The importance of equipment standards and related legislation for pesticide safety*

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Summary

The introduction and enforcement of equipment safety standards is one element for reducing hazards for environment and human health in pesticide application. This has to be complemented by formal education and training of operators as well as periodic inspections of sprayers to ensure safe operation. Suitable basic standards and test procedures are mostly available at an international level and need not be reinvented at national level. However, appropriate national legislation and accompanying measures are required to enforce these international safety standards.

Whereas integrated pest management is reducing the dependency on the use of pesticides for pest management, the environmental and human health problems related to the use of agricultural pesticides remain a serious problem worldwide. By the nature of pesticides there are no beneficial or inert pesticides. For this reason safety and efficiency are essential for achieving sustainable agricultural production. Safety issues concern, the operator, the bystander/rural population, the consumer/user of the treated crops, and the environment in general.

Key-words: Sprayer Standards, Safety, Pesticide Application

1. Introduction

Pesticide use on a global level, but particularly in regions with tropical, subtropical or similar climatic conditions, is steadily increasing (Agrow, 1999). So far, only 2% of world agriculture is under organic production, while a majority of agricultural production uses some sort of pesticides (Willer & Yussefi, 2004). It is unlikely that this will dramatically change within the near future. With exception of European countries, no significant reduction in the overall pesticide consumption can be noticed (FAO, 2004).

There are more or less harmful pesticides. With international agreements such as the Rotterdam Convention or the FAO Code of Conduct on the Distribution and Use of Pesticides it is intended to eliminate the use of the more harmful pesticides and to achieve a more responsible use of the permitted pesticides. Many countries have introduced some form of legislation regarding the registration of the distribution and use of pesticides as promoted by the FAO Code of Conduct (FAO 1996). However, this legislation only refers to the chemical components. By the nature of pesticides, there are no beneficial or inert pesticides. Yet, the regulatory aspects of the pesticide application process are, with very few exceptions, totally ignored.

Application technology and its use are intimately related to safety issues. These issues concern first of all the operator of the spray equipment directly, but due to the nature of the products used and the way they are applied, safety issues are also relevant for the rural population around the treated area, the consumer or user of the treated crops and, last but not least, the environment in general. As environmental contamination is normally not confined to the area where it happens and, in times of

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globalization, crops are exported all over the world, local problems of pesticide application quality become issues of global concern (Friedrich, 2000).

To assess the safety of a production process the HACCP (Hazard Analysis Critical Control Points) procedure can be used. The actual application process is one of the most critical points from the point of view of consumer or worker safety. A more detailed analysis of this critical point shows a number of elements that contribute to the hazards.

In order to address these issues, the entire application technology has to be considered. This comprises the actual application equipment and its quality, including the actual configuration, setting and working condition of the equipment. It further includes the operator and his/her knowledge, proficiency and awareness. The identification of the critical points within the entire application process can lead to the removal of those points and the reduction of the hazard. Priority is given to engineering solutions for the removal of the hazards. For example if leaking equipment is a problem the solution would be to eliminate the leakage and not to rely on protective clothing. Likewise is it preferable to control spray drift with adequate drift reduction technologies rather than relying only on excessive buffer zones (MAFF 1999, Anon 1999).

2. Problems of pesticide application processes

General practice in the application of pesticides, particularly in tropical countries, is far from desirable in terms of economic, environmental and human health considerations (Matthews, 2002). In Europe the use of pesticides and related spray equipment is increasingly controlled (EU Commission, 2004), and drift considerations are leading to strict regulations. Contrary to this, in countries without such legislation, bad practices are common. Modern pesticides have reached the most remote parts of the world, but the technology used for their application often reflects technologies used 40 years ago. This results in a waste of pesticides, unnecessary environmental contamination and extensive health hazards for humans and wildlife.

Compared to generally accept good practices it is very common to see pesticides being overused in terms of quantities and mixtures applied per unit area and over time. Cocktails, mixtures of different products, are often applied 20 to 30 times per season in a number of crops like vegetables, cotton, tobacco, fruits and ornamental plants. Technically there is no justification for these spray regimes if the application was carried out properly.

This demonstrates that pesticide application as often carried out is mostly inadequate for the problem to be addressed. Even where integrated pest management is known and applied, the actual application of control agents, if and when they are used, is mostly the weakest link in the chain. Unsafe equipment, incorrect setting of the equipment, wrong direction of the spray and uneven distribution, result in some areas being left untreated but also lead to overdoses in other spots. This overdosing of the crop creates hazards for both people and the environment. Also, excessive spray pressures and excessive volumes applied in areas where water availability is no problem, leads to drift and runoff.

