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THE CONTRACTOR'S VIEW OF C.D.A.

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Summary The Contractor's view is of C.D.A. as a means to the safe use of very low, and ultra low volumes, and it is here that the present interest lies for him. He is less directly concerned than the farmer with the considerable savings in chemical costs, although these savings are really of major importance to everyone who eats food.

The present is full of problems for this relatively new concept, but the future presents wonderful possibilities for the specialist spraying companies, as long as they do not " miss the boat" by being over cautious.

INTRODUCTION

The contractors view of C.D.A., has been somewhat obscured by the fact that in most cases it has been closely associated with accompanying volume reductions relative to conventional spraying.

Hence, there is a tendency to confuse C.D.A., with V.L.V., and U.L.V.

That it is just as possible to have C.D.A., related to M.V. and H.V. is not very interesting these days, because the major consideration in developing C.D.A., is to reduce volumes of application without losing the benefits derived from higher volumes applied by conventional nozzles.

In fact, to a contractor, C.D.A., looks like the civilised version of V.L.V., and U.L.V., enabling these lower volumes to be applied in a more controlled and accurate manner.

REVIEW

A few years ago, the benefits of ultra low volumes were becoming interesting to users generally, as a result of the fantastic economic improvements achieved by its use in aircraft applications on some of the extensive cropping systems overseas.

At the B.C.P.C., U.L.V., Conference at Cranfield in 1974., our appetites were still further whetted, but it became increasingly obvious that U.L.V., and very low volumes were not likely to be as useful in this country, where a variation of a few feet in swathe width as the wind speed changed could cause all sorts of problems.

Edward Bals was already tackling this problem by developing the new C.D.A., system to regulate the size of drops within a narrow pre-determined band. Thus civilising the wayward offspring of drift spraying - U.L.V.

Progress has been slow, but steady, as far as the development of the machinery has gone, but progress toward the development of chemical

formulations to suit the system, has been even slower, and despite years of trials at W.R.O., there were, at 19th January 1978 only twelve formulations, all of which were herbicides, that had A.C.A.S., Approval for this method of application!

Overseas, progress with low volumes has been faster, and this is perhaps due to the fact that people who have been "glued to the wrong end of the hoe" since they were able to walk, are more tolerant of the slight inaccuracies of drift spraying methods than those of us who have to consider the neighbours, the environment, and every other possibility, before we dare move a sprayer, or think of less expensive food. The introduction of the hand held ULVA machine to the people of the developing nations must have meant a great deal more to mankind than the astronautical step onto the moon!

The exacting requirements in this country have not entirely daunted us, even though contractors' standards have to be even higher than most, if he is to be paid. Materials have to be put onto clients' crops with great accuracy of placement, quantity, and timing, to ensure the maximum possible returns for expenditure, and although many of us have used hand held, and tractor mounted U.L.V., machines, we have tended to think of the system as a little hit and miss; fit only for limited use on easy targets. Thus trials, and practical progress, by contractors have been largely limited to the less critical operations, such as the control of cereal aphids, where the target is not only well presented to the drifting spray, but is also easily killed by the pesticide.

Even then, in one or two cases there were reports of operator illness due to improper methods of use, but the overall results were encouraging, and we are all itching to get on with this sort of application in the near future, as long as we are not putting our people, other people, the crops, or the environment in danger. The introduction of C.D.A., looks like making this possible.

For an up to date view of C.D.A., development, one tends to turn to Edward Bals, who has towered above the rest of the industry in terms of foresight, knowledge, experience, and daring, to say nothing of his sheer physical presence! Mr. Bals' spinning discs seem to form the basic parts of most of the machinery used for obtaining ever increasing accuracy of placement, ever decreasing volumes of spray, and ever decreasing concentrations of active ingredient. Without Mr. Bals' progress, and the progress he has almost forced upon the rest of us, the concept of C.D.A., would, at best, be in its infancy, rather than approaching maturity. He has given us the guns with which to shoot down our enemies, and now it is up to the chemists to give us more ammunition to fire through those guns.

