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AGRICULTURAL SPRAYER STANDARDS AND PROSPECTS FOR DEVELOPMENT OF STANDARDS FOR OTHER FARM MACHINERY

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Summary

In most developing countries the process of delivering pesticides to the target (i.e. application of pesticides) is not well understood nor is it generally well managed. A number of factors contribute to this situation, among them are a lack of adequate policies and legislation, lack of education resulting in poor knowledge, lack of research and capital availability, many and varied pest problems, and socio-economic problems. This results in an inadequate management of pests on one side, and an overuse of pesticides leading to serious environmental and health problems and high pest control costs on the other. Following European experience, legislation on pesticide application appears to be an area of priority. The introduction and enforcement of equipment safety standards is only one component but this has to be complemented with others, such as formal education and training as well as periodic inspections of sprayers to ensure safe working conditions. The requirement for safety standards for other agricultural machines becomes important as the level of mechanization rises. 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 is required to enforce these international safety standards.

Key words: Sprayer Standards, Farm Machinery Standards, Safety Regulations

Introduction

The need for machinery standards arises from different problems. One, which is probably the origin of standards, is the manufacturing process and the increasing need for compatibility of equipment and machines from different manufacturers, countries and regions. This is the traditional area from which most standards organizations have originated their work. Interested parties in this kind of work are mainly manufacturers who gain from obvious economic benefits that standardization brings. Users of the machines benefit because different machines from different manufacturers can be used together.

In addition to these standards for compatibility, there is also the area of safety standards. In this area it is the public sector which has the main direct interest in protecting the population and the environment from the use of unsafe technologies. These standards ensure the observance of basic safety levels even if they seem to go against direct economic considerations. In a functioning legislative environment they are also beneficial for manufacturers, as the observance of safety standards can protect them against unjustifiable liability claims.

For agricultural machinery and equipment one can distinguish between two categories of safety standards, depending on their potential regional importance:

- Safety Standards for Agricultural Sprayers
- Safety Standards for other machines.

The first group, the sprayer standards, is of global importance, as a major part of the hazards sprayers create results from their contents, the pesticides. Therefore, even manually operated sprayers have a considerable hazard potential. Because the use of pesticides is increasing, even in countries with a low level of mechanization, the need for safety regulations for sprayers is a global issue.

For other agricultural machinery the potential hazards, mainly to the operator and bystanders, increase dramatically as motorized mechanization becomes widespread. This is, with the exception of chain saws, a fairly high level of mechanization.

For the countries represented under ESCWA, both types of safety standards are of extreme importance. However, in view of the advances made by FAO in the development of standards and related regulations for agricultural pesticide sprayers, the main focus of this paper will be on sprayers with a few general observations about standards for other machinery.

In this context the paper will not just focus on specific technical features of the standards but also on the regulative environment required to make a meaningful contribution to improved safety.

Agricultural Sprayer Standards

Pesticide use on a global level, but particularly in regions with tropical, subtropical or similar climatic conditions, is steadily increasing (Agrow, 1998). In these regions the presence of commercial companies marketing their products as simple control solutions creates a great pressure to control pests. In the absence of quality control and legal regulations, pesticides are produced and marketed which often are of doubtful quality and present unknown risks (Vereno, 1999). Most countries of this region have therefore introduced some form of legislation regarding the registration of the distribution and use of pesticides as promoted by the respective FAO Code of Conduct (FAO 1996). However, whereas for the chemical components there is some sort of legislation in the form of a registration process in place, the regulatory aspects of the pesticide application process are, with very few exceptions, totally ignored. Legislation regarding the condition of equipment and its safety, operator licenses and spray drift are mostly unknown and generally considered unnecessary and unrealistic. This already demonstrates the kind of regulatory framework which is required for the meaningful introduction of Agricultural Sprayer Standards.

