline to those who work in commerce, in institutes and in advisory services and there would be little advantage in enlarging on them. It is therefore considered that there is greater merit in examining some of the problems involved in the daily work of those who advise. A further limitation is proposed, namely that the examination be restricted to some of the problems of those whose sole purpose is to advise to the best possible advantage of the user of the advice without any other factors influencing the decisions that are made. In short the remarks that follow are based on some of the experiences of the National Agricultural Advisory Service.

Problems arising from the giving of advice affect both the adviser and the grower who puts the advice into practice. The latter will tend to recognise the extremes of the effectiveness of the advice namely either that it has done all that was claimed for it or it has failed completely to effect the desired results. In general he will tend to be less certain in his opinion about intermediate degrees of success. Therefore to make the discussion of problems cover more than the extremes of performance of materials the following assumptions are proposed. If an adviser recommends a treatment and the grower carries out the treatment adhering as closely as possible to the details of usage, (this is one of the assumptions that the introducer of the material generally has to accept) and if the ad-

viser follows up the effect of his advice, as he often does, then the adviser is in a sense the user of the material involved in the treatment. There are limitations to this thesis but irrespective of these it affords a convenient method of presenting the 'practice' side of this account.

Consider first of all what is available to the adviser as the result of research in commerce and institutes. Martin (1961) in his compilation of the chemicals used in crop protection, lists over one hundred active principles in the field of insecticides and fungicides, principles whose names are more or less well known to those working in these fields. Of these compounds many have been introduced on an experimental or commercial basis since 1941 and some 61 within the past 15 years. This reflects the pace at which research has been prosecuted and the hectic rate at which new compounds have been introduced in the post-war period. Not all of these compounds have come into common use in the U.K. but taking the Approval Scheme list (M.A.F.F., 1961a) as a minimal guide there were available up to April 1961, insecticides based on 28 different active principles, fungicides based on 14 active principles and one nematicide.

Some 19 of the insecticidal principles contained in the list (to the date mentioned) have made their appearance within the past fifteen years and only about 6 of the fungicides were developed in the same period indicating the less successful search for fungicides. The story must be carried a stage further. When the number of active principles is multiplied by individual manufacturers' variations on the theme, the number of proprietary materials available is very large. Using the Approval Scheme list as a minimal measure of what is available, in April 1961 the adviser was faced with some 170 insecticides and over 100 fungicides covering sprays, dusts, smokes and seed dressings. On the basis of averages there were about 6 proprietary makes per insecticidal principle and 7 per fungicidal material and to give examples of the range it extended from one demeton-methyl spray to no less than 17 DDT sprays.

Of course the multiplicity of materials is not restricted to insecticides and fungicides. Since the new Approval List was issued there have been nine supplements and there are now 74 active principles involved in some 500 approved proprietary forms (including the herbicides and rodenticides). This is a minimal measure of what is available. The Report of the Research Study Group on Toxic Chemicals in Agriculture and Food Storage (Appendix B) (M.A.F.F., 1961b) lists 153 pesticides currently commercially available in this country and of these 74 have been approved. Analysis of the figures shows that insecticides and fungicides make up 102 of the total and of these 56 have been approved, so that two thirds of the pesticides available in the country are topical to this discussion and only about half of them have so far been approved.

Undoubtedly the adviser is faced with a plethora of materials and the most he may know about the details of formulation is the content of the active material and the fact that it is for example in miscible or emulsion form. It is considered that knowledge of all the components of a product can be of value to advisers in helping in the quicker elucidation of abnormal performance or explaining varietal susceptibility. A topical ex-

ample of the effect for example of a solvent is that mentioned by Womack (1962) in the field of liquid insecticidal seed dressings. Additionally, complete information on formulation might help to speed up improvements in efficiency leading perhaps to lower concentrations and fewer applications. This is the sort of work being tackled by the Research Stations at Long Ashton and East Malling and by commerce, but over and above this the field experience of advisers could surely help work along. In all this it is not suggested that complete information be available automatically for the farmer and horticulturalist. In the main they are probably not interested and in any case manufacturers would not wish to make complete details available to all and sundry.