It is also up to us to decide how we should use the guns, because the only machine that is likely to become available immediately is the Lockinge Farms machine, which appears to depend upon drift to carry 35 micron drops from its single spraying head, which may be satisfactory for easy targets, but is limited to these. The inclination for the present is to utilise conventional booms of our existing machines, to carry the necessary heads to give a complete cover without relying on wind drift.

The introduction of purpose made machines will be a slow business unless the chemical formulations are forthcoming to make the whole exercise worthwhile.

REASONS FOR CHANGE

It seems strange that yet again, it is the farmers who are dragging the rest of the industry headlong into the use of the new system, just as they have done with the tank mixing of chemicals, but there are good reasons for this.

If a farmer uses a new machine or material and knocks out a portion of his crop, his real losses are acceptable because they are not particularly heavy as a rule, and can be considered as sacrificial to the progress toward the eventual 10 tonnes, or whatever, crop.

If a manufacturer supplies a new machine that knocks out a crop, he will certainly get back a second hand machine with no redress, he may get sued for the crop at its fullest possible price, and his reputation will be ruined in that area for ages.

A chemical manufacturer who causes such disaster will at least, have to give away a twenty five litre drum of M.C.P.A., and the contractor will have to pay at the full seed contract, bumper fifteen tonnes crop, on twice the acreage it was when he was spraying it! And what about the next year's crop? The contractor's insurers will take a very serious view, they will look very closely at the fine print on the policy, the manufacturers' leaflet, and the lack of Approval by A.C.A.S.! If they pay, the premium will rise enormously by the following year, and if they do not pay, they will increase the premium anyway, because it looks as if the contractor is taking chances.

Thus, it appears that the farmer is best placed to do the testing, because he has much more to gain and less to lose.

More seriously, much of the farmer's urgency is due to the increasing volumes of water called for by the manufacturers of some of the new materials, which have brought the chores of water carting more forcibly to the farmers' notice.

Even more seriously. Farmers are being forced by ever narrowing margins in their high input and output systems prevalent here since the forties, to look for new ways of competing with the foreign competitors whose low input systems are capable of producing surpluses for dumping on the British market.

The savings in quantity of active ingredients by C.D.A., and other lower volume techniques, can improve the economics of cereal spraying by fifty to eighty percent of the chemical costs, or so we are told, and there are all the additional advantages of speed and timeliness to increase yields.

This reduction of inputs must become increasingly important as farmers see vegetable crops, on which they have incurred all the costs, being ploughed in because distribution and marketing costs make them so expensive in the shops, that consumers cannot, or will not buy them.

REASONS FOR DELAYS IN ADOPTING THE NEW SYSTEMS

Compared with the savings on chemicals, the savings on application costs are small, but some contractors have been nervous of being made redundant by the new easy systems, so this may explain some of the delays as far as we are concerned.

We have also been frightened by the reported problems, which to us mean damage, and claims for compensation. The work carried out by W.A. Taylor and C.R. Merritt and reported in their paper to the B.C.P.C., Insecticides and Fungicides Conference of 1975 (Some Physical Aspects of the Performance of Experimental Equipment for Controlled Drop Application with Herbicides) indicates that there is a definite risk of sideways deposition in cross winds, and we fear the possibility of damage due to resulting overdose in strips.

With business increasing rapidly with conventional methods, there has been little incentive for us to take the risks of leading a revolution. We must beware of being left behind however! Especially because the new methods present us with the opportunity to go so far ahead in specialisation, that we can extend our operations enormously if we get on with it.

Although spray heads have been available for some time, there has been no purpose made spraying machine on the market to carry them, and this is one of the reasons for a slow start by farmers.

The recently held competition for home made machines, and the machine produced at Smithfield by Lockinge Farms should get things moving however so that further major progress will wait for the chemical manufacturers. That chemical manufacturers have not rushed forward is the most understandable of all the delays. They have enormous amounts of extra testing if they are to obtain Approval for their chemicals to be used in this way, and at the end of it all their markets will be reduced because of the need for less chemicals when applied in this way. Manufacturers must take little joy from reports like that in the British Farmer and Stockbreeder of 14th January this year where Mr. Haigh of Lockinge farms was quoted as saying that twenty farms in his area had used the Ulvamast machine to successfully spray 7,285 hectares with an 80% reduction in chemical dose.

