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Smallholder farmers' knowledge, perception and practice in pesticide use in South Western Ethiopia

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Abstract: Pesticides are often used to manage pests and diseases to enhance agricultural productivity. However, pesticides have negative impacts on human and animal health as well as on the environment if not properly used and handled. Hence, this study aimed at assessing the knowledge, attitude and practices of smallholder farmers in agricultural pesticides utilization in three major cereal producing districts of Jimma zone, Ethiopia. For the study original data collected from 140 randomly selected farmers using a pre-tested structured questionnaire and key informant interviews with district level experts were used. The results showed that 98% of the sample households use pesticides; of which 45% purchase pesticides from open market. Furthermore, while the herbicide 2, 4-D was used by 57% of the households, 48% of the respondents did not know the type of pesticides they used. Only 30% read the instructions and less than 40% understand the signs on pesticide containers. Most households perceived that pesticides are useful; however, 98.5% of them witnessed its negative effects. Some health related discomforts reported include nausea, vomiting, headache, and skin irritation with the respective shares of 68%, 18%, 12% and 2%. Ninety five percent of the respondents believed that it is possible to minimize the negative effects of pesticides. But, 80% use normal clothes for spraying pesticides; 40% wash spray equipments in yard; 23% throw pesticide containers in open field and 32% reuse pesticide containers for other purposes. Findings of the study revealed that there is mismatch among knowledge, perception and practice of the farmers. Hence, it is important to carefully design pesticides supply chain and train farmers to create awareness about the careful use of pesticide, and disposal of the leftover and containers.

Keywords: agricultural pesticides, environment, smallholders, Ethiopia

Introduction

In the past decades the use of pesticide to enhance agricultural yield and protect crops from pests and diseases has been highly promoted (Carvalho, 2006).

Considering the fast population growth, increase life expectancy, and the high caloric requirement for healthy and productive life, and the prevalence and resistance of pests to pesticide have influenced farmers to use different types of chemical compounds (Beyer and Biziuk, 2008, Carvalho, 2006, Edwards-Jones, 2008). As a result, utilization of pesticides is considered as modern technology application and most developing countries have been promoting the adoption and utilization of these technologies in order to assure food security.

Ethiopia is one of the emerging countries having different growth and transformation strategies to feed the fast growing population, and to supply agricultural outputs as raw materials to agro-industries and thereby to join the lower middle income countries by 2025 (MoFED, 2010). Given the increasing demand for land in the country, this could only be possible through enhancing agricultural production and productivity by using modern technology. Inputs such as fertilizer, improved seeds, and pesticides are among these technologies. The country's strategic document for A Plan for Accelerated and Sustained Development to End Poverty (PASDEP) shows that 45% of the pre-and post-harvest crop losses was caused directly by crop pests (MoFED, 2006). To circumvent this problem, it is crucial to control pests. This could either be through the use of cultural, biological, chemical (pesticides) and combination of these strategies. In most cases, smallholder farmers use family labor to remove weeds and insect pests. On the other hand, Ethiopia is vastly embarking on education which makes the availability of children for agricultural activities difficult to impossible and demands adults to substitute the activities that were previously covered by school age children. Hence, most farmers are observed applying pesticides to control crop pests (diseases, insects and weeds).

There are different case studies documenting the promotion of pesticides utilization by different countries' governments (Pedlowski *et al.*, 2012), the benefit of pesticides to human kind in reducing pre-and post-harvest crop losses and freeing labor for other activities (Cooper and Dobson, 2007, Edwards-Jones, 2008, Karunamoorthi *et al.*, 2012). However, the pesticides also have negative human health and environmental impacts. Such impacts are especially important in developing countries where majority of farmers are illiterate and regulations are either under developed or less enforced (Ecobichon, 2001, Eddleston *et al.*, 2002). A Worldwide pesticide poisoning in 1990s was estimated to be 3 million with annual death of 220, 000 (Konradsen *et al.*, 2003). Globally, self-poisoning with pesticides accounted for a third of all suicides (Bertolote M.J. *et al.*, 2006). In rural Asia, for example, 60% of all fatal deaths were related to pesticide poisoning (Joseph *et al.*, 2003). Evidence is sparse for African countries with some estimates showing that 46% of fatal and non-fatal hospital admission in Kampala-Uganda in 2002; 50% in Nairobi-Kenya in 1980-3; 30% in Nigerial; 40% in Zimbabwe in 1990s and about 50% in Ethiopia in early 1980s (Gunnel *et al.*, 2007). In addition, occupational illness were also

common because it is impractical and expensive for farmers in the tropics to use safety equipment (Karalliedde *et al.*, 2001); safety instructions are often written in un familiar languages and most farmers in developing countries are illiterate and the instructions are difficult to follow. In Ethiopia, even though there is indication for the occurrence of more suicidal deaths, there is no proper registration and certification of suicidal deaths that is meant for public health purpose in concerned governmental organizations (Ayele, 2014).