Another aspect of the introduction of new materials is the variation in outlook between commerce and advisers during the development stages of new compounds. These differences need not be constant on one side or the other. Commerce may be concerned to find as many possible uses for a compound in one case, and in another effort may be concentrated on its use for the solution of a single major problem. By way of illustration, a multi-purpose insecticide that shows promise will be tried by the adviser to see if it will give better control of one or two pests that are prevalent in his Region e.g. Wheat bulb fly, spider mites, aphids, eelworms. He will perhaps do more work on the compound in the narrower field and over a longer period that those who introduced it. Apart from filling out the details of performance of the compound he may uncover undesirable side effects not shown up in the development work and in this way help manufacturers to amend their views and their labels.

On the other hand compounds may be developed for almost specific use e.g. the control of Apple Scab and Mildew, Potato Blight, Tomato Leaf Mould, the treatment of glasshouse soils for the control of soil fungi and eelworms. Such lines of development may be more frequent where high value crops are involved and often in the case of fungicides. The possibility of control of minor diseases may be less important to the manufacturer and he may not put much effort into research on these aspects. The adviser however is certainly concerned with all diseases that may be affecting the fortunes of his client whether they be widespread or not. He is therefore anxious to examine the performance of purpose-developed materials against a range of diseases on a variety of crops. He is likely to discover new uses for compounds and also uncover undesirable side effects. Examples illustrating contributions made as a result of advisory work are the use of fenson on apples, dinocap on ornamentals and even the long established DDT on Kalanchoe.

At the present time the emphasis on risks, is on safe use as applied to the user and the consumer. Many advisers would also wish that more was known of the performance of materials prior to or at the point of marketing. Clearly if all risks and side effects were to be cleared up before marketing, progress would be a good deal slower than it has been and the costs of introduction would be greater. Perhaps there is no better solution to this problem than to allow practice to fill in the gaps in research at not too great a cost to the user and the seller.

So far the discussion has been limited to what may be termed the ad hoc effects of incomplete knowledge of the performance of materials either as active compounds or in formulation. There is another important effect of the flooding of materials into practice namely that neither producer, adviser or user can keep pace with the output when possible long-term effects are considered. Examples of what is involved here are the problem of resistant races of organisms, the persistence of materials in soils, the effect of residues on beneficial organisms and the effect of materials on wild life. Potter (1961) in his review of the chemical control of insects has covered these points in detail. Jones (1962) has referred to the need to capitalise our knowledge of host/parasite relationships and the writer would extend this to include also the crop protectant. The effects of insecticides and fungicides on ecological complexes is of profound importance and Martin (1962) has reviewed important aspects of the problem with reference to the soil.

Indiscriminate use as a form of insurance against crop loss has recently been much in the public eye and advisers and manufacturers deplore such use. Undoubtedly there is need for more education of those who distribute and those who use crop protectants and above all much more information is required in the field of pest and disease assessment.

What are the real losses caused by pests and diseases and at level of infestation or infection is treatment likely to result in an economic return? For some organisms the risk of crop loss (almost the certainty) and the relative cheapness of avoiding loss coupled with the absence of undesirable side effects made apparent through long usage, are such as to make treatment routine. The organo-mercurial seed dressings on cereals are an outstanding example. But for many pests and diseases this information is not available.

It is not enough to diagnose a condition and advise a programme. What is required is to be able to say in the light of a full knowledge of the biology of the organism and its behaviour under a range of climatic conditions (a) that the level of attack is such as or is likely to develop to such a degree that control measures are necessary to secure an economic return from the crop or (b) conversely to be able to say that control measures are not required. Concisely put this is the acquiring of the ability to relate pest and disease abundance to crop yields.

Is this an idealistic approach? Clearly it could influence the sales and usage of materials if much progress were made. It could contribute much to the expanding fields of farm and horticultural business advice now assuming much greater importance in the present economic climate and likely to be even more important in the light of negotiations to enter the Common Market.