In the absence of specialised knowledge and equipment, unsuitable technology is used for specific spray operations with the result that pesticides are not properly delivered to the target. This leads to a high wastage of pesticides and hazards for operators and environment. Some scientists suggest that only 1% of the pesticides used worldwide actually reach their target (Pimentel 1995). Some application techniques are so well established and popular that a change to safer or less wasteful technologies is very difficult. Examples of these technologies are adjustable nozzles on knapsack

sprayers as well as high pressure and high volume spray guns and lances. The lack of understanding of the equipment also leads to this situation.

Waste means that the products miss their intended targets and are thus not fulfilling any purpose. However, they do not just disappear; but lead to an unnecessary contamination of the environment. The result of this has implications for the entire environment such as birdlife, marine and terrestrial fauna but also on soil life, which leads to soil degradation and erosion problems. In some production systems the economic damage caused by pesticides is higher than the potential benefit derived from their use (Pimentel & Raven, 2000).

Particularly high damage is caused by acute and chronic damage to human health. The estimation of yearly accidental poisoning of spray operators varies widely. This is due to a high percentage of unreported cases. It can be assumed that accidental casualties caused by pesticides are in the range of tens of thousands of cases per year, while general intoxication accounts for up to several million cases per year (Jäger-Mischke, 1989). Even less information exists about chronic and long-term effects on the rural population of pesticide overuse in these areas.

The wasteful application of pesticides leads not only to unnecessary contamination of the environment but also to poor control of pests. Areas remaining untreated or receiving sub-lethal doses remain as focal points for new pest outbreaks. In the absence of proper pest scouting, these points are difficult to spot and lead to repeated treatments of the entire area. This results in even more applications and ending in a vicious circle which finally leads to the destruction of the environmental balance of entire regions and the collapse of the respective cropping systems. In addition such practice leads to potentially high residue levels on the produce with a considerable variability among samples, converting the export of such produce into a gamble as importing countries are tightening their permissible residue limits (Morgan, 1998). A review carried out by FAO suggested that inadequate pesticide application could be a key component causing residues on agricultural produce (Matthews et al., 2003).

3. Problem analysis

There are different elements of the pesticide application process which influence the potential hazards. These include characteristics of the equipment and of the operator.

3.1. Equipment safety for humans

The risk of accidental poisoning is probably the most direct hazard related to pesticide application equipment. Accidental poisoning may be the result of leakage. This is of particular importance with operator carried equipment, where leakage would in most cases directly contaminate the operator. But also the surface characteristics and design features of the sprayer are important, as they have an influence on the amount of pesticides accumulated on outer surfaces of the sprayer, from where they can be taken up by the operator touching the sprayer.

Manufacturers are often not encouraged to offer sprayers of better quality or fitted with any additional features to improve safety or efficiency, whilst not being considered essential for smooth functioning of the equipment. In countries where the farmer as a client is mainly choosing by price and where he/she does not have the resources or technical knowledge to select superior equipment, market demand does not permit the introduction of anything better (Jusoh et al, 1990). Therefore, in many countries where these conditions apply, application equipment is found to be both unsafe and of poor quality. This is particularly critical considering the high usage of manual knapsack sprayers

in many of these countries (Matthews, 2002a). For the operator, manual spraying is one of the most contaminating of all the pesticide application techniques (Spugnoli & Vieri, 1998).

Reports produced for FAO in several world regions have identified problems of sprayer quality. Particularly with used sprayers operator contamination through leakage from different points of the sprayer was very common. (van der Meijden, 1998, William, 1997, Shakoor Khan et. al., 1997, Sriaru-notai et al. 1997, Resurreccion, 1997, Matthews et al., 2002b).

However, even with new sprayers it seems to be difficult to have a completely leak-free sprayer. Existing standards for knapsack sprayers usually assign a certain limit to the maximum permissible leakage, which is usually larger than 0 ml (FAO 2001). While unsafe manual equipment is mainly a hazard for the operator, unsafe tractor equipment and, even worse, aeroplanes, can become serious hazards for the environment and general population. In the absence of any safety standards, spray equipment in many developing countries is built and repaired by individual farmers, village mechanics or small manufacturers who have no clear ideas about the risks involved in making and using this sort of equipment. Particularly critical are agricultural aeroplanes carrying loads of highly concentrated products.