The use of pesticide also has a negative impact on agricultural land, fauna, flora and overall agricultural and environmental sustainability (Wilson and Tisdell, 2001). Despite these facts, in Ethiopia, there is lack of stringent controlling mechanism on the importation of hazardous chemicals; absence of well-established institutions to provide farmers with the knowledge of pesticide application and about safety issues, and expansion of non-licensed vendors increase the importance of establishing effective guidelines to minimize the negative impact of pesticides on the health of farmers and environmental sustainability (Karunamoorthi *et al.*, 2012). The first and important step to establish a program that reduces the negative pesticide impact is through assessing the knowledge, attitude and practices of farmers in agricultural pesticides. Such information is highly limited in Ethiopia in general and in the study area in particular.

Hence, to fill this gap, we used data from 140 households randomly selected from 3 districts in Jimma zone, Oromia national regional state to assess farmers spray practices that might potentially expose them to chemical hazards. This was by examining types of pesticides used, application methods employed, protectives used and pesticides drift. Farmers understanding of pesticides handling, storing and disposal and its effect on the environment; and farmers ability of decoding the information displayed on the product labels which might affect risk reduction were also examined.

Data and research methodology

We collected original data from three cereal, mainly maize and teff, producing districts: namely, Kersa, Limu Seka, and Omonada in Jimma zone, through household survey, covering a total of 140 farmers, and key informant interview with district experts in 2014. Jimma zone is found at a latitude and longitude of 7° 40′ 0″ N and 36° 50′ 0″ E respectively. A three stage sampling was used to select smallholder cereal producers for this study. In the first stage, three districts outlined above out of the 18 districts in Jimma zone were purposively selected based on their potential for cereal production (Fig. 1). In the second stage three kebeles, namely Tikur Balto from Kersa district; Burka Asendabo from Omonada district; and Dora Gabana from Limu Seka district were purposively selected in communication with agricultural

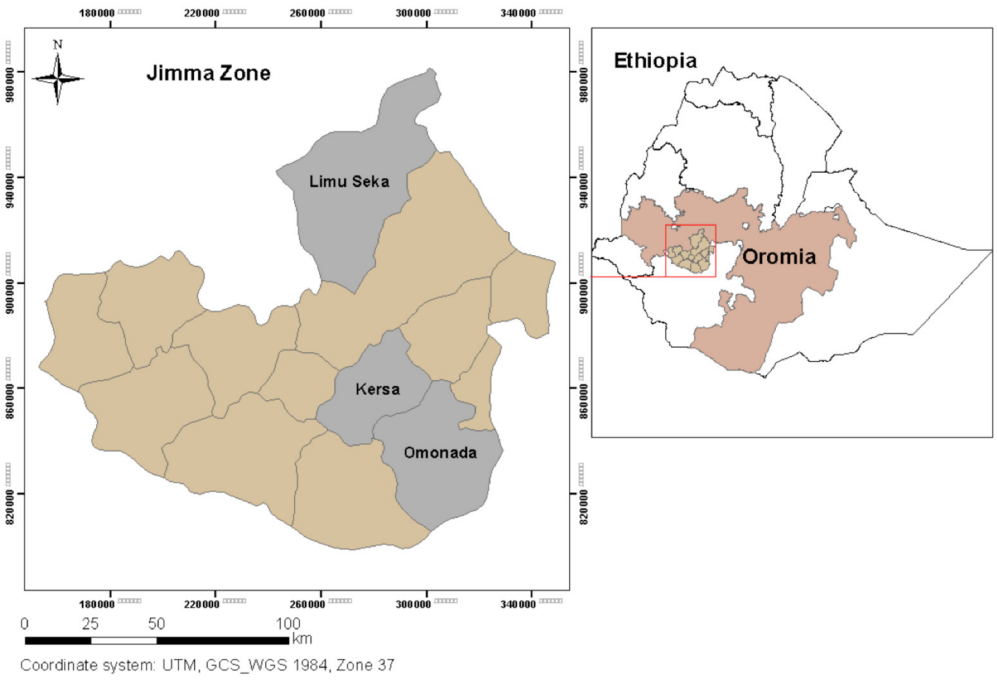

Figure 1 - Map of the Study area

experts in the respective districts. According to district experts, the kebeles are agro-ecologically very suitable for cereal production and represent the cereal producing kebeles in the districts and thereby appropriate to study smallholder farmers knowledge, perception and experiences in pesticide utilization in these kebeles.