As in many other fields of investigation, reliable information is only obtained at the expense of much time and effort and progress is slow. It involves 'extensive' work (surveys) followed by 'intensive' experimentation under a wide range of conditions. Only a few problems can be investigated at any one time. The advisers in the N.A.A.S. have already made

some useful contributions with the help of their colleagues in Research Institutes and the Plant Pathology Laboratory and Strickland (1957, 1958) has given accounts of some of this work. To show the importance of this line of approach, consider some of the estimates made by Ordish (1952) on information available up to 1947. Thus for all cereal crops grown in the U.K. his figure for the annual loss due to common pests and diseases was something under £8 million. Pest assessment work between 1952 and 1956 has shown that in the oat crop alone the annual loss due to Frit Fly alone amounted to about 250,000 acre - equivalents per year. The immense difference between the two figures is enhanced when it is realised that the U.K. acreage of oats has decreased greatly since 1947. Again Ordish quotes a figures of just over £2 million per annum for losses in the Brussels Sprout crop due to all the major pests and diseases. Pest assessment work between 1946 and 1955 puts the range of annual loss due to Cabbage Aphis alone from £0.5 million to £1.25 million with an average of £870,000. Amongst the diseases the incidence and progress of Potato Blight has been examined by N.A.A.S. field surveys and an analysis has been made of the crop losses incurred. These have been reported by Large (1956, 1958) who showed that in 'Blight' years during the period 1947/56, the potential average yield of 9.6 tons per acre was reduced by the disease to about 8.0 tons per acre.

These examples of real losses due to two common pests and one disease illustrate the importance of this type of work. Obviously there is little economic value in collecting information about pest and disease abundance unless it is related to crop yields and clearly the use of crop protectants ties in closely with these.

One very desirable advance would be the practical development of forecasting. This is available now with some degree of accuracy but only on an area or regional basis for Potato Blight, Apple Scab, Wheat Bulb Fly, Sugar Beet Aphids in relation to Virus Yellows, and possibly Leatherjackets. Even so, general warnings ought not to be interpreted as a signal to commence wholesale control operations since incidence will be influenced by the type and variety of crop grown and local environment and the need for treatment will be determined by experience and local knowledge. An excellent example of the combination of forecasting, timing and the economics of control is that given by Gould and Legowski (1962) for Pea Moth control and it illustrates the approach to the use of crop protectants via pest assessment work. For problems like this and especially for those of wider national importance the adviser is in the best position to make the advances required.

Sufficient has been said to illustrate the problems facing the adviser but there are many others such as the effects of sub-clinical infestation on crop yield, timing and rates of applications, efficiency of cover and of the machines used. The economics of usage are most important because so much of the information available relates to older materials and methods and against a different economic background. The safe use of pesticides containing toxic chemicals is of prime importance and is catered for through the Notification section of the voluntary Agricultural Chemicals Approval Scheme which must be given time to mature before assessing its

success.

The researcher be he in commerce or the Research Institute has contributed and is contributing much to the solution of the problems discussed. Much valuable information is also being accumulated by advisers as a result of the practical use of crop protectants on commercial holdings and over a much wider range of conditions than is generally available to the researcher. Having earlier identified the adviser with the user it is abundantly clear that if progress is to be authentic and speeded up, the traffic in information must be a re-cycling process - from Research to Practice and back again.

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Now for my second point. Translating research into practice, particularly abroad, is really reconciling theory and practice and if we are to make theory and practice the same thing then the theory must be as full and complete as possible, and it is when we come to move our home theory overseas that we must look out for and overcome the bigger discrepancies.

We can only peer into the future by our knowledge and analysis of what has happened in the past. Experience has shown me that if I press that button on the wall the light comes on. If I turn the tap marked "C" cold water comes out, theory and practice coinciding. But this does not always happen. If I've not paid the bills it won't happen. Particularly abroad, for in large parts of the world, owing to the strange predeliction the inhabitants have for their own languages, if I turn the tap marked "C" hot water will come out. I have to modify my theory obtained from observation of the facts. This is universal law. This is research. Abroad your home experiences may be reversed.

Now before you translate research to practice you must have some research to start from. Before you expose foreigners to its benefits you must have some idea of whether it is going to be of any use to them or whether they do not know it already. The agricultures you meet overseas vary enormously. In crops, of course, but also in development: they may be very primitive or very advanced.

