MONITORING PESTICIDES IN VEGETABLES AND THE ENVIRONMENT IN MEERUT DISTRICT

I. INTRODUCTION

Meerut district is in the heart of India's well-known green revolution belt of western UP. Local farmers routinely use a large number of pesticides. The common ones include endosulphan, lindane, monocrotophos, chloropyriphos, thiodon, cypermethrin, etc., many of which are banned in the West due to their carcinogenic characteristics. To wean farmers away from pesticides use, Janhit Foundation, a Meerut-city based VO, has been promoting organic farming as an alternative. It has an effective presence in about 100 villages of the Ganga-Yamuna Doab region.

In a reconnaissance survey of villages around Meerut city, undertaken by PSI with the support of Janhit Foundation, pesticides' residues were found in soil and water samples. Farmers revealed that they used various pesticides, either individually or by clubbing together different ones, for growing vegetables and other crops.

Objectives

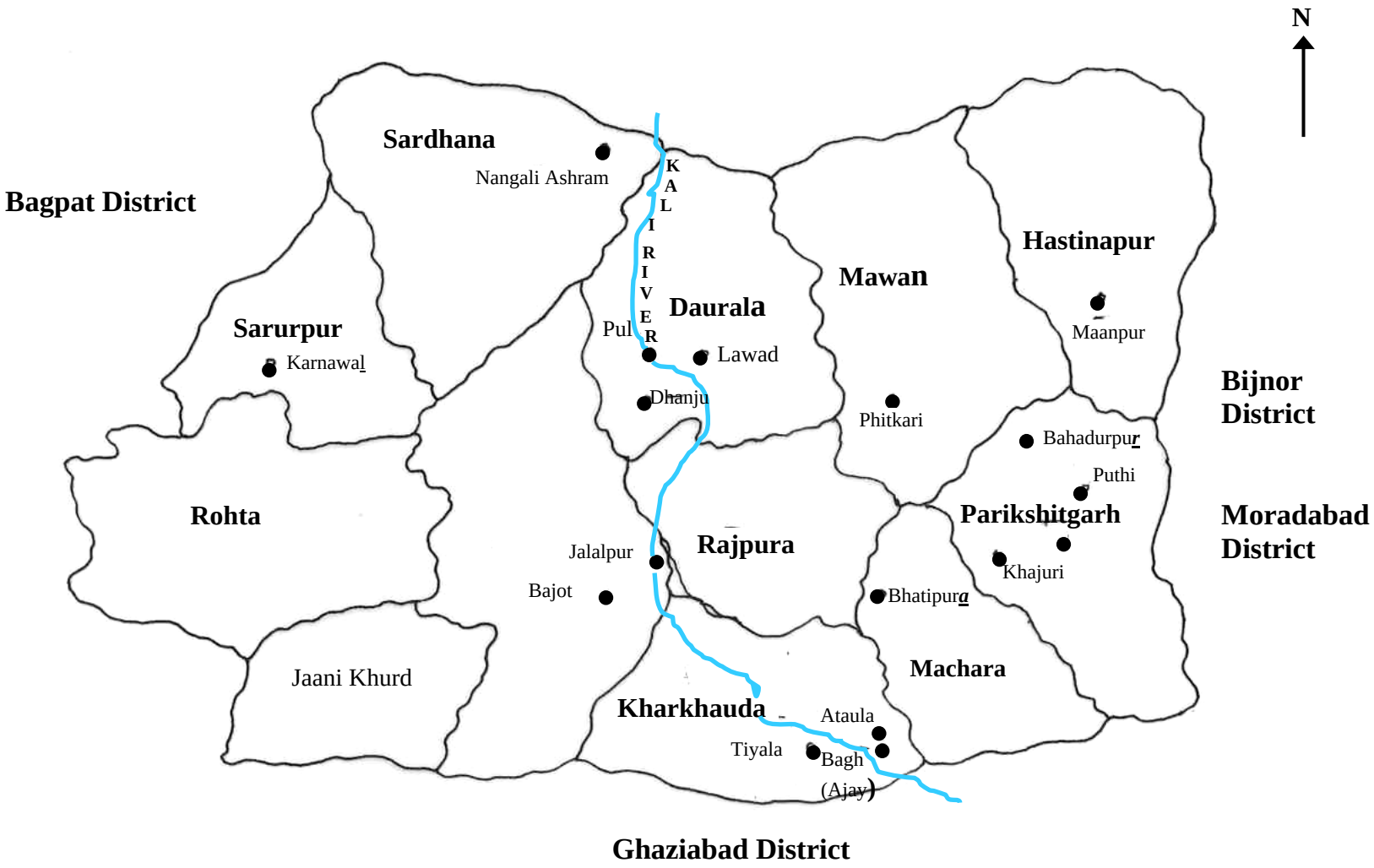
To assist Janhit Foundation's efforts to reduce the use of pesticides and promote organic farming as an alternative in Meerut district by (i) Producing data on the presence of pesticides' residues in the environment (soil and water) and vegetable crops and (ii) preparing campaign materials.