The survey was implemented using a pre-tested structured questionnaire consisting of detailed modules on: demographic characteristics; livelihood making; knowledge and practices in pesticide use; attitude and perceptions in pesticide use; and pesticide use and its environmental effects. The survey was implemented by well-trained enumerators who studied up-to MSc level. In addition, key informant interview on the impacts of pesticide in the area; whether there is established channel through which agricultural pesticide is distributed to farmers; if they provide information to farmers on awareness creation; if incidences of agricultural pesticide related hazards is reported to their office; and their plan in the future was conducted with district level rural development and agricultural extension experts. Data were analyzed using STATA 14 software to describe the knowledge, attitude and practices of farmers on the positive and negative effects of pesticide utilization. The results are presented using appropriate tables and graphs. The conceptual model of smallholders' knowledge, perception and practice is presented in Figure 2.

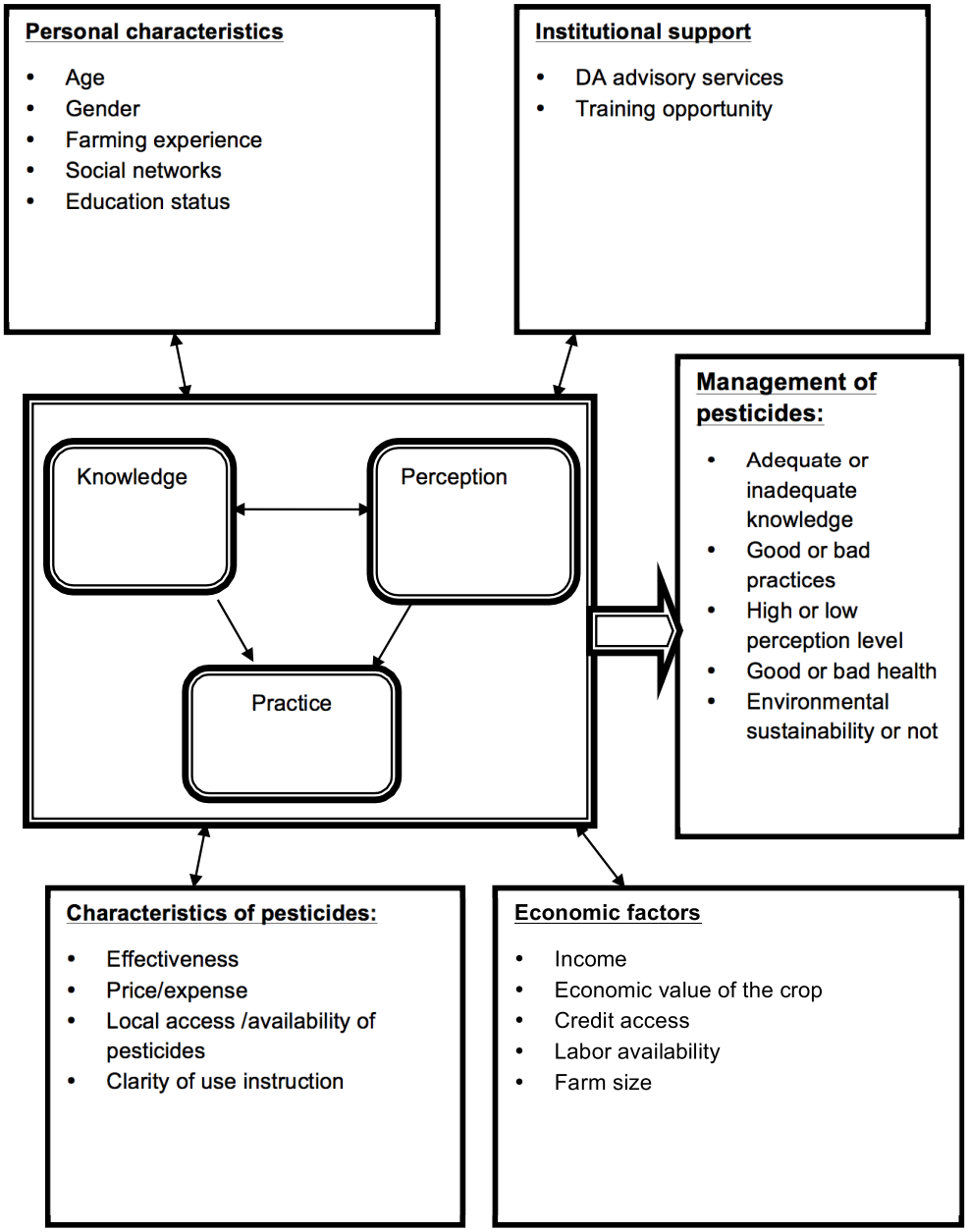

Figure 2 - Conceptual model of the study

Results and discussion

Demographic and socio-economic characteristics of sample households

Ninety percent of the sampled households are male headed with only 10 % of the households being female headed. The mean household heads' age is 42 years old with average family size of 6.44. The family composition shows that almost 50% are dependent family members (<15 and >64 years old). The number of children varies from 0-7 per household whereas the number of working group varies from 0-10 and the old age is between 0 and 1. The education level is low in the study area with average years of schooling of only 2.8. Fourty one percent of the households are headed by illiterate household heads. The average land size owned by a household is 1.86 hectares, of which 61% was allocated for annual crops cultivation. The household heads have an average of 21.5 years of farming experience. The respondents have ample farming experience which witnesses that they are the right persons to respond to questions related to knowledge, perception and practice related to pesticide use.

