SESSION 1

SETTING THE SCENE – THE CHANGING FORCES OF LEGISLATION, FARMING NEEDS, INDUSTRY INITIATIVES, MACHINERY AND PACKAGING DESIGN

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PACKAGING WASTE MANAGEMENT - A KEY ISSUE FOR THE UK AGROCHEMICAL INDUSTRY

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ABSTRACT

Until comparatively recently there was no legislation controlling waste disposal but this all changed with a European Council Directive published in July 1992. By comparison with many other industries the Agrochemical industry does not generate a large volume of waste. Although we manufacture about 14 million packs of a wide range of products every year, the bulk is relatively small (approximately 3,000 tonnes per annum in the UK). However, the packaging waste we generate is perceived to be due to the original contents in the pack. Our industry has many specific problems related to packaging disposal. Currently the vast majority of empty packs are either buried or burnt. If either, or both, of these practices are banned or severely restricted we face a new problem. Firstly we need to meet the new legislation and secondly we must ensure that packaging disposal is carried out in a way that will not jeopardise the Industries excellent record for product stewardship. With a vast range of very different products distributed to farms throughout the UK there are major issues related to pack collection. Other alternatives, including reusable containers are being actively considered. It is quite clear that packaging disposal is now an integral part of the Agrochemical business.

Getting rid of rubbish may sound a very simple process. This is certainly not the case as I am sure this conference with prove.

Throughout the world the problems associated with the creation of waste materials is a major environmental issue. Clearly it is in everyone's interest to reduce waste. The dictionary definition of waste is "something that is left over as useless or valueless". Therefore it is logical to consider the problem from two different approaches. Firstly to reduce the waste we create and secondly to attempt to find ways of converting waste so it is no longer "useless or valueless".

During the 1980's this topic was considered at both a local and international level. In Europe in 1987 the "ACE" programme was introduced (Action by the Community on the Environment) to provide financial support to projects which could be shown to benefit the environment.

In 1991 a Directive (91/157/EEC) was initiated which addressed the specific problem of the production and disposal of products with a heavy metal content such as batteries and accumulators.

The disposal of packaging waste is a critical issue for every production industry. In the UK, we generate over 20 million tonnes of domestic waste every year. Until comparatively recently there was no legislation controlling waste disposal but this all changed with a European Council Directive published in July 1992. The aim was to harmonise national measures and establish targets and essential requirements for packaging which must be met in the areas of return, re-use and recovery in order to reduce the impact on the environment. Subsequently each member state has introduced local legislation to meet these European objectives.

In the UK, the first definitive statement on our likely obligations came with the "Gummer Challenge" in September 1993. This stated that industry must recover between 50 - 75% of all packaging by the year 2000. It went on to establish the responsibility of those in the packaging chain in recovering and recycling the waste they created. Mr Gummer invited the senior representatives of retailers, packers and fillers to work together and produce a plan that could be implemented to meet the Governments objectives.

After much consulting and debate a paper entitled "Producer Responsibility for Packaging Waste" was issued by the Department of the Environment in May 1995.

Suddenly packaging disposal has become a major issue for many industries. The consumer industry is a major generator of packaging waste. Suppliers such as Unilever and Proctor and Gamble and retailers such as Tesco and Sainsbury's have major problems to address. A senior manager of Tesco's believes that compliance with the packaging regulations could cost this huge retailer 2% of its profits - a big issue for a big business.

By comparison with many other industries the Agrochemical industry does not generate a large volume of waste. Although we manufacture about 14 million packs of a wide range of products every year, the bulk is relatively small (approximately 3,000 tonnes per annum in the UK). However, the packaging waste we generate is perceived to be sensitive due to the original contents in the packs.

Let us now consider some of the specific problems our industry faces related to packaging disposal. Currently the vast majority of our empty packs are either buried or burnt at the site of use. But what happens if one or both of these practices are banned or severely restricted:- we have a big problem.

Perhaps we should compare the situation with London in the 1870's. Imagine a total churchyard space of less than 12 hectares with 50,000 dead to bury every year. The solution was burying on top of existing corpses - LANDFILL.

Then we found a creative alternative : CREMATION or BURNING. Imagine the problem we would face today if burying and burning were banned in this disposal industry!

As an industry our first decision is whether we support and defend the practices of on farming burying and burning of packs. It is very difficult to defend pack burial. Apart from the possibility of any pesticide residues leaching into the soil, the majority of our products are packed in high density polyethylene containers. These are inherently not readily biodegradable. They are likely to remain intact for hundreds, if not thousands of years.

The industry must accept that, irrespective of the fact that the environmental risks from any residues are negligible, the inadvertent uncovering of old containers could result in bad publicity. In summary, the negative impact of this practice is likely to be out of all proportion to the risks involved.

On farm burning is also perceived to be environmentally unacceptable but I believe we have a far stronger justification in defending this practice.

The BAA Task Force, considering disposal on farm, concludes that a controlled burn of clean agrochemical packs is similar to a pinewood bonfire. We must not underestimate that growing pressure on banning on farm burning. However, it is well worth defending as it greatly simplifies the disposal of packs and is undoubtably the most cost effective solution for all concerned.

Whatever practical difficulties we face, we must also address the legal aspects of the new legislation. Starting this year we have challenging recovery and recycling targets which increase annually so that by 2001 we must recover 52% and recycle 16% of the packaging waste we generate. With the exception of the end user, everyone in the packaging chain has a legal obligation. The vast majority of companies involved have decided that 'going it alone' is not feasible or practical and therefore have opted to pay one of the recognised recovery organisations to meet their obligations.
It is very significant that these organisations are only required to produce proof that they have recovered the agreed volume of all the component materials i.e. plastic, wood, metal etc. They have no obligation to recover any of the waste created by their customers. As our waste is relatively sensitive and distributed on remote farms throughout the UK, I suspect that they will not be eager to collect our waste and will opt for the bulkier waste which is easier to collect from other industries.

Therefore, we face the ludicrous position of having to pay for our packaging to be disposed of, and still have the practical problem of ensuring that packaging disposal is carried out in a way that will not jeopardise the Industries excellent record for product stewardship.