Field Realities

The general conditions which are found during the application of pesticides lead to field realities in developing countries which are far from desirable in terms of economic, environmental and human health considerations. Whereas in developed countries the use of pesticides and related spray equipment is more and more controlled, and where drift considerations are leading to strict legal regulations, it is common in developing countries to see aerial applications continuing over open waterways or houses. 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.

In cases where agricultural pest management is carried out in developing countries, it 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, results in some areas being left untreated but also leads to overdoses in other spots. This overdosing of the crop creates hazards for both people and the environment. Also, excessive spray pressures and excessive applied volumes in areas where water availability is no problem, leads to drift and runoff. This would indicate three major areas for intervention:

Equipment Safety and Standards

The generally poor economics of farming make it difficult for farmers to afford higher quality equipment as well as improved servicing of equipment. However, better quality and maintenance of application equipment easily pays for the higher investment through savings in pesticides. But farmers often do not know about or recognize these long-term benefits. In many countries it is also easier for the farmer to obtain credit from input dealers or banks for seasonal inputs like the pesticides themselves rather than for investment in items such as sprayers.

In those free market situations where demand for better quality does not exist, manufacturers are not encouraged to offer equipment which is better or fitted with any extras to improve safety, comfort or efficiency, and which are not considered essential for smooth functioning of the equipment. In countries where the farmer as a client is mainly choosing by price and where he does not have the resources or technical knowledge to select superior equipment, market demand does not permit the introduction of anything better. Therefore in many developing countries where these conditions are found, application equipment is often found to be both unsafe and of poor quality. This is particularly critical when one considers the high usage of manual knapsack sprayers in these countries. For the operator, manual spraying is one of the most contaminating of all the pesticide application techniques (Spugnoli & Vieri, 1998). The use of unsafe and leaking equipment aggravates this. In a field study in Indonesia it was found that 58 % of the sprayers were leaking (Hirschhorn, 1993). Reports from Nicaragua confirm this observation (Matus & Beck, 1991).

Reports produced for FAO in several world regions have also mentioned the problem of sprayer quality. A survey carried out in 15 West African countries reported problems with cracks and leaks in the sprayer tanks, which would directly indicate a problem of tank durability, as well as problems of faulty tank lids resulting in operator poisoning by spillage over the back (van der Meijden, 1998). A report from Malaysia mentions 48% of knapsack sprayer tanks surveyed being indented or cracked and gives poorly designed lever operated knapsack sprayers as one reason for operator contamination. (William, 1997). A similar report from Pakistan mentions, among other components, leaking tanks of knapsack sprayers as a source of operator contamination (Shakoor Khan et. al., 1997). Leakage from tanks and other components due to bad production processes and poor quality control of knapsack sprayers is also reported from Thailand (Sriaru-notai et al. 1997). Another report from the Philippines mentions that poor material resulted in accelerated wear and tear. In addition, welding problems, and problems with the pump and cut-off valve were also mentioned (Resurreccion, 1997).

However, the problems of defining safety standards to address leakage of knapsack sprayers even within Europe shows how difficult it is to avoid completely leakage even with new sprayers. While unsafe manual equipment is mainly a hazard for the operator, unsafe tractor equipment and, even worse, aeroplanes, can become serious hazards to the environment and general population. In the absence of any safety standards, spray equipment in many developing countries is built 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. The only safety feature generally found is often a quick release mechanism to empty the tank in case of an emergency.

Maintenance Conditions of Equipment

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 condition, 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. Farmers are also often unaware of the cost implications of badly maintained 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.

Human Factors and Operator Knowledge

Pesticide application technology is hardly ever covered in university curricula and it is only seldom that technical staff working in extension are found to have a clear idea about the correct use of application equipment. If at all, this sort of expertise is often only found within the commercial sector, mostly with multinational pesticide companies (Friedrich, 1997). The general understanding of the risks caused by poor pesticide application is very low with the consequence of a lack of attention paid to this subject and pressure applied by policy makers.