II. METHODOLOGY

The winter vegetable season in western U.P. begins in August-September. Farmers generally spray pesticides between September and November, before these crops are harvested in December and January. The summer vegetable crops are sown in April, sprayed with pesticides from end-April to June and harvested at the end of June. PSI's staff, accompanied by the staff of Janhit Foundation, collected soil and vegetable samples from different locations during the end of November 2004 and in May 2005 (See Fig.1). Considering the nature of pesticides and the possibility of their leaching into the groundwater, samples from dug wells, tube wells, and the nearby Eastern Kali river were also gathered. Fifty samples were analyzed with the help of the Gas Chromatograph in PSI's EQM lab. Information about the frequency of pesticides applications, quantity and types of pesticides used were obtained from the farmers. This information was used to select the pesticides for quantitative analyses. For sampling, extraction and analyses, EPA methods (8081A and 8141A) were followed.

Janhit Foundation used this data in its campaign to reduce the use of pesticides and promote organic farming as an alternative. PSI has assisted this campaign by producing a thousand sets of eight multi-coloured posters in Hindi on the harmful effects of pesticides and the methods and benefits of organic farming.

Fig.1: Location of sampling sites in Meerut



III. RESULTS & DISCUSSION

III.1 Results

Table 1a: Surface Water: (Sampling Date: 19.11.04 – 22.11.04)

S.No	Sample	β-BHC (µg/L)	γ-BHC (µg/L)	Heptachlor (µg/L)	Heptachlor Epoxide (µg/L)	δ-BHC (µg/L)	Aldrin (µg/L)	Unidenti-fied peaks
SW_1	R. Kali, v. Jalalpur	6.2	ND	2.1	32.26	ND	ND	ND
SW_2	R.Krishni	ND	ND	ND	0.07	0.3	ND	ND
SW_3	Pond, v Phitkari	ND	ND	ND	0.06	ND	ND	ND
SW_4	Stream, v. Lawar	ND	ND	ND	ND	0.2	ND	ND
SW_5	River, E.Kali	ND	8.1	ND	29.5	ND	9.9	2

Table 1b: Surface Water: (Sampling Date: 05. 05. 05 – 07. 05. 05)

S.No	Sample	β-BHC (µg/L)	γ-BHC (µg/L)	Hepta-chlor (µg/L)	Heptachlor Epoxide (µg/L)	Fipronil (µg/L)	Endo-sulfan I (µg/L)	Aldrin (µg/L)
SW_6	Pond, v. Bhatipura	ND	ND	ND	ND	ND	ND	ND
SW_7	Pond, v. Khajuri	ND	ND	ND	ND	ND	ND	ND
SW_8	Pond, v. Parikshitgarh	ND	ND	ND	0.1	ND	ND	ND
SW_9	R.Kali, v. Jalalpur	546.75	63.82	60.44	153.46	19.61	ND	16.10