This conference gives us the unique opportunity to look at the current situation in depth, and to consider the implications for the Crop Protection Industry.

It is clear that there is no simple solution to the problems and it is likely that changes will occur, many driven by the new packaging legislation.

We will be able to consider the 5 R's which will all have a role in addressing the issues.

Reduction

The industry has already achieved a significant reduction in packaging for our products. This has been driven by the development of new highly active chemicals which are applied at g/ha rather than kg/ha. This has facilitated the introduction of smaller packs.

Having achieved these reductions in packaging it is grossly unfair that our targets are based on percentage recovery rather than absolute weight reductions.

If we are able to reduce our packaging by 50%, we have reduced the waste to be disposed by 50% - the Government target. Regardless of this we still have a legal requirement to recover 50% of the remaining packaging.

Recovery

This will be covered by subsequent speakers. Although I am firmly committed to the preservation of on farm burning, I feel sure we will ultimately need some form of recovery system. A key issue is whether the best option is to focus on our own packs or join forces with other generators of farm waste.
There is then the issue of having recovered the pack : what do you do with it!

Re-use

The move from one trip packaging to multi-trip packs presents some exciting opportunities. Although this approach will not be suitable for all our products it will help address not only the packaging disposal issue, but also improve operator safety.

Reformulation

If we were holding this meeting in the 1960's or 1970's we would have been considering the disposal of metal cans which had contained phenoxy salts or emulsifiable concentrates. Today we are focusing on plastic containers for suspension concentrates. The 5 litre jug has many facets which make recovery difficult.

Reformulation combined with novel packaging may facilitate easier recovery. These could link with significant changes in the design of machinery which apply our chemicals, as we move towards precision farming.

The last R is removal. Although this is not an immediate option it may be that we will see either biodegradable packs or packs which dissolve in the spray tank.

As this if far from reality we need to address the problems of today as well as the opportunities for tomorrow.

In summary we have two major objectives related to packaging waste. Firstly to meet our legal requirements and secondly to minimise the impact on the environment of any waste we create.

We now have clear UK legislation which arose from the European Directive. However, as with most European legislation it is being interpreted and implemented in many different ways within the Member states. For example, each country has set its own targets and timetable. There is still uncertainty about the classification of empty pesticide containers. At this moment in time we are still unsure whether even rinsed containers will be considered as special waste.

In comparison with other major European Countries we face many challenges in the next few years. Germany has already a fully functional collection scheme while France has far less problems than the UK. They are allowed to put their clean agrochemical packs in the domestic waste stream and they have created a regional network of incineration units for burning waste, funded through a levy imposed several years ago.

Regardless of the legislation we have an obligation to make sure that our packs are not a 'blot on the landscape'. I am sure as an innovative industry we will meet the challenges ahead and I look forward to the presentations we will be hearing at this conference.

DESIGN GUIDELINES, FEATURES AND PERFORMANCE CHARACTERISTICS AND DEVELOPMENT OF CURRENT PESTICIDE CONTAINERS.

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ABSTRACT

A review of currently available design guidelines for alternative types of pesticide container systems is presented. This illustrates how the pesticide industry has been preparing to meet future demands for safer, more efficient and less wasteful packaging and delivery systems to promote the optimised usage of plant protection products. The review highlights available means for reducing the creation of pesticide contaminated packaging waste, avoiding the waste of pesticide and eliminating the risk of inadvertent contamination by accidental mishandling of pesticides during their preparation for use. It outlines the basis on which industry can adopt a more assertive strategy for safe and efficient delivery of pesticide doses to their intended targets, thus maximising the crop protection benefits while minimising the associated disadvantage of potential pollution. General principles underlying container design guidelines are discussed, as well as specific aspects of technical standards, both recognised national standards and less formal industry norms, which determine the scope for integration of improved systems for transport, handling and application of plant protection products in commercial practice.

INTRODUCTION

This review of current design options for pesticide containers identifies fundamental principles underlying their common performance objectives as well as features that distinguish alternative approaches to construction of pesticide containment and handling systems. This paper does not attempt to forecast future trends, nor to provide the blueprint of an ideal container. It describes in broad cross section the recent evolution in commercially available packaging in order to set the scene for discussion of improving systems for safe and efficient pesticide handling, that create minimal waste, and illustrate where scope for innovation or improvement may exist in the future.

Drawbacks in design of conventional containers for pesticides were progressively recognised over recent years (Gilbert 1989), and improvements that were made in response are illustrated by guidance which was subsequently issued by pesticides approval departments e.g. Guidelines for the Design of Liquid Pesticides Containers (ACP 1990). The priorities of competing design features have been set by the combined aims of respective legislation, including COSHH Regulations (HMSO 1988) requiring user safety and convenience, as well as COP Regulations (HMSO 1986) requiring safety to people, wildlife and the environment. More recently, attention has focussed on other aspects of packaging design and construction which have emerged as a new priority. The foreseen need to reduce potential pollution by packaging waste within the European Community (Anon 1991 a) and worldwide (Anon 1991 b) is now being realised in the form of legislation requiring the recovery of a minimum proportion of all packaging materials. Modern design options for pesticide containers recognise the establishment of new patterns and relationships within the infrastructure that supports commercial pesticide use, which favour the return, reuse and recycling of packaging. Scope for innovation now exists within industry, where novel forms of product and packaging can be developed alongside each other, which between them raise standards of accuracy and safety in the routine handling and application of pesticides, while minimising associated economic and ecological costs.

CURRENT SITUATION.

Current UK guidelines for design of pesticides containers that are given in the 'Registration handbook' (HSE/PSD 1996) are shown in table 1.

