Bangladesh j. entomol. (2014) 24(2), 99-113 *ISSN 1021-1004*

RISK ANALYSIS OF PESTICIDE USE IN BANGLADESH AGRICULTURE

H. RAHMAN[1*], M. M. RAHMAN[2], M. Z. ALAM[3], M. R. U. MIAH[4], A. M. AKANDA[5], M. M. HOSSAIN[6]

[1]Assistant Professor, Department of Entomology, [2,3 &4] Professor, Department of Entomology, [5]Professor, Department of Plant Pathology & [6]Professor, Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur -1706

ABSTRACT

A survey was conducted in intensive agricultural area of vegetable and fruit, to analyze the risks of pesticide use in Bangladesh. The results of this survey indicated that the farmers depended heavily on use of pesticides to control different insect-pests and diseases. The literate farmers had higher percent of healthy behavior than the illiterate ones. Most of the farmers did not use protection tools during spraying pesticides. Moreover, they overuse, misuse and neither aware of safe handling nor proper disposal of empty containers. Among the respondent farmers, 77.88% used pesticides according to the suggestion of pesticide suppliers/dealers/retailers and 10.59 % applied according to their own choice. There were 94.44 % illiterate and 17.42% literate farmer did not read and follow the label instructions. Both literate (21.21%) and illiterate (75.56%) farmer prepared spray fluid with bare hands. The results showed that, 63.64% literate and 82.22% illiterate farmer did not take first aid measures in the event of pesticide accident.It was found that, 7.53% respondent pesticide exposure has no risk at all and 6.35% farmers were unware about pesticide toxicity. The study demands that the government, the non-government organization (NGO's) and the interested parties should cooperate to minimize the health and environmental risks caused by the abuse of pesticides.

Keywords: Agriculture, Bangladesh, pesticide usages, risk analysis.

INTRODUCTION

Risk analysis is the process in assessing public health risks from pesticides. It is the process of combining the toxicity and exposure assessments to describe the overall risk from pesticide use (Covello and Merkhoher 2013). It explains the

*corresponding author: E-mail: hrahman@bsmrau.edu.bd

assumptions used in assessing exposure as well as the uncertainties that are developed by unscientific use of pesticides by the user. United States Environmental Protection Agency's (USEPA) role is to evaluate both toxicity and exposure and to determine the risk associated with use of the pesticide. Simply, Risk = Toxicity × Exposure (USEPA 1998). This means that the risk to human health from pesticide exposure depends on both the toxicity of the pesticide and the people coming into contact with it. At least some exposure and some toxicity are required to result in a risk (Asante-Duah 2002).

Pesticide use in Bangladesh is often excessive and unregulated. Farmers come into contact with pesticides, whether in the field, during pesticide application, harvesting, re-entry to collect vegetables, or in their homes to kill mosquitoes, cockroaches, fleas and flies. Storing pesticides may lead to acute and/or chronic exposures, with adverse health consequences. Lower awareness amongst health care providers of the problem of pesticide poisoning have been reported in East Africa (Mbakaya *et al*. 2004) and London (Bailie 2009), South Africa (Ohaya 2005), and in Costa Rica (Wesseling *et al.* 2007). Surveys were conducted in different countries such as Brazil (Garvalho 1990, Skalisz 1991), India (PREPARE 2001), Pakistan (Chester *et al.* 2002), Kenya (Emanuel 1992), Sudan (Abd-Rabou 1996). These studies are considered to strengthen the capacity building and awareness of the farmers by the governmental and the non-governmental organizations (Bd-Rabou and Al-Agha 1998).

In Bangladesh, farmers tend to use more pesticides than required to increase the agricultural production. Lack of following safety measures among the Bangladeshi farmers has many reasons: illiteracy, unavailability of protective devices, low awareness about the danger of pesticide contamination and the neglect of legislation regulating pesticide use (BARC 2008). Farmers' knowledge and perception about pesticide risks play an important role in determining the use of pesticides protection devices (Mbakaya *et al*. 2004.) Education status has an important role in increasing knowledge about pesticides' risks (Shetty *et al.* 2010 Jensen *et al.* 2011). However, knowledge is not sufficient if farmers have low confidence in their ability to apply safety measures related to pesticides use (Ali 2006). Many individuals of the farming community believe that their health is controlled by internal or external factors and this can be one of the reasons of unsafe behaviors during pesticide application (Lau 1992).

