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<http://www.tandfonline.com/10.1080/10807039.2014.953894>

Date deposited: 10th October 2014 [made available 4th November 2015]

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The Use of Pictograms for Communicating Pesticide Hazards and Safety Instructions.

Implications for EU Policy

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Running head: Pictograms and communicating pesticide risks

ACKNOWLEDGEMENTS

The authors gratefully acknowledge funding under the BROWSE FP7 project (Bystanders, Residents, Operators and WorkerS Exposure models for plant protection products., Seventh Framework Programme, Theme: Environment (including climate change) Project Number: 265307 www.browseproject.eu)

Keywords. Pictogram; pesticide; Risk Communication; Sustainable Use Directive; Agriculture.

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Instructions. Implications for EU Policy

ABSTRACT

The literature was reviewed to assess the understanding and interpretation of pictograms used in pesticide exposure risk communication, and to assess the results in the context of the new EU regulatory context for the sustainable use of pesticides and the harmonised labelling and packaging of chemicals. The understanding of pictograms used on pesticide labels is generally low. Standardised approaches utilised by the Food and Agriculture Organisation and Globally Harmonized System fail to account for contextual and cultural differences, and are therefore not universally understood. However, none of the studies reviewed suggest that pictograms should be abandoned as a tool for conveying hazard and safety information. Instead they emphasise the ways in which the pictograms, and their use, can be improved to gain attention, elicit understanding and encourage compliance behaviour. Whilst the policy affecting the handling, labelling and use of pesticides is applied across the EU, there has been no analysis of the different types of pictograms that have been used in the European context, nor the different ways that they are employed (e.g. on labels, on signs, during training). The implications for risk with residents and bystanders are less clear than for workers and operators.

INTRODUCTION

This review examines the research literature and the policy context for the use of pictograms in the risk communication regarding unsafe exposure to pesticide hazards to mitigate risk to relevant stakeholders (for example, workers, operators, residents and bystanders) in and the natural environment. Understanding how to optimise public health in relation to pesticide exposures has been the focus of recent policy documents, which reflects the observation that occupational exposure to pesticides above the safe levels represent a significant source of mortality and morbidity worldwide (Pimentel 1996; WHO 2003). Pesticides are potentially toxic to non-target species and can result in substantial health risks if not used in accordance with label instructions (Pimentel *et al.* 1992). Various stakeholders may be affected, including operators, workers, residents and bystanders. For the purposes of the present discussion, “workers” are defined as a person who, as part of his/her employment, enters an area that has previously been treated with pesticides or who handles a crop that has been treated with pesticides, in line with the EFSA (2010) definition. The same source defines “operators” as those individuals employed in pesticide application. “Residents” are defined as individuals living in areas adjacent to those where pesticides are applied, and “bystanders” as individuals who are inadvertently exposed to agricultural pesticides through non-agricultural activities. The potential negative acute and chronic health effects of pesticide exposure are wide ranging (see for example, the NIH agricultural Health Study in the US, (NIH, 2014) a prospective study of cancer and other health outcomes in a cohort of licensed pesticide applicators and their spouses from Iowa and North Carolina; Pingali *et al.*, 1995). Alavanja and Bonner (2012) note that chemicals in every major functional class of pesticides have been observed to be significantly associated with human cancer development. For example, occupational exposure results in increased individual susceptibility to bladder cancer (Matic *et al.*, 2014). The incidence of childhood cancer may be associated with parental exposure during the prenatal period (Vinson *et al.*, 2011). Occupational pesticide exposure has also been associated with other health problems, including, *inter alia*, increased incidence of Parkinson’s disease (Steenland *et al.*, 2013; Wang *et al.*, 2011), and problems associated with reproductive health and conception (Snijder *et al.*, 2012). Exposure as a consequence of living in proximity to areas where pesticides are being applied may also result in health problems (see, *inter alia*, Beard *et al.*, 2013; Yang *et al.*, 2014; Graciela *et al.*, 2014; Jones *et*

50 *al*, 2014). Bystander exposure may also result in negative health effects (see, *inter alia*, Keams
51 and Prior, 2013; Skevas *et al*, 2013; Alavanja *et al* 2013).

52 Problems in pesticide related risk communication, in particular to potentially vulnerable
53 groups such as the young, old, pregnant or immune deficient, or operators, workers, rural
54 residents, and bystanders, have been identified, which has resulted in health problems for
55 affected stakeholders (Remoundou *et al*, 2014; Palis *et al*, 2006). Communication problems have
56 been found to originate from linguistic problems in understanding risk communication messages,
57 in particular under circumstances where target audiences understand languages other than that in
58 which the communication is delivered. In response, various organisations (e.g. FAO, 1995) have
59 recommended utilising pictograms to communicate about the risks of pesticide exposure. In this
60 context, the term “pictogram” has been defined as a stylized figurative drawing that is used to
61 convey information of an analogical or figurative nature directly to indicate an object or to
62 express and idea (Tijus *et al.*, 2007).