Table 1c: Ground Water: (Sampling Date: 19.11.04 – 22.11.04)

S.No	Sample	β-BHC (µg/L)	γ-BHC (µg/L)	Hepta-chlor (µg/L)	Heptachlor Epoxide (µg/L)	δ-BHC (µg/L)	Aldrin (µg/L)	Unidenti-fied peaks
GW_1	HP, v. Jalalpur	ND	ND	ND	ND	0.4	ND	1
GW_2	HP, v. Sakoti	ND	ND	ND	ND	0.4	ND	1

Table 1d: Ground Water: (Sampling Date: 05. 05. 05 – 07. 05. 05)

S.No	Sample	β-BHC (µg/L)	γ-BHC (µg/L)	Heptachlor (µg/L)	Heptachlor Epoxide (µg/L)	Fipronil (µg/L)	Endo-sulfan I (µg/L)	Aldrin (µg/L)
GW_3	TW, v Bhatipura	ND	ND	ND	ND	ND	ND	ND
GW_4	HP,v Bhatipura	ND	ND	ND	ND	ND	ND	ND
GW_5	HP, v Parikshitgarh	ND	ND	ND	ND	ND	ND	ND
GW_6	HP, v Poothi	ND	ND	ND	ND	ND	ND	ND
GW_7	Desi HP, v Poothi	ND	ND	ND	0.08	ND	ND	ND
GW_8	TW, v Bahadurpur	ND	ND	ND	ND	ND	ND	ND
GW_9	TW, v Lawar	ND	ND	ND	ND	ND	ND	ND
GW_{10}	Desi HP, v Lawar	ND	ND	ND	ND	ND	ND	ND
GW_{11}	HP, v Ajay Bagh	ND	ND	ND	ND	ND	ND	ND
GW_{12}	TW,v Dhanju	ND	ND	ND	ND	ND	ND	ND
GW_{13}	Desi HP, v Karnaval	ND	ND	ND	ND	ND	ND	ND
GW_{14}	Desi HP, v Bajoth	ND	ND	ND	ND	ND	ND	ND
GW_{15}	HP, v Jalapur	ND	ND	ND	ND	ND	ND	ND
GW_{16}	Desi HP, v Atola	ND	ND	ND	ND	ND	ND	ND

HP=Handpump, TW=Tubewell, ND=Not Detected

Table 1e: Vegetables (Sampling Date: 5. 5. 05 – 7. 5. 05)

S.No	Sample	β-BHC (µg/kg)	γ-BHC (µg/kg)	Hepta-chlor (µg/kg)	Heptachlor Epoxide (µg/kg)	Fipronil (µg/kg)	Endo-sulfanI (µg/kg)	δ-BHC	Endrin
V_1	Mooli v Phitkari	ND	ND	ND	6.4	ND	ND	ND	ND
V_2	Brinjal v Phitkari	ND	ND	ND	2.0	ND	ND	ND	ND
V_3	Tomatoes v Lawar	ND	ND	ND	2.1	ND	ND	ND	ND
V_4	Pumpkins v Lawar	ND	ND	ND	2.8	ND	ND	ND	ND
V_5	Torai v Lawar	ND	ND	ND	ND	ND	ND	ND	ND
V_6	Cucumbers v Lawar	ND	ND	ND	ND	ND	ND	ND	ND
V_7	Lauki v Lawar	ND	ND	ND	1.8	ND	2.5	ND	ND
V_8	Green chillies v Lawar	ND	ND	ND	ND	ND	6.0	ND	ND
V_9	Brinjal v Lawar	ND	ND	ND	ND	ND	ND	ND	ND
V_{10}	Bhindi v Lawar	ND	ND	ND	ND	ND	ND	ND	ND
V_{11}	Cucumbers v Bajoth.	ND	ND	ND	ND	ND	ND	ND	ND
V_{12}	Green chillies sabzi mandi v Bajoth.	ND	ND	ND	ND	ND	ND	ND	ND
V_{13}	Tomatoes sabzi mandi v Bajoth.	ND	ND	ND	ND	ND	ND	ND	ND
V_{14}	Brinjals sabzi mandi v Bajoth.	ND	ND	6.6	2.7	ND	12.69	101.3	11.1
V_{15}	Palak sabzi mandi v Bajoth.	ND	ND	ND	ND	57.6	ND	ND	ND
V_{16}	Mangoes v Manpur.	ND	ND	ND	ND	ND	ND	ND	ND

