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Pesticide risk perceptions and the differences between farmers and extensionists: Towards a knowledge-in-context model ☆

Adriana Ríos-González [a,b], Kees Jansen [c,*], Héctor Javier Sánchez-Pérez [a,b]

[a] Society, Culture and Health Academic Area, El Colegio de la Frontera Sur. Carretera Panamericana y Periférico Sur s/n, Barrio de María Auxiliadora cp. 29290 San Cristóbal de Las Casas, Chiapas, Mexico

[b] The Africa and Latin America Research Groups Network (GRAAL), Faculty of Medicine, Biostatistics Unit, Barcelona Autonomous University, Edificio M, 08193 Bellaterra, Spain

[c] Knowledge, Technology and Innovation Group, Wageningen University, Hollandseweg 1, 6706 KN Wageningen, The Netherlands

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ABSTRACT

A growing body of literature analyzes farmer perceptions of pesticide risk, but much less attention has been given to differences in risk perception between farmers and technical experts. Furthermore, inconsistencies in knowledge have too easily been explained in terms of lack of knowledge rather than exploring the underlying reasons for particular forms of thinking about pesticide risks. By doing this, the division between expert and lay knowledge has been deepened rather than transcended.

Objective: This study aims to understand differences and similarities among the perceptions of pesticide risks of farmers, farm workers, and technical experts such as extensionists, by applying a social science approach towards knowledge and risk attitudes.

Methods: Semi-structured interviews and field observations were conducted to smallholders, farm workers, extensionists, health professionals and scientists involved in the use and handling of pesticides. Subsequently, a survey was carried out to quantify the farmers and extensionists' acceptance or rejection of typical assertions expressed previously in the semi-structured interviews.

Results: Smallholders showed to gain knowledge from their own experiences and to adapt pesticides practices, which is a potential basis for transforming notions of pesticide safety and risk reduction strategies. Though extensionists have received formal education, they sometimes develop ideas deviating from the technical perspective. The risk perception of the studied actors appeared to vary according to their role in the agricultural labor process; they varied much less than expected according to their schooling level.

Conclusions: Commitment to the technical perspective is not dramatically different for extensionists on the one hand and farmers as well as farm workers on the other hand. Ideas about a supposed lack of knowledge by farmers and the need of formal training are too much driven by a deficit model of knowledge. Further research on risk perceptions of pesticides and training of rural people will benefit from the development of a knowledge-in-context model.

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1. Introduction

The unsafe handling of pesticides in Latin American countries has been widely documented, revealing practices such as users (farmers and farm-workers) not protecting themselves, use of restricted pesticides, and children playing in the farm (Barraza et al., 2011; Polidoro et al., 2008; Blanco-Muñoz and Lacasaña, 2011). The literature on farmers' knowledge of pesticide risks is steadily growing (for example, Hashemi et al., 2012; Ibitayo, 2006; Mokhele, 2011; Palis et al., 2006; Salameh et al., 2004; Sam et al., 2008). Many of these studies attribute mishandling of pesticides to a supposed lack of knowledge of farmers, who may be qualified as 'under trained' and 'illiterate' (Sam et al. 2008). Solutions are formulated as the need for more 'formal education' or 'better education' (Ibitayo, 2006; Salameh et al., 2004; Sam et al., 2008). However, in many of these studies farmers' perceptions are mainly interpreted from an expert position (Ibitayo, 2006; Salameh et al., 2004; Sam et al., 2008) which may downplay the value of the lay people's conceptualization of risks. Science studies have drawn attention to social processes that disqualify lay peoples' knowledge (Blok et al., 2008) and reinforce the dichotomy between lay and expert (Wynne, 1996). The differences between lay people and expert conceptualization of risk may hinder the implementation of effective risk communication.

* Corresponding author.
E-mail addresses: adrianariosg@hotmail.com (A. Ríos-González), Kees.Jansen@wur.nl (K. Jansen), hsanchez@ecosur.mx (H. Javier Sánchez-Pérez).

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In this study we attempt to examine how farmers and farm workers (considered as lay people) differ in their pesticide risk perceptions from technicians who are supposed to be experts in these matters. The case study was carried out in Chiapas in Southern Mexico among people involved in pesticide use in tomato and banana cultivation. Like elsewhere in Mexico, policies do not promote effective safety measures (Idrovo, 2005). Most of the production of this region goes to the national market and is produced under weak regulations for pesticide application, as is more often the case in developing countries (Galt, 2007; Jansen and Vellema, 2004).

Specifically, this study addresses the questions of how pesticide risk perceptions of farmers, farm workers, and extensionists and other experts are different or similar, how these perceptions are related to practices in the field, and how different groups think about how other actors view and handle pesticides. Our research approach to address these questions has several key elements. First, it broadens the focus from farmers (the single focus of most literature) to other actors by comparing farmers' perceptions with those of extensionists who provide advice about how to handle pesticides. Second, it develops an approach in which risk perceptions are first recorded without using an a priori assessment whether they are correct or not. This differs from most literature on farmers' risk perception which often uses one-sided notions to qualify farmers as 'aware/unaware', 'act incorrectly', and so on. A sociological perspective is taken that assumes that different forms of knowledge can bring useful insights to a particular situation; people's knowledge should be appraised without giving different hierarchy to one or another type of knowledge (Blok et al., 2008). This does not mean that comparison with a technical perspective (to be defined in the next section) is impossible. But such a comparison should be made explicit and is only carried out in a second instance. Third, we investigate how different actors frame pesticide problems (Jansen, 2003, 2008) and blame other actors while talking about pesticide issues. Fourth, we develop a combined qualitative and quantitative approach in order to quantify how representative the various views are and how they relate to other variables (Ton, 2012). This may help to bridge the gap between more interpretative anthropological approaches of local narratives (e.g. Guivant, 2003; Jansen, 2008) and the many quantitative studies on risk perceptions.

2. Methodology

The term 'technical perspective' is defined in this study as a way of thinking in line with scientific knowledge about how to deal with pesticide risks. It is for example reflected in the good practices as defined in International Code of Conduct on the Distribution and Use of Pesticides managed by the Food and Agriculture Organization of the United Nations. It concerns a set of 'good practices' about how to label the package, store, trade, mix, use, adjust spraying equipment, and use personal protective equipment, among other practices. The technical perspective also includes notions used by health specialists on what to do in case of poisonings.

3. Local situation

Chiapas is one of the states with the highest production of fruits and vegetables in Mexico. Soconusco and Frailesca, the locations of our study, are the most important agricultural regions of Chiapas. In Soconusco, with its tropical wet climate, coffee and tropical fruits such as papaya, mango, and banana are grown. In Frailesca, with its humid subtropical climate, farmers cultivate vegetables such as tomato (Instituto Nacional de Estadística Geografía e Informática (INEGI), 2010). In both regions, large-scale farmers and smallholders compete from an unequal starting position (Solis, 2005). Large-scale farmers own large plantations, have been trained in technical innovation, have enough resources to hire farm-workers to apply pesticides, and are integrated into a large commercial-network to market their produce. In contrast, smallholders hardly receive training, have small plots, are less mechanized, lack commercial networks, and thus face unfavorable conditions in the market. They mostly use family labor, which implies that they themselves apply pesticides. Many smallholders depend on government support in order to be able to stay active in agriculture. Another relevant group for this analysis is the farm-workers with no access to land. They work in the plantations in exchange of low wages. Commonly they have not received any type of training in agriculture or in any other job, thus agricultural work is crucial for their survival. The mentioned differences result in high incomes for large-scale farmers, low incomes for smallholders, and very low incomes for farm-workers.