Table 1. Pack design types, for which published guidelines are available:

Packaging design type	Guidance Document
Containers for **liquid** pesticides	WD 8/14
- Home and Garden use supplementary guidance	- annex 1 (1)
- Products for application by painting with a brush	- annex 1 (2)
- Small Volume Returnables (SVR)	- annex 4
- Atypical packaging.. .. from which the product is applied by operators on foot	- annex 5
- ECPA Standard - 63mm screw thread neck ("wide neck")	- annex 6
- Products for application by painting with a brush. Drop test and certification system	- annex 7
Pressurised containers	WD 8/15
(Water) **Soluble** Packs	WD 8/16
Containers for **solid** pesticides	WD 8/17
- Paper sacks supplementary guidance	- annex 1
- Home and Garden use supplementary guidance	- annex 2
Multiple compartment/multiple aperture packs	WD 8/18

These specific guidelines reflect general features of container design which need careful consideration in order to ensure adequate performance of the container. Minimum design criteria must be met in order that approved pesticides can be supplied, transported, stored, and used in a manner safe to people, wildlife and the environment. Suitable containers should be capable of:

- containing the product and preventing loss due to spillage, leakage or permeation during transit, handling and storage;

- giving physical protection to the product and resisting normal external forces to which the container will be subject during filling, storage, transit and usage;

- preserving the integrity of the contents by preventing direct or indirect chemical decomposition and providing protection against climatic conditions;

- allowing instructions for safe product handling and use to be fixed securely;

- providing user safety and convenience during storage, handling, opening, pouring and disposal;

- being compatible, as far as possible, with pesticide filling attachments or 'closed' systems on application equipment.

These fundamental principles of container design should be complied with by both conventional and innovative types of pesticide container.

Under EU arrangements (Official Journal of the European Communities 1997) member states need to conduct a comprehensive risk assessment which takes account of the size, design and type of packaging, for example in evaluation of potential operator exposure. The handling, loading and mixing of the product have to be considered and exposure reduction measures are recommended. Specifically, member states shall examine information relating to the nature and characteristics of the packaging proposed, paying particular attention to the packaging dimensions and capacity, the size of the opening, the type of closure, its strength leakproofness and robustness under conditions of transport and handling as well as its resistance to and compatibility with its contents. Furthermore, before issuing authorisation member states shall ensure that proposed packaging meets requirements for its ultimate decontamination and destruction, with a strong emphasis on avoidance of waste and recovery of utilisable materials and energy.

DESIGN FEATURES

The different types of container described in this section illustrate design features leading to positive performance attributes. These attributes fall roughly into four levels of priority as drivers of pack design. First is operator safety, meaning that the contents of the pack must be capable of being used under normal circumstances without loss of control over them and particularly without contaminating the operator or the surrounding environment. Second is efficient performance in the packs functional role, meaning compatibility with the operational needs of tasks involving the pack (with or without its contents). Third is the creation of waste-reduction options for used packaging, addressing aspects of packaging materials contamination that might limit options for its re-use and recycling and, fourth is the elimination of the need for packaging within the pesticide product delivery system altogether.

Liquid or solid pesticides supplied in simple packs.

Common traditional types of pesticides container are basically vessels of one sort or another (e.g. bottles, cans, drums, sacks, etc') that serve to contain their contents en route to the end user. They require manual opening by users to dispense a required dose and must be re-sealable if the contents are not all used at once. These are essentially one-way, single-trip packagings, that require the user to decontaminate and dispose of them after use. The UK Code of Practice for the Safe Use of Pesticides on Farms and Holdings (HMSO 1990) does not allow re-use of such an empty pesticide container, other than to hold an identical product in the emergency circumstances of dealing with a damaged or leaking identical pack. However, users are now also recommended to select, where possible, pesticides supplied in forms of container which obviate the need for disposal of contaminated packaging materials.

A great deal of improvement in the design and performance of the basic container types that are most commonly found in use has taken place over the last decade. Maunal pouring of liquid from bottles has, in particular, benefitted from more purposeful design of both generic and product- or company-specific packs (Gilbert et al 1988), as demonstrated using a standardised pouring test (Lloyd 1982). Use of a wider internal neck diameter to reduce glugging, splashing and spillage allows easier and less messy pouring by the operator. The further development of such standardised pack testing test methods e.g. for assessing the remainders of contents retained by 'emptied' packs is likely as the range of performance objectives for packs widens. The ease and efficiency of manual rinsing procedures is becoming more important, with pack shape likely to play a key role in avoidance and removal of residues in packaging. Manual pouring from open packs has been shown to be generally inferior in terms of operator and environmental safety than use of engineering control systems to aid dispensing (Frost et al 1989). Recent agreement of a British Standard specification for low-level induction bowls (BSI 1996) is expected to facilitate safer manual pouring and more efficient pack rinsing. Even so, the drive to improve operator safety is now focussing on the part pouring of whole pack contents; a procedure which may be prone to cause operator exposure during handling through contact with pesticide residues contaminating surfaces of the opened and resealed pack, or environmental exposure from the same source. Likewise, even with the best decontamination procedures the design drive remains to eliminate the need to dispose of the used packaging.

Water soluble packaging (WSP) allows manual loading with the advantage of reduced potential operator contamination and accurate dose control, by providing small dose-related sizes of packs that can be added to the spray tank as required, as well as complete disposability insofar as it is ultimately applied in solution with it former contents. The foreseeable risk of undissolved WSP causing blockage of either the spray system or pesticide induction system should be considered and a potential disadvantage remains the vulnerability of the WSP to degradation if it becomes wet, hence requiring its placement in an outer waterproof secondary packaging to protect it in storage and transit. Although this reintroduces the need for packaging needing disposal, the likely lack of contamination of that packaging should favour more creative disposal options.

By contrast, liquid or solid pesticides supplied in multiple compartment / multiple orifice packs may become a less favoured design option. These have the advantage of supplying appropriate combinations of pesticides contained in unit dose sized packs, where the whole pack contents are added to the spray tank to treat an appropriate area. The fact that users are advised to pour simultaneously from more than one opening in each pack, however, leads to the potential disadvantage of an increased risk of operator contamination and spillage during preparation of the spray. Also the irregular shapes of individual pack compartments may lead to increased amounts of product retention within packs after pouring, which creates a pack rinsing problem likely to be exacerbated by the relative lack of easy access for rinse water through the complex multiple and/or narrow pack openings. Due to the complicated geometry of the plastic mouldings of combination packs these are unlikely to be compatible with the couplings or suction probes of available closed filling systems unless a standardised design of twin pack neck can be agreed. Even the 'Packman' transfer system (Schering Agriculture 1990), which is intentionally designed to puncture, empty and rinse the widest possible range of pack types, has recommended twin packs not to be used with that system.