Apart from poor quality, inadequate maintenance is another reason for safety and environmental hazards caused by sprayers in developing countries. Sprayers are usually in very bad conditions, and nozzles and gaskets are hardly ever replaced (Whitaker, 1993). The main reasons for this are carelessness but also lack of spare parts and a service infrastructure. Leaking knapsack sprayers are particularly dangerous as a recent survey carried out in Cameroon showed that 85% of the operators do not use protective clothing (Matthews et al. 2002b). Although developing countries use only 10 to 25% of the world's pesticides, they suffer up to 50% of the acute poisoning and 73% to 99% of the fatalities among pesticide applicators (Corson, 1990).

3.2. Equipment safety for the environment

Equipment safety for the environment refers to the efficiency with which the equipment can deliver the pesticide to the target, thus enabling reductions in the application rate, increase the target deposit and hence reduce the off-target deposits caused by drift, evaporation and run-off. The technical components which have an influence on this quality aspect are the type and position of atomizers as well as special features such as air assistance and electrostatic charge of the spray. But also the general sprayer design, such as boom stability, have a major influence as they affect the distribution quality and hence the accuracy of application. Obviously, aspects of efficiency become more important the bigger the equipment or the larger the area is which is covered by the equipment.

A further important characteristic for environmental safety is the accuracy with which the equipment delivers the pesticides and to which it can be calibrated. This serves to reduce the volumes of left-over spray liquid at the end of the spray operation. But, also technical design features such as the internal residues which are retained in the sprayer at the end of the spray operation, the quality to which the sprayer can be cleaned internally and externally and the ease with which it can be emptied are important components of environmental safety of an equipment and are hence reflected in modern safety standards for sprayers (FAO, 2001).

Environmental safety would also address the working conditions and maintenance of equipment. In a vegetable project in Indonesia a 70% reduction in spray volume was achieved solely by replacing the old worn nozzles of the most commonly used knapsack sprayers with new flat fan nozzles (Stallen & Lumkes, 1990). With the generally high prices of pesticides, regular investment in new

nozzles should be attractive for farmers if only from the economic point of view, without even considering environmental and health aspects.

3.3. Equipment Ergonomics

As the equipment price is often the most important criterion determining the purchase of a sprayer, ergonomic aspects are often the first ones to be sacrificed. For example, in the absence of recognized standards, most of the knapsack sprayers on the market have uncomfortable and unsafe harnesses (Baleguel Nkot et al., 2002). In case of knapsack sprayers uncomfortable equipment leads to early fatigue. This can then result in accidents affecting not only the operator but also the environment, as toxic products are involved. It also contributes to the image of applying pesticides with a knapsack sprayer not only being a dangerous, but also a hard and unpleasant job. As a result, often unskilled and "cheap" labour is contracted for this task. Operator safety, comfort or efficiency is usually not considered, if the equipment is not operated by the farmer him/herself but by hired farm labour (Friedrich, 1997).

Also for tractor operated, self propelled or aerial spray equipment ergonomic aspects are of importance to facilitate the operation of the spray equipment and to avoid accidents. Aspects such as easy reach of sprayer controls, clearly visible instrumentation, and easy access of loading areas or specific facilities to make the loading process safer are therefore included in modern sprayer standards as safety relevant features (FAO, 2001). Under this aspect even air-conditioned cabins with adequate air filters for self propelled sprayers should not be considered luxury but a safety feature.

3.4. Operator skills

The required operator skills are much more than just knowing how to operate the equipment. They refer to knowledge and proficiency.

Knowledge includes the understanding of the pest, its biology and behaviour as well as the pesticide, its function and working principles. Only in this way can the application operation be properly targeted in space and time. It further includes the understanding of dangers related to certain operations of the pesticide application which can lead to environmental contamination such as discharge of left-overs and contaminated washing water.

Proficiency refers to the understanding of the principles of spray formation and delivery and ability to set, calibrate, and operate the spray equipment in the optimal way. This includes the right choice of equipment and accessories, the correct positioning of the atomizers for the job, as well as for environment and climatic conditions, the correct setting and calibration, the professional operation, emptying, decontamination and washing procedures of the equipment as well as the maintenance operations.

In addition to these skills, operators need to be trained to create a basic awareness about the dangers involved in pesticide use and the environmental consequences. This would help them to act responsibly in all the above mentioned operations.