Different types of pesticides are used in the study sites: the highest number of applications is with fungicides in banana and tomato (tridemorph, mancozeb and bitertanol: between 35 and 52 applications per year). The most used pesticides are the herbicides glyphosate and paraquat, and the insecticides bifenthrin, carbaryl and carbofuran. Some of them (e.g. carbofuran, carbaryl, paraquat and tridemorph) have been banned in European countries due to their potential environmental hazard (European Union (EU), 2003). All pesticides are sprayed, except for carbaryl, which is applied by granulates. In many cases, conditions of applications in Mexico lead to unsafe use. For example, all farmers eat in the field, up to 47% use the pesticides without any personal protective equipment (Tinoco-Ojanguren and Halperin, 1998), only 28% take a shower after having applied pesticides, and 42% of the farmers store pesticides in their homes (Blanco-Muñoz and Lacasaña, 2011).

4. Methods

Unlike many other studies on pesticide risk perceptions that use either qualitative (e.g. Guivant, 2003) or quantitative methods (Isin and Yildirim, 2007) we developed a combination of both methods. First, data on perceptions of pesticide risks and pesticide practices were collected using semi-structured interviews and field observations. Subsequently, we formulated a survey containing a set of typical assertions based on local expressions related to pesticide risks. In the second step we quantified peoples' acceptance or rejection of these assertions through a survey. In this way the survey questions were formulated very much in the local discourse. This not only increased comprehension by respondents. It also allowed for asking about assertions that a scientist would normally not include in a survey (see for example assertion 1–3 in Table 2).

The field observations of pesticide use practices were carried out during November and December of 2009 in four study sites: one large-scale banana farm and one banana co-operative (collective farm) located in the Soconusco region, and one large-scale tomato farm and one community with smallholder tomato farmers in the Frailesca region. We selected sites that would be instructive for observing different kinds of pesticide use according to researchers knowing the region and key informants from farmer associations.

The semi-structured interviews ($n=27$) with large-scale farmers ($n=8$), smallholders ($n=4$) and farm-workers ($n=4$), health professionals (physicians, health promoters and employees of the ministry of health) ($n=4$), scientists (researchers working in agriculture) ($n=3$) and extensionists (employees of the ministry of agriculture and pesticide companies) ($n=4$) took place in November 2009 and January 2010. Within each group, we selected those respondents who were involved in pesticide use and management; e.g. farm workers who apply pesticides were selected over those who do other tasks. Interviews with farm-workers were conducted in their house and not in the plantation in order to avoid that interviewees would feel intimidated and reluctant to talk about the different actors around the farm. Except for two tomato smallholders and two farm-workers who stated feeling ashamed of being recorded, all the other interviewees gave their consent to be recorded during the whole conversation. Two large scale farmers and one extensionist asked to stop the recording at one point of the interview. All interviews included similar questions; the questions were formulated in different

variations depending on the role of the particular actor interviewed. First, we asked about their work career, e.g. we asked farmers to describe the history of their farms and to the rest of the actors how they started their current job. Subsequently we asked farmers about their methods of pest management, extensionists and scientists about the problems of pests control and health professionals about the health problems in the area. Then we inquired about the advantages and disadvantages of their work in relation to pest management and the use of pesticides. In this part of the interview we asked to actors who do not manipulate pesticides; to health professionals about the principal health risks in the area and to scientists about the main problems in the agricultural production. In many cases interviewees then themselves started to talk about pesticides (not yet introduced as topic by the interviewer). Only in the fourth part of the interview, we asked farmers/farm workers, extensionists, scientists and health professionals about their views on pesticide risks, for example, if they think that pesticides are harmful or not for environmental and human health. If the interviewee had not previously mentioned any disadvantage of pesticides and health risk of these substances, but now stated that pesticides are harmful, then we asked why they had not mentioned pesticide risks earlier on. Based on this question it was possible to deepen the conversation about pesticides risk. Finally, we asked all interviewees to give their view on what other actors do regarding pesticides in order to study any form of blaming.

The survey used a Likert scale and was conducted face to face to 99 smallholders and 96 extensionists during February and March 2010. Respondents specified their level of agreement or disagreement with 30 items according to a five-point scale; 1=strongly disagree, 2=disagree. 3=neither agree nor disagree, 4=agree, 5=strongly agree. Each item corresponded to an assertion. The assertions that in the analysis were most remarkable and could be further interpreted by triangulation with data from the semi-structured interviews and observations are listed in Table 2. To reduce possible gender influence during interviewing the female interviewer was mostly accompanied by a male assistant.

5. Type of analysis

5.1. Analysis of the interviews

The semi-structured interviews and behavior were transcribed and coded (using NVivo 8.0, software for qualitative analysis), interesting assertions were identified, and differences between the various actor groups were explored. We did a preliminary analysis to design the survey (see a longer discussion in the results section). In this phase we did not use the technical perspective as the standard from which to formulate the assertions and instead of this, we took a more neutral position, not giving more authority to either the farmer or the extensionist's view (we hypothesized that the extensions' view would more or less follow the technical perspective). The technical perspective already prioritizes the expert view of what is risky (Wynne, 1996). We consider that our approach gives more insight into the origins and dynamics of the different types of knowledge. However, we do not think that a fully neutral or agnostic position regarding whether a particular view on risk is more or less correct and can be maintained throughout the analysis (drinking a pesticide is likely to cause more harm than keeping it in the bottle). Hence, in the later stage of the analysis we used the technical perspective as a yardstick when necessary. For the discussion below, we classified first the respondents' answers in three groups. The first two are expressions meaning “there is risk” and expressions meaning “there is no risk” or “there is little risk”. Then we found a category of people who in one interview expressed “there is risk” in one moment while in other moments “there is little risk”. Secondly, these expressions were checked with field observations, in particular the practices of respondents who had asserted that pesticide use involves risks, for example a pesticide user who expressed that there is risk but does not protect himself. In the case of actors who do not handle pesticides (scientists and health professionals) we observed behavior and interviewed them during field visits about their own possible exposure and the exposure of others (e.g. regarding any kind of protection they used when going to farmer fields).

The interviewees who only used expressions of ‘there is risk’ in the interview and showed practices confirming this, were considered to have a *risk aware* attitude. Those who only used expressions downplaying the risk or did not find them important and showed practices confirming this were considered to have a *risk disregarding* attitude. Then we found people who expressed ‘there is risk’ but whose practices did not coincide. We also found people who in a single interview expressed different perceptions: in one moment as risk aware while in other moments disregarding risks. These last two categories we call the ***risk dissonant*** attitude.

We looked how these three categories of attitudes were distributed over the different actors, grouped in various ways: type of actor (large-scale farmer, smallholder, farm worker, extensionists, health-professionals and scientists), exposure to pesticides (exposed=to have contact with the substance, non-exposed=not having or little contact with the substance) and school level of the actors. The latter ranged from farm-workers without elementary school and smallholders with elementary school and in few cases with high school to large-scale farmers, extensionists with a university degree and scientists with a postgraduate studies (‘low-schooling’=high school or less, and ‘high-schooling’=university degree).

5.2. Analysis of the survey

The level of agreement of the respondents with the various assertions in the survey was analyzed for different groups using crosstab and chi-square tests (using SPSS v. 15). Relevant variables were type of actor (farmer or extensionists), exposure and the schooling level of farmers. Considering that having completed elementary school is a minimum requirement for more remunerated jobs (as alternative to agricultural work), the schooling level of farmers were classified into ‘elementary school not completed’ and ‘elementary school completed’ (the latter includes higher education).

6. Results

This section presents separately the results of the semi-structured interviews and the observations (qualitative, interpretive study), and of the survey (quantitative study). In the discussion section we will make cross-links. In Each sub-section we will successively discuss perceptions that people have about the risk attributed to the pesticides itself (risk nature of pesticides), the risk perceptions that relate to the role of pesticides in agriculture, and the perceptions of people about who is to blame for possible problems with pesticides (blaming).