Liquid pesticides supplied in returnable and large packs.

Development of policy toward the handling of used pesticide containers historically has varied widely around the world (GIFAP 1991). Development of policy aiming for the reduction and recycling of pesticide packaging has depended on developments in associated areas of decontamination of empty packs and the consequent utility of recycled materials. Returnable pesticide packs can offer a less polluting and less wasteful option to conventional packs in several ways, depending whether they are small packs intended for manual handling or larger packs intended for mechanically aided handling. Small packs which are returnable from the user back to their original source are a means of greatly minimising the amount of packaging material ultimately needing safe disposal. A potential disadvantage lies in the need for assurance that packs have been decontaminated effectively after emptying, or otherwise treated only as required, to render them safe for collection and reutilisation (although it is in the users interest not to throw away expensive product with the container). Effectiveness of decontamination by rinsing is crucial. Unrinsed packs require disposal as potentially hazardous waste, which is either expensive or polluting, or both. Rinsed packs, however, can either be disposed of more safely and easily or can be collected for re-use. Whole packs can feasibly be re-filled with the same product they originally contained, although this might warrant some initial redesign of new packs and requires the informed co-operation of users to treat empty packs correctly. Otherwise pack materials can be re-utilised, either as raw material for constructing other moulded plastic items or for energy recovery when simply burned as fuel.

Returnability closes the previously open-ended supply chain to recycle empty packaging, offering the obvious advantage for the user in avoiding the problem of disposal themselves.

Establishment of the trade infrastructure necessary for the economically viable organised collection of empty packs is underway. Simple recovery schemes for clean packaging materials to allow compliance with packaging waste regulations are now being approved in the UK (Pesticide Outlook 1997).

Large containers (typically 300 - 500 litres in capacity) are by their nature 'returnable'. Pesticides have traditionally been supplied straight to end users in such intermediate bulk containers (IBCs) in other countries (e.g. USA and Canada); the user often being a contract applicator with high demand for the same product. Fewer U.K. users would be expected to have a sufficiently large requirement for any single pesticide to need its supply in such large containers. Thus in the United Kingdom, packaging evolution toward large bulk packs moving directly between manufacturer/supplier and the end user is less likely. A compromise scenario can arise when IBC packs supplied to the distributor level could be used in turn to fill, or re-fill, the small packs of the end user. Otherwise users could obtain product from a manufacturer supplied through the local distributor in specially constructed mini-bulk multi-trip end user packs designed to stand up to multiple use over a longer period of time than current packs, although they will ultimately be a limited use item. Uptake for such systems is reported to be rising fast among UK farmers (Farmers Weekly 1998). These packaging systems need to undergo regular inspection and maintenance to ensure their continuing suitability for their purpose. Ideally, maximum advantage might be gained from such a supply infrastructure if only the user's required dose was metered out at the distribution point. The user would then need only to dispense the whole contents of the (re-)filled container to treat their intended area or to fill the intended sprayer tank, which would reduce both operator contamination hazards and the risk of dose metering errors. Ultimately, this concept can be seen as redefining the concentrate container into a form of concentrate reservoir that functioned as a detachable component of the spray machine.

Adaptor-packs.

Double-use of pesticide concentrate containers to transport and supply product and to serve as reservoirs on spray equipment is expected to develop more in the future. This approach, which has a longer history in use with small hand-held sprayers will probably become more prevalent with larger types of spraying equipment with the advent of greater standardisation among functional components at the commercial level. Such standardisation ranges from the formal British Standard for closed transfer sytems (BSI 1996) to the less formal industry standard 63 mm diameter neck with ASTM thread (GIFAP 1990). Adaptable packagings can either supply liquid pesticide in containers capable of being attached to closed transfer systems or in-line mixing systems to fill an equipment tank, or supply liquid or solid pesticides in a container which can be attached to become the integral pesticide reservoir of the applicator. The horizon for development of waste-avoiding adaptor packs would allow their attachment to in-line mixing systems carried on a sprayer so they feed concentrate to the spray line for dilution before application only in the precise amounts needed to do the required job.

CONCLUSIONS

A key stage has been reached in the evolution of pesticide packaging. The traditonal assumption of one-way-trip packs, with their inherent handling and disposal requirements, is being replaced by a more sophisticated approach to the issues concerned. The traditional ways of packaging, pesticides have evolved chiefly to suit the needs of their transport and distribution. Current emphasis upon safety, particularly with respect to prevention of operator exposure, has required an integration of new features into packaging design that suit the needs of operational use systems. The imminent future demand for reduction and elimination of packaging waste will bring the ultimate needs of waste disposal more into the design requirements. The overall pesticide product marketing and delivery chain is set to become more complex, but probably more efficient.

Key topics to be considered in the future are pack dispensing (handling safety and dosing accuracy), pack rinsing, pack disposal (including WSP), returnable packs, closed system packs, mini-bulk containers and adaptor-packs. Delivery to the user of improvements in the ways of packaging pesticides will depend upon adaptations to the industrial infrastructure for supplying the user and innovation in packaging and handling technologies. For wide adoption, investment will be required, so incentives must be found to attract the market. Initiative lies with the industry.

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AN OVERVIEW OF THE DEVELOPMENT OF CROP SPRAYER DESIGN DURING THE LAST DECADE

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EVOLUTION OF CHEMICAL INDUCTION SYSTEMS

During the last decade sprayer technology has advanced very dramatically. In addition to new application techniques there has been substantial development of chemical handling systems and other safety related features. A decade ago, a typical crop sprayer would have a rudimentary system of chemical induction. This would consist of, at best, a chemical lance that would be used to draw pre-mixed chemical through the sprayer pump and into the tank. The alternative to this would be emptying liquids or powders through the tank opening via a filter basket. Attention to the safe handling of chemicals mainly centered around wearing the appropriate protective clothing, ie face mask, apron, gloves.