63 There are three principal drivers for developing risk communication about pesticide
64 exposure within the European Union. The first is the *Sustainable Use of Pesticides Directive*
65 (2009/128/EC)¹, which is currently being implemented across the EU and places new obligations
66 on Member States to ensure that training and certification are provided to distributors and users
67 of pesticides with regard to hazards to the health and safety of those using or handling them, as
68 well as to members of the public and the natural environment (see Table 1).

69 The directive is being applied in addition to existing legislation that obliges employers to
70 take measures to protect the health and safety of their employees from chemicals in the
71 workplace (transposed in Member States according to Directive 98/24/EC² on the protection of
72 the Health and Safety of workers from the risks related to chemical agents at work). The
73 Directive on the Sustainable Use of Pesticides also requires that Member States implement wider
74 awareness raising initiatives on the hazards associated with pesticides. The second is the

¹ European Commission, Pesticides Directive (2009/128/EC), establishing a framework for Community action to achieve the sustainable use of pesticides, Official Journal of the European Communities, 24.11.2009.

² European Commission COUNCIL DIRECTIVE 98/24/EC of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work (fourteenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC), Official Journal of the European Communities, 05.05.2009.

75 implementation of the *EU Classification, Labelling and Packaging (CLP) Regulation (EC)*
76 *1272/2008*³, which aligns European legislation in accordance with the United Nations' Globally
77 Harmonised System of Classification and Labelling of Chemicals (GHS). Amongst a raft of
78 harmonising measures⁴ the CLP and GHS introduces nine new pictograms (replacing older and
79 more diverse symbols) to convey standardised pictorial hazard information on product labels (see
80 Section 3). The CLP entered into force in January 2009 and will progressively repeal the
81 classification and labelling of dangerous substances (67/548/EEC) and dangerous preparations
82 (1999/45/EC) Directives by June 2015. The third is the increasing prevalence of migrant workers
83 in European agriculture (see, *inter alia*, Hoggart, and Mendoza, 1999; Kasimis and
84 Papadopoulos 2005; Rogaly, 2008; Ruhs, Rogaly, and Spencer, 2006; Rye and Andrzejewska,
85 2010). Many migrant workers may only be temporary based in a particular European country
86 and have limited language skills relative to the language(s) predominantly applied in their place
87 of work. Whilst there is an ethical and legal obligation to train migrant workers in the safe use of

³ Regulation (EC) No 1272/2008 of the European Parliament of the Council,
of 16 December 2008 on classification, labelling and packaging of substances and mixtures,
amending and repealing, Official Journal of the European Communities, 31/12.2008 Directives
67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.

⁴ "CLP is the Regulation on classification, labelling and packaging of substances and mixtures.
This Regulation aligns previous EU legislation on classification, labelling and packaging of
chemicals to the GHS (Globally Harmonised System of Classification and Labelling of
Chemicals). Its main objectives are to facilitate international trade in chemicals and to maintain
the existing level of protection of human health and environment. The GHS is a United Nations
system to identify hazardous chemicals and to inform users about these hazards through standard
symbols and phrases on the packaging labels and through safety data sheets (SDS)." Taken from
http://ec.europa.eu/enterprise/sectors/chemicals/classification/index_en.htm, accessed 4th August
2014.

agricultural pesticides, to ensure that occupational health and safety is prioritised, and that health and safety regulations are adhered to, there may be increased scope for the use of pictograms (following appropriate training in their meanings and implications) in risk communication activities associated with the practical use of pesticides amongst workers who may not be able to read labels, and in workplaces where multiple languages are spoken. This must operate in parallel to the broader issue of the need to manage occupational health and safety in increasingly multicultural teams and organisations (Starren *et al*, 2013).

The aims of this review, therefore, are to i) summarise the state of the evidence on the use and understanding of pictograms in hazard and safety communication relating to pesticides, and; ii) consider the implications of this evidence in terms of the part that pesticide pictograms might play in the new regulatory environment in the European Union.

