The Importance of Spray Drift Management around the World

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Abstract

Pesticide spray drift is important in world agriculture because of its high visibility as a symbol of waste, and potential contamination of water, humans and the environment. In the US, drift is considered to be the #1 issue by State Depts of Agriculture. Evolutionary changes in crop protection affecting acceptance of drift mitigation strategies include new chemistries, government policy, new crop protection terminology/tactics, farm economics, risk aversion, and intensification of public perception. Endangered Species and new water regulations have significantly large buffer restrictions pending in order to mitigate spray drift. Grower groups have requested greater flexibility for site and operationally specific drift mitigation strategies. Some of the critical issues for improving the importance and acceptance of drift mitigation include: grower empowerment, partnership efforts with large government policy programs, on-site flexibility for risk mitigation, creation of added value in insurance rates, information, stewardship, neighbor communications, reduced buffers, and provision of costs/benefits. Pesticide stewardship can be more than a buzzword with an integrated drift management strategy and grower participation in drift mitigation solutions.

Introduction

Spray drift is defined as the physical movement of a pesticide through the air at the time of application or soon thereafter to any site other than that intended for the application, i.e., non-target (Anon 1999). Most pesticides are applied by the atomization of liquids through a nozzle under pressure. The creation of small droplets within the spectrum allows them to be easily moved by air currents to other than the intended –plant targets. The proportion of fines within the spray cloud is critical (as is the wind velocity and direction at the time of spraying) to the potential off-site movement, hence the development of new nozzle technology.

Pesticide spray drift is considered important to world agriculture because it represents not only a highly visible symbol of waste but also the potential contamination of water, humans, and the environment. For example, drift management in the EU, in general, is shown in actions via the water directives with the use of buffer zones, and in some countries, windbreak vegetation, pesticide reduction schemes, inspection and monitoring requirements, fines (GER) of improper utilization of drift nozzles, and calibration clinics. In Australia and NZ, we have published documents (and a web site) on the establishment and use of windbreaks for drift mitigation. Data on human health continue to dominant the perception and reality of hazards posed by the off-site movement of spray drift (Anon 2001a, and Anon 2001b). Health authorities are increasing their monitoring of pesticide intrusions world-wide and are attempting to document specific causes due to drift. Ramos and Gupta (2004) report that human safety is a continuing issue as emphasized by the fact that between 1998 and 2000, approx. ½ of all reported California pesticide poisonings related to agricultural use occurred as a result of pesticide drift. The industry has greatly reduced the highly toxic and known “bad actors” but some still remain due to lack of sufficiently useful replacements. An increasing number of cities (Cal) are promoting urban planning for housing developments close to agriculture and which will restrict developments to minimum distances from farmlands (P. Klassen, pers com). A more innovative urban planning program has being proposed in Oregon which establishes standards for restricted distances and the use of buffer distances and windbreaks for housing developments near to agricultural production (Cavallaro 2004). As water becomes scarce and water quality more important, it is clear that we will see an increased impact on drift management guidelines from new government policies.

Technology/strategy	Impact
General	
Regulatory structure	FQPA, risk reduction, labeling specifics, application restrictions
Population demographics	Increasing conflicts at rural/urban interface; communication/proactive stance essential
Pesticide policy	IPM, risk reduction to aid targeting; farm policy increases crop diversity, decision making, and drift concerns
Ag economics	Global competition, prices pressure input reductions; ag business integration will affect user strategies, capabilities, and options
Knowledge	Decrease in applications via thresholds, prediction models, and CV resistance/tolerance to pests all aid drift reduction goals
Delivery technologies	
Seed coatings	Increased seed value and early plant health protection requirements suggest new opportunities for target-specific controlled release AI's/fertilizers
Herbicide weed wipers	Declining use—speed of travel and appropriate AI plus weed complexity issues
Sensors	Tree crop sensors (on/off), sprayer match to foliar target requirements, weed ID technologies with GPS/GIS
Nozzles	Drift and VRT nozzles, plus drift classification schemes, standardization, calibration/output clinics, closer crop/nozzle distances
Shrouds	Shrouds/shields, and air assistance useful in expanding weather-limited operating conditions plus reducing off–target percentages
User strategies	
Strategy integration	Coarse nozzles, reduce sprayer to target distances, reduce pressures, use drift mgt. adjuvants, ID and avoid vulnerable sites, and adjust strategy for high-risk sites, and changes in weather constraints
Restricted delivery	Real-time drift predictors, drift models aid precision timing and delivery
Buffers/windbreaks	Space and vegetation mitigate off-target movement; some regulatory and label requirements
Cropping strategies	More plants/unit ground, less off target losses, increased high-density plantings
Education	Mgt./training of new skills, more pro-active users; high-risk site ID with appropriate drift minimization tactics
Genetic engineering	Crop protection from within reduces need for external use of pesticides