Progressively, we have seen the introduction of more sophisticated chemical induction systems that attempt to remove the operator from any exposure to the chemical. The first, and (arguably) the most popular system is the induction bowl. This typically consists of a hopper into which the chemical can be introduced (either in powder, granular or liquid form), the lid is closed and then a valve opened to introduce the chemical into the sprayer tank. The early designed hoppers were really nothing much more than a receptacle positioned conveniently on the sprayer for introducing chemical. Sophisticated plumbing systems were developed from the addition of Venturi devices so that instead of relying on the pump suction, pressure from the pump could be used to draw the chemical in and also aid in the mixing process by virtue of the violent, turbulent, agitation effect. The additional benefit of using a Venturi type system, in place of a simple suction type system, ensured that there was no possible route for chemical to syphon back into a watercourse during the suction filling process. Further development of the induction bowl saw the inclusion of hopper rinsing devices and more recently systems of washing the residue from inside the chemical container. Further refinements of the hopper have seen the bolt on "addition" of closed transfer type chemical devices that pierce the chemical container.

More recent developments have closed transfer type systems rely on dry brake type coupling attachments to the chemical container and introduction of the neat chemical either by gravity, suction or pressure. These have evolved from the larger free standing devices such as the 'Schering Packman' which would take a complete container, puncture it, rinse it and transfer the chemical and washing to the sprayer tank as to the more sophisticated type of 'Chemlock' product. These closed transfer systems have not yet begun to replace the popularity of the chemical induction bowl, which is still perceived as a very simple, reliable and effective way of introducing chemical safely. Other reasons for the very slow uptake of such systems are lack of standardisation of chemical container connectors, the ability of these transfer systems to deal with powders and granulars and disposable bag type products, more complex and sometimes unwieldy plumbing and lastly the additional cost associated with them (range of chemicals available with the appropriate container).

CHEMICAL INJECTION SYSTEMS - A SAFER AND MORE EFFICIENT ALTERNATIVE?

Chemical injection systems are another means of safely introducing chemical into the spray delivery system, but again these have not proved to be popular. Chemical injection systems have been available now for a number of years, but their extremely high cost (up to 50% of the cost of a typical sprayer) plus issues of complexity of operation, reliability and again the ability to deal with non liquid type products has made them a relatively unattractive proposition. In addition, the use of small 5 litre to 10 litre containers will require decanting into larger vessels. The parallel development of closed transfer systems has helped but may not be practical where large numbers of containers require emptying, rinsing and disposing of.

However chemical injection does potentially have a number of benefits. The principal of metering neat chemical into the clean water as it is delivered to the spray nozzle has an obvious attraction from the safety point of view. There is no potential hazard of mixing chemical and of course there is no large volume of pre-mixed chemical held in the main sprayer tank - only clean water. The risk of large volumes of contamination associated with leaking tanks and spillages is therefore minimised. In addition potential cross contamination is further minimised as there is no longer any need for tank rinsing. The system also lends itself to the use of returnable chemical containers as unused neat chemical can simply be returned back to the container.

The forthcoming evolution of "prescription spraying" as a result of the move to precision farming driven by GPS systems could well open up opportunities for chemical injection systems. One can see the opportunity to have 3, 4 or possibly even 5 neat chemicals metered precisely into the spray delivery system, singularly or in any combination as and when dictated to by the control system from the yield/weed mapping information. However, this has to be tempered with the practical constraints of complexity of the system, reliability, and this state of the art at present at least of which the extremely high capital cost.

OPERATOR SAFETY - A MAJOR DESIGN FACTOR

In addition to safe chemical handling systems, today's sprayer designer must also look at wider safety and operator issues. Some 10 years ago it was unheard of to provide clean water for operators to rinse their hands. Some 7 years ago it was not even considered that tank rinsing should be undertaken in the field and the volume of rinsate should be minimised. 5 years ago, no consideration was given to carrying a sufficiently volume of clean water to be able to satisfactorily rinse the tank in the field. The development of tank rinsing nozzles has evolved into a precise system of rinsing out the sprayer tank with a very low water volume. This is a considerably more effective and efficient way of chemical de-contamination than the old system of filling the tank and agitating. In addition, it is no longer environmentally acceptable to drain some 2-3000 litres of contaminated tank washings into a soak away or ditch. It is recognised as good practice to be able to clean out the sprayer tank in the field and to spray out the washings onto an underdose of part of the crop. Modern clean water rinsing systems now provide sufficient water and effective rinsing nozzles so that this is very easily achieved.

The provision of hydraulic boom folding and in-cab controls is nearly now a standard feature on most modern sprayers. This obviously is a big contributor to operator safety by virtue of the fact that all boom functions and spraying functions can be done within the safety (and comfort) of the air-conditioned and filtered cab. More and more machines are also being sold with sophisticated computerised automatic dose control systems. The attendant improvement in accuracy application obviously improves the accuracy of the chemical but also reduces wastage and has obvious environmental benefits.

SPRAYER SOPHISTICATION - WHAT ARE THE BENEFITS?

The inclusion of these ever more sophisticated chemical handling systems, rinsing systems and control systems obviously adds considerably to the cost of the sprayer. How then does the farmer justify this additional expense? The justification is not only in terms of efficient and economic use of chemical, but also a huge impact is made to the productivity of the sprayer. Chemical induction systems have more than halved typical times for introducing chemical. Slow, laborious pre-mixing and using a chemical lance to suck the chemical on board have been dramatically speeded up by the use of induction hoppers. A slow process of driving the sprayer back to the yard, filling it full with clean water, putting the sprayer into the agitation mode and draining the full tank of rinsate off to be repeated sometimes 2 or 3 times, could take up to 1½ hours. Typically modern clean water systems can rinse the tank and spray out the residue in less than a quarter of this time. The operator no longer has to stop the tractor, get out of the cab and manually fold and unfold booms every time he either meets an obstruction or when he moves from one field to another - again another dramatic saving in time and energy. The net result for these sprayer improvements is a huge improvement in the sprayer productivity. The quest for ever larger machines with bigger tank capacities and boom widths stretching to 30 metres and beyond has also had an impact on sprayer productivity.