Farmers and particularly spray operators in developing countries are often illiterate and do not understand the recommendations on the label of the products or the instruction manuals of equipment, even if they exist. People are often not at all aware about the working principles and dangers related to pesticides and should therefore never be allowed to use particularly hazardous products. Unfortunately, the situation is exacerbated by the fact that many products belonging to WHO categories I or II, while being banned or restricted in developed countries, are preferred in developing countries (Dinham, 1999).

To make the situation even worse, for spray operations like knapsack spraying or flagging for aerial applications, cheap labour including children is often used. In the absence of legislation that would prohibit these practices it becomes even less financially attractive to invest in proper spray equipment. In many developing countries the manual knapsack sprayer is the most commonly used application equipment, not only on small holder farms, but also on large commercial plantations. In some countries manual spray gangs are replacing aerial applications. Starting with the selection of equipment, a farmer without technical criteria will usually choose the cheapest equipment, and, possibly, the most durable. Aspects of operator safety, comfort or efficiency are of lesser

importance, especially if the equipment is not operated by the farmer himself but by hired farm labour.

Consequences

In this situation and in order to still achieve control, pesticides are overused in terms of quantities and mixtures applied per unit area and over time. So called cocktails, mixtures of different products applied 20 to 30 times per season are very common in a number of crops like vegetables, cotton, tobacco, fruits and ornamental plants. Even without integrated pest management approaches, there is no justification for these spray regimes if the application were to be carried out properly.

In the absence of specialised knowledge and hardware, 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. It has been estimated that about 50% of pesticides used are wasted by bad application (Perry, 1995). The existing application techniques are sometimes 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. In absence of professional sales persons for sprayers and knowledgeable farmers in developing countries, sprayers are often marketed in their cheapest standard version without any extras.

Waste in this sense means that these products miss their intended targets and are thus not fulfilling any purpose. However, they do not just disappear; they lead to an unnecessary contamination of the environment. The environmental contamination is alarming in developing countries. The result of this has implications on the entire environment such as birdlife, marine and terrestrial fauna and last but not least soil life, which leads to soil degradation and erosion problems. In particular, these effects of pesticides in the soil are ignored, just as long as the products do not appear in the groundwater.

Apart from the environment, human life is also directly affected. The estimation of yearly accidental poisoning of spray operators varies widely. This is often due to a high percentage of unreported cases. It can be assumed that accidental casualties caused by pesticides are in the range of several ten thousand 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. Fifty percent of the cases of intoxication and 99% of the accidental casualties caused by pesticides occur in developing countries (Keifer, 1991).

The unnecessary contamination of the environment through wasteful application leads on the other side to poor control of pests. Areas remaining untreated or receiving sublethal doses remain as focal points for new pest outbreaks. In the absence of proper surveys, 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. With the above described effect

on the soil life, soil structure is also lost, leading to erosion, which then transports the contaminated soil by water or wind to other areas.

Conclusions

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. However, outside Europe very few countries have as yet taken up issues of pesticide application regulations in their policies.

The pesticide application needs in the countries of the ESCWA region, from a safety and environmental point of view, are exactly the same as in Europe. It is not acceptable to consider the value of the environment or human life in Europe as being greater than in other regions. This means that 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. In Europe an increasingly rigid legislation is being introduced which will ensure that actual pesticide use in the field does not lead to later conflicts with residue legislation. In this way the farmers will be guided (or forced) to adopt safe practices. I refer to the standardization of spray equipment, periodic sprayer checks and the mandatory licensing of spray operators, green codes for buffer zones etc., which are becoming increasingly common in the legal system of European countries at national level as well as at a European level through CEN. On the other hand exporters from developing countries to Europe increasingly face difficulties in coping with quarantine regulations on the one side and yet staying within residue tolerance limits on the other. A situation which arises as a result of the obsolete equipment and spray practices in the countries of origin.

But also Europe itself cannot escape from the environmental problems created through pesticide misuse in developing countries. We are living in one and the same world and there are no barriers to prevent the environmental impacts from spreading around the globe.