Farming communities are not adequately informed about the potential risks and hazards associated with the pesticides. As a result, farmers use pesticides without full understanding of their impact on human health and environment. Therefore, this study was planned and designed to describe the pesticide usages; perceptions and health effects amongst the farmers in selected agro-based areas in Bangladesh and thereby analyze the potential risk associated with pesticide application.

MATERIALS ANDMETHODS

This study was conducted during January to April, 2013 with a view to analyze the risk and the factors associated with pesticide use and handling. A predesigned questionnaire was prepared in advance to collect data during interview to the respondent farmers.

Study area: The study was conducted in selected districts of Bangladesh. The selected districts were Jessore, Magura and Barisal (Table 1). The reasons of selecting these districts where agriculture is the main occupation in these areas, variety of crops are produced (such as rice, wheat, fruits and vegetables) and farmers use different types of pesticides in their crops.

Table 1. List of surveyed areas under three selected districts of Bangladesh.

District	Upazilla	Union / Post office
Jessore	Jessore	Churamonkathi, Khojarhat, Lebutala
	Chowgacha	Chowgacha, Mashila, Muktarpur, Patibila
	Bagharpara	Bondobila, Mathavanga, Satiantola
	Jhikorgacha	Gazirdarga, Godkhali, Magura
	Monirampur	Chalkidanga, Chondipur, Dighirpar, Helanchi
Magura	Magura	Bogeya, Gangalea, Magura
	Shalikha	Bunagati, Chandra,Sandra, Simakhali, Sotokhali
	Mohammadpur	Sunda, Nagra, Babukhali, Shirgao.
	Sreepur	Nakol, Goyeshpur, Radhanagar, Amtoli
Barisal	Barisal	Amirgonj, Khanpura, Lakutia
	Babugonj	Babugonj, Kanpur, Lakutia, Mirgonj, Rohomotpur,
	Ujirpur	Dohorpara, Guthia, Baherghat, Pirerpar, Sholok

Respondent farmers: A total of 425 respondent farmers including 405 males and 20 females were interviewed in the selected districts. Respondent farmers consisted of farmers and farm workers in rural areas (at village level under different union/post office) in different upazilla (Table 1) where crops were mostly cultivated using farm inputs particularly pesticides. Hundred percent (100%) farmers were involved in agriculture. Most of the farmers had general experience in agricultural production and their experience ranged between 2 to 60 years with an average of 21 years. The age of the respondent farmers were ranged between 15-80 years old with and average of 42 years.

Data collection & analysis: The questionnaire was designed in advance and data were collected through a farm survey by face to face interviews with farmer's/farm workers and field observations during farming activities. The interviews were conducted by the researcher and four volunteers. The volunteers live in the same targeted areas. Primarily, the researcher trained the volunteers on the interview methodology, including the proper and standardized application of the questionnaire.

To document pesticide use on the vegetables and fruits, 5-10 farmers were selected from each village. Farmers who have been involving in growing vegetables and fruits for at least two years were selected as a respondent. In order to get reliable data, interviews were verified, corrected and rationalized by repeating questions, asking neighboring farmers, interviewer's own judgment in evaluating the accuracy of responses. The interview schedule was designed to collect information on local units. Farmers' practices related data were collected at two levels. One directly from the sample farmers by administering pre-designed and pre-tested questionnaires and second one was recording of data in pre-formatted register software in computer at 1 month interval from the sample farmer through field and crop inspection. The collected data were coded, analyzed, and tabulated using the Statistix 10 (Data analysis software for researchers) and Microsoft Excel 2016 program.

RESULTS

Risks of pesticide use and handling were analyzed through surveying and collecting relevant information from agro-based areas of Bangladesh. The respondent farmers were evaluated by interviewing questions through farm and

home visit to analyze the risks associated with pesticide use and handling, there by creating awareness to the farming community.

Direction of pesticide used by the farmer: The application of pesticide use in the study areas was directed by several advisory groups. The directions of pesticide use are presented in Table 2.