7. Results of semi-structured interviews and observations (the interpretive study)

From 28 actors approached for this study, 27 accepted to be interviewed. The smallholders and farm-workers ($n=8$) were exposed and had low-schooling, while other actors ($n=19$) were non-exposed and had high-schooling, with the exception of three large-scale farmers who have low-schooling (Table 1).

7.1. Perceptions of the risk nature of pesticides

The interview data reveal that smallholders gained knowledge about the health risks of pesticides from different sources. One important source was their own experiences, which often led to adaptations in pesticides practices, risk prevention or locally-rooted views on how to treat pesticide contaminations. For example, we discovered that smallholder tomato farmers had stopped using carbofuran (an insecticide/nematicide), which had

Table 1
Risk perception and attitude according to type of actor, exposure and schooling level.

	Expressions observed during the interviews				Respondents whose daily activities confirmed their expression "there is risk"		Risk attitude		
	n	"There is risk"	"There is no or little risk"	Both expressions	Confirming	No confirming	Aware	Disregarding	Dissonant
Total actors	**27***	**16**	**2**	**7**	**6**	**10**	**6**	**2**	**19**
Type of actor									
Health-professionals	4	–	1	3	–	–	–	1	3
Extensionists	4	3	1	–	–	3	–	1	3
Scientists	3	3	–	–	3	–	3	–	–
Large-scale farmers	8*	6	–	–	–	6	–	–	8
Smallholders	4	3	–	1	3	–	3	–	1
Farm-workers	4	1	–	3	–	1	–	–	4
Exposure									
Exposed	8	4	–	4	3	1	3	–	5
Non-exposed	19	12	2	3	3	9	3	2	14
Schooling level									
Low-schooling	12	7	–	5	3	4	3	–	9
High-schooling	15	9	2	2	3	6	3	2	10

* Two large scale farmers avoided talking about pesticide use, thus we could not determine their expressions regarding "there is risk" or "there is no or little risk". In these cases we could through field observations determine their risk attitude as dissonant.

been used for years in those communities. Asked about why they had stopped, a smallholder in a group conversation stated: "After many years of applying this pesticide, we realized that many of us feel nausea and dizziness after mixing or applying this pesticide, thus we know that pesticides are not good for our health" (Interview 1, [21–12–2009] all translations of quotes and interview questions from Spanish to English by the authors). They link these bodily experiences in the field to their decision to reduce the use of carbofuran. Likewise idiosyncratic treatments may also be based on local experiences. For example, the oldest smallholder tomato farmer stated: "Once I became sick due to the pesticides, I came home with dizziness and nausea, my wife gave me water with lemon and that relieved me. That is a good remedy to relieve the effects of pesticide, thus I advise my friends to relieve the symptoms with water and lemon" and later he stated "drinking a glass of milk before applying [pesticides] is good to prevent intoxication" (Interview 2, [22–12–2009]). During the field work, we encountered many smallholders who drink a glass of milk before applying and stated to drink lemon with water when they feel nausea. We observed women soaking clothes impregnated with pesticides after applications in water with lemon before they wash it. They explained that the lemon removes the toxicity of pesticides (short personal communication in the field, [10–12–2009]). These practices evidence that for smallholders one source of knowledge is their own experiences, often, as the second quote suggests, shared with friends and thus subject to social interaction at the local level.

This does not mean that all perceptions about health risks that differ from the technical perspective originate among smallholders themselves. Some come from people with higher schooling levels. One of the interviewed farm-workers, when asked if pesticides imply risks to human health, answered: "Some of us have already been adapted; I have been growing tomato for a long time, thus I do not cry and I am not afraid, but there are people who are quickly affected. (..) Pesticides do not affect equally the people. It depends on how we are made; those who are adapted are stronger. All pesticides are toxic but there are people who resist and others who do not resist". When asked how he knew that pesticides do not affect people equally, he replied: "I have heard it from an extensionist, we were talking about it" (Interview 3, [21–12–2009]). Although this quote is not by itself sufficient evidence for considering extensionists as the source of such ideas, it raises the question about how different or similar the views are between farm workers and smallholders on the one hand, and extensionists on the other hand (to be discussed later).

Another issue revealed by the data concerns on how actors read the label on the package. Interview data suggest that users interpret the labels differently from the official message that they contain. For example, some people believe that the shift from red-labeled pesticides to pesticides with a green or blue label (indicating a lower acute human toxicity) has reduced the health problems. "I wonder it is because of the liquids they spray; my mother in law died of cancer, my father in law too, [like] most of the people here. (..) The current [pesticides] arrive diluted for the human: the labels indicate it and tell 'no toxic' or 'slightly toxic' and the letters of the product are green or blue: formerly the labels were red and with a big skull" (Interview 4, [15–11–2009]). The farm-worker related the red label to higher levels of cancer. However, the colors on the labels refer to acute toxicity and not to cancer. Although the simplicity of the color system has had its function in pesticide risk management, it has introduced new meanings not foreseen in the design of the labeling system. In the same way we found that farmers sometimes considered the colors to be an indication of effectiveness, whereby red labeled pesticides were considered more effective (see the discussion below about the survey). Again this goes against the technical perspective: the color is not a measure of effectiveness.

7.2. Risk perceptions related to pesticides in agricultural practice

By means of classifying the expressions and observed practices of actors we identified the type of risk attitude (Table 1). A small proportion of the interviewees (6 out of 27) showed a 'risk aware' attitude. An example of this attitude is the interview and observations of one smallholder tomato farmer who, even when we have not yet introduced pesticide risk as topic, stated: "Formerly there were no such terrible diseases as nowadays. I think that it [sickness such as cancer] is due to the amount of pesticides we use in tomato. (..) I even do not want to eat my own tomato. (..) All of us want someone to teach us how to produce organic tomato; I think that every tomato farmer wants to stop using pesticides, because these [pesticides] mean danger for our health" (Interview 5, [28–12–2009]). Besides his wish to stop using pesticides, expressed during the interview, we also observed him performing

adapted practices to prevent pesticide risk. He used a specific set of clothes for applying pesticides composed of a long-sleeved shirt, pants, gloves and a handkerchief, which he normally left in the field. Occasionally he took the clothes home where his wife washed it separately and hung it on a high clothesline to keep them away from the children. Though these and similar practices may not be an adequate protection, the mere intention is an expression of a risk aware attitude.

On the other hand, we also found actors who disregarded pesticide risks, although this was a minority (2 out of 27). One of these two was a physician who seemed to give priority to other types of risk, thereby neglecting what happens in agriculture. When asked if she thinks that the use of pesticides in the farming community presents health risks for the population, she answered *"no"*. Several of her statements can be interpreted as a narrative to minimize the importance of pesticide risk: "the cases of cancer that have been registered are of women, but they do not even apply pesticides. (..) In Comitán the production of tomato is higher than here, but the population is not sick. (..) If they [the farmers] eat tomato, they wash it but they do not remove the bottom, where the cholera could be present. That is even worse" (Interview 6, [19–12–2009]). In this answer she referred to the idea that pesticide contamination causes cancer. The shift in her words to cholera as a much higher risk of tomato consumption indicates her prioritization of risk. The second risk disregarder in the sample was an official of the Ministry of Agriculture who strongly stated that pesticides are crucial for agricultural production "There is no another way to manage pest control; (…) you will not find any alternative [different to pesticides] to manage banana pests because that is not possible; it is like that!" (Interview 7, [14–12–2009]). This interviewee did not want to talk about pesticide risks. Both cases are examples of people who prioritize other risks (infectious diseases, yield reduction) and deny or neglect pesticide risks.