In order to make an impact in reducing hazards related to the use of pesticides, countries have to address, through legislation and regulations, not only the chemical products and their permissible residue levels but simultaneously the hardware, which is the spray equipment, as well as the software, which is the human component. Regulations in this sense have to be designed in a way that they are feasible, can be implemented and followed up within a given budgetary situation and preferably be introduced in a way which demonstrates and actually provides benefits to as many involved stakeholders as possible.

Equipment Standards and Certification Procedures

The quality of spray equipment offered to the farmers in developing countries in terms of human and environmental safety can only be improved with the introduction of mandatory certification procedures. Free market forces do not lead to the promotion of safe equipment. For meaningful certification, a country must have adopted effective standards in national legislation and introduced regulatory procedures that enable a routine checking for compliance with those standards. In some countries with local artisan manufacture of sprayers, politicians might hesitate to introduce quality standards that could force these low quality manufacturers out of the market or increase the requirement for additional technical assistance. However, at a national level, the damage to the economy caused by low quality sprayers is probably higher than the economic contributions of those few small enterprises.

In the majority of cases manufacturers are able to offer good quality equipment if the market or regulations demand it. In these cases, incentives for improved quality have to be introduced. In many developing countries a lack of knowledge leads to a demand for cheap and hence poor equipment. The only solution is to limit the market to quality equipment by introducing a certification system based on specific technical standards.

For a government to introduce such a certification system, it is not necessary to have its own test centres or to test each piece of equipment themselves. In some countries, the certification process is based on a 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.

A certification system can only be implemented if there are approved national standards for that kind of equipment. The formulation of internationally agreeable standards, as carried out by FAO (FAO, 1998) can help developing countries to adopt standards without the need to invent new ones. On the other side, technical 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 an official certification system. 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.

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

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).

Regular Periodic Sprayer Inspections

Experience in Europe has shown that educated operators and good quality equipment provide no guarantee that the sprayers in use are maintained in a proper working condition. Inspection schemes to assist the farmers to maintain the performance of their equipment over its working life will be necessary. Therefore, procedures have to be implemented to ensure the proper operation of application equipment. These schemes can be introduced on a voluntary basis, with or without the

support of the commercial sector. However, experience in Europe shows that sooner or later the schemes will need to become mandatory (Wehmann, 1993).

The necessary checks 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, and the commercial sector profits by providing the service or through selling the required wearing parts; 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 checks. In Germany, this system was introduced in 1993 after past experience with voluntary checks, which had only been used by 20% of the farmers. In these checks only 50% of the equipment was found to be in good working condition, and therefor the government decided to introduce mandatory checks (Wehmann, 1993). In Nicaragua mandatory checks on spray aeroplanes were introduced in 1991, following a one-year voluntary check which had been accompanied by a heavy publicity campaign. By that time the checks were widely accepted and the introduction of mandatory checks did not cause any problem (Friedrich, 1995). However, mandatory checks can only be introduced after the infrastructure to carry out the checks is installed.

While voluntary sprayer checks are common in the entire European Union as well as in some neighbouring countries, an increasing number of countries has introduced the checks on a mandatory basis, such as Austria, Belgium, Croatia, Denmark, Finland, Germany, the Netherlands, Slovenia and Switzerland (Ganzelmeier & Rietz, 1998). This list is probably soon to be increased in countries such as Norway, Spain, Poland, the Czech Republic. Within the European Union, harmonization of the respective test procedures and the sprayer standards is advancing and will very soon influence legislation within EU member countries.

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 and, at a later stage, expansion to all spray equipment.

Operator Training

Lack of knowledge at all levels has been identified as the main reason for deficiencies in pesticide application practices. Education on pesticide application technology has to be introduced at all educational levels and has to be formalised. The occasional training courses given to extension workers in many developing countries have not shown any impact at all. 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 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 dedicated specifically to this subject and who are paid for their courses. 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, of course, by the government as the representative of the public interest in a safe environment.