Table 1. Emerging technologies and strategies affecting placement efficiency (drift) of pesticides.

A number of symposia and workshops have been held on application technology and which have included sessions on spray drift (Hall 1994, Buckley 1998, Anon 2001a, Anon 2001b, and Sayles and Siddhanti 2003), and the recent application symposia of Cross et al 2002, and Bateman et al 2004. As we will see during these sessions, we have updated information on nozzle technology, education, spray management strategies, regulations, harmonization efforts, and models. Some of these emerging technologies are listed in Table 1 (Hall (2002). Recent data from the UK also emphasizes the point that **drift is but one part of misapplication factors**, with ca 60% of pollution being from point sources and drift being a small component of all losses by diffuse sources (40%). This data was complemented by data from the insurance industry showing 47% from the wrong product, 32% from inadequate rinsing, 8% in the wrong field, and 11% from drift (Buckley et al 1998). Nevertheless, the US state Depts of Agriculture now report the **#1 issue being reported to them is drift.**

As shown in this meeting agenda, drift management has involved classification of nozzles, an education thrust, hands-on calibration clinics and inspection of sprayers, global harmonization discussions, low drift nozzles, shrouds and air assistance, adjuvants, regulatory thrusts, buffers and drift models. Each country has developed their own strategy on the management of drift governed by government policies such as the EU water directives, a general pesticide reduction strategy, the pesticides indices project, education thrusts, both monitoring and inspection requirements, and the AI restrictions for environmental risk goals. During this meeting, we will have updates on EU and German efforts on drift nozzle mandates with the 25, 50 and 75% guidelines with appropriate fines for non-conformance, the NL buffer regulations, over-tree spraying, the Australian windbreak efforts, and the US labeling thrust as well as development of BMP's.

These advances continue to improve the user ability to more efficiently direct sprays without excess losses to the environment.   At first glance, it would seem that of course drift management is important, which is why we are here from all parts of the world to discuss the subject.   But it also seems to represent only a small fraction of the misapplication factor. So how we can we improve the development of more effective ways of improving this stewardship effort? I would point out that these same topics, many with the same titles, have been utilized in past symposia and the many workshops held within the respective countries represented here today. Just what has allowed change to take place in this technology and why hasn't it proceeded at a faster pace then we have seen over the past 20 years? There are a number of changes in crop protection tactics, and technologies that have affected how such tactics are received and accepted.

The Changing Environment for Agriculture

A significant evolution in pesticide related tactics for agricultural crop protection has taken place in the last 20 years. The many facets of change include new chemistries, shifts in government policy, societal implications, new terminologies and technologies and include an intensification of public perception because of demographic changes.   These changes will have a distinct and unique affect on how growers accept and advance their respective practices in the absence of direct regulatory restrictions. For example, crop protection chemistries are now much more powerful, specific, more expensive and less toxic (to man and the environment). Government policy has increased the focus on pesticides and now clearly delineates and limit uses because of environmental hazards and include an overall pesticide reduction strategy as well (EU) while at the same time encouraging IPM strategies. Water quality issues and Endangered Species policies now dominate the discussions about pesticide use restrictions. The Endangered Species Act has profound implications for the amount of buffer space being mandated (in the case of salmon in the NW) which would remove a significant % of ground from a grower's available landscape thus limiting his livelihood. Lacking an accepted set of strategies by EPA and ignoring the pending threats of excessive regulations, will only create an untenable economic situation for our farmers.