Research really springs from Baconionism: to quote Sir Francis it is "the uncovering of the secrets of nature".

In translating research to practice we must first of all keep the ends firmly in view. It is very easy not to see the wood on account of the trees. Let us look at these ends, quite frankly; they are:- (1) To reduce losses from pests and diseases, and make agriculture more productive; (2) To increase or maintain the business of the manufacturers of Agricultural chemicals.

These two ends are not always compatible, though they are not necessarily antagonistic: it is, after all, "enlightened self-interest" that has made us what we are today, a densely populated island with a high standard of living compared with most of the rest of the world. This is because we have been able to translate the results of research into practice. The results obtained frequently turned out to be very different from what the discoverer intended, but research has payed dividends.

Let us look at the chain of events leading from two such discoveries. I am taking a very early overseas discovery, and a comparatively recent one. The first one is stepping outside the frame: it is due to Dr. Cohen's referring to me as Atlas. I want to refer to his brother, Prometheus, the inventor of fire. First the legend of fire. Prometheus, wanting to breathe life into man, brought down fire from the mountains. Of course it was most useful, but people were not grateful. The usual inventor's fate befell him, he incurred the anger of the vested interests, and Jupiter had him chained to Mount Caucusus, where a vulture was continuously eating his liver. However in practice this piece of research more than fulfilled

its promise so far, though megaton fire bombs may yet destroy all life.

If Prometheus was disappointed with his results so probably, in the long run, were the French and English discoverers of BHC in the high hopes of their's: it was not the universal insecticide it appeared to be, it smelt, the insects fought back in that wicked way animals have. ("Cet animal est très méchant, quand on l'attaque il se defend"). I have tried to ascertain the fate of the French and English inventors of BHC; they have not been chained to a mountain and I am glad to say they are both reasonably prosperous. As to their health, I believe they tend to suffer from that nervous tension associated with business cares in the chemical industry, with ulcers eating the stomach rather than vultures the liver.

That old cynic, Humboldt remarked that there are three stages in any great discovery, firstly to deny its existence, then to say it was not important, finally to attribute it to somebody else. However apart from this what usually happens today? Some new pesticide is discovered, either through years of patient fundamental research, screening thousands of compounds or because someone has picked up the wrong bottle or used a Fahrenheit thermometer instead of a Centigrade one and done it by this or a similar accident. The Research Department does this. They are supposed to be long-haired boys in back rooms; though they are directed by egg-heads. Why only these two hirsute extremes should concern themselves with research I don't know. I talk now about different departments. The work may really not be as formalised as this and all done on the back of an envelope, but it is done this way even so. The product is then passed to the Development Department, who patent it if possible and look for home and overseas markets. They must find out if it is safe to user and consumer of the produce sprayed. Then the commercial Department must get to work. Not much is heard of this, but it is really the most important of the lot. They shade into the Development Department of course - they must study the product's economics. How much can they get for it? How far can it be tied up in patents, and in how many countries? How profitable will it be? What is it going to be called? Publicity department are also important: they must name the product. One can make big mistakes in naming products for foreign markets; I have known cases where at the best the trade names were unpronounceable in the foreign language and at the worst were downright indecent.

At some point in this chain will be a tiresome and interfering body charged with setting some sort of official approval on the product. It exists to check up on the claims of the manufacturers and it may frequently appear to you to be very irksome as in most cases it is compulsory. In Britain we tend to do without it as a system of voluntary control works very well. You Chairman and Dr. Cohen has spoken of this, though doubts are arising as to whether the position with regard to pesticide residue in food is adequately controlled and some further interference may be needed.

Abroad not the same reliance is placed on the voluntary principle. There is usually either no registration scheme at all, or one in which official approval must be obtained before sales of a new pesticide can be

THE TRANSLATION OF RESEARCH TO PRACTICE - OVERSEAS

by George Ordish
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You have been exposed for the best part of a week to addresses of a highly specialised nature from this platform and it falls on me to give a much more general paper, on a subject it is difficult to talk on. Much of what I say is self evident, and to many is your daily pre-occupation.