The Use and Effectiveness of Pictograms

According to Tijus *et al.* (2007) there are three principal types of pictogram. A *figurative* pictogram should accurately evoke the object or situation represented (e.g. a flame representing flammability). An *abstract* pictogram portrays only partial aspects of the concept to evoke its full intended meaning (e.g. a curved line to indicate a bend) and an *arbitrary* pictogram bears no resemblance to physical reality (e.g. a no entry sign). The main benefits of pictograms are:

- They can potentially be interpreted more accurately and quickly than words
- They can serve as instant reminders
- They improve understanding of warnings for those with visual or literacy difficulties
- They can make warnings more noticeable or ‘attention-grabbing’
- They can increase the legibility of warnings
- They are more easily processed at a distance than textual information (Tijus *et al.* 2007)

Laughery and Wogalter (2006; in press) have shown that, for a warning pictogram to be effective it should i) attract attention; ii) elicit knowledge and enhance users’ comprehension of warnings, and iii) enable compliance behaviour. They further highlight that the effectiveness of a warning in each of these areas is conditioned by both design and non-design factors. Design factors are those that relate to the characteristics of the actual warning (e.g. a pictogram), whereas non-design factors relate to contextual factors that are independent of the actual warning design. Some examples are provided in Table 2.

Despite the purpose and intended benefits, research has shown that the understanding of warning pictograms is limited and that, on account of non-design factors, even if a member of the target audience understands the pictogram or warning, it does not necessarily lead to compliance behaviour.

The existing use and scope of pictograms for communicating hazards and safety instructions for pesticides and other chemicals in Europe

The CLP Regulation, implementing the UN GHS, introduced nine new pictograms for use in the classification and labelling of chemicals. These pictograms are black, on a white background within a red square set at a point. They replace a set of seven orange-backed pictograms which were used in Europe (Figure 1).

Research undertaken by the European Chemicals Agency (ECHA, 2012) found that public understanding of the GHS pictograms across the EU is generally low reflecting the relatively early stage of implementation (as all products will not be required to adopt the new system until 2015). Associated with this is the need for greater awareness raising regarding interpretation of symbols. Hesse *et al.* (2010) have argued that the lack of current understanding can also be attributed to the fact that the GHS/CLP system was not tested before it was put into use, although it is arguable that end-user understanding might improve with time as symbols become more familiar to the relevant end-user constituencies. To increase awareness and aid training the European Agency for Safety and Health and Work (OSHA) have produced a promotional poster, leaflet and video ⁵

In addition to pictograms, the CLP also harmonises and mandates the uses of appropriate ‘Signal Words’, ‘Hazard Statements’ and ‘Precautionary Statements’ for use on product labels and Safety Data Sheets (not all chemicals will require all four of these elements). Signal Words (either ‘Danger’ or ‘Warning’) are intended to indicate the relative level of severity of the hazard; *Hazard Statements* are intended to describe the nature of the hazard, and *Precautionary Statements* are intended to describe recommended measures to minimise or prevent adverse consequences resulting from exposure to a hazardous substance. There is a significant number of both Hazard Statements and Precautionary Statements that are to be selected according to the

⁵ see <http://www.napofilm.net/en/napos-films/multimedia-film-episodes-listing-view?filmid=napo-012-danger-chemicals>, accessed 4th September 2013.

chemical's properties as specified in the CLP Regulation. The Precautionary Statements are further broken down into four categories:

- I. Prevention – e.g. 'Keep only in original container' (P234)
- II. Response – e.g. 'Get medical advice if you feel unwell' (P314)
- III. Storage – e.g. 'Store in a dry place' (P402)
- IV. Disposal – e.g. 'Dispose of contents to ...' (P501)

There are two important considerations to bear in mind in terms of the implications of the CLP Regulation for the use of pictograms in the communication of and training in hazards associated with pesticides. The first is that there are vastly more hazard statements than there are pictograms. This means that different chemical products can carry the same pictogram but that the nature of the hazard can differ. Persons unable to read a label, therefore, are not provided with the same level of hazard information as those that are able to read. The second is that within the CLP pictograms are only used to convey information about the hazard and there are no required pictograms to convey instructions about how to reduce the risk of the hazard posed. Such instructions are contained only in written form through the Precautionary Statements. Unless a label is provided in multiple languages, therefore, it is again the case that a non-reader is provided with less information than a reader. EU legislation requires employers to ensure that measures are put in place to reduce the risks associated with workplace hazards. This is implemented, with regard to signage, through Directive 92/58/EEC on the minimum requirements for the provision of safety and/or health signs at work. This Directive includes the provision of 'mandatory signs' to prescribe specific safety behaviours and practices. They are round in shape and consist of white pictograms on a blue background (Figure 2). It should be noted that these signs relate to general health and safety and not specifically to pesticides.

The FAO Guidelines on Good Labelling Practice for Pesticides (FAO, 1995) provide international pesticide-specific recommendations to industry and national regulators. The guidelines include recommended hazard symbols and safety pictograms. Unlike the CLP Regulation, the FAO Guidelines use the word 'symbol' for the pictorials used to convey hazard and only uses the word "pictogram" for those pictorials used to convey safety information. The hazard symbols are similar to those replaced by the CLP Regulation (Figure 1). The FAO guidelines also differ from the CLP Regulation, therefore, because they recommend not only pictorials for conveying hazard information but also for conveying 'key safety information' and

recommendations on how to reduce or minimise the risk of harm. The guidelines propose 14 safety pictograms (Figure 2) that are divided into storage, activity, advice and warning categories.