If chemical manufacturers approach the new systems slowly, it may be a good thing, because it will force us all to move slowly, experimenting with the most simple chemicals, and the safer chemicals, on the simple targets, before blossoming out to use critical chemicals on vulnerable crops. This steady progress, if achieved, will be safer than the usual helter skelter into new chemical usage, or mixture usage.

W.R.O., have worked on C.D.A., applications of herbicides for several years now, and in collaboration with Horstine Farmery, they have shown that growth regulator herbicides can be applied satisfactorily as long as weather conditions are good. The requirements for reduced wind speeds however, appear to have ruled out the two part days that were suitable for conventional spraying in the spring of 1977.

In proportion with the rest of the chemical business of the U.K., we are only on the threshold, with only twelve herbicides and no fungicides or insecticides available as Approved by A.C.A.S., on 19th January 1978. That there are twelve more herbicides in the Approvals pipeline is encouraging, but there is still an enormous amount of work to be done before the rest of the manufacturers enter the race with the early starters from Shell and Union Carbide. In fact, it is the users who are leading all the way, and we must hope that the strictures shortly to be placed upon the industry by B.A.A.'s Distributors' Registration Scheme will not stifle progress even more.

What the Health and Safety at Work Executive will make of the new systems

will also be of interest, because in many cases chemicals are being used in unauthorised ways, and dangerous ways, and there is little doubt that the inspectorate is aware of this and watching carefully for signs of danger to all those concerned.

Contractors are particularly vulnerable when using new methods, and new chemicals because they spray many more acres in the course of a year than the farm tractor driver. Therefore with this move to greater concentrations the men must be even more carefully supervised. With the even faster operations the Contractor's man will probably increase his annual sprayed acreage by four or five times, so the old rules for user protection may well have to be either added to or completely replaced by requirements for this new hazard. Even hitherto unscheduled substances may well become more of a hazard causing establishment of new parts of the Agricultural Poisons Lists.

There are obviously many problems and intangible areas, such as risks of expensive damage to crops, risks of loss of public goodwill, and by no means least, risks to operators' health, so we must not be foolhardy. In view of the advantages, principally in cost saving on chemicals, and timeliness however, the difficulties would have to be monumental to prevent V/U.L.V, C.D.A., catching on, so contractors " must get in there" !

We can start gently with modifications to existing sprayers, and then take advantage of new machines, if they are better, when they come forward.

THE FUTURE

When looking into the future, one understands what Rabelais meant when he said on his death-bed, " I am going to the great perhaps! "

It has been suggested that the ease of spraying with reduced volumes will mean a reduction in contractor involvement. Well this may seem to be the case at first sight, but many of the old problems will still be there.

The development of C.D.A., appears an important stepping stone to "the great perhaps" of V.L.V., and U.L.V., applications in this country, but if we double and treble spraying speeds many of the old problems become even worse! For instance, on/off has to be instantaneous and absolutely accurate if we are to prevent the hideous bare patches across field ends for which drivers are blamed by people who do not understand the difficulties.

The decrease in chemicals' selectivity normally associated with the use of low volume can, we hope, be overcome by the reduction in dosage associated with C.D.A., at lower volumes, but there are still greater dangers where overlapping of swathes occur, so exact tracking will be important. Increased speed will require greater driver comfort in the cabin and in the suspension systems with a clear view of all spinner heads. Filtration and agitation will both need to be of a high standard, and shorter booms are likely to be back in fashion to avoid the weight and complexities of making longer booms stable at high speed. This trend will be encouraged by the high cost of flushing out expensive concentrated chemicals from lengthy feed pipes.

In the Crystal Ball one sees a very lightly framed vehicle with lightly sprung narrow wheels, these probably powered by hydraulics to give flexibility of movement for row crop widths. The boom may have to be forward mounted to ensure complete visibility from a bubble cabin. The cabin will be padded and suspended, the interior will resemble that of a small aircraft cabin with a

radio/radar picture screen to show the field outline and the tracking lines to be followed by the driver in order to properly spray the field. The machine will show up a superimposed trace, and alarms will sound if there is a deviation from course. In fact there is the possibility of even computerising the guidance once the machine has been introduced at the start position. This will allow the driver more time to concentrate on the supervision of the spray system.