Besides the quality and maintenance of the equipment, the knowledge and proficiency of the operator are important elements for safe and efficient pesticide application. It could be argued that this is actually the most important element, but either of the two – the quality sprayer and the skilled operator – could not achieve best results without the other element to complement each other.

4. Regulations for Improving Pesticide Application

Forces of a free market are not assisting in solving the problems of bad pesticide application. In absence of official quality regulations, unsafe equipment will always be cheaper and hence be more competitive than safe equipment. There is also no real incentive under a free market to invest in proficiency training as beneficiaries are often different from those who would have to assume the costs. Reliance on voluntary schemes building on increased awareness has also not proven to be successful in the long run (Wehmann, 1993). Only the recent tightening of the import regulations for maximum residue levels into the European Union has resulted in increasing interest in the quality of the pesticide application process in Non-European countries, but that involves exclusively the export industry and does not necessarily affect the production for national markets.

In order to make an impact in reducing hazards related to the use of pesticides, countries have, therefore, to address, through legislation and regulations, not only the chemical products and their permissible residue levels. Simultaneously the application equipment as well as the human operating the equipment have to be considered. Regulations to this effect have to be designed in a way that they are feasible, can be implemented and followed up within a given budgetary situation. Preferably they should be introduced in a way which demonstrates and actually provides benefits to as many involved stakeholders as possible.

FAO has, with a programme for Safe and Efficient Application of Agrochemicals and Bioproducts, provided assistance to member countries in this area. Guidelines addressing the different aspects of agricultural pesticide sprayers, safety, efficiency, use and the regulatory framework (FAO, 2001), have been published and are as technical guidelines an integral part of the recently revised new FAO Code of Conduct for the Distribution and Use of Pesticides (FAO, 2002). As in the FAO guidelines described, three areas of intervention addressing the equipment quality, the working conditions of actually used spray equipment and the operator skills, will have to be considered at the same time in order to achieve a significant impact.

4.1. Quality of new sprayers - Standards

A mandatory registration procedure for new equipment is one step to improve the quality of spray equipment offered to the farmers. For a meaningful registration, a certification process has to be established. This involves generally the adoption of standards for spray equipment at national level, an established certification process to prove or declare compliance with these standards and procedures for monitoring of compliance. It would also involve effective penalty mechanisms in case of non compliance.

In the majority of cases manufacturers are able to offer good quality equipment if the market or regulations demand it. Incentives for improved quality have to be introduced. The most successful solution to this is to limit the market to quality equipment by introducing a registration system based on certification against specific technical standards (Anon, 2002).

For a government to introduce such a registration system, it is not necessary to have its own test centres or to test each piece of equipment themselves. In some countries, the registration process is based on a manufacturer's declaration, but in this case the legal instruments must be in place to sanction false declarations. Inspections would have to be carried out randomly but they should be frequent enough to discourage false declarations. On the other hand, a certification system can also

be introduced on a voluntary basis by manufacturers using the certificate as a quality trademark and for sales promotion. In any case it is important to apply the same standards to all equipment.

A certification system can only be implemented if there are approved national standards for that kind of equipment. The formulation of internationally agreed standards, as promoted by FAO (FAO, 2001) as well as by ISO can help countries to adopt standards without the need to invent new ones. On the other side, technical standards, as the FAO or ISO standards, without a supporting legal framework do not have any impact on the quality of equipment on the market.

Technical standards have two aspects; one is to describe the minimum requirements of equipment in order for it to be approved or certified. This type of standard will usually be used for official certification. Secondly, standards can also describe the desired level of technology in order to induce improvements in equipment quality. These standards can be introduced by manufacturers' or users' organizations which provide a quality seal for equipment fulfilling the requirements. Usually standards like ISO standards reflect the actual state of the art in commercial manufacturing. They might, in special cases, be adapted to suit national conditions and to make a national certification process feasible.

Standards will have to be dynamic and reflect the actual situation regarding technical development and scientific knowledge. Therefore, when backing registration systems and standards with a legal base, it is not recommended to include the technical standards as integral part of the corresponding law. Instead the law should refer to the specific technical standards as the basis for the certification system (FAO 2001).

It is advisable to accompany the introduction of sprayer standards and a certification system with some awareness creation campaign which shows the benefits accruing to the farmers (savings in pesticide costs and reduction of hazards), the general population (reduced hazards) and the manufacturers (elimination of substandard cheap equipment from the market).