A larger group of respondents (19 out of 27) combined risk awareness and disregarding risks; we call this the 'dissonant risk' perception. From these respondents 12 out of 19 expressed to be aware of risk during the interviews or did not want to talk about pesticides but exposed practices that reject or neglect that there is risk. For example, a large-scale banana farmer asked us to stop recording the interview and then in many moments showed risk aware attitudes in the interview, such as the following statement: "They [pesticides] are so toxic! It is necessary to use protection while applying pesticides; therefore in our farm we provide protective equipment to the workers" (Interview 8, [16–12–2009]). During the field work, employees of this farm assured that they comply with the rules of safe use of pesticides established in the 'agricultural good practices protocol' (Secretaria de Agricultura Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGRPA), 2002) because they want to obtain a certification that would make market expansion possible. However, we observed that the personal protective equipment and showers are not sufficient for the number of farm-workers who apply pesticides in this farm. This coincided with what one farm-worker of this farm stated: "No, [in the farm] they have never given protective equipment to me (..) no… they have neither said how I must apply the pesticide" (Interview 9, [13–11–2009]). This expression can be seen as a rejection of what his employer, the large-scale farmer quoted above, had stated. Likewise another large-scale farmer stated: "The pesticides cause harm, therefore we are trying to reduce the applications in the farm" (Interview 10, [14–12–2009]). However, during the fieldwork in his farm, the production manager explained that they try to reduce the number of pesticide applications because pesticide costs put a pressure on profit margins; they had already shifted to using cheaper pesticides (communication during the field work, [17–12–2009]). Hence, the large-scale farmer presented the reduction of pesticide applications as part of a risk aware discourse, while it was basically a strategy to diminish the production costs. We consider this as a dissonance between expressed perceptions in the interview and practical reasons in the farm.

We also found other forms of dissonant risk attitudes. 7 out of 19 interviewees showed contrasting perceptions within an interview (independently of their practices in the field). These statements in particular informed the formulation of the assertions included in the survey for quantitative analysis (Table 2). An example of this form of dissonance is the case of a farm-worker who shifted his expressions about pesticides from negative while talking about possible health consequences to positive when talking about work load. "I think that sooner or later the pesticides will affect us". Asked about disadvantages and advantages of working in the farm he stated: "I do not like it because, for example, today I dropped everything and it [the pesticide] splashed on me. (..) The advantage [of applying pesticides in the farm] is that it is only three hours [from 6:00 to 9:00 am]; that is why I like it. Well, it is not that I like it. I mean, I prefer that. Even while I do not like it, I prefer it because it is only three hours and they [the farm owners] pay the whole day [9.2 dollars]. In this way I can do other jobs thus I earn more. (..) My son tells me to stop with this work because it can affect to my health but in this way I am early at home [to do other jobs]. (..) I have sprayed for many years and nothing has happened to me" (Interview 4, [15–11–2009]). Initially, this interviewee expressed that pesticides can cause harm, which is an indication of a risk aware attitude. When we moved to talk about pesticide use in his work, he indicated to prefer applying pesticides. From this moment in the interview he shifted to giving statements trying to downplay the risk by alleging that he has not got sick. Such a shift in meaning attributed to pesticides within a single interview suggests that when people consider pesticides within the context of agricultural practices and their socioeconomic situation, this leads to the expression of dissonant attitudes of risk.

The collected data on risk perceptions showed clear differences for the type of actor and exposure and less clear differences for schooling level (Table 1). The risk aware attitude was identified for the major proportion of smallholders (3 out of 4) and for all scientists ($n=3$), whereas dissonant attitude were identified for all large-scale farmers ($n=8$), farm-workers ($n=4$), the major proportion of extensionists (3 out of 4), and the health professionals (3 out of 4). Likewise the risk aware attitude was identified for a larger proportion of directly exposed actors (3 out of 8) than for non-exposed actors (3 out of 19). In contrast, interviewee attitudes according to the schooling level differed slightly. One quarter of the low-schooling actors showed risk aware attitude (3 out of 12) whereas only a fifth of the high-schooling actors showed this attitude (3 out of 15).

7.3. Blaming

We also collected data on how interviewees perceive the attitude of other actors towards pesticides (Table 1). The data revealed that 11 out of 19 non-exposed interviewees put all the blame on pesticide users (smallholders and farm workers). Most of them disregard pesticide risks and consider themselves blameless. Expressions to blame users were variations on one idea: "pesticides are not harmful; the problem is not the pesticides but how the people handle the pesticides". For example an extensionist working in a pesticide manufacturer stated "My product [pesticides] aims and is manufactured to control plagues. (..) [But] who misuses it? [He used an ironical style of expressing] (…) the long term problems that they [smallholders] have in their intestines, genitals and nervous central system could be attributed to

Table 2
Assertions included in the survey and percentage of extensionists and farmers agreeing with a particular assertion

		Type of actor			Schooling of farmers		
		Extensionists % (*n*)	Smallholders % (*n*)	*p*	Elementary school completed % (*n*)	Elementary school not completed % (*n*)	*p*
Perceptions contrasting with technical perspective							
1	Current pesticides are not as harmful as in the past; nowadays less people die from poisoning	37 (92)	43 (91)	.253	38 (45)	50 (44)	.172
2	People exposed to pesticides become resistant to its effects	23 (90)	56 (90)	.000	51 (23)	58 (25)	.327
3	If a label shows a skull, the pesticide is dangerous. If it does not show a skull it is no so dangerous	39 (91)	58 (93)	.006	60 (47)	59 (44)	.566
Perceptions regarding place of pesticides within the agricultural context							
5	Agriculture is more profitable with the use of pesticides than without.	66 (92)	83 (97)	.008	83 (48)	81 (47)	.481
6	The effect of pesticides on the environment and human health are justified by the benefits that these substances bring to agriculture.	46 (89)	65 (88)	.009	52 (46)	83 (40)	.003
Blaming							
7	In case of an accident with pesticides, the user is to blame.	82 (73)	83 (78)	.446	83 (48)	84 (43)	.593
8	Pesticides are not harmful if they are applied correctly.	63 (91)	68 (98)	.250	61 (49)	77 (47)	.080
9	Pesticides harm the health of the farmers, because they do not protect themselves.	88 (95)			–	–	–
10	Extensionists think that we do not use protection because we do not want to and we do not know the harm it can cause, but the truth is that nobody gives us protective equipment*		64 (89)		–	–	–
11	The producers do not apply the pesticides correctly because they do not know; they lack training	78 (96)			–	–	–
12	Extensionists think they know better than us how to control pests because they have studied, but they do not have the experience in the field as we have.		73 (92)		–	–	–

* The expression "anybody gives us protection" is used by smallholders to refer to the idea that institutions do not provide economical support to buy protective equipment nor advices them on how to protect themselves.

pesticides but the problem is not the product, it is rather the doses they use. (..) I have not found any evidence of cancer in our products. I am an environmental engineer, thus if our products are dubious, I would be the first to raise the hand" (Interview 11, [25–01–2010]). First, this extensionist referred to the idea that if users would apply the recommended doses of pesticides they would not be at risk. This suggests that the misuse of pesticides is perceived as much more risky than the substance itself. Second, although he attributed problems with intestines and some other health problems to pesticides, he prioritizes carcinogenic pesticides as the only serious health problem, creating a frame in which pesticides that are not carcinogenic are not really harmful. Third, on the top of this, he hinted to be blameless because he is an environmental engineer, presuming and underlining the superiority of expertise.