In "translating research to practice abroad" there are four main points I want to make:- 1. The principles are the same whether at home or abroad; 2. Theory and practice should be the same thing; 3. The economics of the subject must be studied and 4. Are we being too complacent? What are we missing?

Taking the first, my colleague Dr. Cohen dealt ably with these principles and mentioned in particular the two-way traffic in ideas, which is particularly applicable to my theme, for as research can learn from practice so can home learn from abroad. We have many distinguished foreign visitors with us who have contributed much to this conference. What is home to us is abroad to them and so I can take the world as my theme. Today we must be internationalists, but agricultural science always has been that; Jethro's Tull's, "Horse hoeing Husbandry" was translated three times into French and pesticide discoveries frequently came into England from abroad. To mention a few:- Tillet's seed dressing, de Bary's work on potato blight, Grison's lime sulphur, Bordeaux mixture, DDT, parathion and so on to the latest compounds mentioned today, to quote but a few.

First of all I want to speculate on the nature of research and I have started by looking up the word in Dr. Johnson's dictionary and find two relevant quotations:- "It is not easy to research with due distinction ..." (Wotton), a remark with which I am sure you will agree and from Glanville "By a skilful application of those notices, may be gained in such researches the accelerating and bettering of fruits, emptying mines and draining fens." All these are sentiments we have much in mind to this day.

When one thought one knew almost everything one also thought it was much easier to translate research into practice, though in reality it was not, and people were surprised when this or that carefully worked out system absolutely cast-iron in the knowledge of the day, did not work.

For instance Tillet in his famous experiment at Troyes in 1750 discovered the cause and cure for bunt in wheat; nitre, salt and lime seed-dressings; but this weak fungicide soon bred out a resistant race of the disease and the attack became bad again. This sort of thing leads to our saying that theory and practice are different things. I do not subscribe to this statement. It's too facile and woolly a remark. If theory and practice do not agree it's because the theory has not been worked out well enough, or in sufficient detail.

made. The first situation puts a great responsibility on the manufacturer, if he is a responsible one, as ethically he should see that his product is safe to use under a large number of varying conditions in possibly a distant country. This is expensive work and he must decide whether to take a risk on some new product or indulge in the expensive work of testing.

Consequently the alternative system, that of obtaining official approval of a product may not appear so irksome when the above mentioned alternative is considered: it does take the responsibility away from the manufacturer, though this registration will increase the work he has to do and thus reduce his profits.

Obviously close co-operation between manufacturer and respective government testing station will expedite the work. The larger countries are concerned to know if the material is safe and effective: the smaller also but they usually lack facilities for testing. They will also tend to consider the foreign would-be importer as large and wealthy and may give the impression that all they want is a substantial registration fee. I think this fee is justified even if they do but little testing. Such a country may be comparatively poor and this fee is at least an earnest that the importer has some faith in his product, that he considers it will be of some use and seriously intends to develop it.

Translating research into practice is in effect sharing the benefits of new knowledge. It is an economic activity and this is my third point. It means you must consider it in economic terms and should study your potential market in these terms. Your product will rise or fall, by the economics of use. We in the British Government's new Department of Technical Co-operation are making surveys of this nature; we have recently published one on central Africa and have others in hand. We try and find out the present, potential and future usage of pesticides, the damage pests do and the benefits pesticides, or other methods of control, can give. If surveys of this nature are not made, either by governments or industry, a great deal of time and effort may be wasted. There is a great deal of interest in such methods of approaching pest problems abroad and I urge this method for your consideration.

A problem which is going to face a manufacturer selling abroad sooner or later is that of the market where the farmers could use a pesticide with benefit to themselves but the business would give no, or very little profit to the manufacturer. For instance sorghum seed dressing in a remote area. This might vastly improve a crop, raise productivity in an area, change the social pattern, but not be worth the manufacturer's while for the small turnover involved and the great distribution difficulties they would experience. What is to be done? There are many instances of this sort of thing. It seems unfortunate if a primitive community cannot benefit because the business of supplying them is not profitable. I suggest that the manufacturer who finds such an instance in his surveys should draw the attention of governments and international bodies, such as F.A.O. and United Nations, to the possibilities. This is in essence the problem of all primitive communities, how can they be helped to help themselves?