Means of livelihood making is one of the important determinants for respondent pesticide utilization. The more someone produces diversified crops the more he or she can have the chance to use pesticide. Table 2 shows that the major means of livelihood for smallholder farmers in the study area is crop cultivation with 100% of households cultivating crops followed by livestock rearing and beehives respectively accounting for 96% and 34%.

Knowledge and Practices of Smallholders in Pesticide Use

Table 3 provides the common types of pesticides and the purposes for which they were often used. Accordingly, 98% of households use chemical pesticides with the

Table 1 - Demographic and socio-economic characteristics of sample households

Variables	Observation	Mean	Standard deviation	Min	Max
Head Sex (dummy 1 if male and 0 other wise)	140	90%	-	0	1
Head age in years	140	42.22	11.91	23	75
Children Age below15 (number)	140	3.11	1.74	0	7
Adult age 15-64 (number)	140	3.18	1.68	0	10
Old age above 64 (number)	140	.05	0.22	0	1
Education (years)	140	2.8	2.41	1	10
Education (% of illiterate)	140	0.41	0.042		
Family size (number)	140	6.44	2.32	1	12
Total land area (ha)	140	1.86	1.21	.025	5.5
Farm experience (years)	140	21.49	11.67	2	60

Source: Authors calculation from own survey, 2014

Table 2 - Means of livelihood for the sample households

Means of livelihood	Total sample	Frequency	Percent
Crop cultivation	140	140	100
Livestock rearing	140	134	96
Trade	140	20	14
Laborer	140	18	13
Beehive	140	48	34
Fire wood selling	140	8	6
Construction materials	140	15	11
Remittance	140	4	3
Major occupation (farmers)	140	140	100

Note: The vertical summation is more than 100% as households participate in more than 1 activity
Source: Authors calculation from own survey, 2014

intensity ranging from occasional to regular use. Occasional use is the situation in which households use pesticides either every other year or use only for one purpose or use only one type of pesticide whenever need arises. Households who use chemical pesticides on regular basis are those who use it every year, use it for more than one purpose and/or use different types of pesticides. The most commonly used pesticides were 2, 4-D (Herbicide), which 57% of the households used in the year prior to the survey time.

Table 3 - Common types of pesticides and purpose for which they were often used

Rate of using chemical pesticides	Total sample	Frequency	Percent
Regularly	140	57	41
Occasionally	140	80	57
Do not use	140	3	2
Types of chemical pesticides used			
2, 4-D	137	78	57
DDT	137	2	1.6
Glyphosate (round –up)	137	12	9
Malathion	137	4	3
Do not know	137	66	48
Purposes of using chemical pesticides			
Weed control	137	125	91
Insect control	137	105	77
Fungi control	137	29	21
Rodent control	137	41	30
Other	137	1	1

Source: Authors calculation from own survey, 2014

Unexpectedly, 48% of households have used a type of pesticide they did not know. This could be because of the combination of illiteracy and the fact that the brands and the names of chemicals pesticides are written in the language which most households are not familiar with. This is in line with Karunamoorthi *et al.* (2012) in which they found that most households cannot understand the instructions because of low level of education; the instructions are written in a language that farmers cannot understand and even the instructions are too technical for framers to understand. The authors emphasized the importance of awareness creation through trainings and promotions to raise the knowledge of farmers with regard to understanding the type of chemicals they are already using and the proper management of chemicals.

The purpose of using chemical pesticide varies from household to household. Ninety one percent of households used pesticides for weed control; 77% for insect control; 30% for rodent control and 21% for fungi control. Weeding is one of the most labor demanding farm activities and is the threat for farm productivity. They mainly use 2, 4-D for selective killing of the broad leaf weeds and Glyphosate (round-up) for land clearing. Studies show that using pesticides for weed control in poor countries, releases labor from hand weeding, and this enables the adult labor to engage in other more fulfilling activities (Cooper and Dobson, 2007) and children for schooling. Chemicals such as DDT (dichlorodiphenyltrichloroethane) and malathion are also used for insect and rodent control. According to Karunamoorthi *et al.*, (2012), although it has been banned not to be used as agriculture pest controls, DDT has been extensively applied by farmers as a pesticide, which has been procured illegally through the black market at a low cost.