Table 2. Direction of pesticide use in the selected areas

Pesticide application directed/advised from	Sampled farmer	
	Number	Percentage
a) Packet label's direction	87	20.47%
b) Pesticide suppliers / dealers/retailers	331	77.88%
c) Agricultural extension worker (UAO/AEO/SAAO)	290	68.24%
d) Neighboring farmers and relatives	170	41.18%
e) NGO's worker	52	12.24%
f) Mass media	15	3.53%
g) Past experience	251	59.06%
h) Own choice	45	10.59%

It was found that the highest percentage (77.88%) of farmer used pesticides according to the suggestion of pesticide suppliers/dealers/retailers. Agricultural extension worker such as Upazila Agricultural Officer (UAO), Agricultural Extension Officer (AEO) and Sub-Assistant Agricultural Officer (SAAO) could able to advise 68.24% farmer in safe application of pesticides. On the other hand, 41.18% farmer got advice from neighbor and relatives and 20.47% from packet label direction. Mass media and NGO's worker advised 3.53% and 12.24% farmer respectively. But 59.06% farmer applied pesticide according to their past experience. Unfortunately, 10.59 % farmer sprayed pesticide according to their own choice.

Use of safety measures during pesticide application: Data regarding safety measures taken by the farmers during spraying pesticides are presented in Table 3. None of the farmers in the surveyed area was found to use mask and hand globes. There was 26.35 % farmer who used hat/head cover during spray.

Table 3. Safety measures taken by the farmers during spraying pesticides

Safety measures		Number of farmer (Out of 425)	Sampled farmers (%)
a)	Using mask and hand globes	0	0.00
b)	Using hat/head cover	112	26.35
c)	Using glasses	12	2.82
d)	Putting on boots/ shoes	4	0.94
e)	Covering head and face	149	35.06
f)	Wearing full-sleeve shirt/kurta	195	45.88
g)	Wearing full-length lungi/ trousers	370	87.06
h)	Washing hand, face and body after spray	96	22.59
i)	No safety measure	134	31.53

Only 2.82% farmer used spectacles during spraying and about 1.0% farmers put on boots/shoes. However, 35.06% farmer covered their heads and face during pesticide application and 22.59% farmer washed their hands, faces and body after spraying. Wearing full-sleeve shirt/kurta by the farmer during spray was found 45.88% and wearing full-length lungi/ trousers was found 87.06%. In the study areas, 31.53% farmers did not take any safety measure during spraying.

Farmers attitude/behavior during application of pesticides: Sampled farmers are divided into two broad categories such as literate and illiterate farmers. Out of 425 farmers, 335 are literate (attend in educational institutions and are able to read and write) 90 are illiterate (did not attend any educational institutions and unable to read/write). Their attitude, behavior, and responses are presented in Table 4 and the results are described under the following parameters.

Read and follow the label instructions: Most of the illiterate (94.44%) farmer did not read the labels on the bottle/package and did not follow the instructions. Only 5.56% sampled farmer followed the label instruction with the help of literate farmer and family members. But it was found that 17.42% literate farmer did not follow the label instructions (Table 4). This results corresponds with the study conducted in Ethiopia where most of farmers did not read instructions on pesticides packages due to illiteracy or they are just reluctant to read them (Al-Agha *et al.* 2005).

Preparation of spray fluids: Among the respondent 78.79% of the literate farmer and 24.44% illiterate farmer did not prepare spray fluid with bare hands. They mix pesticide in water with a stick. While mixing, they wear hand gloves and glasses/eye shield. But 21.21% of literate farmer and 75.78% of illiterate farmer did not do that. They use bare hand in pesticide mixing which might result severe health risk for them (Table 4).

Cleaning of sprayer's nozzle: Most of the interviewed farmers used sprayer for application of pesticide. But they were not cautious about safety use of sprayer machine. Among the respondent farmer, 77.78% illiterate farmer and 18.93% literate farmers did not use thin wire for cleaning nozzle orifice. Some of them place mouth to clean nozzle by blowing. The remaining percentage of farmer clean nozzle in secure condition (Table 4).