There is a great need to do this in many overseas communities where the battle against hunger is by no means won and where the pesticide expert can be of great help.

Now I come to my final point. Let us avoid complacency: what are we missing? Let me give an example. I mentioned the discovery of the insecticidal properties of BHC, a great discovery it was. It was made in 1943 in France and England. But Faraday had actually made the product in 1825. What a long time it took us, 118 years for practice to catch up with research. Moreover the French had used the material in the 1914-18 war, burning it to form smoke clouds, and did not find out any insecticidal properties in it. Surely, as it killed lice, that curse of the trenches, the operators and the smoked, must have benefited greatly from it? Somehow the vital observation was missed. Moreover we knew and had used ortho and paradichlor-benzene as insecticides for years and years: why had not someone tried tacking on a few more chlorine atoms to the benzene ring much earlier than they did? Possibly because the research and development workers were too far apart, as were also the different disciplines: chemists and entomologists did not mix. This idea that research and practice were different things prevailed.

With the examples of Prometheus and BHC before us I put to you that there may well be many discoveries in the notes, laboratories and minds of the research workers available at the present moment which we are not using, and we do not want to wait 118 years to see them developed. I do not think our ancestors were less intelligent than we are. Certain things right under their noses they did not see - what can't we see?

Let me give an example of what I mean, Tillets' remarkable experiment on the cause and cure of bunt in wheat was made in the mid 18th century and the results published in 1751. Some elaborate small plot experiments, repeated for two years, showed the cause to be the bunt dust and the cure, seed-dressing: I now show you some slides.

Tillet proved himself on being a practical man, he would not indulge in "philosophical speculations" as to the cause of the disease, although he noted that the causal dust resembled the dust (spores) in an old puffball. Had he done so he might have advanced crop protection by a hundred years. Is there any "philosophical speculation" we are not indulging in that we should be? There is of course a two way traffic in ideas and we could do well to accept them from abroad as well as export them, as Dr. Cohen has pointed out. There is the concept of "diagonal sciences" of Roger Caillois, where phenomena in one discipline can be explained by observations in another and de Chardin's plea that our ideal should be for not only the research worker, but also the man in the street, everyday to wrest a secret from nature. This after all was Francis Bacon's ideal and it still holds good.

Discussion

Q. Dr. P. Becker

Dr. Cohen has spoken of the importance of the adviser as a liaison between research and practice. This task is being made more and more difficult by the type of common names which are now being coined for the newer chemicals. This started with demeton methyl and dimethoate which, compared with names such as aldrin, malathion, phenkapton etc., are much less easily remembered by the adviser and grower who have a very limited knowledge of chemistry. At this Conference we have heard of azinphos-methyl, thioquinox, metham-sodium, phosphamidon and similar unwieldy names. Surely it is possible to devise simpler ones. I should like to take this opportunity to beg those concerned with manufacturing new common names to pay more attention to the interests of the adviser and user and to produce names which are easier to use and remember.

A. Dr. M. Cohen

I am not really able to satisfy the plea made by Dr. Becker. Advisers are not responsible for inventing common names and many would agree that the list of names grows longer and more confusing. On the other hand, when proprietary names become well known long in advance of the general acceptance of a common name, advisers are put in an awkward position. This happened in the case of demeton-methyl mentioned by Dr. Becker.

There is every advantage in settling accepted common names as early as possible in the history of chemicals. As to who should invent such names, it is doubtful whether advisers would be any better at this than the chemists. Dr. Miller may be able to comment further.

Dr. Miller then stated:

The activities of the British Standards committee responsible for common pesticide names has a continuous impact on my work so far as the Notification Scheme is concerned. I agree with Dr. Becker that some of the more recent names are difficult to pronounce but I do not agree that nowadays new names are not coming forward soon enough.