There are different criteria that determine households' ability and preference to use pesticides. Among these criteria, safe to use is the most preferred factor (Fig. 3). About 80% of the respondents voted for it, followed by effectiveness and quick action of the chemicals as preferred by more than 70% and 65% of respondents respectively. Commercial availability of the chemicals is also important for more than 50% of the households. Most households apply pesticides using knapsack backpack sprayer (97%) with only a few of them applying using spot application (3%).

Table 4 gives the relationship among men, women, boys and girls about the decision and who application of pesticides among the interviewed households. The result shows that men take most of the decision about whether to apply, when to apply and how to apply pesticides (59%) and take lion share in applying pesticides (53%). Women also participate in supporting their husband in the decision making about whether to apply pesticide or not (28%), but only very few (3%) of them decide alone. Forty percent of the farmers use hired labor for pesticide application. Boys and girls neither have significant contribution in pesticide application decision nor in the practice of pesticide application. Hence, most of the pesticide application decisions as well as application practices are men's work.

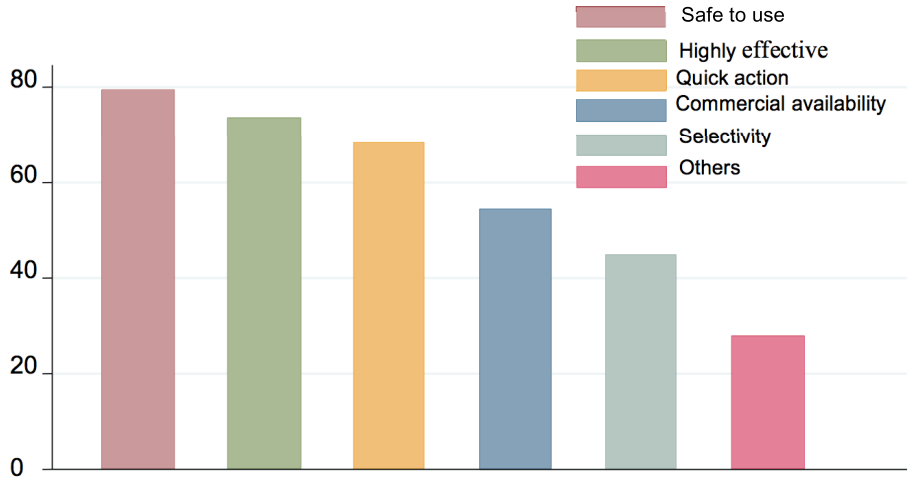

Figure 3 - Criteria for choosing pesticides
Source: Authors calculation from own survey, 2014

Table 4 - Task division among men, women, boys and girls regarding decision and application of pesticides

Pesticide decision maker and /or applier	Who decide pesticide application		Who apply pesticides	
	Frequency	Percent (%)	Frequency	Percent (%)
Men	81	59.1	73	53.3
Women	4	2.9	1	0.7
Men and women	38	27.7	-	-
Son	2	1.5	5	3.6
Hired labor	12	8.8	56	40.9
Others	-	-	2	1.5
Total	137	100	137	100

Source: Authors calculation from own survey, 2014

Table 5 provides the sources from which households buy pesticides and the source of information or advice for farmers to use chemical pesticides. Accordingly, 45%, 26%, 8% and 18% of the households respectively purchase pesticides from open market; office of agriculture and rural development (development agents); licensed venders and from vendors whom they are not sure about whether the venders are licensed or not. This has two implications. First, farmers have low knowledge about the importance of buying chemicals from known or licensed venders so that they can trace back if the chemicals harm their human or livestock health and/or if the chemicals are not effective may be because of adulteration. Second, the table clearly

Table 5 - Source of chemical pesticides and source of advice use chemical pesticides

Sources of chemical pesticides	Observation	Frequency	Percent
Bureau of Agriculture (through DA)	137	35	26
Licensed venders	137	11	8
Vendors, not sure about license	137	25	18
Open market	137	62	45
Others	137	4	3
Total		137	100
Source of information about pesticides			
Own decision	137	33	24
Advice from Development agents	137	84	61
Advice from suppliers	137	1	1
Advice from neighbor or friends	137	19	14
Total		137	100

Source: Authors calculation from own survey, 2014

shows that there is mismatch between the level of promotion and the level of supply by development agents. The majority of farmers (61%) were advised by development agents to use chemical pesticides, however, only a forth of households get pesticides through development agents. There is no much link between other suppliers either licensed or non-licensed venders and farm households. Only 1% of the farm households get advice from suppliers. This is due to absence or low level of market coordination for agricultural input in general and pesticides in particular.

Figure 4 presents the result of knowledge about pesticides, trainings in relation to pesticide and information about pesticide hazards. Around 90% of farmers have heard about the risks and hazards from pesticides. Nevertheless, more than 30% of the farmers used pesticides without a label or instruction on its container; and less than 40% of farmers understand the signs on the pesticide container. Likewise, around 60% have bought pesticides containing instructions in languages with that farmers are not familiar. Only 30% of the farmers can read the label or instructions on the containers. This together with the low level of education in the study area could result in using chemicals that are not appropriate for a specific service.