The introduction of a mandatory license for pesticide equipment operators can help to increase farmers' interest in this training. Although it is always better to count on awareness creation and 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 here 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 should then expand to commercial tractor sprayer operators and then 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. The only non European country I am aware of where such a general mandatory system is in place is Belize.

Other Farm Machinery Standards

For standards for other farm machinery, much the same principles as described in the introduction apply. While general manufacturing standards are mainly in the interest of the respective Industry, Governments do have a mandate in the area of safety standards in order to protect consumers and the environment. Aspects of functionality and durability of machines should as far as possible be left to free market forces, but even here government can at least give incentives to initiatives for standardization and testing by creating enabling environments and supporting the establishment of suitable structures.

For this paper, however, the focus will remain on safety standards for agricultural machinery as an area of main concern for governments. Again the issue here is not so much the development of suitable standards and corresponding test procedures; the standards are often already available in an internationally agreed form. In view of facilitating international trade it is therefore recommended to adopt, where available, existing established standards as a basis for national standards. This would also facilitate the verification through testing, as this could be carried out in any test institution which subscribes to the corresponding standard.

Detecting the Problem: Awareness

Legally binding mandatory safety standards for agricultural equipment only exist in very few, mostly European, countries. Even in those countries implementation varies depending on the different legal systems and the cultural aspects of the delegation of responsibilities. In most other countries, however, awareness about the dangers of agricultural machines and the actual economic impact of related accidents is not well developed. This is partly due to the fact that proper recording mechanisms or statistics for farm machinery accidents are often missing. Whereas in countries with some sort of health or social insurance systems, the cases might still be recorded, they remain completely unaccounted for in many developing countries. Farm machinery accidents by nature are often severe, resulting in fatalities or permanent handicap of the injured person and seriously affecting future income earning capacity. Often the persons with major exposure to risks are farm workers with a low social status, which makes it even less likely that their case is put to the policy maker's level.

Apart from the lack of awareness at policy level, the involved farming community and machinery operators also tend to show a distorted perception of the risks they incur. Even if they are aware about the general risks created by the machines they use, they usually do not consider themselves in acute danger, particularly with an increase in routine and familiarity (Whitman & Field, 1995).

Safety Standards

A number of safety standards for most agricultural machinery are already available internationally, particularly in Europe. So far the focus in agriculture is still directed to equipment standards, which means defining the required safety features on the machines, while for industrial processes the move is going to process standards describing the safety features of production processes.

Safety standards have mostly been derived from painful experience, trial and error and corresponding testing. They define the technical characteristics of protective structures or design features that should, as engineering solutions, make the incidence of accidents unlikely or at least avoid major injury to the operator in the case of accident, such as roll over protection frames for tractors.

The standards will be used for respective legislation according to need, which in effect means according to the incidence of specific accidents. There are a number of machines and components, which need safety features as a matter of priority, others might be decided according to local needs.

For example, tractors are universally used and roll over accidents are also very common, not only in hilly topography. Even the US in 1993 there were still a couple of hundred fatalities due to tractor roll over accidents reported (Myers & Snyder 1995). Test procedures for tractors are internationally established by the Organization for Economic Co-operation, OECD, through its standard codes for testing agricultural and forestry tractors. Thirty centres in 28 countries officially apply these codes. Codes 1 and 2 refer to tractor performances, while code 3, 4, 6, 7 and 8 refer to protective structures and code 5 to noise level at the driver's position. Tests carried out under these codes confirm whether a structure conforms to the requirements for deformation limits and safety. Test results for

codes 1 and 2 are published on the internet as well as in printed form, results for tests 3 to 8 can only be obtained through designated national authorities (OECD 2000).

Similar, but more general, regulations exist for other common sources of safety hazards, such as rotating parts. Of specific relevance to agriculture are power take off shafts, drive belts and chains and their respective pulleys, fans and blowers. Another area is cutting tools such as mowers, shredders, choppers, as well as lifting devices and so on. In all cases the standard for the approval of a safe design always goes hand in hand with a standardized test procedure.