One other regularly displayed form of blaming users involved one or another reference to the "Mexican idiosyncrasy", a term which is often used by locals to allude to the stereotype of the Mexican lounging around a cactus, traditionalist, defiant and reckless. Some people attribute this stereotype only to poor and low-schooled people who live in rural areas. Extensionists, large-scale farmers and health professionals regularly use this frame when blaming smallholders and farm-workers. For example a large-scale farmer stated: "We have to face our idiosyncrasy. (..) People contaminate by throwing away the wrapping of processed food [he referred to plastic in the streets] because formerly they did the same with the traditional products [he referred to the countryside]. (..) Thus, this problem originates in our education" (Interview 12, [17–12–2009]). In this view coming from rural areas means to be uncivilized and environmentally unconscious. Another example was an extensionist working for a pesticide manufacturer and responsible for risk communication, who stated: "They [smallholders] do not read the label, they prefer to ask to their friends. (..) We [he and his colleagues] were in a meeting to define the design of labels and we coincided that the problem is cultural. The idea of Mother Nature has taken root among the peasants very strongly. Therefore, like the Spanish who managed to conquer us with the virgin Guadalupe [Maria], we will search for a symbol with which the peasant can feel identified" (Interview 11, [25–01–2010]). In his analogy between the strategies for communication with smallholders and the establishing of Spanish dominance during the conquest of Mexico, he presumed to be the dominant part that has the moral right and power to reshape peasant's culture. From this perspective, it is culture rather than the nature of the technology or social relations that is the underlying prime cause of problems related with pesticide use (Jansen, 2008).

Smallholders and farm-workers in their turn blamed the extensionists (3 out of 4), but unlike the latter, pesticide users also considered themselves as blameworthy. One smallholder typically blamed extensionists as follows: "In the Ministry of

Agriculture, they [the engineers] sit cross-legged on their desk, smoking their cigarette. I feel they should come here. (..) We do [apply pesticides] with our understanding, but sometimes we do so wrongly. Once there were farmers who used to spray nitrate mixed with herbicide, some engineers saw that and said to the farmers no to do that because they can cause an explosion, but [mostly] there is nobody who tells us anything (..) We would like that the engineers teach us organic methods. There is a farmer in Agronomos [another farming community] who grows organic maize and has good results" (Interview 5, [28–12–2009]). This smallholder complained about the lack of attention from extensionists but would also welcome guidance about organic agriculture by an extensionist. A difference between smallholders and farm workers on the one hand and extensionists on the other hand is that the former also blame themselves when considering pesticide-related problems. In the interviews, 3 out of 4 farm-workers and one smallholder expressed such self-blaming. Interestingly, this self-blaming overlapped with the idea expressed by non-exposed actors that it is not the pesticides that are harmful but that the user has to be blamed for any harm caused by pesticide handling. An example of self-blaming was given by a farm-worker: "Sometimes at the end of the journey my neck and my chest turn red and itch, just like this [he showed us the rash on his chest]. I do not know what it is. I believe that it is because I touch the bags [those impregnated with pesticides] and all that having contact with substances [pesticides] and that kind of stuff. However, it must also be because I do not always use protection [he uses a tone showing shame]. I only use a pair of gloves sometimes, but it hampers my work and makes me sweat even more. (Interview 13, [13–11–2009]). Such forms of little self-blaming occur often in interviews.

The frame of self-blaming can also be partly incorporated but at the same time ironized. One farm-worker who described an accident in the farm stated: "A colleague farm-worker became sick, he used to pick up the bags [those impregnated with pesticide], we told him to ask for a mask…[silence, expressing hhhummm, and continuing with a cynical tone in his voice]: in the farm they give us boots. Everybody there uses boots, thus if we get sick it is our fault. I have been years working there and I have never got sick" (Interview 14, [27–11–2009]). This farm worker suggested that it is your own fault when you get sick because you do not wear protective equipment. At the same time he talked ironically about the notion that with the availability of some personal protective equipment the worker will be blamed for accidents and damage, rather than the farm owner.

8. Results of the survey

We did a preliminary analysis of interviews in which we identified the following interesting issues: perceptions that contrast with the technical perspective, the reference to the role of pesticides in agricultural production and the importance of blaming people for negative effects of pesticide use. From the items of the survey we selected the 12 assertions with the most remarkable results (Table 2). Some of these assertions contrast with the typical technical perspective. The schooling level and the exposure t pesticides were very different between the two groups: farmers and extensionists. All extensionists had university degree whereas most smallholders barely finished the elementary school (63% had not finished elementary school and 36% had entered, though not necessarily finished high school). Whereas extensionists are occasionally exposed to pesticides (once per month), all smallholders are exposed almost daily during the growing season of tomatoes. In an initial analysis we noticed that the distribution of responses showed clear tendencies. For many assertions the majority of the respondents chose for "disagree" (option 2) or "agree" (option 4), a minor proportion chose "strongly disagree" (option 1) and "strongly agree" (option 5) and only few respondents chose "neither agree nor disagree" (option 3). To show the contrast we eliminated the responses of option 3 and we categorized options 4 and 5 as *agreement* and options 1 and 2 as *disagreement*.

8.1. Perceptions contrasting with the technical perspective

We hypothesized that extensionists would have ideas that approximate the technical view considering that they are trained in pesticide toxicity and thus would disagree with assertions that go against the technical perspective. However, an important percentage of extensionists expressed ideas that deviate from the technical perspective (Table 2, assertions 1–4). Agreement with the idea of "Current pesticides are not as harmful as in the past; nowadays less people die from poisoning" were almost similar for both groups (43% and 37%, respectively, $p=.253$). Although more smallholders than extensionists agreed with "People exposed to pesticides become resistant to its effects" (56% and 23%, respectively, $p=.000$), the fact that almost a quarter of the extensionists agreed is remarkable. This result coincides with the finding of the semi-structured interviews suggesting that high-schooled actors may support ideas that differ from the technical perspective (e.g. Interview 3).

Just as it was found in the semi-structured interviews (e.g. Interview 4), both extensionists and smallholders appeared to interpret the labeling differently from the original intentions of the designers of the labeling system (Table 2, assertions 3–4). Smallholders agreed more than extensionists with two ideas: "If a label shows a skull, the pesticide is dangerous. If it does not show a skull it is no so dangerous" (58% and 39%, respectively, $p=.006$) and "Pesticides with a red band are the most hazardous but also the most effective against pests" (80% and 64%, respectively, $p=.013$). Assuming that the lower percentages for the extensionists is an expression of better technical knowledge (red band and skull only inform about acute toxicity, not overall hazardousness; band color is no indication of effectiveness) it is remarkable that still a high percentage of the extensionists agree with these assertions.

8.2. Perceptions regarding the role of pesticides in agricultural production

In the semi-structured interviews the interviewees often expressed dissonant risk perception when they started to talk about the role of pesticides in agricultural production (e.g. Interview 4). Especially smallholders agreed with assertions that justify the risks they take when applying pesticides (assertions 5–6 in Table 2), such as "Agriculture is more profitable with the use of pesticides than without" (83% and 66%, respectively, $p=.008$) and "The effect of pesticides on the environment and human health are justified by the benefits that these substances bring to agriculture" (65% and 46%, respectively, $p=.009$). It is noteworthy that both assertions may have a particular meaning for each group of actors. Agriculture is the major source of livelihood for smallholders and increasing yields is an important issue for them. Therefore smallholders may be more eager to seek justification for the use of pesticides than extensionists, who do not depend economically on agricultural production. The position of the actor in the agricultural process seems to be important in shaping risk perception.

8.3. Blaming the user and the other

The notion that the problem is not the pesticide but how people handle pesticides (blaming the user for misuse), as identified in the semi-structured interviews, is actually shared by smallholders and extensionists (Table 2, assertions 7 and 8). While this idea means that extensionists put the blame on the other, for smallholders it means self-blaming. Interestingly, the results of the survey showed that a similar percentage of smallholders and extensionists agreed with the idea that "In case of an accident with pesticides the user is to blame" (83% and 82%, respectively, $p=.446$). Likewise, similar percentages of smallholders and extensionists agreed with the idea "Pesticides are not harmful if they are applied correctly" (68% and 63%, respectively, $p=.250$). This supports the idea that if harm occurs, the reason is incorrect handling (misuse).