In addition, only 20% of the households were able to check the expiry dates on the containers, 37% did not check and 43% of them did not know whether it had or not. This is not surprising since most of the respondents are illiterate and only few of them can read the label on the pesticide containers as a result. Furthermore, households purchase pesticide might be from retailers in small amount where they do not have access to the original container of the pesticide.

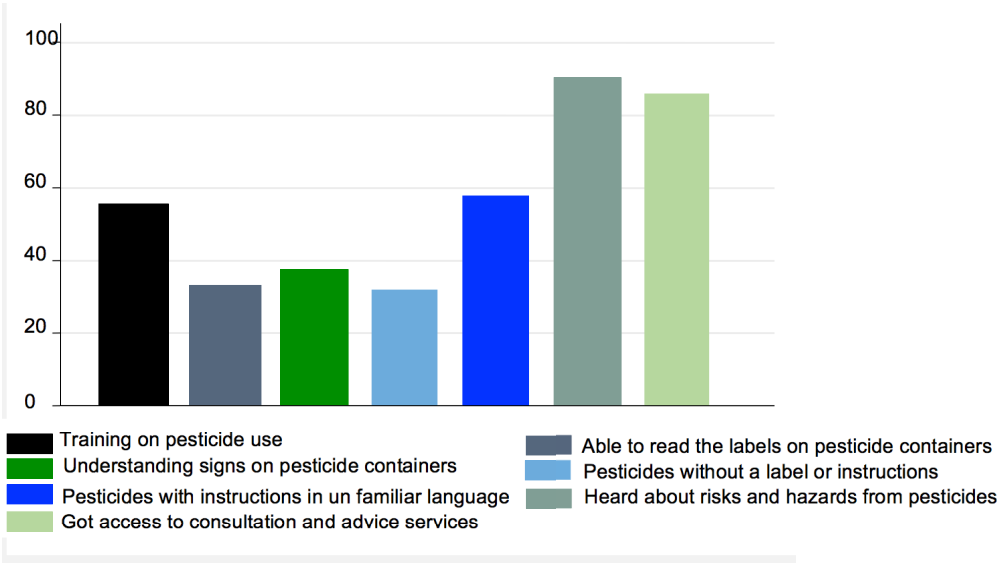

Figure 4 - Respondents knowledge of pesticide use.
Source: Authors calculation from own survey, 2014

Perception of Smallholders on positive and negative effects of pesticides

All households who used chemical pesticides believe that pesticides are useful (47%); very useful (33% and sometimes useful (20%) (Fig. 5). Ninety five percent of the respondents perceived that pesticides solve their problems in terms of pest control. Furthermore, 75% believed that pesticides increased the level of crop production. A formal cost-benefit analysis by Cooper and Dobson (2007) showed that the benefit from pesticides out ways the costs associated to pesticides.

Most households explained the use of chemical pesticides in terms of weed control; its immediate action, and controlling weeds by substituting labor or by being supplemented with minimum labor effort after applying the chemical pesticides. Others added that pesticides are also useful to control pests and prolong the shelf life of crops for future use. As a result, the majority of the respondents (62%) reported that their pesticide use increased each year whereas 18%, 16% and 4% respectively reported decrease, increase or decrease, and did not know.

Not only its benefit but households also perceived the drawback of using chemical pesticides. Table 6 gives the perceptions of respondents on the harm pesticides poses on human and animal health, and the environment. Almost all (98.5%) of the households believed that pesticides have negative effects on human and animal health. However, 16% reported the absence of any harm of chemical pesticides on

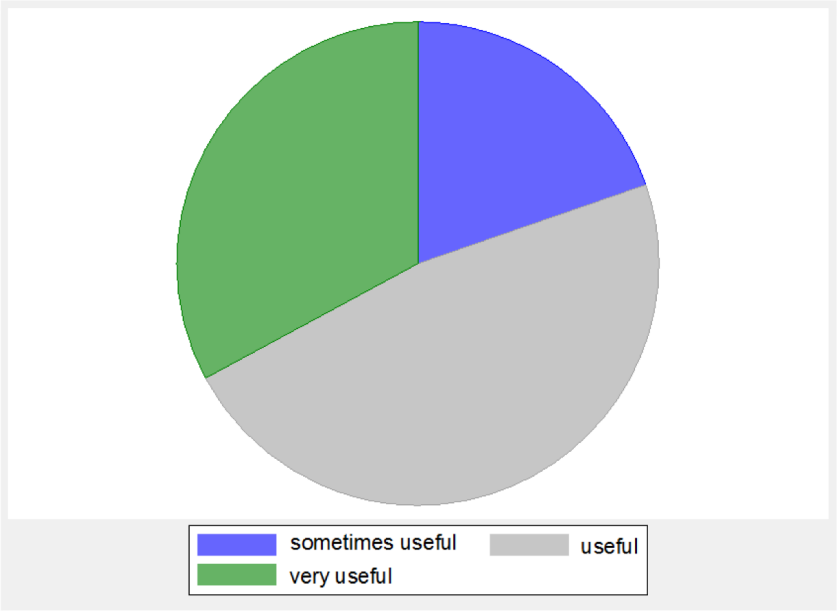

Figure 5 - Respondents perception on the benefit of pesticide.
Source: Authors calculation from own survey, 2014