Use of protective uniform: Hundred (100%) of the studied farmer neither wear a protective uniform nor use special clothing during pesticide application and on an average 59.76 % of the farmers don't take any precautionary measures like using mask, hand gloves, head cover, face shield, full sleeve shirt/kurta, full length trousers/pajamas, and shoes during spraying. This study showed that 51.82% of literate farmer and 88.89% of illiterate farmers did not follow any precautionary measures to prevent pesticide contamination (Table 4).

This result is consistent with the results of many studies conducted in different countries of the world by several authors (Mekonnen and Agonafir 2002, Ngowia *et al.* 2007, Sneldea *et al.* 2008 & Williamson *et al.* 2008) and another agricultural area in Egypt (Tchounwou 2002 & Ibitayo 2006). The reasons for not using protective devices among the present sample could be due to low level of knowledge about the safety measures, unavailability of protective devices at governmental agricultural association and their high cost at private sectors. In addition, hot weather was among the causes of low use of protective devices as reported is studies conducted by Rucker (2004) in USA.

Pesticide application vs considering wind direction: Windy day is strictly prohibited during pesticide application. But 57.78 % of illiterate farmer and some of the literate farmer do not follow wind direction during application of pesticide (Table 4).

Eating / Drinking/ Smoking: Although eating and drinking are prohibited for handling and application of pesticides, only 7.60% literate farmers admitted that they ate or drunk or smoked during pesticide application. In the case of illiterate farmer 66.67% did these activities during pesticide handling and application. The lower percentage among the literate farmers was due to their knowledge on toxic and hazardous effect of pesticide. High percentage of smokers did not know that smoking could have harmful impacts on the human health during application of pesticides (Table 4).

Washing of pesticide container and aquatic health: Among the respondents 87.13% of literate and only 27.78% of illiterate farmer in the surveyed area did not wash pesticide bottle or pesticide sprayer in the pond or canal (Table 4). The remaining percentages of farmers did that and contaminated the water resources deliberately. Among the sampled farmers 90.14% from the literate and 10% from the illiterate group knew that pesticides from the bottle or sprayer surely contaminate the water of the pond/canal/river and other water body.

Notice of pesticide application: Following field application of pesticide, there should be noticed by displaying signboard or red flag or use of empty pesticide bottle or bag or container in the field so that everybody sees and understands that the field is sprayed with toxic pesticides. However, 65.91% of literate and 18.89% of illiterate farmers usually noticed after pesticide application. In addition, 76.85% farmer from the literate group and only 36.67% from the illiterate group did not let any children or domestic cattle or poultry birds enter into that field within 7 days of spray. The remaining percentages of farmers did not do this code (Table 4).

Reuse of empty pesticide container: Most of the empty pesticide containers are considered as one of the hazardous wastes if they were not thoroughly washed and rinsed after use. Among the respondent, 86.37% of literate and 17.78% illiterate farmers did not keep different things even edible commodities in the pesticide bottle or package. Results showed that 70.14% of the literate and 43.33% of the illiterate farmers dispose pesticide containers either by burning or buried in the soil. Some of the farmers threw those containers away in usual trash. Both of these group of farmer did not rinse the containers after use. The remaining percentages of the interviewed farmers admitted that they could use these empty containers for domestic purposes when the size and the shape are

affordable for some kinds of uses (Table 4). The result is consistent with the studies conducted in Gaza and Greece (Damalas *et al.* 2008). In contradiction, a study conducted in Iran reported that more than 50% of the farmers sell empty containers for recycling (Nazaril *et al.* 2011). The farmers in the present study had no knowledge about recycling.

Storing of pesticide: This study showed that 84.60% of the farmers store pesticides in their homes or houses without lock and keys, while only 15.40% stored them in the farms (Table 4).

First aid in the event of accidental pesticide toxicity: In the event of an accident, the patient must be provided with first aid as per instructions labeled of that particular pesticide bottle and immediately the patient including the pesticide bottle/package should be taken to the doctor. In this study, 36.36% literate and 17.78% illiterate farmers took these first aid measures in the event of pesticide accident (Table 4). The remaining percentages of farmers were not well aware of first aid treatment. There were few farmers who reported to the health centers for treatment resulting from pesticides use.

