Bull. Environ. Contam. Toxicol. (2004) 73:787–793

DOI: 10.1007/s00128-004-0496-8

Bulletin of Environmental Contamination and Toxicology

# Contamination Levels of Organochlorine Pesticides and Farmers' Knowledge, Perception, Practices in Rural India: A Case Study

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Received: 23 April 2004/Accepted: 8 September 2004

In a country like India, the use of pesticides has become inevitable to sustain and improve current level of crop production by protecting the crop from pests. Being a sub-tropical country, India observes varying temperature and humidity profile through out the year, which brings a vast array of pests to be tackled. Some pests are found to attack multiple targets (various crops) and have even acquired resistance from prolong use of common pesticides. This only enforces farmers to go for newer variety if available or the higher doses of existing ones leading into greater exposure to pesticides due to widespread application in agricultural and environmental pest control (Fleming et al. 1999). In India, literacy rate is very low, particularly in the rural mass that triggers the improper and non-judicious use of pesticides by the farmers. It exposes them to ill effects of pesticides during inappropriate handling, storage or disposal and when not covered with Personal Protective Equipments (PPEs) (Winstead 1993). Additionally, the use of incorrect (high) doses of pesticides by farmers leads to contamination of their products, which in turn causes a great risk for consumers/end users.

Thus, the study was aimed to determine the contamination levels of organochlorine pesticides (OCPs) in the vegetables and to identify the causes at farmers' end (knowledge, perception, and practices). The study was divided into two phases. The first phase targeted to determine farmers' knowledge, perception and pesticide-use-practices (KPP) in rural Agra (renowned worldwide for Taj Mahal) by conducting a baseline survey. However, the vegetable samples were collected from the subject farmers in the second phase and were extracted and analyzed to determine the contamination levels of organochlorine pesticides (OCPs) by Gas Chromatograph in the vegetables.

The study mainly deals with pesticide-use-practices adopted by Indian farmers and their awareness about the PPEs and contamination occurred due to such practices. The objective of the study brings into light the extreme need of Integrated Pest Management Programme (IPM) in India.

## MATERIALS AND METHODS

The information provided here was derived from the survey that was conducted in 15 blocks of Agra region. From each block, 5 villages were selected and out of each village, 10 vegetable farmers were questioned about their pesticide-use-practices.

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The content of questionnaire was formulated on the basis of information required from the farmers. On an average each questionnaire took half an hour to get completed by interviewing the farmers. The survey was conducted on period basis and villages were visited personally by one of the authors. The questionnaire aimed to obtain a real picture of farming system in general and about the farmer's knowledge, perception, and pesticide-use-practices. Farmers were asked to record the major pest problems and to indicate, from where they received the information about the pesticide use. They could choose one or more of the following list; own experiences, inputs from pesticide seller, extension staff and any other staff from research institute or others. Farmers were also asked to specify which pesticide they use, its frequency and target species.

In the second phase, the collected vegetable samples were extracted and analyzed for the presence of OCPs. The extraction part was carried out by cutting 50gm of the sample into pieces and was mixed with acetonitrile (repeated thrice with 50 ml) in a blender. The resultant mixture was then poured into separatory funnel and shaken with the 3:2 mixtures of n-hexane and dichloromethane for one hour. After shaking, the separatory funnel was left in the same position for 30 minutes to have distinct layers; n-hexane layer was then taken into round bottom flask, concentrated to dryness by rotary evaporator and leftover being discarded. The samples were then subjected to florisil column to remove all the kind of impurities (moisture and other undesired components) and were finally prepared in 2 ml of n-hexane (HPLC grade). Samples, thus obtained, were injected (1 μL) and analyzed for the presence of organochlorine pesticides by Gas Chromatograph (Hewlett Packard 5890) with selective electron capture detector (ECD) that allowed the detection of contaminants (OCPs) even at trace level concentrations (in the lower ppb range) from the matrix to which other detector do not respond. The conditions for Gas Chromatograph as maintained during the analysis were: Injection temperature 250°C, oven temperature 180°C, Ramp-I 220°C with hold time 7°C/min, Ramp-II 250°C with hold time 8°C/min, detector temperature 325°C and carrier gas was nitrogen ($N_2$) with steady flow rate of 5mL/min.