Table 1f: Soil (Sampling Date: 05. 05. 05 – 07. 05. 05)

S.No	Sample (Name of the village)	Fipronil (µg/kg)	Endrin Aldehyde (µg/kg)	Hepta-chlor (µg/kg)	Heptachlor Epoxide (µg/kg)	Dieldrin	Endosulfan -II (µg/kg)	4,4′ DDE
So_1	Bhatipura	30.6	ND	ND	26.32	ND	ND	ND
So_2	Poothi	60.81	ND	ND	ND	ND	ND	ND
So_3	Lawar	233.7	78.82	ND	ND	5.73	5.21	456.7
So_4	Dhanju	145.5	ND	6.78	8.68	ND	ND	ND
So_5	Karnaval	475.76	ND	11.01	22.33	ND	ND	ND
So_6	Bajoth	41.33	ND	ND	ND	ND	ND	ND
So_7	Jalalpur	142.07	ND	ND	ND	ND	ND	ND
So_8	Tiala	35.48	ND	ND	ND	ND	ND	ND
So_9	Atola	28.47	ND	ND	ND	ND	ND	ND

ND: Not Detected

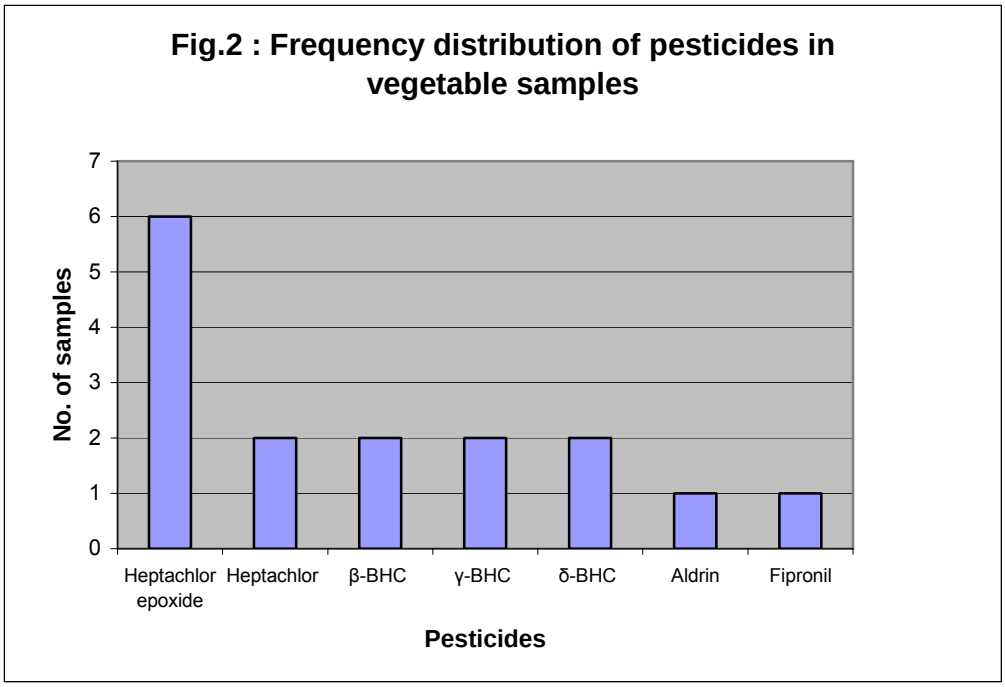
III.2 Discussion

The results of the GC analyses are summarized in the Table 2 below.