The sprayer will probably be the least expensive part of the whole outfit and may well consist of a series of plug-in units that will be carried out on a purpose made trailer each morning, ready filled according to the programme for the machine's work schedule. This will obviate the waste of chemical, time and money, involved in the usual proceedures of dumping, decontamination, and refilling the conventional sprayer.

There will be a replacement unit for each of the chemicals, consisting of a pump, driven by the tractor's ready positioned hydraulic motor which will be integral with the plug-in tank to which will be fitted all the necessary valves, relief valves, etc., etc., culminating in feed pipes and spray heads that are simply clipped onto the vehicle's boom.

The operator will set off in the morning in his air filtered and conditioned cabin, travelling at forty or fifty miles per hour. At the field he will select and set wheel widths from the cabin, he will already have his C.M.P.P. unit fitted for spraying, so at a touch of the button his booms will unfold, and he, having set the machine into its start position on the screen, can sip his tea as the machine bowls merrily across the field at fifteen to twenty miles per hour. After two or three changes of spray modules, all by hydraulic and electric machinery, he will perhaps stretch his legs and have more tea before returning home, refreshed, after spraying his two hundred hectares for the day.

The possibilities are endless when we get away from the enormous bulk of water currently required as a chemical carrier.

Such machines will be very expensive of course, and will suit the contractor, who can utilise them to the extent that their cost will require.

Thank goodness that by the time these dreams all materialise, my Evrard self propelled sprayer (referred to by Dr. Mathews as " The Last of The Dinosaurs" last year), with its five miles per hour one hundred and twenty foot boom, will have earned its retirement. What a fantastic attraction it will be in a museum when we have all become used to our thousand hectares per day pocket sprayers!

It all seems rather pie in the sky, but, <u>if</u> the snags of C.D.A. at ultra low volumes can be overcome, <u>if</u> machinery makers can produce the machines, and <u>if</u> chemical makers can produce the formulations required, then my "non -flying aeroplane" is a possibility, and at £50,000 to £100,000 per unit, only contractors would be mad enough to use them.

On the other hand of course, someone may find a different way of killing pests, and we could easily put our imagination to work to make a pilotless <u>flying</u> machine that can do all the same things by remote control without touching any part of the crop.

It certainly looks as if, for once in farming and crop spraying, small (volumes) may be increasingly beautiful!

A VIEW OF THE IMPACT OF CDA ON THE AGROCHEMICAL INDUSTRY

"AGROCHEMICALS AS GOOD AS THEIR APPLICATION"

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Summary The complexity of pesticide application creates problems in analysing the most effective means of achieving the optimum result from such application. CDA aims at overcoming one of the most important barriers to better utilisation of pesticides. It is suggested that the technique should be widened in the hope that meanwhile effort be made to improve the general standards of application. The Agrochemical Industry can meet the present demands of CDA but is it the most appropriate use of scarce resources when seen in the overall context of agricultural needs?

The programme note for this session indicates that the paper should "summarise the progress of CDA towards the achievement of a reliable method of pesticide application and to review the prospects for the technique". CDA is essentially an alternative method for applying pesticides, thus it is desirable to review the objectives of pesticide application before entering into debate and discussion of CDA as such. There have been many definitions of the objectives of pesticide application, but the ultimate aim is to ensure the optimum result from the use of the pesticide in terms of economic return to the grower. Many factors contribute towards an effective application of a pesticide but the ultimate application process is subject to variables outside the control of the individual applicator. It is the need to take this variability at the time of application into account that leads to label recommendations that are sometimes criticised as being over-general and allowing too much variability. It is important to recognise these factors at the outset in considering any application technique, for failure to realise this implication does entirely nullify consideration of any change.

The definition used above is perhaps significant in that no mention is made of the degree of control of the pest or of increase in crop yield. These are, of course, factors in the overall achievement of an acceptable economic return to the grower but what is truly being assessed is the balance of input and output in the overall process. The inputs to the application process consist essentially of chemical and the application technique. This latter is made up of the spraying machine (be it ground or air), the operator and, that most difficult to define, the total management and logistics of the operation. Output is a combination of yield, quality and often, reduced costs of harvesting. Within this somewhat complex equation it is, of course, also necessary to build in the minimum impact upon the environment. But this, in essence, will be taken into account if the appropriate balance of input to output is calculated.