4.2. Working conditions of sprayers in use

Educated operators and good quality equipment alone provide no guarantee that the sprayers in use are maintained in a proper working condition. Inspection schemes to assist the farmers in maintaining the performance of their equipment throughout its working life will be necessary. Therefore, procedures have to be implemented to ensure the safe and correct operation of application equipment in use (Wehmann, 1993).

The necessary inspections and repairs can be carried out by the commercial sector. Particularly in an introductory phase, this approach should be the first choice to convince the involved parties of the benefits that this activity provides for each of them: the farmer saves money through reduced pest control costs by using properly adjusted and calibrated equipment, the commercial sector profits by providing the service or through selling the required wearing parts; and the general public benefits from reduced environmental contamination and general hazards.

The testing service can, therefore, be provided through agricultural equipment dealers and workshops, extension services, or government entities. In any case, it should mainly pay for itself through fees and contributions from the beneficiaries.

Eventually, it might become necessary to introduce mandatory inspections. However, mandatory inspections can only be introduced after the infrastructure to carry out the inspections has been installed. While voluntary sprayer inspections are common in the entire European Union as well as in some neighbouring countries, an increasing number of countries has introduced the inspections

on a mandatory basis. The first countries with such schemes were Austria, Belgium, Croatia, Denmark, Finland, Germany, the Netherlands, Slovenia and Switzerland (Ganzelmeier & Rietz, 1998). In the meantime the European Union is considering to harmonize the legislation regarding pesticide application EU wide (EU Commission, 2004).

The introduction of mandatory periodic inspections of equipment could be carried out in a step by step approach, starting, for example, with spray-aeroplanes and any equipment which is used to offer contractor-spray services to other farmers expanding, at a later stage, to all spray equipment.

4.3. Operator certification

Education on pesticide application technology has to be introduced at all levels and has to be formalised. A long-term strategy is required, beginning at university level. The subject of pesticide application technology should be mandatory for agricultural engineers as well as for plant protection specialists. Clear statements and commitments from policy makers are a first step, and which could eventually lead later to licensing and controls at field operator level.

Practical and formal training of farmers and equipment operators has to be introduced. The use of government extension services for this purpose has usually not proven to be efficient and sustainable. A better approach would be the creation of small groups of trainers, who are paid for their courses, dedicated specifically to this subject. Ideally these trainers should have a practical background and have operated spraying equipment themselves. They should be trained and kept up to date with refresher courses by master trainers. The established training capacity should cover the expected long-term needs. Training could begin strategically with contractors who offer service to other farmers and then be extended to private farmers and operators. The cost of the training could be paid by trainees, agro-chemical companies (preferably indirectly through taxes), by equipment manufacturers and by the government as the representative of the public interest in a safe environment.

The introduction of a mandatory license for operators of pesticide application equipment can help to increase farmers' interest in this training. Although it is always better to count on voluntary participation, examples from several European countries have shown that at a certain stage it is necessary to introduce legal pressure in order to assure interest in the training (Devereux-Cooke, 1995). Again, a stepwise approach is recommended: in terms of priority a mandatory introduction of spray operator licenses should start with the operators of aerial spraying and fogging, and should then expand to commercial tractor sprayer operators, and after that to every spray operator (regardless of whether by tractor or knapsack) who sprays areas other than their own. It can be assumed that someone offering spray services charges money. A fee-paying operating license for such a business could be justified. Once such a system is well established, licensing can be expanded to all spray operators including farmers spraying their own fields.

Besides Belize (Friedrich, 1999) Cameroon is one of the few non-European countries with some mandatory spray operator licensing. Initial experience with farmers receiving training in pesticide application, through qualified and well equipped master trainers, has shown a clear reduction in the pesticide use within the trained communities. This reduction is significant enough to provide incentive to farmers to pay for the training. It has also been noted that the demand for sprayer spare parts and nozzles increased as a result of the training, as the cost savings in pesticide pay for these additional investments in very short time (Baleguel, 2003).

4.4. Good agricultural practice

The establishment of Good Agricultural Practices is becoming common for different areas in agricultural production. In this given case it would be the good agricultural practice in the application of pesticides. In some countries these have already legally binding status. They are also the base for establishing maximum residue levels for pesticides in agricultural produce. As a first approach, maximum residue levels are usually fixed by determination of the actual residue levels while applying all elements of good agricultural practice (Matthews et al, 2003).