Based on above result, it might be concluded that the state of being literate or illiterate is a prime factor in all the aspects of knowledge. The results showed that the literate farmers had higher percent of healthy behavior than the illiterate ones. Hence, they are concern about reading labels, mixing pesticides using gloves, washing skin coming in contact with pesticides, avoid eating, drinking, smoking during pesticide spraying, changing clothing's after pesticide application, and providing first aid treatment. Moreover, very few of them used pesticide containers at home. Activities related to precautionary measures such as wearing hand gloves, head cover, face shield, full sleeve shirt/kurta, full length trousers/pajamas, and shoes were not significantly different among the educated and non-educated farmers. There was a significant difference among the two groups in the total mean score of knowledge.

Table 4. Farmers attitude/behavior during spraying pesticides based on education.

Knowledge / Instruction(s)/Behavior	Sampled farmer (425)				χ^2, <0.05
	Literate (335)		Illiterate (90)		
	Yes	No	Yes	No	
Read the labels on the bottle/package and follow the instructions (if you cannot read, please get help from others who can read).	277 (82.58)	58 (17.42)	5 (5.56)	85 (94.44)	** 7.2
Do not prepare spray fluid with bare hands. Mix them with a stick. While mixing, wear hand gloves and glasses/eye shield.	264 (78.79)	71 (21.21)	22 (24.44)	68 (75.56)	** 8.4
While cleaning the sprayer's nozzle do not place your mouth on it or blow on it. Use thin wire for cleaning the nozzle.	272 (81.07)	63 (18.93)	20 (22.22)	70 (77.78)	2.2
Before spraying pesticides take all precautionary measures such as wearing hand gloves, head cover, face shield, full sleeve shirt/kurta, full length trousers/pajamas, and shoes.	161 (48.18)	174 51.82)	10 (11.11)	80 (88.89)	** 6.7
Do not spray pesticides against the wind. Determine wind direction first and then spray. Do not spray when it is windy.	299 (89.32)	36 (10.68)	38 (42.22)	52 (57.78)	1.5
Do not eat or drink or smoke while spraying pesticides. The reaction may be toxic or even fatal.	310 (92.40)	25 (7.60)	30 (33.33)	60 (66.67)	2.5
Do not wash pesticide bottle or pesticide sprayer in the pond/canal/other water bodies.	292 (87.13)	43 (12.87)	25 (27.78)	65 (72.22)	** 6.7
Pesticides from the bottle or sprayer will contaminate the water of the pond/canal/other water bodies and will be dangerous/deadly for the fish, cattle, birds and people.	302 (90.14)	33 (9.86)	09 (10.00)	81 (90.00)	** 4.5
After applying the pesticides in the field, display a signboard or red flag or use an empty pesticide bottle, so that everybody sees and understands that field was sprayed with pesticides.	221 (65.91)	114 (34.09)	17 (18.89)	73 (81.11)	* 3.5

After pesticide spray do not let any children or domestic cattle or poultry birds enter into that field within 7 days.	257 (76.85)	78 (23.15)	33 (36.67)	57 63.33)	1.6
Do not keep other things in the pesticide bottle or package. Do not keep pesticides in any bottle or package used for keeping food or medicine.	289 (86.37)	46 (13.63)	16 (17.78)	74 (82.22)	1.8
Tear up the pesticide package or break the bottle into pieces and then bury them under the ground.	235 (70.14)	100 (29.86)	39 (43.33)	51 (56.67)	* 3.2
Store pesticide in the farm. If stores in houses, keep it under lock and key so that they are out of the reach of children. Do not keep other things or medicine where pesticides are stored.	283 (84.60)	52 (15.40)	10 (10.11)	80 (88.89)	1.2
In the event of an accident, provide first aid to the patient following the instructions on the label of that particular pesticide bottle. Take the patient and the pesticide bottle/package to the doctor as soon as possible.	122 (36.36)	213 (63.64)	7 (7.78)	83 (92.22)	1.4

Note: Figure in the parenthesis are percentage (%) of the data.

Risk assessment: According to the verbal confession 28.71% of farmer thought that pesticide exposure caused a large and significant amount of risk (Table 5).