TRAILED, MOUNTED AND SELF-PROPELLED SPRAYER DEVELOPMENT

The evolution of tracking trailed sprayer with "intelligent drawbars" to minimise headland crop damage have been an exciting new development. The challenge of achieving articulation in the field to cause the sprayer wheels to follow the rear tractor wheels, and yet eliminate unwanted articulation when on the road has been achieved both by the clever use of hydraulic damping systems, and also more sophisticated electronically sensed hydraulic steering drawbar systems.

Similarly a radical design approach to mounted sprayers which we pioneered some 8 years ago, resulted in the almost universally adopted 'Slimline' tank concept which concentrates the weight of liquid very close to the tractor axle thus enhancing stability.

The development of high clearance self-propelled sprayers, capable of achieving very high work rates has presented new challenges in sprayer design. For example, vehicle suspension systems have been developed to minimise stresses and strains on both operator and vehicle even at very high spraying speeds. A new chassis and low profile tank design has been necessary to maintain a low centre of gravity to enhance stability usually compromised by high clearance.

Nozzle technology, chemical handling, electronic spray controls and boom suspension systems have arguably advanced the quickest during the last 20 years of my involvement with sprayer design. Boom suspension has had a dramatic effect in overall sprayer performance allowing boom widths to advance from 40 foot (12 metres) to 30 metres plus and still allow ever faster spraying speeds, without boom breakages which were once a regular headache for the farmer.

And to conclude ....

THREE WISHES FROM A SPRAYER DESIGNER'S PERSPECTIVE

1 The chemical industry would standardise on container type.
2 Clear definition Europe-wide on approved chemical handling systems
3 Farmers would not complain about the cost!

CROP PROTECTION PRODUCT (CPP) CONTAINER[1] MANAGEMENT-INTERNATIONAL EXPERIENCE AND THE MANUFACTURERS' STRATEGY

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ABSTRACT

The principles of "responsible care" and "correct use" continue to apply after Crop Protection Products (CPP's) are applied to the target crop. It is not acceptable that used CPP containers be allowed to simply accumulate on farms without guidelines for ultimate disposal/recovery. The CPP manufacturers have developed a comprehensive Container Management Strategy. This embodies "guiding principles" accepted in other sectors ("reduce - reuse - recycle") but goes further by shaping the strategy in the light of the special circumstances surrounding CPP containers; the vital positive role performed by the container in assuring safety, the wide dispersion of the waste, and the need to give assurances with respect to CPP residues in containers. A number of countries have pioneered programmes to implement container cleaning and container collection. Lessons from these experiences are reflected in the strategy. The strategy comprises these key building blocks; quality container designs, on-farm cleaning, then final treatment by one of three approaches - on-farm disposal, municipal waste, or collection. Each of these qualify as "closed channels". The strategy gives action check-lists for CPP manufacturers and national trade associations. A proactive approach to implementing the strategy across Europe is advocated recognising the "pull" for high standards from grower level and the continuing prospect of regulations affecting CPP packaging.

PURPOSE & SCOPE

This paper explains the collective philosophy and strategies of the major manufacturers of Crop Protection Products (CPP's) with respect to packaging waste management. It takes an international perspective but puts a special focus on Europe. This serves as an "umbrella" for other conference papers giving a deeper technical treatment of the specific topics. It is not intended as a review of specific laws or the scientific literature.

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[1] This paper and the ECPA Strategy focuses on the primary container. They do not necessarily address other elements of the "packaging system".

[2] The author is Zeneca Agrochemicals' Headquarters' external representative on packaging issues. He sits on several industry bodies concerned with packaging including ECPA's Packaging Expert Group (PEG). The paper cites some policy positions formally adopted by the industry but these are complemented with some of the author's views which are not necessarily formal policy of ECPA or any other industry body.

The focus of this paper is on strategies for the most familiar "product presentation" - the pourable formulation in a rinsable container. However, it is important to recognise the enormous contribution to waste minimisation being made by innovative advances in CPP chemistry, CPP formulations and delivery systems.

* There is the steady general trend for potent active ingredients to replace their less potent predecessors.

* Improved formulation technology is allowing higher concentrations (provided safety is not jeopardised).

* Newer presentations like water soluble bags and water dispersible formulations can reduce quantities of contaminated packaging.

* In some market sectors, the use of multi-trip containers is increasing.

All these initiatives are manufacturer led and contribute to a reduction in single-trip packaging. However, it is not anticipated that these changes could eliminate the need for the traditional packaging system.

THE ISSUE

Historically, little attention had been given to "container management" after the container's primary job had been done, i.e. containing the product through the supply chain.

Consequently it was common to find heavily contaminated CPP containers on farms, either accumulating indefinitely or disposed of using entirely ad-hoc arrangements in the absence of generally agreed guidelines.

In line with the general increase in concern for the environment, the question of CPP container disposal has attracted the attention of all stakeholders in the supply chain - manufacturers, distributors, advisors, regulators, and, not least, the farmers who have been in the front-line dealing with packaging waste.

This increased awareness has been influenced significantly by developments in waste management outside the agricultural sector. For the public at large, packaging is a particularly conspicuous example of "waste". As a result, it has become a rallying point for environmental concern and the subject of environmental legislation - "the politics of the dustbin!". Often, laws like the EU Packaging Directive have been conceived for beverage containers but their scope all-encompassing to include CPP packaging. As "packaging waste" has become popularised, several commonly accepted "beliefs" or "dogmas" have emerged, e.g.:

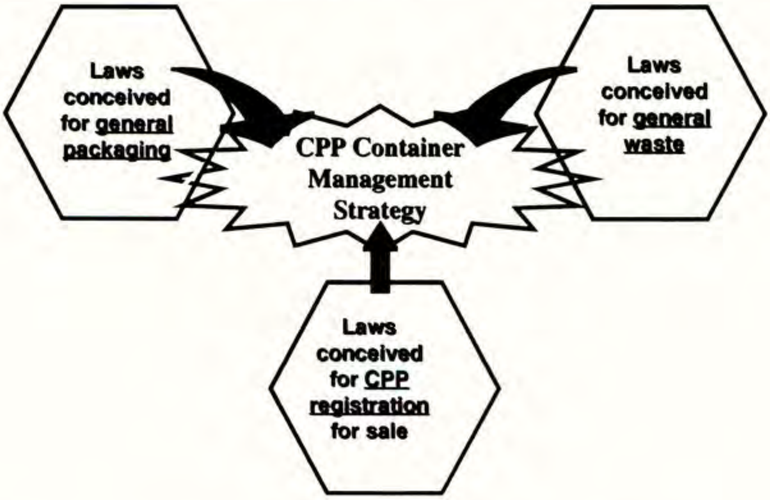
* "quantities of packaging material must be reduced".
* "it is always best for packaging to be collected from end-users".
* "materials recycling is superior to energy recovery".