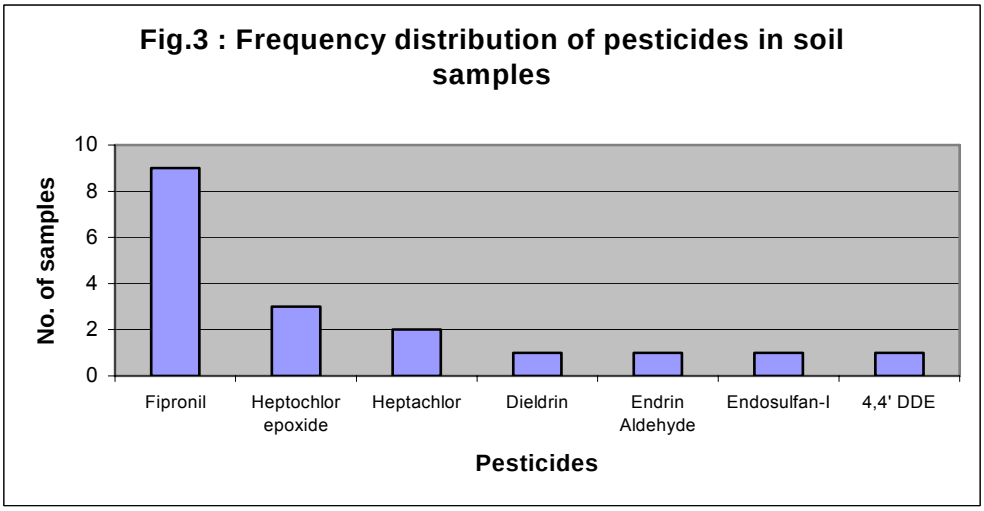
Table 2: Summary of results

S. No.	Type of sample	Total no. of samples	No. of samples with pesticides residue	Pesticides Found
1	Surface water	9	7	β-BHC, γ-BHC, Heptachlor, Heptachlor Epoxide, δ-BHC, Aldrin, Fipronil, plus unidentified peaks
2	Ground water	16	3	Heptachlor Epoxide, δ-BHC, plus unidentified peaks
3	Soil	9	9	Heptachlor, Heptachlor Epoxide, Fipronil, Endrin Aldehyde, Dieldrin, Endosulfan II and 4,4′ DDE
4	Vegetable	16	8	Heptachlor, Heptachlor Epoxide, Fipronil, Endrin, Endosulfan I and δ-BHC

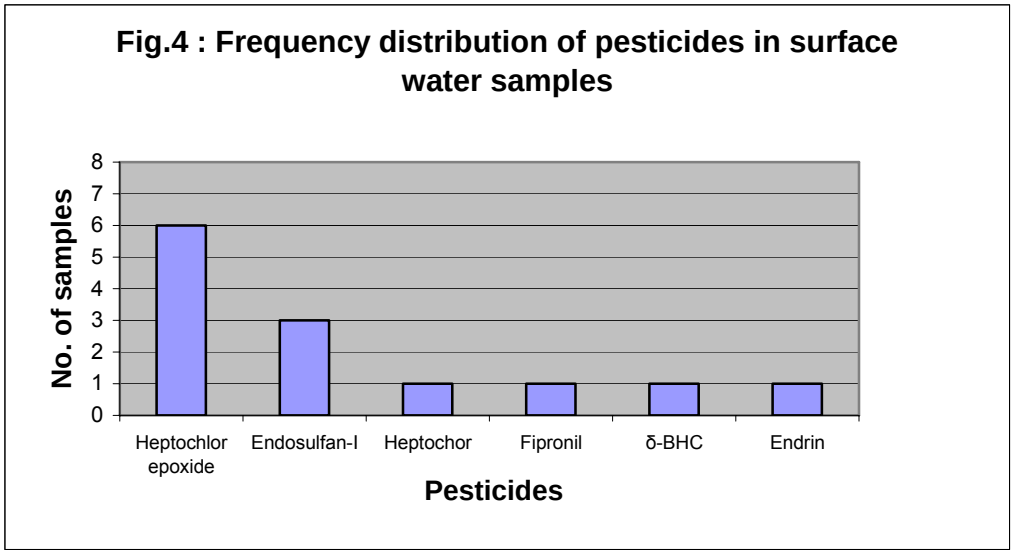
Vegetables: Eight vegetable samples from a total of 16, each from a different location, showed the presence of pesticides' residues. Six of the eight contaminated samples had only one type of residue -- Heptachlor epoxide alone in 4 samples, Endosulfan –I alone in 1 sample and Fipronil alone in 1 sample; one sample had residues of two pesticides (Heptachlor epoxide and Endosulfan–I) and one sample showed the presence of five different pesticides. The concentrations of pesticides ranged from a low of 1.8 ppb (μg/kg) of Heptachlor epoxide to a high of 101.3 ppb of δ-BHC. **There are, however, no available Indian standards for pesticides in vegetables.** The frequency distribution for the different types of pesticides is shown in the bar chart (Fig. 2) below.