Safety Regulations in National Legislation

In a globalized world these standards exist and are available virtually all over the world, which means that the sheer existence of standards is not an issue. The task for the legislator is to identify the need for a safety regulation for a specific circumstance. The standard would only describe the technical parameters for that feature to be safe but it has no legal character as such.

The legal character is given to a standard in two ways. One is that the national authorities might fix for given standards national performance criteria to reflect national reality. If, for example, in the OECD code 5 for the noise level of a tractor, the test procedure is universally accepted as a standard, different countries might still fix different noise thresholds as a permissible maximum in order to reflect the existing manufacturing capacities for noise protection and not come up with a national standard which would all of a sudden make the entire national production of tractors illegal.

Another issue is how a safety standard is introduced: is it applicable only for newly manufactured or imported machines or also for old machines already on the market? If yes, what is the time frame allowed for updating machines in use to comply with new standards? Again, legislation has to induce improvements, but which also respects the national capacities for update and inspection.

The mechanism for the verification of the compliance with safety regulations also has to be carefully considered according to the existing legal system and the capacity for follow up. For the verification of compliance of new equipment there are basically two systems: one is the declaration procedure by the manufacturer, backed up or not by certificates from officially approved test centres. With this the manufacturer or importer respectively assumes the liability for compliance. The alternative to that is the actual testing for national approval which is something we do not recommend. National resources for these rather expensive tests are normally not available; the manufacturers would refuse to pay for the tests if they would serve only one market. Most machines are tested somewhere, and the policy should actually encourage the harmonization of standards by acknowledging certificates issued by other authorized or certified institutions rather than developing individual national test centres.

Subscription or collaboration with international organizations or networks would assist in this process. For tractors it has already been mentioned that OECD is handling tractor tests, insuring also that all test centres carry out work to the same standards of accuracy. At the European level, a network for testing agricultural machinery (ENTAM) has been created, assuring a harmonization and mutual recognition of test procedures, standards, reports and certificates between the subscribed official national test entities. The network also ensures the maintenance of accuracy standards across

the members. The final objective for this network is also for each test station to specialize in a limited number of machinery types to test, and to delegate the other type of machines to another member station. Tests are becoming increasingly expensive and, as not each machine but only one sample is tested, the numbers of tested machines are relatively low.

As some of the agricultural machines, for example tractors, have rather a long expected lifetime, the retroactive introduction of new safety standards will have to be considered. In this case follow up and verification is even more difficult. Often this process has to be accompanied by an awareness creation campaign and public promotion and educational processes. Verification can be done in different ways also depending on the type of equipment, either with periodic inspections in central places, such as workshops, or by inspections on the farm. Public officials, law enforcement units, insurance or social security companies or institutions might be delegated to carry out these inspections.

Even if this is not possible or feasible, the existence of national safety legislation would still be potentially useful because in the case of accidents, it could be used for law suits which claim damages from the responsible party in cases where the equipment did not comply with the corresponding safety standard.

Conclusion

The introduction of standards and a certification system is not an end in itself. They should be used to guarantee a minimum quality of equipment available on the market and induce technological progress. The standards have to be accompanied by a regulatory framework. As a part of this, regular checks on, for example, pesticide application equipment should be promoted in a way such that all participants see a clear advantage for themselves. A third component particularly for pesticide application equipment is the training of operators. The objective of the training programme should be to provide, in a sustainable manner, farmers and application equipment operators with the technical knowledge necessary for safe and efficient application. The introduction of a mandatory license should never be an end in itself and only be considered if it contributes to more efficient training.

The introduction of safety standards for agricultural machinery only makes sense if they are incorporated into a legal framework. The timeframe for this legal framework to actual impact at field level is often long and the process arduous for all stakeholders. However, over the years the investment will pay and where operational safety legislation and regulations have been introduced the incidence of injuries and fatalities in agriculture have been significantly reduced.

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