The optimum result from an application of pesticide is likely to be a combination of high yield and quality. This will be most effectively achieved by the application of the correct dose at the correct time. Rutherford (1977 b) has shown that relatively few operations are achieving this desired aim. It is reasonable to assume that an achievement of a better level of operation would show an overall increase in the average benefits of pesticide application. Why, then, are field operations falling short of the desired level? Principally, this is due to the management of the operation, the general logistics and, to a lesser extent, the need for operator training and perhaps a greater recognition that the pesticide application operation on the farm is not just another cultivation.

Nation (1977) has shown the significance of the various inputs into the spraying operation with regard to the total daily achievement. The computer model demonstrated clearly at the NIAE Open Day the advantage of high speed operation, low volume of liquid and relatively short and infrequent travelling between sites.

A somewhat similar but less sophisticated analysis of a large scale contract operation in the period 1958 - 1962 led to similar conclusions; it is relevant to consider these in the context of the approach indicated by CDA.

Three factors were shown to be primarily concerned in achieving high, efficient daily outputs viz:

Speed of operation
Prevention of breakdown/down time
Water volume

Taking these in turn, the speed of operation was by far the most significant. But this is a matter of tractor design and it is surely debatable as to whether the pesticide application operation can ever justify the provision of highly specialised equipment except on very large farms and for contract use. In this connection, the U.K. farm structure is unique in the European scene and perhaps, to some extent, in the world. It could, of course, be argued that a re-design of the tractor as such is desirable not only for pesticide application, but that is a subject outside this particular symposium.

Turning now to the ability to keep machines going, or to prevent breakdowns, this is a major source of problems in the majority of pesticide application operations; arising from filter blockage, nozzle blockage, down time for changing chemicals and no matter which technique is used, these factors will be very significant. In the study referred to, a reduction in volume was coupled directly with an increase in down time, bearing in mind that the study was carried out with highly skilled operators who were subject to re-training every year, it is significant that reduction in, for example, pipe diameter, itself led to problems which had not been anticipated (e.g. blockages due to chemical drying out).

A reduction of volume is clearly very desirable and in the study referred to it was one of the major factors which could, in theory, have led to an increase in output, but in practise, as indicated above, it was more important to maintain actual operation in the field. This was ultimately resolved by providing a source of clean water, a very high output transfer mechanism from water supply to sprayer and intensive filtration designed to ensure no blockage. In relation to CDA, this position is probably well worth further examination and consideration.

Cussans and Taylor (1978) have indicated that the major advantage of CDA lies in reduction in water used for application and, therefore, theoretical increased output. However, as has been demonstrated by Rutherford (1977 a, b) and in the study referred to above, the achievement of higher output will only be accomplished

provided that the equipment, the chemical and the operator are totally compatible. It would seem reasonable to assume that equipment can be designed to suit the cropping requirements. It is, therefore, necessary only to consider the chemicals and the operation.

How far will CDA impact upon the agrochemical industry? What are its implications for the industry? Indeed, how far do the considerations already outlined in the paper apply to the chemical industry? It is perhaps as well to dispel an illusion which appears to be current. As far as one can determine, it is reasonable to assume that almost all materials could be formulated to be used through CDA equipment as now available. However, it must be borne in mind that such formulations may require specific clearance by the authorities with regard to residues and toxicological data relating to operator safety. These can clearly be carried out. The question then arises not only for the chemical industry but also for agriculture in general, as to whether this is the best use of the scarce resources available in this area of research and development. Clearly, any chemical manufacturer will have to be satisfied that the potential through CDA justifies the investment of valuable scarce resources which could otherwise be employed in developing chemicals for use through a wider range of application equipment already in existence.

The chemical industry then can meet without doubt the demands of CDA as an application technique, but what are its implications for the ultimate user and the success and benefit from the pesticides which will be applied?

In the first instance, examination should be made of the implications for dosage rate. Assuming that in most cases the present rate of use of active ingredients is the appropriate one for the particular task in hand, then reducing the volume in which the material is applied increases the rate of risk of inaccuracy. A relatively small inaccuracy at a high dose rate in terms of water per hectare, becomes significant if the same percentage error occurs at a much more concentrated rate. This will need to be considered carefully in relation to label proposals and in assessing the results in the field.