There are different approaches to legislation addressing risk management with regard to pesticide residues or drift. One approach is to determine the limits and impose sanctions if the limits are found to be exceeded. This system depends on strict controls and is so far only applied for export produce into demanding markets. It also assumes that the originator of the hazard is actually aware about the measures to take in order to avoid the hazards related to pesticide use. It is assumed that farmers adhere voluntarily to best management practices (Ontario, 1998; BCPC/ATB, 1991). The above analysis has shown that this is not necessarily the case. Even in science, the exact mechanisms and cause-effect relations for drift and other environmental off target contamination through pesticides and the ways to avoid them are not yet fully understood. They are subject to intensive investigation in order to serve legislation with better guidance (Mackay et al. 2004).

The other approach, as applied in Europe, is much more prescriptive, by actually imposing good agricultural practice in pesticide application as far as possible (BBA, 1998). Spray equipment can only be sold on a market if it complies with strict standards, which cover each safety relevant feature of the sprayer (Rietz, 1997). Technical inspection of the spray equipment are regularly carried out, checking all technical parameters of the equipment, including, for example, the wear of nozzles (Mostade et al. 1994, Landbruksdepartementet 1991). Spray operators have to participate in training and pass an examination in order to obtain a license to operate a sprayer (MAFF, 1998). For the operation of the sprayer itself there are legally binding procedures established, including the management of buffer zones, the observation of climatic factors, the sprayer settings and spray speed (BBA, 1998). Spray settings and application rates have to conform to indications given on the product label, which also has legally binding character in some countries. Logs of the spray have to be kept in order to verify the data (MAFF, 1998).

Precision farming technologies are becoming particularly relevant for these procedures. They do not only allow eventually a spatially more accurate application in terms of dose rate and point of application, but they allow also an exact logging of the spray operation registering all relevant operational settings in relation to the geographic position of the machine.

While the level of prescription differs from country to country it appears that the approach of prescriptive good agricultural practices can reduce the hazards related to pesticide application. But, also for the farmer, this approach provides advantages as it relieves him/her from the responsibility and provides a certain level of protection as long as he/she can prove to have complied with the prescribed procedures. Pesticide application has become such a complex issue that most farmers usually haven't got the means to decide upon many parameters without professional guidance.

In times of globalization it is obviously preferable to harmonize, as far as possible, the good agricultural practice guidelines for pesticide application. For this reason a workgroup of the international organization for standardization is looking into the establishment of general guidelines for good agricultural practice in the application of pesticides (ISO TC 23/SC 6, 2004). Also at the level of the European Union there is a strong movement to harmonize the regulations regarding pesticide application (EU Commission, 2004).

5. Conclusions

Safe and efficient pesticide application is crucial for reducing hazards related to agricultural pesticide use. With a clear political agenda in several European countries to reduce the use of pesticides it is therefore not surprising that legislation has accordingly taken up the issue of pesticide application. At this point in time, in European Countries, issues of sprayer standards, working conditions and operator training are being addressed by legislation at national as well as regional level. The proposals not only include the introduction of mandatory sprayer tests but also other measures, like operator licenses and registration of spray equipment. Another element is the strict adherence to good agricultural practices for pesticide application and extremely tight drift legislation. Among those, there is even a ban for aerial pesticide application proposed, which has created considerable concern within that particular industry, not only in Europe (EU Commission, 2004).

However, outside Europe very few countries have as yet taken up the issue of pesticide application regulations in their policies. Europe itself cannot escape from the environmental problems created through pesticide misuse in developing countries. There are no barriers to prevent the environmental impacts from spreading around the globe. The recently tightened maximum residue levels in the EU for import products have resulted in an increased interest in good agricultural practices by the fruit and vegetable export industry. This includes good pesticide application practices and safe equipment. In Europe advanced levels of quality application equipment and operator proficiency are the base for these limits. It will be very difficult to achieve the same limits with unsafe, badly maintained equipment and unskilled operators. In addition to this, importing countries are increasingly requesting the certification of production processes in the countries of origin according to good agricultural practices. These practices are, so far, defined often individually by the specific interested parties or certification bodies according to their specific interests.

So far these regulations concern mainly the export industry to demanding markets. But there is no reason why regulations, such as those developed in Europe regarding human and environmental safety, should not be applied in the same way globally. Therefore countries should consider undertaking proactive steps in adopting and implementing similar regulations regarding the equipment and practices used for the application of pesticides. As these elements are now also included in the updated version of the FAO Code of Conduct on Distribution and Use of Pesticides FAO member countries should within their voluntary commitment to that code also introduce the necessary steps to improve pesticide application and with this reduce the hazards related to pesticide use.

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