The survey results confirm the finding of the semi-structured interviews that smallholders and extensionists blame each other for the lack of personal protection (Table 2, assertions 9–12). Whereas the majority of extensionists (88%) agreed with the idea "Pesticides harm the health of farmers, because they do not protect themselves", the majority of smallholders (64%) agreed with "Extensionists think that we do not use protection because we do not want to and we do not know the harm it can cause, but the truth is that anybody gives us protective equipment". Likewise, we found that both groups questioned the knowledge of the other. A majority of extensionists (78%) agreed with the "The producers do not apply pesticides correctly because they do not know; they lack training". A majority of the smallholders (73%) agreed with "Extensionists think they know better than us how to control pests because they have studied, but they do not have the experience in the field as we have". These results not only show that extensionists and smallholders blame each other, but also indicate that they have different views on who has better knowledge and no confidence in what the other actor knows.

The smallholders and extensionists in this study have very different schooling levels and levels of exposure to pesticides, so the differences between both groups corresponded also to the differences according to schooling level and exposure. To deepen the analysis of schooling we also compared the schooling level of smallholders. In almost all assertions smallholders who did not complete elementary school and smallholders with elementary school completed showed similar levels of agreement, with exception of assertions 6 and 8. Smallholders with elementary school not completed agreed more with "The effect of pesticides on the environment and human health are justified by the benefits that these substances bring to agriculture" (83% and 52%, respectively, $p=.003$) and with "Pesticides are not harmful if they are applied correctly" than smallholders with elementary school completed (77% and 61%, respectively, $p=.080$). A low-schooling level coincides with smallholders justifying the use of pesticides and expressing self-blame.

9. Discussion

Risk communication is seen as a key element to promote the safe handling of pesticides, whereby much emphasis is given to labeling and education as instruments for improving such communication (Hashemi et al., 2012; Lichtenberg and Zimmerman, 1999). The results of our research provide new insights about such communicative activities. In this section we first discuss the issue of labeling and then the role of formal education in understanding risk information. After that we discuss the relationship between experts and lay people, focusing on the constraining role of blaming as discursive strategies. Finally, this discussion helps us to formulate an alternative model for the classical model of thinking about the knowledge deficit of pesticide users.

This study offers insight into the discussion of how to compose pesticide labels. Several studies have documented that users often do not read the information; one reason for this is that information is often too technical and not understandable (Damalas et al., 2006; Waichman et al., 2007). Particularly in conditions of developing countries with illiterate users or users with less formal education, one has tried to solve this problem by using simplifying symbols, e.g. as pictograms or the color of the label. The use of a red band on the label of highly hazardous pesticide with a high acute toxicity is well known. Our study confirms Rother's (2008) finding that also the simple pictograms may be misunderstood. The results of our study suggest that simplification may lead to new misunderstandings and false images of safety and risks (e.g. that red labels are more effective for pest control). There is no simple solution to this dilemma. Some studies attribute farmers' lack of understanding of the label to a low schooling level or lack of training (Damalas et al., 2006; Mokhele, 2011). In contrast, this study found that label interpreters with a higher schooling level such as extensionists who have received training in pesticide use, also misunderstand the pesticide labeling in unexpected ways.

This study also provides data that reflects the relationship between the level of formal education (schooling level) and a correct interpretation of pesticide information. The results show that an unexpected high number of extensionists express attitudes that are dissonant with the mainstream technical perspective. Like smallholders, many extensionist share views that can be considered incorrect from a technical perspective (although the percentage that deviates from the technical perspective is different for smallholders and extensionists). This study demonstrated that the schooling level is not necessarily related with a more correct risk perception of pesticides, reflected in the little difference in risk perception of high-schooled and low-schooled actors (Table 1) and the finding that not only farmers but also extensionists have ideas that differ from the technical perspective (assertions 1–4, Table 2). Moreover, there were no significant differences in the opinions of smallholders with elementary school completed and smallholders with elementary school not completed (with the exception of assertion 6). These results differ with other studies that suggest a more direct, linear relationship between schooling level and risk perception (Yassin et al., 2002; Hashemi et al., 2012; Blanco-Muñoz and Lacasaña, 2011; Ibitayo, 2006; Salameh et al., 2004; Sam et al., 2008; Mokhele, 2011). For example, one study found that in Mexico workers with an education level above elementary school are more aware about pesticide risks than those with a lower level (85.7% versus 52.9%, $p=.04$) (Blanco-Muñoz and Lacasaña, 2011). One reason for the difference in findings may be that we developed a different methodological approach. Although we compared farmer's expressions with a mainstream technical perspective we did not a priori categorize farmers' expressions from a normative perspective that classifies them as technically 'correct' or 'not correct' (Yassin et al. 2002., Hashemi et al., 2012, Blanco-Muñoz and Lacasaña, 2011). In our study we used a sociological approach whereby we first just recorded pesticide perceptions from a more neutral position, i.e. formulating assertions based on people's own ways to express the matters rather than following the 'technical correct' approach. More formalized, technical correct questioning in other studies could, instead, privilege the higher-schooled farmers, whereas drawing more 'incorrect' answers from the lower-schooled farmers. Added to this, we also interviewed extensionists in the same way, taking a symmetrical perspective as much as possible (most other studies only interviewed farmers or farm workers). Only at a later stage in the analysis we compared the given expressions with a mainstream technical perspective. If our argument is valid that a more

formal education does not lead in a linear way to more 'correct' pesticide perceptions (i.e. in line with the technical perspective), a more dynamic view on pesticide knowledge will have to be developed (in which formal education may just be one element).

If the level of formal knowledge is not the single explaining factor how much of the technical perspective is followed by actors, we have to look at other factors. One major factor that appears to be important in our study is the position of the actor in the labor process. By this we mean how people make a living and the role that pesticides play in this process. Justifying pesticides by smallholders has been attributed to the poor conditions of life and dependence of smallholders on agricultural production (Kishi et al., 1995, Hunt et al., 1999, Recena and Caldas, 2008) and their situation of vulnerability (Fonseca et al., 2007). Our study suggests that many users do not just deny pesticides risks even if their short term income is dependent on working with pesticides. But we also observed that the latter experiences influence the expressed perceptions. In the qualitative interviews we observed shifts in expressions when the interview evolved from talking about the properties and effects of pesticides to the issue why people apply pesticides. In the first moment, many respondents expressed to be aware about possible health effects, using negative qualifications for pesticides, whereas in the second moment they used less negative qualifications of pesticides or only positive ones, shifting to language expressing the need to apply, either to have the spraying job as farm-worker or to save the harvest as smallholder. Therefore we argue that neglection of pesticide risks in a dissonant risk attitude is less driven by a lack of knowledge as by strategies to make a living in the given conditions. Both smallholders and larger farmer may be locked into the use of pesticides to save the harvest and thus their investments. The role of actors in the labor process also helps to understand the apparently rejection of pesticide risks by the health professionals who displayed a dissonant attitude. Their epidemiological perspective informs them that diarrhea or tract infections are a much larger risk than pesticides as diarrheas frequently reach epidemic proportions.