Soil: All the nine soil samples recorded the presence of Fipronil, a moderately hazardous class-II organochlorine insecticide.[1] Interestingly only one sample, each, of surface water and vegetables had Fipronil while no ground water sample recorded any Fipronil. Fipronil residues tend to stay in the upper 15 cm. of the soil and exhibit low potential to leach into the groundwater.[2] Other pesticides found in the soil samples were Heptachlor (two samples), Heptachlor epoxide (3), Endrin aldehyde (1), Dieldrin (1), Endosulfan-II (1) and 4-4/ DDE (1). Their concentrations ranged from a low of 5.21 ppb (Endosulfan-II) to a high of 78.82 ppb (Endrin aldehyde). The concentration of Fipronil in soil ranged from a low of 28.47 ppb to a high of 475.76 ppb. **There are, however, no Indian standards for pesticides in soil.**



Surface Water: Seven samples of surface water out of the nine analyzed contained pesticides. Seven types of pesticides out of the eight that were monitored were present in the surface water samples. Thus it is clear that most of the pesticides sprayed in the fields run off into the surface water bodies. Their frequency distribution is shown in Fig. 4 below.



[1] International Programme on Chemical Safety (1998): Environmental Health Criteria, WHO, Geneva.
[2] U.S. Environmental Protection Agency (1996): Fipronil Pesticide Fact Sheet EPA737-F-96-005, Washington, D.C.

The insecticides Heptachlor epoxide and δ-BHC were found most frequently in the surface water samples, whereas none of the samples contained Endosulfan. Five unidentified peaks were also found in three samples. The concentrations of Heptachlor epoxide ranged from 0.06 μg/L or, parts per billion(ppb), to 32.26 ppb. δ-BHC concentrations on the other hand were generally lower, ranging from 0.2 ppb to 0.4 ppb. The relative abundance of Heptachlor epoxide and δ-BHC can be attributed to the interconversion of relatively unstable isomers into stable degraded products.

All the three Kali river samples had a mix of pesticides in them. One sample of the river water taken from Jalalpur village had six types of pesticides in it with concentrations ranging from a low of 16.1 ppb (Aldrin) to a high of 546.75 ppb (β-BHC).

The surface water data thus suggest that most of the pesticides sprayed in the fields run off into the surface water bodies, where they tend to persist. More surface water samples analyzed in November 2004, at the end of the spraying season, had pesticides in them (and a greater variety) than in May 2005, at the start of the spraying season. It is also likely that in May there was not enough time or rain to transport the pesticides from the fields to the water bodies.