## RESULTS AND DISCUSSION

It was found that most of the farmers exhibited the general familiarity with the pesticides. About 80% could name an insecticide or fungicide by its brand name, which was more common and used frequently by the shopkeepers, though farmers were not aware of their scientific names. The majority of farmers cited the pesticide shopkeepers as the main source of information and reported that government agencies/units are no where involved in dissipating general information regarding usage and other related practices. Also, 80% of the farmers relied on pesticide seller, 20% of the farmer relied on their own experiences, no farmer relied on the media advertisements, extension officer or the university staff (Figure.1). However, farmers in few villages, which are in direct connection with the cities, get influenced with the media advertisements but practically they found it better to rely on advices of pesticide sellers. Thus, in more than 90% of cases, shopkeepers played key role in determining and extending when and which

**Table 1.** An over-view of education, quality of land, sources of irrigation and farm sizes of the villagers of Agra region

| **Education** | | **Quality of Land** | | **Sources of Irrigation** | | **Farm Size** | |
|---|---|---|---|---|---|---|---|
| Middle | 20% | Irrigated good Fertile | 70% | Well | - | Large | 10% |
| High school | 20% | Un-irrigated Fertile | 25% | Tube well | 100% | Medium | 70% |
| Intermediate | 55% | Problematic Unfertile | 5% | Canal | - | Small | 20% |
| Others | 5% | Others | - | Others | - | Marginal | - |

**Table 2.** Maximum residue limit (MRL) of OCPs in vegetables decided by FAO/WHO (FAO/WHO1986) and Ministry of Health, Government of India. (WHO, 1989)

| **Pesticides↓ Organization→** | **FAO/WHO** | **Ministry of Health, India** |
|---|---|---|
| DDT | 1.0 mg/kg | 3.5 mg/kg |
| BHC | 0.2 mg/kg | 3.0 mg/kg |
| Endosulphan | 2.0mg/kg | 2.0mg/kg |
| Dieldrin | 0.10 mg/kg | 0.10 mg/kg |

pesticide the farmers should use on fields. It was found that these pesticide sellers are not well-educated and learnt about pests after observing pests in their own fields and giving advices on the basis of their own experiences. The plant protection department and extension services hardly added to pesticide sellers' or farmers' knowledge. Most farmers' practiced the methodology suggested by shopkeepers, while giving least attention to read the written directions on the package. Farmers also lacked the practical demonstration. As the literacy rate in India is very low, written labels and directions were not found sufficient to be considered as an effective means of communication to the farmers. (Table.1 gives an over-view of education, quality of land, sources of irrigation and farm sizes of the villagers of the selected region.) To gain additional insight into the farmers' knowledge of pesticide and their role in crop production and protection they were asked about the usage of pesticides. It was found that most (90%) of the farmers observed the use of pesticides as a guarantor to high yields and stated that good quality of crop is not possible without the use of pesticides. About half of the farmers mentioned that it is desirable for pesticide to kill all the insects in a field and not just the intended target. Also, most farmers (80%) considered that new chemical pesticides are better than the old ones. Farmers displayed an overall high level of knowledge concerning the toxic effects of pesticides. As many as 90% of the farmers agreed to the fact that the pesticide are toxic and should be kept out of the reach of the children. The responses by the farmers in this regard are

**Table 3.** Showing no. of farmers (in percent) using protective clothing and types of protective clothing used by them.

| Use of protective Clothing | | Type of protective clothing used | |
|---|---|---|---|
| Yes | 2% | Scarf | 1% |
| | | Rubber boots | - |
| No | 98% | Gloves | - |
| | | Masks | 5 |
| No Answer | - | Two or more items | - |
| | | Others | - |
| | | No Answers | - |

**Table 4.** Responses of farmers towards statements made to them in order to ascertain their plant protection attitudes.

| Statements | Agree | Disagree | Unsure | No Answer |
|---|---|---|---|---|
| Without using pesticide no crop can be grown. | 95% | - | 5% | - |
| Methods of using pesticide are told by shopkeepers but not by any govt. agent. | 100% | - | - | - |
| Pesticides are poisonous but do not affect human beings. | 80% | 15% | - | 5% |
| There are no disadvantages of using pesticides. | 90% | - | 10% | - |
| Pesticide increases both quantitative and qualitative yields. | 90% | - | 10% | - |
| Using pesticide is a costly affair but in comparison to increased production, the cost is compensated | 80% | - | - | 20% |