The research results indicate that attributing a lack of knowledge to a particular group is a discursive strategy to blame the other (humans rather than the technology) for harm resulting from pesticide use. The results have revealed that extensionists and scientists expressed themselves in a more consistent way about pesticide risks and use than the 'non-experts' (Table 1). Large-scale farmers also expressed a consistent narrative. We hypothesize that scientist, large-scale farmers and extensionists are used to defend their position in a discussion about pesticides, meanwhile smallholders and farm-workers are not used to express their insights on pesticides linguistically and, thus, may express dissonances. Therefore, smallholders and farm-workers may appear as more inconsistent. This could lead to the suggestion that they need to require more (formal) knowledge. As we have argued above, blaming users by referring to a lack of knowledge is rooted in a reductionist explanation of the nature of pesticide knowledge of smallholders and farm-workers (Blok et al., 2008, refer in this context to the 'imagined' lay-person) and a more comprehensive model is needed. The process of boundary setting between those who know, or are supposed to know, and those who lack knowledge relates to the discussion on the public understanding of science and the division and relationships between 'experts' and 'lay people' (Blok et al., 2008; Jansen, 2008). Our results point at boundary setting processes, in particular by extensionists who blame the users for problems. By doing so, they reproduce the model of a large expert-lay distance. Smallholders also reproduce this distance by showing mistrust in their own knowledge. But smallholders also tend to point at some typical faults of extensionists, thus developing a double position: extensionist should know and deliver (advice but also protective equipment) but in real life they often fail to do so. Despite farmers' questioning of the role of extensionist, they demanded training from the last actors. It is worth to notice that the concept 'training' can differ from both groups (experts-lay) (Binder and Schöll, 2009). It is likely that existing training concepts will fail as they are based on the classical expert-lay division and the model in which pesticide users are just seen as recipients of formal knowledge and have no knowledge, skills or experiences to tap into.

This discussion brings us to the point where we have to develop a broader and more refined model of knowledge about pesticide risks that goes beyond a simple knowledge deficit model (Jansen et al., 2004) (Fig. 1). We will call this refined model the knowledge-in-context model. The first element is that formal education and the congruence between the expressed perception and the technical perspective are not (or not only) the standards to assess people's knowledge about pesticide risks. Rather an analysis is needed of knowledge in its context in order to understand why people, for example smallholders and farm-workers, express dissonant attitudes. Both individual conditions (e.g. livelihood situation) as well as more systemic factors, such as the organization of the labor process or the dominance of particular risk narratives, shape the knowledge that people express (formal education is just one element of this context). The second element is that experiences of people inform their views. Farmers who have suffered accidents with pesticides perform more safety practices than those who have not suffered accidents (Feola and Binder, 2010). Our study shows that personal experiences, often in combination with social interaction (talking among farmers), led farmers to adapt their pesticide safety practices. Experiences mentioned were not only practical experiences with pesticides (e.g. accidents in the field), but also experiences with 'institutions', such as the distrust of extensionists discussed above. The third element of our knowledge-in-context model is the important role of larger knowledge networks that strongly shape pesticide use perspectives (Toleubayev et al., 2010), and may induce changes in behavior (Barraza et al., 2013; Toleubayev et al., 2011). In our research the current social discourse on organic farming appeared to be a point of reference for many farmers and has produced shifts in their thinking about pesticides (not necessarily in their practices of pesticide use). This element also links individual oriented research on risk perception to approaches that identify and analyze the more collective social processes that shapes peoples thinking. For example, former banana plantation workers in Central America have filed collectively law suits against the manufacturers of dibromochloropropane (Bohme, 2011; Rosenthal, 2004). Galt (2007, 2008) has analyzed how farmer perspectives of risk emerge and adapt to the concrete political economic situation.

A knowledge-in-context model will have consequences for ideas about training in pesticide safety measures that is now predominantly based in the knowledge deficit/ignorant user model. Calls for more training about risks and safety measures that are uncoupled from further analysis of peoples view on the context of pesticide use, including the social relationships that shape how people practice agriculture, may not change attitudes. Methods based on guiding farmers to share their own experiences and learn from it could be more effective in pesticide risk communication. Our study shows that (similar to the finding of Damalas et al., 2006) other farmers are a principal source of information about safety measures, rather than extensionists or information on the label. It confirms the notion that to bring about changes in pesticide practices requires multiple actions at different levels, ranging from the intra- and interpersonal level to market and political structures (Cole et al. 2011; Orozco et al., 2011).

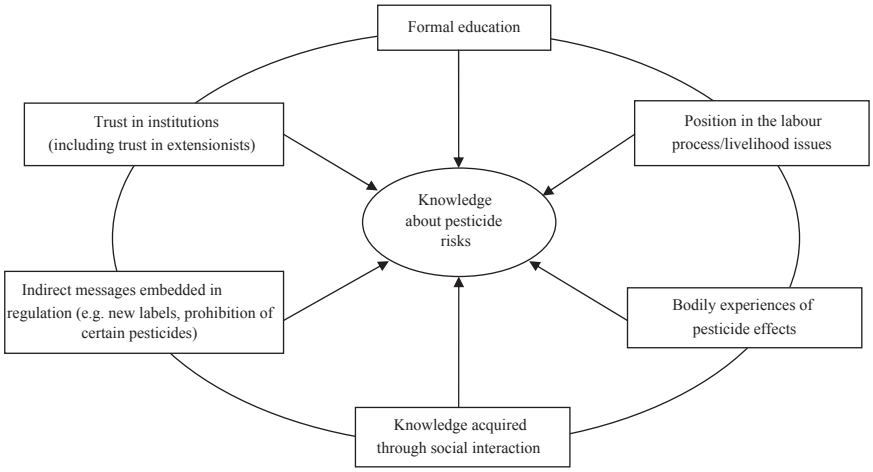

Fig. 1. Knowledge-in-context model.

10. Conclusions

In this study we analyze from a social science perspective the knowledge and risk perception of pesticides of different actors. Smallholders often derive their risk perception from direct experiences with handling pesticides, whereas extensionists draw to a larger extent on formal education. Notwithstanding these differences, risk perceptions of extensionist not always coincide with the technical perspective as taught in formal education. On the other hand, smallholders' knowledge acquired through practical experiences has often resulted in attempts to take safety measures while handling pesticides. Our study shows that blaming is a social practice that creates a difference between experts and lay people regarding who follows good practices. However, despite the social construction of a contrast between these two groups, we found that commitment to the technical perspective is not dramatically different for extensionists on the one hand and farmers and farm workers on the other hand. Finally, we conclude that ideas about a supposed lack of knowledge by farmers and the need for formal training are too much driven by a deficit model of knowledge. In contrast we propose a knowledge-in-context model for analyzing people's risk perception and consider that it will have consequences for training in pesticide risk and risk reduction strategies, for example that training in pesticide risks and safety practices should focus more on real life conditions, people's own experiences, and local forms of knowledge transmission.

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References

Barraza, D., Jansen, K., van Wendel de Joode, B., Wesseling, C., 2011. Pesticide use in banana and plantain production and risk perception among local actors in Talamanca, Costa Rica. Environ. Res. 111 (5), 708–717.

Barraza, D., Jansen, K., vanWendeldeJoode, B., Wesseling, C., 2013. Social movements and risk perception: unions, churches, pesticides and bananas in Costa Rica. Int, J. Occup. Med. Environ. Health 19 (1), 11–21.

Binder, C.R., Schöll, R., 2009. Structured mental model approach for analyzing perception of risks to rural livelihood in developing countries. Sustainability 2, 1–29.

Blanco-Muñoz, J., Lacasaña, M., 2011. Practices in pesticide handling and the use of personal protective equipment in Mexican agricultural workers. J. Agromed. 16 (2), 117–126.

Blok, A., Jensen, M., Kaltoft, P., 2008. Social identities and risk: expert and lay imaginations on pesticide use. Public Underst. Sci. 17 (2), 189–209.

Bohme, S.R., 2011. Preserving a forum for transnational litigation is a public health imperative. Int. J. Occup. Med. Environ. Health 17 (1), 95–97.

Cole, D., Orozco, F., Pradel, W., Suquillo, J., Mera, X., Chacon, A., Prain, G., Wanigaratne, S., Leah, J., 2011. An agriculture and health inter-sectorial research process to reduce hazardous pesticide health impacts among smallholder farmers in the Andes. BMC Int. Health Hum. Rights 11 (Suppl. 2), S6.

Damalas, C.A., Theodorou, M.G., Georgiou, E.B., 2006. Attitudes towards pesticide labelling among Greek tobacco farmers. Int. J. Pest Manage. 52 (4), 269–274.