the environment. The result shows that smallholders are more aware and concerned about the effect of chemical pesticides on human and animal health than its effect on the environment. Their low perception for its effect on the environment could be dangerous for their livelihood since a third of households participate in beekeeping. The result shows that respondents had felt different symptoms of health problem after applying pesticides. Overall, more than 66% of respondents had felt discomforts; of which 68%, 18%, 12% and 2% respectively felt nausea, vomiting, headache, and skin irritation (Fig. 6).

However, 95% of the respondents believe that it is possible to minimize the negative effects of pesticides. Figure 7 gives the summary of protective measures used by respondents that could minimize the negative effects of pesticides. Accordingly, 71% of respondents check spraying equipment before use, 97% and 95% of the respondents respectively reported that they wash their hands, and themselves and their clothes after applying pesticides. This is encouraging to minimize at least the acute effect of pesticides. However, 32% of the households reuse the pesticide containers for other purposes including using it for drinking water. Karunamoorthi *et al.* (2012) reports that 77.2% of households they surveyed use empty pesticide containers for different household purposes including food and water storage.

Table 6 - Smallholders perception about the harm of chemical pesticide on human and animal, and the environment

Responses	How do you think about the effect of pesticide on animal and human health?		How do you think about the effect of pesticides on the environment?	
	Frequency	Percent (%)	Frequency	Percent (%)
Not harmful at all	2	1.5	21	16
Harmful to a limited extent	39	28.5	42	30
Moderately harmful	32	23	33	24
Harmful	53	39	27	20
Very harmful	11	8	14	10
Total	137	100	137	100

Source: Authors calculation from own survey, 2014

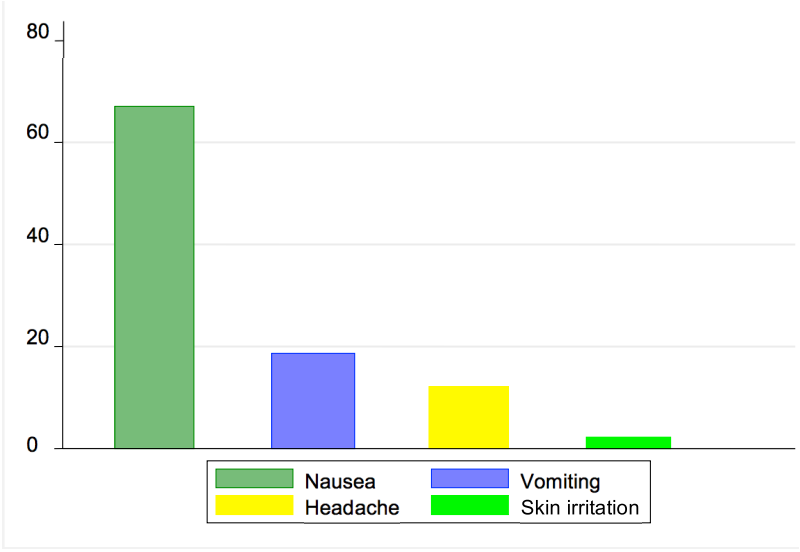

Figure 6 - Incidence of health related discomfort from pesticide use
Source: Authors calculation from own survey, 2014

Though the households deemed to perceive that it is possible to minimize the negative effect of pesticides, this knowledge did not always seem to be enough to induce farmers to adopt basic safety procedures, such as using a complete set of protective device during and after working with pesticides. Eighty percent of the households use just normal clothes, 58% of the households; however, use boots to protect their foot and leg from exposure. This is probably because of the fact that farmers use boots while undertaking any agricultural activities. Overall, the protective measures are