The guidelines state that the pictograms depicting the need to wash after use and to lock the product out of the reach of children should appear on all pesticide labels. Unlike the CLP Regulation they also recommend the use of a colour-coded bar on the label to denote toxicity. The CLP Regulation, on the other hand, states only that colour *may* be used on other parts of the label “to implement special labelling requirements”. Similar to the CLP Regulation the guidelines also include a much wider range of ‘safety statements’ that go beyond the information conveyed in the safety pictograms. Even though safety pictograms are included in the FAO guidelines, therefore, there is still additional information and detail provided only textually.

Given that the CLP Regulation is more recent and is legally binding it is expected that the labelling requirements for pesticides in the EU will principally follow these requirements rather than the FAO guidelines. Whilst the CLP Regulations allow other information to be included on product labels they also state that other information should be kept to a minimum and not call into question the main elements of the information conveyed according to the requirements of the regulation. An example could be risk mitigation measures such as the use of buffer zones, reference to specific pre-harvest interval or re-entry time, use of PPE during m/l or application (see COMMISSION REGULATION (EU) No 547/2011, 2011)⁶. The difference between the CLP Regulations and the FAO guidelines may reflect their intended audiences and the different regulatory contexts in which they are applied. The FAO guidelines, for instance, are designed to be applicable internationally and useful in developing countries where the product label may be the only source of information to those working with pesticides. In the EU, on the other hand, there is a clear obligation on employers to ensure the Health and Safety of their

⁶ COMMISSION REGULATION (EU) No 547/2011 of 8 June 2011 implementing Regulation (EC) No 1107/2009 of the European Parliament and of the Council as regards labelling requirements for plant protection products.

workers from the risks related to chemical agents at work (Directive 98/24/EC)⁷. It might be expected, therefore, that the responsibility of understanding product labels rests principally with the employer and they are expected to convey the necessary information (such as the Precautionary Statements) and take the necessary measures to protect their employees (e.g. through appropriate procedures and provision of personal protective equipment).

On account of the more stringent requirements for training and improved practices in the Sustainable Use of Pesticides Directive there is potential for greater use of pictograms (and possibly for more pictograms) over above their use on product labels. The use of pictograms could be extended, for instance, to communicate safety information/precautionary statements in training sessions and in the provision of workplace signage.

The use of pictograms to convey hazard and safety information for pesticides

There is a wide literature on the understanding and interpretation of pictograms and warnings more broadly (see, inter alia, Davies *et al*, 1998; Knapp *et al*, 2005; Lim *et al*, 2000). This review, however, focuses specifically on the use of pictograms for the communication of hazard and safety information in relation to the handling, storage and use of pesticides. The literature was searched using Web of Knowledge, Scopus and Google Scholar using the terms ‘pesticide*’ AND (pictogram OR symbol* OR label* OR sign*). Appropriate articles were selected through a review of the abstracts and the reference lists of the selected articles were also reviewed to pick up any additional relevant articles not found by the original search. Following this process a total of 11 relevant articles were identified for review.

The literature included research undertaken in the USA (among Latino migrants) (LeProvost *et al.*, 2012), Brazil (Waichman *et al.*, 2007), South Africa (Rother, 2008), Tanzania (Lekei *et al.*, 2004), Ivory Coast (Ajayi and Akinnifesi, 2007), Australia (Wilkinson *et al.*, 1997), Greece (Damalas *et al.*, 2006), Italy (Rubbiani, 2010) and the UK (Avory and Coggon, 1994; Edworthy

⁷ COUNCIL DIRECTIVE 98/24/EC of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work (fourteenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC), Official Journal of the European Communities, 5.5.1998.

et al. 2004). It should be noted that both of the UK examples and the Greek example referred to labelling of pesticides more generally, rather than to the specific use of pictograms. The work was undertaken in the disciplines/areas of occupational health (Avory and Coggon, 1994; Lekei *et al.*, 2004; LeProvost *et al.*, 2012; Rother, 2008; Rubbiani, 2010; Waichman *et al.*, 2007), agriculture (Ajayi and Akinnifesi, 2007), pest management (Damalas *et al.*, 2006; London and Rother, 2007; Wilkinson *et al.*, 1997) and ergonomics (Edworthy *et al.*, 2004). All of the work cited focussed on farmers or farm workers, with the exception of Edworthy *et al.* (2004) who also considered amateur pesticide users. These pictograms are displayed on professional use pesticide labels. Bystanders and residents have no reason to handle pesticides and according to the new regulation they should not have access to pesticides. However, exposure through proximity to application areas indicates the need for risk communication to these stakeholders. None of the studies undertaken in the European Union contextualise their analysis in terms of the regulatory or policy context and they were all undertaken before the implementation of the Sustainable Use of Pesticides Directive and the CLP Regulation.