Ground Water: Only two pesticides were found in three out of the 16 ground water samples. Their concentrations were also low, ranging from 0.08 ppb (Heptachlor Epoxide) to 0.4 ppb (δ-BHC). The comparative absence of pesticides in the ground water is contrary to their relative abundance in surface water bodies. It indicates that runoff from the fields transports the pesticides to the surface water bodies and that the pesticides have a limited potential to leach through the soil into the ground water. The pesticides monitored in this project are organo-chlorines. The leaching potential of organo-phosphatic pesticides may be different.

III.3 Conclusions

The above data show that **farmers in Meerut district spray** a variety of pesticides in their fields. These include **banned and restricted pesticides** such as Aldrin, Endrin, Dieldrin and Heptachlor (all banned) and BHC, Lindane (both restricted). [3] **It is clear that most of the pesticides sprayed in the fields end up in the surface water bodies.** The data also suggests that the pesticides tend to persist in the soil and surface water bodies.

IV. SUPPORT TO ORGANIC FARMING CAMPAIGN

In a sense, Janhit Foundation's campaign against the use of pesticides and in favour of organic farming began during the collection of the samples. During the reconnaissance survey and sampling visits, the scientists from People's Science Institute (PSI) and the staff of Janhit Foundation met with farmers in their fields. During the sampling, farmers helped collect samples from their fields. At the same time, PSI's scientists and Janhit's staff helped the farmers to understand the need for the study and the need for alternatives to chemical pesticides.

While the analyses were being done in PSI's laboratory in Dehra Doon, the staff of Janhit Foundation met the Block Development Officers (BDOs) in the different blocks of Meerut district. At informal interactions with local farmers in the BDO's office they were told about the various adverse health impacts of pesticides use. They were given a demonstration at a unit set up outside the BDO's office. Typically, around 15 percent of the farmers showed an interest in organic

[3] N.P. Agnihotri (1999): Pesticide Safety Evaluation and Monitoring, All India Coordinated Research Project on Pesticide Residues, IARI, New Delhi, pp22-23; Central Insecticides Board (CIB), Faridabad, 2005.

farming. They were then enrolled in Janhit's campaign to promote organic farming. Free earthworms and five kilograms of traditional seeds were provided to these farmers to start organic farming. Janhit Foundation regularly monitored the progress made by these farmers.

During the campaign phase, PSI's scientists provided study materials and technical support to the Janhit staff. They also visited the working area of Janhit Foundation in Meerut district to keep abreast of the campaign's progress. At the same time they developed their own knowledge base on alternative farming practices like natural, organic and biodynamic farming, alternatives to pesticides and integrated pest management. They attended several workshops on this subject and built alliances with groups like Kheti Virasat in Punjab and Thanal Conservation Council in Kerala who are promoting similar concepts in their respective areas. They met successful organic farmers in Uttaranchal, Uttar Pradesh, Himachal Pradesh and Punjab to understand the different technical and economic aspects of organic farming. They also approached institutions like the Uttaranchal Organic Commodity Board, Dehra Doon and Centre for Sustainable Agriculture in Hyderabad to understand the market dynamics and certification procedures involved in marketing organic produce.

Once the laboratory analysis and data interpretation was over, PSI's scientists prepared a set of 8 muliticoloured posters (See Annexure 5). Then along with a team of Janhit's field staff they held meetings in the villages from where they had collected the samples and presented the results of their study. The discussions focused on the effects of chemicals based farming on soil quality, experiences in Bathinda, Kasargod and other pesticides affected areas of the country and the methods, benefits and economics of organic farming. They advised them to start organic farming in two bighas of their fields for their own consumption. This would give them an idea about the feasibility of the process and would also ensure that at least they would not be eating pesticides-laced food.

Once the laboratory analysis and data interpretation was over, PSI's scientists took active part in Janhit Foundation's awareness campaign. A set of 8 muliticoloured posters was produced as campaign material. PSI's scientists went along with a Janhit team to well-attended farmers' meetings in the villages from where they had collected their samples. They highlighted the results of their study, the adverse health impacts of pesticides use and the effects of chemicals-based farming on the soil. They also drew parallels between Meerut and Bathinda, Kasargod and other pesticides ravaged areas of the country. The Janhit team talked about the methods and benefits of organic farming.