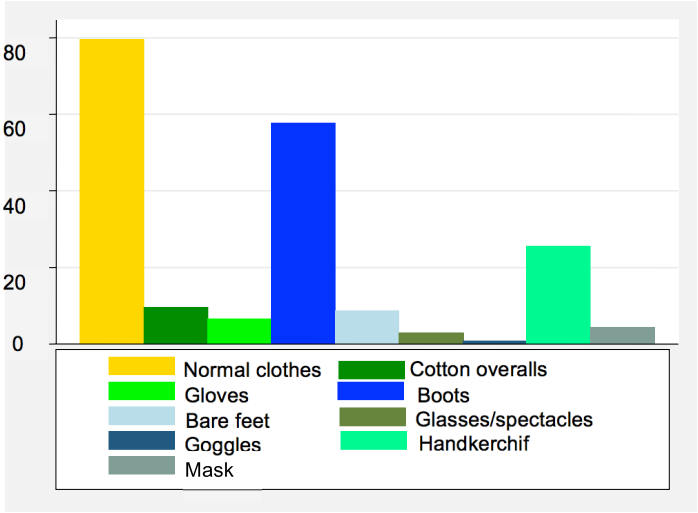

Figure 7 - protective measures during pesticide application
Source: Authors calculation from own survey, 2014

very week. Only 25% of the households use handkerchief around their mouth. All the rest of protective measures are used by less than 10% of the respondents. This result is line with findings of Pedlowski *et al.* (2012) in Brazil where they report that, the knowledge of knowing the risks of pesticide had not induced farmers to use all the safety procedures and full protective gears.

Pesticide Use and its Environmental Effects

In this section we provide the result with respect to the households practice with the effect of pesticide on environment. The way they manage pesticide left over; the places they wash pesticide containers as well as spray equipments; the way residue of the washed equipments managed; whether they wash spray clothes separately from other clothes or in combination; and how the containers of pesticides are disposed off after use. The result shows that highest share of households (26%) dispose the left over in bath room while the least share of them (6.6%) decant it in rivers. Karunamoorthi *et al.* (2012) reported, from southern part of Ethiopia, that 25.8% of the farmers they interviewed decant pesticide leftover in bush/river/streams. Pedlowski *et al.* (2012) explains that pesticides can potentially contaminate ground water through leaching and run-off due to their physicochemical characteristics which facilitate their mobility in the soil layers.

Table 7 - Pesticide use and environmental awareness of smallholders

Questions	Responses	Frequency	Percent (%)
If there is pesticide left over, where is it disposed/stored?	At well at home	29	21.1
	Bathroom	36	26.3
	Outside the yard	27	19.7
	Nearby River/lake	9	6.6
	Other	36	26.3
	Total	137	100
Where is the equipment washed?	In yard	55	40.2
	In canalization	14	10.2
	In solid waste disposal	27	19.7
	Others	41	29.9
	Total	137	100
Where does the residue from the washed equipment go?	In canalization	10	7.3
	In Yard	62	45.3
	In River	21	15.3
	Other	44	32.1
	Total	137	100
Do you wash spray clothes separately from the domestic washing?	Yes	96	70.1
	No	41	29.9
	Total	137	100
How are the containers or packages disposed of?	Thrown in open field	32	23.4
	Buried	56	40.9
	Burnt	16	11.7
	Put in rubbish/trash	5	3.6
	Other	28	20.4
	Total	137	100

Source: Authors calculation from own survey, 2014

Conclusion and Policy implication

In the past decades the use of pesticide to enhance agricultural yield and to protect crops from pests and diseases has been highly promoted including in developing countries such as Ethiopia. However, pesticides have negative effects on human and livestock health as well as the environment. These effects are especially in countries where rules and regulations are either not in place and or less enforced. Hence, this study uses original survey data from 140 smallholder cereal producing households and key informant interviews with district level experts to assess the knowledge, perception and practices of smallholder households in three districts of Jimma zone, Ethiopia. The study result shows that almost all households use pesticides (98%); with 45% those purchased pesticides being from open market. While 2, 4-D (Herbicide)

was used by 57% of the households, surprisingly, 48% of the respondents did not know the type of pesticides they used. Only 30% of them read the instructions on the pesticide containers and less than 40% of them understand the signs on pesticide containers. There is mismatch between the level of promotion of pesticides by development agents and the level of supply of pesticides. Pesticide utilization is highly promoted while its supply through development agents is very low. This gap increases the chance for entrance of informal venders to supply pesticides illegally which in combination with the low level of education of farmers in the study area will increase the pesticide related risks.

There is also mismatch between knowledge and practice of households in pesticide utilization. Many of them witness the negative effects of pesticides with 90% of the households have even heard the risks related to pesticide hazards on one hand and they believe that it is possible to minimize the negative effects of pesticides on the other hand. However, majority of households use normal clothes while spraying pesticides; wash pesticide spray equipment containers in yard; store pesticides in home at will carelessly, in bathrooms, throw pesticide containers in open field and reuse the containers for other purposes. In addition, illegal or informal venders store pesticides in shops and kiosks together with other consumables. This will have a serious public health problem as there is no guarantee for pesticides not to contaminate the consumables. Hence, this calls up on the broader policy direction including market coordination for pesticide supply through training and legalizing the informal or illegal pesticide suppliers; developing a standard manual in local languages for farmers, training and following them up to make sure the proper application of pesticides; and proper management of pesticides leftover and pesticide containers.

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