The (In)Effectiveness of pictograms

Despite recognition in the literature that the addition of pictograms on pesticide labels does enhance the accessibility of farmers and workers to warning information (Lekei *et al.*, 2004; Wilkinson *et al.*, 1997) the majority of the literature suggests that pesticide pictograms are of limited effectiveness in terms of getting attention, conveying information and, particularly, in encouraging compliance behaviour (Ajayi and Akinnifesi, 2007; Rother 2008; Waichman *et al.*, 2007). This has been demonstrated in studies that focussed on the farmers'/workers' understanding of pictograms. In their study of Brazilian farmers Waichman *et al.* (2007) report that all of the respondents were unable to correctly understand at least 5 out of the 14 pictograms they were shown (based on FAO safety pictograms) and that more than 50% of respondents did not correctly understand *any* of the FAO safety pictograms. Rother (2008) reports that 50% or more of the farm workers sampled in South Africa *incorrectly interpreted* the FAO pictograms whilst Ajayi and Akinnifesi (2007) report that some specific pictorials were better understood than the others by 50% of participants. Of the four pictograms tested in Italy by Rubbiani (2010), two were largely understood correctly whilst the other two were understood by 52-55% of respondents.

Differences in understanding and compliance according to design factors

In their study of Greek tobacco farmers, Damalas *et al.* (2006) report that 72% of respondents agreed that most of the information provided on pesticide labels is hard to read, whilst 94% agreed that it is hard to understand. Similarly, Waichman *et al.* (2007) report that the majority of Brazilian farmers sampled do not read pesticide labels because the fonts are too small and the language is overly technical. In the UK, Edworthy *et al.* (2004) argue that the location of pesticide safety information as well as the language used has an objective influence on the degree to which respondents complied with the warning labels.

All of the three studies examining farmers and workers' interpretation of the FAO pictograms show significant differences in interpretation according to the different pictograms. In general, the advice pictograms (for instance recommending use of personal protective equipment) were better understood than the storage, activity and warning pictograms (Figure 3). This was particularly true for the pictograms depicting the need to wear gloves, wear boots and wash after use. The pictogram depicting the need to wear a respirator, however, was very poorly understood in all three examples (1% correct in Brazil [Waichman *et al.*, 2007], 10% correct in South Africa [Rother, 2008], and 2% correct in Ivory Coast [Ajayi and Akinnifesi 2007]). The storage pictogram, which the FAO recommends be included on all pesticide labels, was correctly understood by only 21% of the South African workers, by 15% of the Ivorian farmers and by 0% of the Brazilian farmers. Whilst the advice pictograms are largely figurative, the warning pictograms (relating to harmfulness to livestock and the aquatic environment) are more abstract, which may explain why they were also poorly interpreted, i.e. an abstract pictogram requires a greater degree of inference on the part of the observer, and it is less intuitive. Hence, abstract and arbitrary pictograms are unlikely to be understood unless their meaning has already been conveyed through another medium (speech, text). Even where meanings have been previously conveyed abstract and arbitrary pictograms still require the observer to remember the correct meaning.

In terms of indicating the level of danger, Rother (2008) reported that the skull and cross bones hazard pictogram and the colour red were the most influential elements regarding understanding of pesticide labels. LeProvost *et al.* (2012) also reported that traffic-light colour coding was well understood to indicate different levels of danger among their sample of migrant workers in the US. This supports wider research on hazard communication, which argues that colour-coding is especially useful in agricultural contexts where literacy is low (Banda and

Sichilongo, 2006). The CLP Regulation does not include colour-coding, although it does replace the European orange-backed style for pictograms with a red border (see Figure 1).

LeProvost *et al.* (2012) considered the use and development of pictograms (or symbols) for the training of migrant workers. In working with the migrant workers to prepare the training material LeProvost *et al.* reported that the workers preferred highly realistic and vivid symbols to convey information about tobacco plants and about the possible symptoms of exposure to pesticides. The lifelike symptom illustrations (which are not strictly pictograms or symbols) were described as the most effective in capturing the interest of the workers and they were able to accurately identify the symptoms portrayed.