It seems to me that the B.S.I. committee is finding its principle, that whenever possible a common name should reflect the chemical name of the pesticide and that related chemicals should have related common names, is proving more and more an embarrassment to it. It is a pity more consideration has not been given to the "donamen system" whereby names consist of seven letters, alternating four consonants and three vowels. This system, after allowing for words which are unpronounceable or unacceptable for various reasons in the major languages, gives a potential of seven million names and surely, of these, several thousand names with a chemical flavour could be selected and reserved for pesticides. Wittingly or otherwise, the committee has established several donamen names and, so far as I could see, no one had difficulty with one used quite a lot at today's sessions. I refer to menazon.

The difficulties that have to be overcome before a common name can be finally established are truly immense and it would take quite a time to describe them. One of the major problems is to clear a potential name from conflict with registered names in the major countries. The number of proprietary names already registered, and not always used, particularly for pharmaceuticals, is prodigious.

But the B.S.I. committee is overcoming these difficulties and is well in sight of its goal - to establish a common name for a pesticide before it is marketed. With this happy state, one would not have to spend two or three years using a proprietary name only to have to spend the next two years unlearning the name because, belately, a common name has been established. As I have said, the committee is achieving its aim and I can think of several chemicals which have common names and which are not yet commercially available in this country. Menazon, thioquinox and thiodemeton, discussed at this Conference, are examples.

I am a chemist but I confess I do not attempt to remember the chemical names of pesticides. I try to remember the common names and I always have handy my "Grey Reference Book" should I want to look up the chemical name. This reference book is, of course, the recently published British Standard 1831:1961 on Recommended Common Names for Pesticides.

Q. Dr. William Davies

(1) The number of 'trade names' for chemicals should be reduced and kept at a minimum, e.g. 2,4-D has numerous trade names which seems to me unnecessary.

(2) Research and Practice - Research of necessity involves analysis and fragmentation of a problem or problems. It seems to be no one's business to synthesise new information based on research into practical systems of husbandry. The farmer who makes use of "fragmented" results of research has ultimately to synthesise these into his farming techniques. Research workers and farm advisers must help and should conduct experiments whose set purpose and design is to aggregate and synthesise new knowledge into modified farming systems.

A. Dr. M. Cohen

Dr. Davies has raised a different point from that mentioned by Dr. Becker who was concerned about common names rather than trade names.

I think it is important to remember that crop protection materials contain more than the active ingredient. The method formulation and the concentration are important. In the competitive world of commerce Messrs. X consider it essential clearly to distinguish their product based say on DDT from that marketed by Messrs. Y, and for this purpose trade names are inevitable. The crop protection products industry is not unique in this respect!

Q. A. N. Other

I still feel that a point could be made here. Those of us who advise on these chemicals, and those who use the chemicals, are not really interested a bit in what is contained and what is used to make up the chemicals. What we want is a simple name to remember.

A. Dr. M. Cohen

I think the best that can be done is being done. Reference has already been made to the British Standards list. I doubt very much whether the statement that advisers are not interested in the chemicals themselves is really true. It is important at least to know whether the chemical is a chlorinated hydrocarbon or an organo-phosphorus compound on the score of precautions in use.

Q. Dr. E. Holmes

There are two other aspects of Mr. Ordish's economics which are completely different; cases where even if he worked out all the sums he has talked about, the desirable spraying would not be done. One example is in Ghana. My late Company has done a tremendous amount of work on cocoa capsids in Ghana. Although the cocoa grower does not believe he can afford to use the product which is necessary for the job, spraying is very well worthwhile from the national point of view. Another case is in Uganda. The cotton grower has the money to do the job but not at the time spraying is needed. Here it is first necessary to persuade the Governments, in their own interest nationally, to subsidise or make loans. In Ghana subsidies have helped growers to spray cocoa, and, in Uganda, loans have financed cotton spraying until harvest when the grower has the money to pay - in both cases to the great benefit of the countries concerned.

A. Mr. Ordish

Dr. Holmes' remarks are an example of the complexity of the economics of the subject; in fact they are an example of the point I mentioned where local economics create a situation beyond an individual's powers to overcome; the problem then becomes a national or international one. The two cases Dr. Holmes mentions are cases which could well be followed in other parts of the world and these other cases need bringing to light.