Table 5. Risk assessment categories and responses of the farmers in the studied area.

Category of risk	Sampled farmer (no.)	Risk (%)
a) No risk at all	32	7.53
b) Some small risks	114	26.82
c) A medium amount of risk	42	9.88
d) A large and significant amount of risk	122	28.71
e) Dangerous and very toxic risks	88	20.71
f) I don't know	27	6.35

But 26.82% farmer believe that it had some small risk, while 20.71% farmer found it as dangerous and very toxic. Only 9.88% farmer considered as a

medium level of risk. Unexpectedly 7.53% farmers believedthat pesticide exposure had no risk at all. Not only that 6.35% farmers knew nothing about pesticide toxicity. The results indicated that the farmers of Bangladesh are not well conscious about the pesticide risks and its possible health hazards.

DISCUSSION

The results are indicated alarming situation in surveyed area in Bangladesh. Some of the farmers applied pesticide according to their personal will either wrongly or inappropriately. Majority of the farmer's dependent on the advice of pesticide suppliers, dealers, and retailers to spray pesticide in their field. The dealers and retailers in Bangladesh had no sufficient knowledge on pesticide and its proper application to crops (Parveen & Nobukazu 2001). Sometimes the farmers were misguided by these agents due to their personal and manufacturer benefit. A high percentage of farmer showed unsafe behavior during pesticide use and handling. They did not read and follow the label instruction provided in the pesticide bottle or packages. They prepared spray fluids with bare hands, cleaned sprayer nozzles with open mouth, did not use protective clothing and did not consider wind direction during pesticide application. They did not notify the field by displaying signboard, red flags or empty pesticide containers after spray. Moreover, the they reused the empty containers for keeping house hold commodities. In rare cases farmers took the opportunity of first aid or medical treatment from the Government hospitals in the event of pesticide toxicities.

These results of the present study would help building awareness among the farmers in Bangladesh. Governmental and non-governmental sectors should work for raising farmer's awareness. The ministry of agriculture should take initiative to encourage the farmers to reduce pesticide use by judicial application, shifting from synthetic pesticides to bio-pesticides and organic farming which ultimately prevent environmental pollution and health risks.

REFERENCES

ABD-RABOU, A. N. 1996. On the hazards of pesticide use and misuse in Khartoum State and some histopathological studies on the effects of carbamate insecticides on experimental animals: A thesis submitted for the award of the degree of M. Sc. in the Institute of Environmental Studies, University of Khartoum, Sudan. pp. 220-232.

AL-AGHA, M. R., BAROUD, N. S. & ABD-RABOU, A. N. 2005. Environmental health risks to farmers as a result of pesticides' mismanagement in Khanyounis Governorate - Gaza Strip, The 7th International HCH and Pesticides Forum, Kyiv, Ukraine, June 5-7, 2003, 197-200.

ALI, W., CLAYDEN, C. & WEIR, R. 2006. Attitudes and behaviors toward pesticide risk reduction: a critical appraisal of the literature. NZHTA Report. **5**, 1-101

ASANTE-DUAH, D. K. 2002. Public health risk assessment for human exposure to chemicals. Springer Science & Business Media. pp.87-89.

BAILIE, R. 2009. Notification of Pesticide Poisoning: Knowledge, Attitudes and Practices of doctors in the rural Western Cape. *S. A. Fam. Pr.* **20**, 117–120.

BARC. 2008. Proceeding of the workshop on Maximum residues limits of pesticide in Agricultural Commodities and Food in Bangladesh. Bangladesh Agricultural Research Council (BARC). 63p.

BD-RABOU, A. & AL-AGHA, M. R. 1998. Environmental awareness in handling and application of pesticides among farmers in Rafah Governorate – Gaza Strip, The V international HCH and Pesticide Forum, Bilbao, Spain, June, 25-27, 1998.

CHESTER, G., SABAPATHY, N. N. & WOOLLEN, B. H. 2002. Exposure and health assessment during application of Lambda-cyhalothrin for malaria vector control in Pakistan. *Bulletin of the World Health Organization (WHO).***70** (5), 614-619.

COVELLO, V. T. & MERKHOHER, M. W. 2013. Risk assessment methods: approaches for assessing health and environmental risks. Springer Science & Business Media.