It has been a matter of concern for the industry that these dogmas could be applied blindly to the situation of CPP packaging waste management even if not appropriate according to scientifically based assessments. The threat is that "dogmas" and solutions associated with beverage bottles will be inappropriate to the circumstances of CPP packaging.

This paper does not argue that these dogmas are always "wrong". In many specific situations, they are right. What is wrong is to apply them blindly - the circumstances rule!

There are also important influences on container management from regulations directed at general waste and registration for sale of new CPP products.

Figure 1. Container management strategy - needing to account for diverse sets of laws



The manufacturers welcome appropriate regulatory controls in this field but are concerned that regulations could become disproportionate and poorly harmonised.

In the absence of a clear and comprehensive strategy, this "worst-case" scenario can be envisaged (highly simplified).

Step 1 Sub-optimal disposal of uncleaned containers left on-farm with no regard to guidelines.

Step 2 Pressure for regulatory controls.

Step 3 Local, uncoordinated collections initiatives.

Step 4 Containers classified as hazardous waste because collection activity not preceded by a cleaning campaign.

Step 5 Legal liability for collection placed on industry.

Step 6 New stewardship concerns raised by uncontrolled use of container material in recycling initiatives. This scenario would clearly be adverse from both stewardship and cost viewpoints.

At the same time there is a significant "pull" for improved waste management options from grower level. These have been the drivers to develop clear strategies.

SPECIAL CONSIDERATIONS TO DRIVE STRATEGY

For CPP packaging, the following special considerations need to dominate when devising improved strategies for waste management.

* **The packaging performs a critical positive role** in assuring product safety during transportation, storage and dispensing. It is imperative that this positive role is not endangered in the name of better waste management.

  For example, packaging could be "lightweighted" beyond present limits we accepted a lower "drop test" performance. However, this would increase the risk of container leakage during transportation.

* **The supply chain is long and specialised. The waste is dispersed.**

  Few human activities are as geographically dispersed as agriculture. Furthermore, it is practised under an enormous range of conditions with respect to scale as well as levels of income education and infrastructure. On top of this, the activities are seasonal. These considerations inevitably compound the complexity and cost of collecting packaging waste. It is important that prospective moves to container collection are demonstrably positive and not inadvertently negative! This could occur if facilities involved in waste management failed to meet reasonable standards or if the supposed resource gain from recovering packaging was outweighed by the fuel used for additional vehicle journeys.

* **The CPP residues inside packaging are a higher priority than the packaging itself.**

  Accordingly, any strategy must emphasise the minimisation of residues in containers, then as an additional assurance, arrange that the channels for subsequent use and ultimate destruction are "closed" and suitably approved in order to address perceived risks, not just actual risks.

This has driven the industry's strong support for energy recovery[3] as the preferred final treatment methods for CPP rinsed containers.

The development of material recycling options are well known and can play a useful role. In USA and Canada, the material recycling option plays a key role in the programme. Importantly, the industry took great care to go through a careful process for risk evaluation and selection of these end-uses.

Materials recycling and energy recovery are sometimes viewed as rival approaches but it is more logical to consider materials recycling as providing another life prior to ultimate destruction. There is general agreement that energy recovery is the preferred approach for this final destruction irrespective of whether the container has one or multiple lives.

INTERNATIONAL EXPERIENCE - PITFALLS AND LESSONS

The strategy of the major CPP manufacturers has been founded on the special considerations above and practical experience in the most proactive countries. There are now some impressive "role model" countries, e.g.:

* Netherlands - The exemplar for rinsing implementation.
* Canada, USA and latterly Germany - with industry-tailored collection programmes now capturing over 50% of containers put onto the market (for rinsable products).

This section summarises the key pitfalls and lessons.

Never just collect packaging

The act of collection is a visible sign of commitment and action but in isolation achieves nothing. It will raise expectations but in the worst case scenario, the organisers would face an accumulating "stockpile" of heavily contaminated containers but no money or plan for final treatment.

Container cleaning programmes - a big role for all stakeholders

This is the subject of a companion paper (Smith, 1998).

The need for on-farm container cleaning is a fundamental requirement irrespective of the subsequent arrangements for disposal/recovery.

[3] The definition of energy recovery conforms to that adopted in the ECPA Container Management Strategy (Anon. 1997). This is a broad definition which includes certain uses in the steel smelting process like that used currently in Germany.

These are the ingredients for a successful programme:

* A container cleaning requirement displayed on all product labels (short wording).

* Container cleaning promoted by National Associations (NAs), manufacturers and the entire chain. Emphasis on economics as the main motivator.

* Strong uptake of "integrated pressure rinsing" equipment on tractor drawn sprayers, (except where agriculture is small scale/unmechanised). Consideration should be given by public sector agencies to these incentive mechanisms:

  - Technical standards.
  - Fiscal incentives.
  - Training.

Even if all these ingredients are successfully applied, a container cleaning programme will trigger some new questions from growers, e.g.:

* What about containers for products not intended for dilution in water?
* What to do with the container after cleaning? (see below)
* What about containers which are hard to clean by virtue of their design? (see below)

General

Experience shows that container management strategy needs to be conceived and implemented as a broad project which addresses the diverse issues involved. This is vital since the different elements of the programme are interdependent. Collection will fail without rinsing. Cleaning will fail without quality container designs etc. It is hard to overemphasise the needs for:

* Strong multifunctional teams.
* Strong administration.
* Multi-stakeholder participation.
* Alliances with organisations competent in waste management.
* Sound financing.
* A proactive philosophy.