With crop protection strategies, for example, we have gone from the goal of pest 'death' to the more elaborate terms of yield increases, quality benefits, resistance management, IPM goals, and combinational tactics, and now towards more sustainable and bio-intensive levels to include whole farm and agro-ecosystem approaches. These latter efforts, involve multidisciplinary team efforts, and grower empowerment alliances. The changes in how one approaches problem solving efforts is thus now quite different and more complex thus putting simple questions of pest control in a different perspective. Along with a different agricultural economy and cost marketing structure, development of drift management tactics without rigid regulatory restrictions will thus require a greater awareness of grower behavior, risk aversion and rationale of grower decision-making. Societal changes include demographic movement from urban to rural agricultural landscapes accompanied by a much higher public perception of RISK and the increased nearness of housing to farmlands has resulted in a significantly increased visibility of off-site pesticide drift. Technology has produced GIS/GPS system potentials although they have not yet achieved full potential. New nozzle technology systems, controllers, and sensing devices have all contributed to a greater awareness of environmental contamination hazards and add to the more complex management system now demanded of pesticide users. The increased costs of pest control, of course, have their attention, as profitability is a major driver of changes in agricultural production practices.

Improving Drift Management Implementation

So it would appear that we have been successful in demonstrating the importance of drift mitigation around the world or have we? Woods (pers com 2003) stated that " an issue ignored is a crisis invited" and thus we see increased stewardship efforts by companies.   We are here to communicate our respective findings from the various countries and provide greater impetus for a harmonized approach to drift management. Thus we will hear of actions in Europe, UK, Australia, and the US, etc, on legislation, drift management regulations, equipment inspections, monitoring, etc. Yet we in the US still have significant incidences of drift intrusions, worker exposures and complaints about sprayer calibration being less than par. Why after all this emphasis is this still the case? How can we improve the case of the importance of drift management to the user clientele? What are the critical missing links that we should emphasize this week? Should we have more meetings, change directions, add more $ to the education, include more hand-holding at the farmer level? Who will pay? What seems to be missing from this picture as the message is apparently not being received as fast as we would like thus creating potential for additional regulatory restrictions.

Several grower groups (Cal DPR- Drift Min. Initiative 2001) have requested greater flexibility at the farm leading to site and operationally specific BMPS's based on sound science. Increasingly under greater scrutiny and restrictions (Clean Water Act), the American Farm Bureau, for example, supports legislation that encourages locally designed and implemented solutions including voluntary incentive-based approaches to solving water quality problems (AFB, 2003). Interestingly, we at OSU now have a pending PILOT project on a farmer self-assessment of spray drift risk, which addresses cost/benefits, incorporates GIS technologies with on farm satellite imaging, and an options decision array based on a site and operationally specific analysis of the growers capabilities. Thus we identify the site risks on each farm block and address the individual options for drift mitigation based on farmer equipment and operationally specific parameters. This approach thus overcomes the "one size fits all" mentality and the " treat all for the sake of the fraction of risky sites" tactics currently being advocated. Using best available science, and proven scientific tactics of nozzles, application management, buffers and windbreak vegetation, we hope to show that creativity at the farm level will result in drift management tactics with far more acceptance than one tactic fits all. Gower empowerment can thus lead to more powerful total farm actions on a long- term basis for both environmental and economic evolution. We also are advocating the merging of the drift mitigation – air quality thrusts into the larger areas of government sponsored conservation and water quality programs, which carry with them significant monetary support.