European Union (EU) (Ed.), 2003. Regulation of the European Parliament and of the Council no. 304/200. OJEU. European Union Parliament. Brussels, Belgium.

Feola, G., Binder, C.R., 2010. Why don't pesticide applicators protect themselves? Exploring the use of personal protective equipment among Colombian smallholders. Int. J. Occup. Med. Environ. Health 16 (1), 11–23.

Fonseca, M.G.U., Peres, F., Oliveira-Araújo, F.J., Uchoa, E., 2007. Percepção de risco: maneiras de pensar e agir no manejo de agrotóxicos. Ciência en Saúde Coletiva 12 (1), 39–50.

Galt, R.E., 2007. Regulatory risk and farmers' caution with pesticides in Costa Rica. Trans. Inst. Br. Geogr. 32 (3), 377–394.

Galt, R.E., 2008. Beyond the circle of poison: significant shifts in the global pesticide context. Global Environ. Change 18 (4), 786–799.

Guivant, J., 2003. Pesticide use, risk perception and hybrid local knowledge: a case study from Southern Brazil. Int. J. Sociol. Agric. Food 11 (1), 41–51.

Hashemi, S.M., Hosseini, S.M., Hashemi, M.K., 2012. Farmer's perceptions of safe use of pesticides: determinants and training needs. Int. Arch. Occup. Environ. Health 85 (1), 57–66.

Hunt, L.M., Ojanguren, R.T., Schwartz, N., Halperin, D., 1999. Balancing risks and resources: applying pesticides without using protective equipment in Southern Mexico. In: Hahn, R.A. (Ed.), Anthropology in Public Health: Bridging Differences in Culture and Society. Oxford University Press, New York, USA, pp. 235–254.

Ibitayo, O.O., 2006. Egyptian farmer's attitudes and behaviors regarding agricultural pesticides: implications for pesticide risk communication. Risk Anal. 26 (4), 989–995.

Idrovo, J.A., 2005. Hacia una Salud Pública Pluralista: El Caso de los Plaguicidas y la Salud Humana. Revista de Salud Pública 7 (3), 349–359.

Instituto Nacional de Estadística Geografía e Informática (INEGI). (INEGI) (Ed.), 2010. Anuario Estadístico 2010. Aguascalientes, Mexico.

Isin, S., Yildirim, I., 2007. Fruit-growers' perceptions on the harmful effects of pesticides and their reflection on practices: the case of Kemalpasa, Turkey. Crop Prot. 26 (7), 917–922.

Jansen, K., 2003. Crisis discourses and technology regulation in a weak state: Responses to a pesticide disaster in Honduras. Dev. Change 34 (1), 45–66.

Jansen, K., Vellema, S., 2004. Agribusiness and Society: Corporate Responses to Environmentalism Market Opportunities and Public Regulation. Zed Books, London.

Jansen, K., 2008. The unspeakable ban: the translation of global pesticide governance into Honduran national regulation. World Dev. 36 (4), 575–589.

Jansen, K., Leeuwis, C., Mani, S., Roquas, E., Skutsch, M., Verschoor, G., 2004. Unpacking and re-packing knowledge in development. In: Kalb, D., Pansters, W., Siebers, H. (Eds.), Globalization and Development. Themes and Concepts in Current Research. Kluwer, Dordrecht, pp. 163–190.

Kishi, M., Hirschhorn, N., Djajadisastra, M., Satterlee, L.N., Strowman, S., Dilts, R., 1995. Relationship of pesticide spraying to signs and symptoms in Indonesian farmers. Scand. J. Work Environ. Health 21 (2), 124–133.

Lichtenberg, E., Zimmerman, R., 1999. Information and farmers' attitudes about pesticides, water quality, and related environmental effects. Agricult. Ecosys. Environ. 73 (3), 227–236.
Mokhele, T.A., 2011. Potential health effects of pesticide use on farmworkers in Lesotho. S. Afr. J. Sci. 107, 7–8.
Orozco, F.A., Cole, D.C., Ibrahim, S., Wanigaratne, S., 2011. Health promotion outcomes associated with a community-based program to reduce pesticide related risks among small farm households. Health Promot. Int. 26 (4), 432–446.
Palis, F.G., Flor, R.J., Warburton, H., Hossain, M., 2006. Our Farmers at risk: behaviour and belief system in pesticide safety. J. Pub. Health 28 (1), 43–48.
Polidoro, B.A., Dahlquist, R.M., Castillo, L.E., Morra, M.J., Somarriba, E., Bosque-Pérez, N.A., 2008. Pesticide application practices, pest knowledge, and cost-benefits of plantain production in the Bribri-Cabécar Indigenous Territories, Costa Rica. Environ. Res. 108 (1), 98–106.
Recena, M.C., Caldas, E.D., 2008. Risk perception, attitudes and practices on pesticide use among farmers of a city in Midwestern Brazil. Rev. Saude Publica 42 (2), 294–301.
Rosenthal, E., 2004. The DBCP pesticide cases: seeking access to justice to make agribusiness accountable in the global economy. In: Jansen, K., Vellema, S. (Eds.), Agribusiness and Society: Corporate Responses to Environmentalism, Market Opportunities and Public Regulation. Zed, London, pp. 176–199.
Rother, M.A., 2008. South African farm worker's interpretation of risk assessment data expressed as pictograms on pesticide labels. Environ. Res. 108 (3), 419–427.
Salameh, P.R., Baldi, I., Brochard, P., Saleh, B.A., 2004. Pesticides in Lebanon: a knowledge, attitude, and practice study. Environ. Res. 94 (1), 1–6.
Sam, K.G., Andrade, H.H., Pradhan, L., Pradhan, A., Sones, S.J., Rao, P.G., Sudhakar, C., 2008. Effectiveness of an educational program to promote pesticide safety among pesticide handlers of South India. Int. Arch. Occup. Environ. Health 81 (6), 787–795.
Secretaria de Agricultura Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGRPA) (Ed.), 2002. Manual de Buenas Prácticas Agrícolas. México DF.
Solís, D.V., 2005. Rural Chiapas ten years after the armed uprising of 1994: an economic overview. J. Peasant Stud. 32 (3-4), 461–483.
Tinoco-Ojanguren, R., Halperin, D.C., 1998. Poverty, production, and health: inhibition of erythrocyte cholinesterase via occupational exposure to organophosphate insecticides in Chiapas, Mexico. Arch. Environ. Health 53 (1), 29–35.
Toleubayev, K., Jansen, K., Van Huis, A., 2010. Knowledge and agrarian decollectivisation in Kazakhstan. J. Peasant Stud. 37 (2), 353–377.
Toleubayev, K., Jansen, K., Van Huis, A., 2011. From integrated pest management to indiscriminate pesticide use in Kazakhstan. J. Sustain. Agric. 35 (4), 350–375.
Ton, G., 2012. The mixing of methods: a three-step process for improving rigour in impact evaluations. Evaluation 18 (1), 5–25.
Waichman, A.V., Eve, E., Nina, N.S.C., 2007. Do farmers understand the information displayed on pesticide product labels? A key question to reduce pesticides exposure and risk of poisoning in the Brazilian Amazon. Crop Prot. 26 (4), 576–583.
Wynne, B., 1996. The sheep safely graze? A reflexive view of the expert-lay knowledge divide. In: Lash, S., Szerszynski, B., Wynne, B. (Eds.), Risk Environment and Modernity Towards a New Ecology. Sage, London, pp. 44–81, May.
Yassin, M.M, Abu Mourad, T.A., Safi, J.M., 2002. Knowledge, attitude, practice, and toxicity symptoms associated with pesticide use among farm workers in the Gaza Strip. Occup. Environ. Med. 59 (6), 387–393.