**Table 5.** Contamination levels of pesticide residues in different vegetables of Agra Region (ppb)

| Vegetables | T-BHC | T-Endosulphan | T-DDT | Aldrin | Dieldrin |
|---|---|---|---|---|---|
| **Brinjal** | 7.72 | 7.25 | 4.57 | 2.23 | 1.82 |
| **Carrot** | 5.98 | 2.15 | 3.57 | 4.24 | 0.43 |
| **Cauliflower** | 3.81 | 3.28 | 7.21 | NT | NT |
| **Raddish** | 5.57 | 4.60 | 8.14 | NT | NT |
| **Cabbage** | 2.52 | 12.36 | NT | NT | NT |
| **Gourd** | 4.15 | 8.78 | 7.25 | 1.29 | NT |
| **Tomato** | 3.21 | 8.95 | 5.82 | 1.81 | 1.84 |
| **Pea** | NT | NT | NT | NT | NT |

**Table 6.** Contamination levels of OCPs in different blocks of Agra region. (ppb)

| Blocks | T-BHC | T-Endosulphan | T-DDT | Aldrin | Dieldrin |
|---|---|---|---|---|---|
| **Baroli Ahir** | 4.69 | 8.29 | 5.65 | 2.09 | 1.61 |
| **Itmadpur** | 3.65 | 5.24 | 4.40 | 2.59 | 1.22 |
| **Bichpuri** | 1.50 | 5.25 | 3.40 | 2.06 | 1.50 |
| **Sanyaa** | 4.60 | 6.65 | 5.67 | 2.14 | 2.09 |
| **Achnera** | 3.47 | 5.75 | 4.50 | 2.10 | 2.08 |
| **Shamshabad** | 3.52 | 12.29 | 9.47 | NT | NT |
| **Khandoli** | 4.13 | 8.28 | 6.69 | NT | NT |
| **Fatehabad** | 7.97 | 7.06 | 8.03 | 1.29 | 1.48 |
| **Jaitpur Kalan** | 4.16 | 9.28 | 7.80 | NT | NT |
| **Akola** | 6.58 | 6.28 | 9.18 | NT | NT |
| **Baha** | 2.34 | 13.18 | 7.17 | NT | NT |
| **Pinahat** | 2.67 | 11.24 | 7.82 | 2.04 | 1.50 |
| **Jagner** | 6.28 | 9.91 | 6.65 | 2.84 | 2.62 |
| **Fatehpur Sikri** | 3.69 | 8.48 | 7.83 | 1.93 | NT- |
| **Kheragarh** | 3.52 | 2.80 | 2.10 | NT | NT |

summarized in Table. 4 The study found that many farmers were familiar with the potential health hazards associated with pesticide usage. This section of the survey sought to determine the influence of these beliefs on their actual pesticide use practices. Most of the farmers were taking care with regard to storage of pesticides. Almost, 75% of them did not store pesticides, but purchased and used them when required. About 80% of the farmers shown familiarity towards the toxic nature of pesticides and used to throw away the empty containers. It was found that farmers did not use the empty container for any purpose. Perhaps the most significant finding of the survey relates to the use of protective clothing when applying pesticides (Table 3). Over 90% of the farmers reported that no PPEs were used. About 5-10% of the farmers used clothe masks on their mouth and nose while spraying but only with specific pesticide that emits obnoxious smell. No farmers reported the use of boots, goggles, gloves etc. during application. However, some of the farmers (60%) reported using polythene bags in their hands, while preparing solutions of the pesticides for application. Most (90%) of the farmers reported washing of the hands and legs after spraying but they are not aware of accumulation of pesticides onto their hair and other exposed parts (skin) of the body. The survey found that lack of information towards the source of such clothing is a major contributing factor for not using them (PPEs). However, nearly (10%) reported that in older times, the companies of the pesticides used to provide PPEs, but now no one is providing them with the pesticide package. Economic considerations also play an important role for the farmers to go for the protective measures or make such arrangements.

The results of analysis of vegetable samples of different blocks of Agra region are summarized in Table 6. It was found that T-Endosulphan (α-Endosulphan and β-Endosulphan) is the most abundantly used organochlorine pesticide in all the

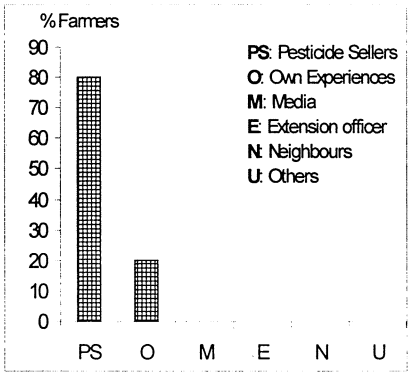


**Figure 1.** Sources of information influencing farmers' decision-making related to pesticide use in different crops of fruits and vegetables.