Education, technology development and government policy (including label restrictions) have been the recent major thrusts of drift mitigation strategies. However, serious attention to the development of site-and operationally specific tactics, which **integrate** an array of technologies, i.e., management tactics, edge practices, the use of buffers zones and buffers including windbreak vegetation seem to be missing. With the exception of the tree fruit meeting by Hall, (1994**), none of the meetings and workshops have included the identification of cost and benefits for drift mitigation strategies or grower coalitions.** This is true even of the workshop today. Without a sense of costs and benefits being identified, serious progress in taking the risks of change is not likely to occur. In addition the concept of a silver bullet single technology solution while appealing to agriculturists, is not a sustainable practice and an integrated approach is a vital step towards improving the acceptance rate of additional drift management practices. Making these concepts straight- forward is a critical first step however. The solutions of complex environmental problems such as drift are beginning to be resolved by the use of Ecosystem approaches (Smit et al, 1998) with broad multidisciplinary linkages. Interestingly, the Univ of Chicago recently formed a new multidisciplinary series of partnerships in a new Institute aimed at more effectively addressing the complex studies of WIND; patterns, movements, etc – an interesting similarity to drift problems. Clearly, the movement of particles such a liquid droplet can also benefit from similar approaches in multidisciplinary research partnership. The emergence of GMO technology forces us to look at the movement of genetically engineered pollen (soil particles) in a similar approach as they will also move in wind currents under many of the same conditions as liquid particles as noted by Hall (2003) in a recent study of vegetation capture of pollen. Modeling technologies will undoubtedly help us improve our guidance to users of current agricultural tools. Nevertheless, I do not foresee the need for growers to individually utilize the tools such as AgDrift or PRIZM as they attempt to establish a site and operationally specific set of options for their farms. On the other hand, how much is safe enough when we utilize established sound science data (including our drift database) to provide these options for drift mitigation? I give credit to US EPA WED who have recently established a comprehensive study of herbicide ecological effects to answer this question of ecological safety (Anon. 2003). We know from our scientific literature that *each component of drift mitigation can cumulatively add to the overall reduction of spray leaving the* *target field*, and thus our recommendation for utilizing (as many as possible) proven factors of drift mitigation.

I see a number of missing elements from the current discussions of spray drift. Firstly, the lessons learned from other complex environmental problems suggest that we:

a. Identify costs and benefits,
b. Know user behavior and rationale,
c. Provide clarity in our approach to change, and
d. Know linkage opportunities,

These lessons also show that multidisciplinary approaches, which take time and are filled with bureaucracy, also provide significant opportunities that a single program approach does not offer. Knowing what inhibits acceptance of change is also vital to achieving success. Consequently, we must make some effort in understanding grower inhibitions and apprehensions about change when they face increasing costs, more paperwork, difficulty in finding labor and markets in a global economy, etc. Buying new sprayers @ $50,000+ is not viewed by growers as a practical solution to resolving "a small problem like <5% drift. Sharing diminishing resources has also proven to be successful in the water coalitions in California (CURES 2004). These recent coalitions have resulted in US Fish and Wildlife Service calling the Huichica Creek coalition the most creative, grower based organization that they had ever encountered. This coalition activity suggests that, in the presence of oncoming regulatory restrictions, they will undertake a proactive stance in providing a more practical grower oriented solution. It remains to be seen whether they will do this in the shadow of pending regulations??

Development of grower power has shown to be successful but it will take creative leadership willing to impart the time and effort to get reluctant participants underway in an effort that they do not feel justifies a new sprayer, or even the time for planning drift options, etc. In my opinion, the only way we are going to achieve the goal of enhanced drift management at the user level is to better utilize the Drivers" of drift policy i.e., water, endangered species, pollinators, demographics, etc. For example, the 2002 US Farm Bill does include the Conservation security Program (CSP) and brings additional financial support for conservation measures adopted by the farmer. This currently does not include air quality or drift components. We miss the opportunity to avail ourselves of added agency resources including financial if we do not encourage the inclusion of appropriate drift mitigation strategies in these programs. Likewise, the various Water Acts also provide the opportunity to accomplish similar goals, as does the Endangered Species Act.

We know that the **major constraints to adoption of change** include:

a. The presence of a federal program without flexibility,
b. Contain too much scientific language vs farmer lingo,
c. Lack measures of success visible to the grower,
d. Do not clearly merge with farm based goals,
e. Are not perceived as practical and hence seen as risky,
f. Lack an incentive for learning, and
g. Mandated federal programs frequently miss the mark since they are not user defined.