THE MANUFACTURERS' POLICY & STRATEGY - KEY ELEMENTS

The CPP manufacturers have active packaging expert groups and meetings are held regularly at international level to recommend policies, guidelines and "best practice".

They are developing, at international level, a common position (the draft is included as Appendix 1) with respect to container management.

This section summarises the European Crop Protection Association (ECPA) strategy (Anon. 1997) which fits in with this global position.

Figure 2 puts the various building blocks in context.

Figure 2. ECPA container management strategy - three[4] approaches for recovery/disposal

The unacceptable practices

The following practices are no longer acceptable:

* Indefinite accumulation of waste packaging at farm level.
* Entry of used container material into waste streams lacking safeguards.
* Non-approved container reuse.

In addition, the 'good' approaches hereafter are not recommended if they cannot be well-implemented.

Quality packs and on-farm container cleaning

There are three contrasting approaches to container disposal/recovery. All three depend on two essential building blocks:

* Quality container designs to maximise the capability to remove residues.
* On-farm container cleaning ensuring that residue removal happens in practice (Smith, 1998).

Figure 2 shows the interdependence of the strategy's 'building blocks'.

[4] The three approaches are not arranged here in a hierarchy. The text discusses ranking of the options and how to select for particular circumstances.

Non hazardous classification and closed channel

The rinsed container presents no hazard for the purposes of transportation and handling in approved waste channels. It is imperative that a 'non-hazardous' classification is secured opposite relevant authorities for the rinsed container.

At the same time, even cleaned container waste should not be allowed to enter uncontrolled waste streams leading to undefined end-uses. This position reflects the 'precautionary principle' that the public at large and regulators expect the industry to observe.

The three approaches for disposal/recovery

With containers conforming to industry guidelines and containers effectively cleaned on-farm, there are then three approaches supported for disposal or recovery. These must be considered and selected on the basis of local assessments of environmental impact, economics, logistics and legislation.

* Schemes for CPP packaging collection then energy recovery as the preferred approach to final treatment. Material recycling opportunities may prove worthwhile as an "extra life". Selecting this "collection" approach requires that key criteria are satisfied; practicality, acceptable cost and stewardship assurances.

* Inclusion in municipal waste streams, preferably with energy recovery, and provided safeguards are in place, in particular concerning avoidance of the possibility of crop protection chemicals containers being selected out for inclusion in non-approved material re-cycling streams.

* On-farm disposal observing guidelines for best practice provided that a study has shown there is no feasible alternative.

None of these approved approaches allow for scenarios where used containers would enter unknown or uncontrolled waste streams. All three qualify as "closed channels"

All three options are needed to span the diverse situation found across Europe. All demand effective implementation of 'best practice' guidelines to achieve quality operations in practice.

STRATEGY IMPLEMENTATION

For implementation of the strategy, specific actions are identified for both national CP associations and for CPP manufacturers:

National crop protection associations

* Set up a container management task force to establish a container management strategy and to deal with the rinsing and disposal campaign.

* Audit current packaging against GCPF (formerly GIFAP) design criteria.

* Discuss campaign principles with authorities to gain their approval and support. Specifically gain agreement for a non hazardous classification.

* Implement communication campaigns on rinsing at farm and dealer level.

* Incorporate disposal of post consumer packaging waste into education campaigns.

* Conduct farmer surveys to assess attitudes and degree of compliance to rinsing and disposal recommendations. Agree a budget and funding mechanism to implement strategy and campaigns.

* Actively network with other national associations to share information and experiences on collection and recovery schemes.

<u>CPP manufacturers</u>

* Implement quality container designs.

* Implement newer technologies which contribute to minimising packaging waste.

* Reduce the amount of packaging requiring disposal.

* Promote best practices for container rinsing and disposal through education programmes including training field sales and technical staff.

* Include information on rinsing on product labels/instructions for use.

* Be prepared to provide appropriate technical information on rinsing to National Association on rinsing and disposal procedures.

The activities above should engage fully with other stakeholders as appropriate.

CONCLUDING REMARKS AND NEXT STEPS

There is "pull" for improved container management from field level. At the same time, there could be new regulations affecting packaging arising from diverse areas. Given this scenario, it makes sense to take a proactive positive working in appropriate "multistakeholder" groups.

REFERENCES

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APPENDIX 1 **DRAFT**

CROP PROTECTION INDUSTRY (GCPF). GLOBAL POLICY ON PACKAGING WASTE MANAGEMENT

The crop protection industry is committed to the safe and beneficial use of crop protection products. Responsible management of packaging systems is an integral part of this overall commitment. Therefore, industry member companies will strive to manage packaging systems for our industry's products in ways that foster safety, environmental protection, customer convenience and resource conservation. A hierarchy approach to managing packaging systems will embrace the following order of preference where technically and economically feasible.

* Reduce the amount of packaging components.
* Reuse packaging where possible.
* Recycle empty containers and other packaging components for energy or material value.
* Dispose of those packaging components which are non-reusable or non- recyclable in accordance with environmentally and economically sound practise.

There are several options for achieving packaging waste management goals.

Reduce:

* Use of higher activity chemistry.
* Increase concentrations of formulations.
* Use of water soluble film packaging.
* Lightweighting containers.

Reuse:

* Use of bulk/reusable containers.
* Reuse of secondary packaging components, i.e. pallets.

Recycle:

* Will promote complete use of container contents and subsequent container rinsing.
* Will include a rinsing and disposal instruction on all appropriate product labels.
* Will support education and training programmes designed to facilitate container rinsing.
* Considers that energy recovery in approved quality facilities is the most suitable and economic solution for the disposal/recovery of used crop protection packaging, where viable collection schemes are available.
* Accepts that only in certain countries, i.e. USA, Canada, where qualified facilities are available can approved end uses for recycled plastic containers be a viable option.
* Accepts that, in many countries, on-farm burning or burying will have to continue until better alternatives are developed which are practical and economical. Industry will act proactively to achieve better alternatives.
* Will provide a decision model to help select packaging waste management options for crop protection product packaging.