Differences in understanding and compliance according to non-design factors

Farmers and workers may not comply with pictogram hazard and safety information because they do not read the labels. Waichman *et al.* (2007) and Damalas *et al.* (2006) report that 78% and 30% of their samples (respectively) do not read pesticide labels. This may be linked to the design factors outlined in Section 4.2, but it may also represent cultural factors or practical constraints. So, for instance, Greek farmers stated that they do not read the labels because they cannot understand them or because they (claim to) already know the information (Damalas *et al.*, 2006). Rother, on the other hand, reported the absence of a culture of reading labels among South African workers (2005, cited in Rother 2008) as well as the practical constraint imposed by the fact that farmworkers may not have access to pesticide containers in order to read the labels (2008). This is particularly important since the implementation of the FAO guidelines on pesticide labels in South Africa may be the only source of hazard and safety information available to workers (Rother, 2008). Rother (2008) further emphasises the importance of cultural and contextual influences on the correct understanding of pictograms, even though they are intended to be ‘culturally neutral’.

In terms of different groups of pesticide users, Edworthy *et al.* (2004) found that among a UK sample experienced users were less likely to comply with warnings than less experienced users. Similarly, Waichman *et al.* (2007) found that willingness to read pesticide labels was not positively correlated to level of education or farming experience. This suggests that cultural factors as well as complacency may have a bearing on the responsiveness of farmers and workers to complying with pictogram hazard and safety information. Rother (2008) found a greater level of understanding among men than women and attributed this to both practical non-design factors

as well as to design-factors. Rother reports that women's farm work in South Africa is generally perceived to involve tasks with a lower exposure to pesticides and they therefore rarely receive training on pesticide safety and health issues. She also argues, however, that pictograms should not be gender neutral, since gender-specific pictograms are required for women in order to advise them not to breastfeed or pick up a child prior to washing hands, and to remove any clothing contaminated by pesticides. Special pictograms should be developed for compounds toxic to reproduction or embryonic development, although such substances are not permitted in some regions such as the EU.

Critical Confusion of Hazard and Safety Information

One of the most concerning findings from the literature is that misunderstandings on account of design and non-design issues can lead to interpretations of pictograms that would increase rather than decrease the risk of exposure (Ajayi and Akinnifesi, 2007; Rother, 2008; Waichman *et al.*, 2007). This is referred to as critical confusion (Rother, 2008). Ajayi and Akinnifesi (2007) showed that in their efforts to cover their noses and mouths during spraying, Ivorian farmers inadvertently brought the chemicals closer to their airways by using absorbent clothing and other cotton fabrics. Only 2% of respondents correctly identified the pictogram depicting the need to wear a respirator. Rother provides another example of critical confusion associated with the pictogram used to denote the product expiry date. The pictogram depicts a clock set at an arbitrary time of five to twelve and several of the South African respondents interpreted this to mean the time at which the pesticide should be applied. Rother points out, however, that this practice could increase environmental contamination or the risk of poisoning because certain pesticides break down and become more toxic under high ambient temperatures (Rother, 2008). In addition, the recommendation for use of gloves, in particular during mixing and loading of the concentrated pesticide, can lead to an increase in systemic exposure due to increased dermal absorption of the compounds under inclusion, if the gloves used are not of the impermeable type or not maintained and used in a proper way.

Perspectives on the existing approaches to the use of pictograms

The most common criticism of the existing standardised approaches to the communication of hazard and safety information *via* pictograms is that, contrary to their claims, they are not easily understandable, culturally neutral or universally understood (LeProvost *et al.*, 2012; Rother, 2008; Waichman *et al.*, 2007). Instead, they are interpreted differently according to cultural and

practical factors. Equally, Rubbiani (2010) has also argued that interpretations not only differ in space but also in time. Interpretations change as information is processed on multiple occasions (and each occasion might present different sets of contextual circumstances) and understanding, knowledge, or compliance of hazards, risks and safety measures can therefore increase or decrease over time. The literature recommends that pictograms should be more *culturally specific*, risk communication should *not be gender neutral* if there are legitimate reasons otherwise (for example, differences in exposure or toxicity) and pictograms should be developed in collaboration with the target audience (LeProvost *et al.*, 2012; Rother, 2008; Waichman *et al.*, 2007). The literature also suggests that pictogram comprehension may be improved through greater use of colour-coding to denote level of hazard; the use of more vivid and realistic illustrations and locating pictograms alongside the instructions for use in the product information (LeProvost *et al.*, 2012; Edworthy *et al.*, 2004; Damalas *et al.*, 2006).

Conveying safety information to European Operators, Workers, Residents and Bystanders

Table 3 distinguishes those recommendations relevant for the protection of i) operators; ii) workers and iii) residents and iv) bystanders identified in the BROWSE project⁸. The recommendations, however, are not necessarily for communication to those groups but for their protection. So, for instance, the key recommendations for the protection of residents and bystanders are aimed at operators rather than residents/bystanders themselves. In the rightmost two columns of Table 3 the utility of pictograms for conveying the recommendations is considered.