So what is needed?

There are some questions that we should raise in our discussions during this international meeting. For example, do we do enough to optimize the dose transfer process or put another way, can we utilize the drift regulatory thrust to drive the research needed to reveal how to put more into the field and thus, achieve less waste? In the US, can we emphasize the point that faster travel speeds can be minimized at those identified points of site vulnerability, but we have to document any costs (to the operator/custom operator) of these adjustments. Growers have called for site and operationally specific options – we should take these requests and move on it. Why must we treat all 500 acres for the sake of <5 acres of vulnerable edges on 6 of 10 blocks of the farm with a sub-optimal delivery process of crop protection? Surely, engineering technology will allow us to change the delivery process – **from the tractor seat ---** on these vulnerable edges without stopping to change nozzles or to use less than optimal drop patterns on the majority of the farm? In the US, we must address the perception that faster is better – as far as custom applicators are concerned. Faster travel speeds mean higher booms and increased potential drift. We can and must insure the critical adjustments for those defined vulnerable sites, which require lower travel speeds and lower boom heights along with larger drops. GIS technology is still not where it should be, although it is recognized that new technologies typically show a very long acceptance curves as documented by seed corn, and now GMO technologies. Clearly, making appropriate changes in delivery patterns, spray volume, and drop size should all be able to be done from the tractor seat. And why can't we have communications on the tractor seat to alert applicators to changing wind speed and wind direction? Can we plan those changes in advance of crop season in terms of tactics for vulnerable site edge modifications, and notification of neighbors, with the knowledge that off – site sensitivities must be recognized and managed? Thus in attempting to manage risk (of spray drift), we must first attempt to insure that risk assessment, and risk characterization are defined as demonstrated from the early days of RA/RM process evaluation (Figure 1), which is what we are trying to do with the OH PILOT program. Nevertheless, if we partner in the key players, and fully utilize what NASA and other participating agencies have developed, i.e., EPA/NASA satellite agreements, the NRCS GIS work for conservation utilization and others, then we can more effectively utilize all the tools that are being developed. We do not have to do it all in one full swoop – just some small steps to get key grower participants into the scheme of planning for drift mitigation.

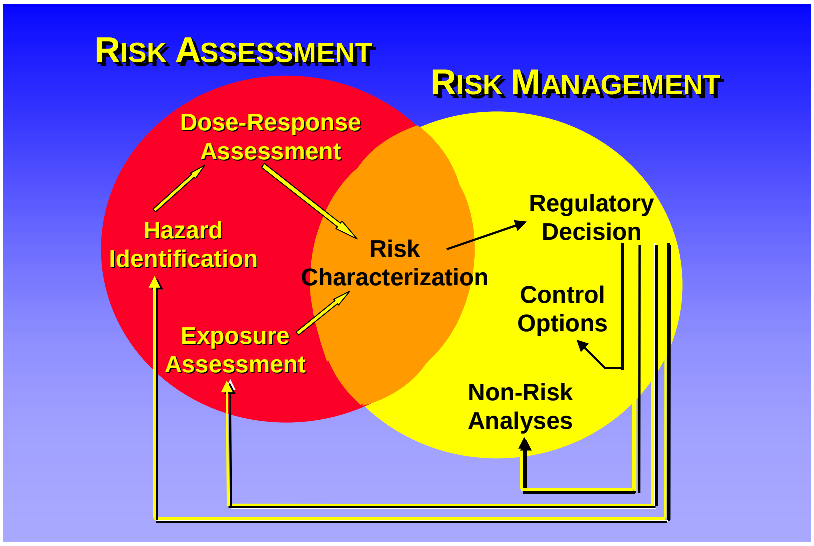

Figure l. The risk assessment, risk characterization, and risk management process.