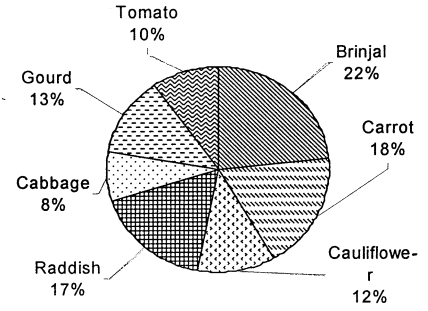


**Figure 2.**Distribution of T-BHC in vegetables

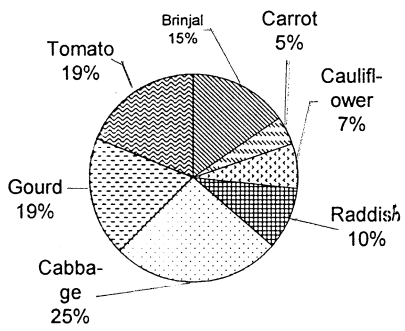


**Figure 3.** Distribution of T-Endosulphan in Vegetables

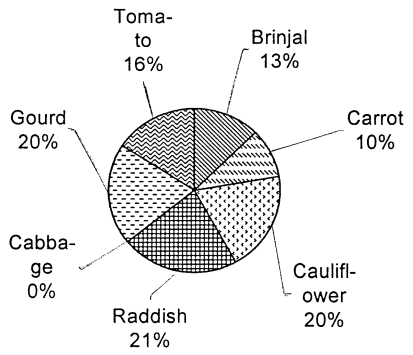


**Figure 4**. Distribution of T-DDT in vegetables

samples. Although DDT is banned, yet residues of T-DDT (op'-DDT, pp'-DDT and pp-DDD) were detected in all the samples. The data apparently indicates that in most of the blocks the concentration level of T-BHC (α-BHC, β-BHC, and γ-BHC) is lesser than T-DDT and T-Endosulphan as observed. The concentration levels of different pesticides in selected vegetables as shown in Table 5 signify that aldrin and dieldrin were found to be in trace amounts in few and non-traceable in most of the samples. It is important to mention here that in the pea samples, no pesticide residues were reported, this may be due to the presence of green coating (peel) over the eatable portion of the pea that might prevent the pesticide to penetrate up to the eatable portion. The distribution of T-BHC, T-Endosulphan, and T-DDT (in percent) in selected vegetables can be observed in Figure 2, 3, and 4 respectively, which shows that maximum concentration of T-BHC was found in brinjal (22%) with minimum in cabbage (8%). Similarly, maximum Endosulphan level was observed in cabbage (25%) with minimum in carrot (5%) and maximum DDT contamination was found in raddish (21%) with

nil in cabbage (0%)

Though, the concentration of these pesticides were well below the established tolerances as shown in Table.2 (FAO/WHO 1986; WHO 1989) but continuous consumption of such vegetables even with moderate contamination level can accumulate in the receptor's body and may prove fatal for human population in the long term.

Many developing countries still ignore the importance of an IPM approach and rely on pesticides for quick solution to deal with the pest problems. The survey found that farmers have enough understanding of the dangers of the term, 'acute pesticide poisoning' but lack awareness of the long-term chronic risk of pesticide usage. The farmers overvalue benefits of the pesticide application and undervalue their ill effects. A well-developed and co-coordinated programme on farmer's participatory training and research that focus on experimental learning and field observations that could locate this vicious circle by enhancing farmers' perception of pests, their ecological casualties and non-chemical alternatives and management options as suggested elsewhere (Braun et.al.2000; CABI 2001; Nelson et.al.2001). Ideally farmers' participatory research and training programme should be complemented by a well-developed mass media campaign promoting the use of this endemic natural enemy.

*Acknowledgments* .We thank Dr. Ashok Kumar, Head of Department, School of Chemical Sciences, Department of Chemistry, St. John's College, Agra for providing necessary laboratory facilities. One of the authors (MB) is thankful to Central Pollution Control Board for providing Junior Research Fellowship.

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