The indications from the survey carried out by ADAS (1976) clearly demonstrate the need for operator training, and more effective machine calibration and maintenance. The requirements of the equipment used for CDA will surely be greater in terms of maintenance and accuracy in calibration. The question which the chemical industry will need to answer is "How far can it build into its products the necessary safety factor to take into account the probability of inaccuracy in application through the equipment which is proposed". Building in such safety factors can be costly in terms of formulation, especially with greater constraints arising from concentration in the applied material.

The chemical manufacturer must be concerned with achievement of acceptable results from the use of its products under a wide range of environmental situations in the hands of a wide range of ability of operator.

To date, CDA equipment has primarily been used in the hands of highly skilled operators often under the control of research organisations. The results of the work to date as exemplified by O'Keeffe et al (1976) and Harris (1977) and others, would indicate that the technique is far from reliable at this stage.

This prompts the suggestion that care is needed not to damn what is clearly a very desirable development due to the fact that neither the equipment nor chemicals have yet been developed to a position in which they are mutually compatible and provide a satisfactory result when used in the hands of the practising operator. There are, of course, exceptions which prove the rule and there have been practical examples of excellent field operations, but so far as the author is aware, there

have been no published results indicating the degree of significance of reproducibility of the work done by this equipment.

Consideration to date of CDA appears to be dominated by the objective, desirable as it may be, of the saving of diluent and thereby improving the rate of application of pesticides. But how far does it meet the criteria for application which was given at the beginning of this paper. In this context, the old plea of the application engineer to be told what the biologist needs, appears very relevant. There are many examples which can be quoted mainly from the so-called ULV operations in plantation crops where a careful choice of chemical, operational equipment including choice of droplet size, and method has led to a far better balance between the input and output and overall a more economic benefit to the grower and indirectly to the population at large. This is perhaps what is needed in consideration of the present progress with CDA. The work to date has shown clearly many advantages of moving towards a controlled drop size application with reducing diluent and an overall improvement in the logistics of the spraying operation. But why choose 250 µ droplets: 150 µ would appear to be more effective on theoretical grounds (Lake 1977). This may then be linked to a somewhat different volume per hectare; but should not the opportunity afforded by CDA be taken to re-assess application techniques? It is time surely to reconsider the desirability of continuing with application recommendations that relate the use of chemical whose dose is calculated in relation to individual plant situations on the basis of an application rate per area of land. It is surely relevant to consider how far we can move towards accepting treatment on a leaf area basis rather than simply ground area. The suggestion that this may be too difficult for operators and others to accept is surely not compatible with the consideration of the introduction of highly sophisticated equipment such as CDA.

The concept of CDA offers a changed vista for pesticide application as currently accepted in the United Kingdom. The apparent challenge to the agrochemical industry to meet the demands of the present proposals is small. There can be little doubt that the challenge can readily be met but it raises a number of fundamental questions which must be recognised by all concerned in the pesticide business.

The work of Rutherford (1977 a,b) and others has clearly shown the need for improving the overall standards and particularly the management of pesticide application operations in the United Kingdom. In any consideration of the further development of CDA, it is surely important that the requirement to lift the present general standard of operation to at least the average is not overlooked. There are 52,000 spraying machines currently in use in the U.K. Surely these must be used more efficiently before we change to a new technique. But, whilst improving the efficiency of the present, there is no reason why one should not prepare for the techniques of the future. The suggestion in this paper is that those techniques should be widened in scope and that CDA should be reviewed in total as a means of overall improvement of pesticide performance rather than simply one of reducing the volume of liquid as important as that may be. The work of the many institutions within the aegis of ARC has been very important to date but there would seem to be an opportunity to further develop the total concept of CDA through the many technologies available to ARC in toto in the United Kingdom.

That the resources available for research and development and advisory work are finite must be recognised in any development-type activity. The question as to where these resources can be best deployed is not a matter for this symposium, but perhaps arising from it will be a reassessment of the utilisation of present resources, the implications for agriculture as a whole of the development of CDA and, from that, a realignment of the overall project.

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