Recommendations

So what can we do to improve the status of drift management as we discuss the updated advances for the next few days? How about including in our recommendations, the clear message of importance to our users, development of cost benefit linkages, which are necessary to help elicit rapid changes in current farmer behavior. Partnerships efforts are critical and we can insure the development of more creative innovative solutions to site vulnerability identification and management if we include farmers in the discussion of solutions and options. The inclusion of farmer knowledge herein is not obvious and in my opinion we miss a great opportunity to aid the cause of increasing the importance to this clientele. We must promote flexibility in their operation while at the same time recognizing that the regulators must see something that improves the performance measures and insures needed restrictions. To insure acceptance of new technologies plus education of new management tactics, we must create a sense of **added value** to the users with some effort at a. reduced insurance rates, b. value of information and service, and c. a greater awareness of the value of stewardship and neighbor relations. We must clearly demonstrate to those who relate to the concept of WIFM or "what's in it for me", that there is indeed great value in going these extra steps to insure future farming without excess regulatory restrictions and which also enhances their marketing capacity and ability to continue farming. If we just act defensively, we miss the opportunity to advance our case for improved delivery of what we think are necessary crop protection tools needed for producing the foods stuffs for a rapidly increasing world population. While I have addressed these steps and focused on the US, I am confident that similar tactics can be utilized in other countries. In order to keep current on what is being achieved not only in the regulatory arena, but also in the science of application technology, I would urge that the suggestions of Hewiit and Wolf (2004) for a data base regarding drift be established. In that way, the science of accepted techniques of drift mgt can be rapidly identified and merged into various country practices and guides using the database of **accepted sound science** as the basis for advances.

The Critical Issues for Increasing the Importance of Drift Management

Transmit the importance of drift mgt to the user
The pending ecological regulatory restrictions could provide added incentives
Partnership efforts are necessary with diminishing resources
Promotion of flexibility in site- specific tasks with regulatory approval for performance
Create added value for drift management tactics in

- Reduced insurance rates
- Information
- Service at the farm level
- Stewardship enhancement and community visibility
- Enhanced urban/rural communications
- Reduce buffers per LERAP

Use the "Environmental Drivers" to aid incentives and encourage change

- Water
- Endangered Species
- Pollinators/natural areas
- Demographics/Food Production Needs

Presence of growers and evidence of organized coalitions
Provide costs and benefits of risk management practices
The need for integrated/comprehensive strategies vs "silver bullet" nozzle changes
WEB site for global database on drift science, i.e.; a source for best avail science
Document ecological impacts on non-point source pollution
Examples of flexible drift management systems according to risk by site

Make it easy to do what's right

Conclusions

What about performance measures, the most difficult of goals because of monetary issues? Accountability and legal issues with regulatory authorities thus remain high on the agenda. We challenge you to consider the aforementioned questions and suggestions as you discuss the issues. Are these elements contained within the respective topics – why not? Should they be? If so, we ask you consider them so as to provoke an in depth discussion while we have this opportunity as an International community of experts gathered here this week. Thus we have a unique opportunity, thanks to our organizers, to merge our respective elements of practices, standards, ISO issues, and to provide an impetus, within your various sessions, to increasing the pace of change s as I have raised here. We must move this important issue up to the next level. We recognize that there will always be differences in drift mitigation practices between countries because of regulatory structure and government policies, the respective agricultural economies, and farming cultures. Nevertheless, we also recognize that the science of drift management as uncovered by respective trials can be accepted and at least selectively utilized by various countries. The elements of the atomization process, nozzle design, GIS technologies, management practices, use of buffer space and now windbreaks as well as restricted active ingredients are all common to drift mitigation tactics in our countries. In my opinion, a **comprehensive, but flexible strategy of drift mitigation** albeit it more complex, will have a greater long- term effect on user acceptance, especially if aided in its development by growers themselves. The experience of integrating new drift mitigation tactics and technologies into the overall risk management process for pesticide environmental loading will be invaluable as we continue to expand world food production capacities. Pesticide stewardship can be more than the latest buzzword but in fact, encourages a wider array of government support, which can aid an abundant supply of safe and healthy food for a growing world population.

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