The farmers raised many questions and doubts, particularly about the economic and technical feasibility of alternatives to pesticides-based farming, e.g.:

- Although we see the negative effects of pesticides, what other options do we have?
- How is the shift from chemical to organic farming going to affect the crop yield, because most of us are marginal farmers?
- Do we have any solutions for area-specific problems like the termites that are affecting our fields?
- What are bio-pesticides? Are they available in the market?
- Do we have a market for the organic produce?
- How are organic products certified? Is certification necessary for selling organic products?
- What is the State Government doing to promote organic farming?

The PSI/Janhit staff agreed with the farmers that a sudden shift to sustainable and profitable organic farming was not possible. The process would need to be gradual but sustained. They advised the farmers to start organic farming in two bighas of their fields for their own consumption. This would give them an idea about the feasibility of the process and would also ensure that at least they were not eating the pesticides-laced food themselves. It would also limit the initial loss of productivity during the changeover. The key to successful alternative farming practices was multiple cropping including timber, cereals, pulses, oilseeds and vegetables crops. Additional activities such as dairy, poultry and apiary farming can augment income and ensure that manure and seeds are produced on the farm.

As far as the area specific problems were concerned, PSI's scientists and the Janhit staff suggested the use of neem and neem-based products to tackle the problem of termites. They told the farmers that the certification processes for organic farm products was a slow one. Generally it takes about three years of organic cultivation to get a national certification and about 7-8 years for international certification. The Janhit staff agreed to conduct training on different aspects of organic farming in their villages.

The PSI /Janhit team emphasized that a clear-cut state policy on organic farming had to be put in place and that the farmers would have to mobilize political support for it. A desirable policy would provide organic farmers with easier access to enhanced low-interest loans and other institutional credit facilities from government financial institutions.

Responding to the farmers demands for training Janhit Foundation along with PSI approached the National Centre for Organic Farming (NCOF) in Ghaziabad for funds to conduct training programmes on organic farming. NCOF recognised Janhit Foundation as a training institution for organic farming. A small sum of Rs. 13,000 was released by NCOF to conduct these workshops. One two-day orientation workshop has already been organised in Meerut. Four other workshops will be organized to cover the entire district. The study conducted by PSI has been highlighted in the training materials given in these workshops.

During the campaign PSI's team verified that Janhit Foundation had enrolled 209 farmers as practitioners of organic farming in 2004. As a result of the activities described above, another 182 farmers were enrolled 2005. At the same time, however, about 30 farmers from the 2004 list had stopped organic farming in 2005. Lists of these practitioners are appended at the end of this report.

V. CONCLUSIONS

The study of pesticides in the environment and vegetables in Meerut district shows that farmers in Meerut district spray a variety of pesticides in their fields. These include banned and restricted pesticides such as Aldrin, Endrin, Dieldrin and Heptachlor (all banned) and BHC, Lindane (both restricted). [4] Most of the pesticides sprayed in the fields end up in the surface water bodies. Interestingly, only a tiny fraction of the organo-chlorine pesticides appear to leach into the ground water. The data also suggests that the pesticides studied tend to persist in the soil and surface water bodies.

Interactions with local farmers show that they are aware of the harmful nature of chemical pesticides, but in a general way. They are, however, not well informed about the alternatives.

[4] N.P. Agnihotri (1999): Pesticide Safety Evaluation and Monitoring, All India Coordinated Research Project on Pesticide Residues, IARI, New Delhi, pp22-23; Central Insecticides Board (CIB), Faridabad, 2005.

Discussions regarding organic farming, during the awareness campaign highlighted the economic difficulties associated with the switch-over. This calls for policy changes that favour organic farming. During the project period the number of farmers enrolled with PSI's project partner, Janhit Foundation, as practitioners of organic farming increased from 209 in 2004 to about 360 in 2005.