In Table 3 the recognition of the need to follow up additional information provided on labels and instructions speaks to the issue raised in Section 3 of this paper. Namely, there is a vast

⁸ The aims BROWSE project (supported by the EU 7th Framework Programme) are to Review, improve and extend the models currently used in the risk assessment of plant protection products (PPPs) to evaluate the exposure of operators, workers, residents and bystanders, and to involve all relevant stakeholders and end-users and take full account of relevant gender issues in developing the exposure models and policy tools. For more information, please see <https://secure.fera.defra.gov.uk/browse/index.cfm>, accessed 4th August 2014.

amount of additional information on the nature of the hazard and the necessary precautions that need to be taken that is provided only in written format on the labels. As a consequence of it being unlikely that the CLP Regulation will allow additional pictograms on product labels to convey such additional information, and there is still a need to better communicate this information to operators and workers, (where language or cultural barriers might exist), it seems appropriate to further explore the label. Hazard and safety information should be conveyed to operators and workers in accordance with the training requirements of the Sustainable Use of Pesticides Directive. There is scope, however, for pictograms to play a role in communicating this information during training (LeProvost *et al.*, 2012), and more widely in workplace signage. This would require those responsible for providing and conveying safety information to consider how pictograms might be used for the particular pesticide products in use at the particular workplace. Where language barriers exist, there is a clear role for the extended use of pictograms during training (LeProvost *et al.*, 2012).

Although there is scope for the greater use of pictograms in training, it is important to stress that they should never *replace* the full and frequent verbal training in a language understood by the trainee. They can however, be used to complement the training, facilitate recall and encourage compliance.

Discussion and Implications for the Implementation of the Sustainable Use of Pesticides Directive

This review has brought together findings from the literature on the understanding and interpretation of pesticide pictograms as well as the new EU regulatory context for the sustainable use of pesticides and the harmonised labelling and packaging of chemicals. For those countries where data are available, the understanding of pictograms on pesticide labels by workers and operators is generally low. According to ISO Standard ISO9186 on Public Information Signs, a symbol can only be accepted if 67% of the users understand it. Many of the pictograms used on pesticide labels fall well below this level of understanding. The literature explains this poor understanding through recourse to a number of design and non-design factors. In particular, criticism is directed at the standardised approaches of the FAO and GHS systems, which fail to account for contextual and cultural differences, and are therefore not as universally understood as envisaged. None of the studies reviewed, however, suggest that pictograms should be abandoned as a tool for conveying hazard and safety information. Instead they emphasise the

ways in which the pictograms, and their use, can be improved to gain attention, elicit understanding and encourage compliance behaviour. With the exception of a limited study by Rubbiani (2010), there has been no analysis of the interpretation of pictograms related to pesticides in the European Union. Whilst the policy affecting the handling, labelling and use of pesticides across the EU is the same, there has been no analysis of the different types of pictograms that have been used in the EU and the different ways that they are employed (e.g. on labels, on signs, during training). The implementation of the Sustainable Use of Pesticides Directive and the concurrent CLP Regulation suggest that a study of this nature could provide useful insights on the communication of hazard and safety information.

The review of the policy context in the EU revealed that unlike the international FAO guidelines the labelling requirements for chemical products requires only hazard pictograms and not safety pictograms. Safety information is required by the CLP in the form of 'Precautionary Statements' but these are in text form only. This, along with additional textual information provided on labels, ensures that – through the label alone – more information is available to the reader than the non-reader on a label in a given language. However, it can be argued that within the EU there is additional legislation to ensure the safety of workers through measures that oblige employers to i) protect them from the risks associated with chemical agents at work (Directive 98/24/EC), and ii) to utilise adequate health and safety signage in the work place (Directive 92/58/EEC). The EU Workplace Health and Safety Directive (89/391/EEC) is a European Union directive that sets out general principles for protection of workers' Occupational safety and health. It was adopted on 12 June 1989 and the EU member states had to transpose it into their national laws by 31 December 1992.

The principal question that this review raises, therefore, is *whether there is a need for the greater use of pictograms to convey pesticide hazard and safety information and, most particularly, to facilitate the implementation of the Sustainable Use of Pesticides Directive*. The literature has shown that effective understanding of pictograms is facilitated by training. Moreover, it has shown that that training should be repeated (Rubbiani 2010) to account for changes in interpretations over time and to prevent complacency amongst pesticide distributors, handlers and users. The need for initial and additional training as stipulated by the Sustainable Use of Pesticides Directive provides an important means of ensuring the effectiveness of pesticide pictograms. The broadened scope of the Sustainable Use of Pesticides Directive, and

the increasing prevalence of migrant workers in the EU, suggests that there may be a wider role for pictograms. Specifically, consideration must be given to the need for additional pictograms, the format they will take, how they will be used and to whom they will be targeted.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge [redacted by HERA's editor]

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552 Table 1: Subjects to be covered in training for professional users, distributors and advisors according to
553 Article 5 of the Sustainable Use of Pesticides Directive.