DAMALAS, C. A., TELIDIS, G. K., STAVROS, D. & THANOS, S. D. 2008. Assessing farmers' practices on disposal of pesticide waste after use. *Science of Total Environment.* **390**, 341-345.

EMANUEL, K. 1992. Country report: South Africa. The Pesticide hazard; A global health and environmental audit, The Pesticide Trust, Zed Books. pp.148-158.

GARVALHO, W. A. 1990. Risks from occupational exposure to organochlorine insecticides. Bahia, Brazil, Cited from WHO/UNEP.

JANSSEN, M. M. T. 1997. Contaminants in: Food Safety and Toxicity, Vries, J. (Ed.), CRC Press LLC, ISBN 0-8493-9488-0, 1st edn., Boca Raton, USA. pp. 61-71.

JENSEN, H. K., KONRADSEN, F., JORS., E., PETERSEN, J. H. & ANDERS, A. 2011. Pesticide Use and Self-Reported Symptoms of acute pesticide poisoning among aquatic farmers in Phenom Penh. *Journal of Toxicology*. **63**, 9-14.

LAU, R. R. 1992. Origins of health locus of control beliefs. *Journal of Personality and Social Psychology.* **42**(2), 322-334.

MBAKAYA, C. F. L., OHAYO, M. G. J. A., NGOWI, A. V. F., MBABAZI, R., SIMWA, J. M., MAEDA, D. N., STEPHENS, J. & HAKUZA, H. 2004. The status of pesticide usage in East Africa. *African Journal of Health Science.* **1**, 37–41.

MEKONNEN, Y. & AGONAFIR, T. 2002. Pesticide sprayers' knowledge, attitude and practice of pesticide use on agricultural farms of Ethiopia. *Occupational Medicine.* **52**, 311-315.

NAZARIL, M. R., BIN, H.J. & HASSAN, S. 2011. The role of television in the enhancement of farmers' agricultural knowledge. *AJAR*. **6**, 931-936.

OHAYA, M. G. J. A. 2005. Occupational pesticide exposure among Kenyan agricultural workers. PhD thesis. Wageningen University. pp. 282-297.

PARVEEN, S. & NOBUKAZU, N. 2001. An analysis of pesticide use for rice pest management in Bangladesh. *Journal of International Development and Cooperation.* **8**(1), 107-126.

PREPARE. 2001. Country report: India. The pesticide hazard: A global health and environmental audit, The Pesticide Trust, Zed Books. pp. 159-172.

SHETTY, P. K., MURUGAN, M., HIREMATH, M. B. & SREEJA, K. G. 2010. Farmers' education and perception on pesticide use and crop economies in Indian agriculture. *Journal of Experimental Sciences.* **1**, 3-8.

SKALISZ, R. O. 1991. Country report: Brazil. The pesticide hazard: A global health and environmental audit. *The pesticide Trust, Zed Books.* pp 81- 96.

SNELDEA, D. J., MASIPIQUEN, A.B. & DE SNOOA, G.R. 2008. Risk assessment of pesticide usage by smallholder farmers in the Cagayan Valley (Philippines). *Crop Protection.* **27**, 747-762.

TCHOUNWOU P. B., ASHOUR B. A., MORELAND-YOUNG, C., RAGHEB, D. A., ROMEH, A. A. & EL-ADAROSY, G. 2002. Health risk assessment of pesticide usage in Menia El-Kamh Province of Sharkia Governorate in Egypt. *International Journal of Molecular Sciences.* **3**, 1082-1094.

USEPA. 1998. Guidelines for ecological risk assessment (Vol. 2). EPA/630/R-95. p.38

WESSELING, C., HOGSTEDT, C., PICADO, A. & JOHANSSON, L. 2007. Unintentional fatal paraquat poisonings among agricultural workers in Costa Rica: A report of 15 cases. *American Journal of Industrial Med*icine. **32**(5), 433–441.

WILLIAMSON, S., BALL, A. & PRETTY, J. 2008. Trends in pesticide use and drivers for safer pest management in four African countries. *Crop Protection*. **27**, 1327-1334.

(MS received for publication 03 September 2014)