1. All relevant legislation regarding pesticides and their use.
2. The existence and risks of illegal (counterfeit) plant protection products, and the methods to identify such products.
3. The hazards and risks associated with pesticides, and how to identify and control them, in particular:
 - (a) risks to humans (operators, residents, bystanders, people entering treated areas and those handling or eating treated items) and how factors such as smoking exacerbate these risks;
 - (b) symptoms of pesticide poisoning and first aid measures;
 - (c) risks to non-target plants, beneficial insects, wildlife, biodiversity and the environment in general.
4. Notions on integrated pest management strategies and techniques, integrated crop management strategies and techniques, organic farming principles, biological pest control methods, information on the general principles and crop or sector-specific guidelines for integrated pest management.
5. Initiation to comparative assessment at user level to help professional users make the most appropriate choices on pesticides with the least side effects on human health, non-target organisms and the environment among all authorised products for a given pest problem, in a given situation.
6. Measures to minimise risks to humans, non-target organisms and the environment: safe working practices for storing, handling and mixing pesticides, and disposing of empty packaging, other contaminated materials and surplus pesticides (including tank mixes), whether in concentrate or dilute form; recommended way to control operator exposure (personal protection equipment).
7. Risk-based approaches which take into account the local water extraction variables such as climate, soil and crop types, and relieves.
8. Procedures for preparing pesticide application equipment for work, including its calibration, and for

its operation with minimum risks to the user, other humans, non-target animal and plant species, biodiversity and the environment, including water resources.

9. Use of pesticide application equipment and its maintenance, and specific spraying techniques (e.g. low-volume spraying and low-drift nozzles), as well as the objectives of the technical check of sprayers in use and ways to improve spray quality. Specific risks linked to use of handheld pesticide application equipment or knapsack sprayers and the relevant risk management measures.

10. Emergency action to protect human health, the environment including water resources in case of accidental spillage and contamination and extreme weather events that would result in pesticide leaching risks.

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556 Table 2: Design and Non-Design Factors Conditioning the Effectiveness of Warnings

	Design Factors	Non-Design Factors
Attract Attention	- Location	- Proportion of target population
	- Size	with visual impairment
	- Colour	- Likelihood of distraction
	- Contrast	
	- Format	
Elicit Existing Knowledge	- Use of well-known terms	- Perceived hazardousness
	- Signal words	- Familiarity
	- Connotation	- Knowledge stage and attention
	- Brevity	stage
	- Format	
	- Explicitness	
Enable Compliance	- Use of pictorials	
	- Attention and knowledge factors	- Familiarity
	- Explicitness	- Modelling the behaviour of
	- Pictorial symbols	others
		- Stress
		- Cost of compliance

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558 Source: Adapted from Laughery and Wogalter (2014).

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561 Table 3 Some key recommendations arising from BROWSE project and the utility of pictograms in conveying them

For the protection of the Target Group	Recommendations	Utility of Pictograms
Operators	Follow up label instructions	Given that safety information is conveyed only in writing according to CLP labelling, it is sensible to remind operators to remain familiar with the written labels and instructions. This issue also demonstrates the limitations of using pictograms alone for conveying safety information. Suitable for both training and workplace signage.
	Respect personal hygiene (wash hands before breaks/after spillage, shower after application)	Widely available and common pictograms available for conveying this information. Suitable for both training and workplace signage.
Workers	Respect re-entry time	Use of a clock symbol could be used to remind workers of this imperative. However, this symbol has been shown to be subject to critical confusion (Rother, 2008). It may be more straightforward, therefore, to deploy temporary 'no entry' or 'keep out' signs around recently treated crops. This could also serve to warn residents and bystanders
	Wear gloves during activities in treated crops	Widely available and common safety pictogram. Suitable for both training and workplace signage.
Residents and Bystanders	Keep drift to a minimum	This information is addressed to the operators for the minimization of drift. Since there are various means by which drift can be minimised, a generic pictogram to denote this activity would be difficult to implement. Perhaps more appropriately addressed in the design and implementation of operating procedures by management.
	Communicate with the public about what you are doing	This information is addressed to the operators for the minimization of drift. Not appropriate to use pictograms. Emphasis is on management to ensure adequate communication. Warning signs could be deployed, however, during application.

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564 Figure 1: The new GHS/CLP pictograms (here presented in black and white rather than black symbols

565 framed by orange). Source: European Agency for Safety and Health at Work

566 (<https://osha.europa.eu/en/topics/ds/materials/old-new-clp-pictograms/view>)

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Figure 2: FAO Safety pictograms for pesticide labels. Source: FAO (1995).