

Research Article



Improper Safety Measures and Associated Health Effects of Pesticides in Farming Community – A Cross Sectional, Gender Based Study in Theni District, Tamil Nadu (INDIA)

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ABSTRACT

Pesticides are chemical substances used to minimize the disease causing insects and pests in world wide. Due to unsafe use of pesticides, the farm workers in the agriculture field are easily incorporated to health problems. This study is mainly focused on the improper safety measures and associated health effects of pesticides on gender difference in the farming community. Human activities in agriculture fields expose synthetic organic pesticides to environmental diversity which remains harmful. To know the effect of pesticides on human being, we collected information regarding the agricultural workers in the age group of 25 to 75. The details collected through questionnaires contains information on gender, age, occupation, food habits, exposed to pesticides, pesticides used, knowledge about pesticide container used to mix the pesticides in the field, safety measures while working in the farm and signs and toxicity symptoms during and after working with pesticides. The pesticide Dimethoate is the most often used insecticides (67%) followed by Copper hydroxyl chloride (59%), Monocrotophos (62%), Copper oxychloride (57.1%), Chlorpyrifos (58%) and Profenofos (48%). The mean age group was 50 in female and 55 in male. 23.5% female workers and 17.5% male workers having 35 to 44 years experience in agriculture field. Among the female and male workers the illiteracy was high in female workers (63%) than male workers (43%). However, there were gender differences in knowledge of pesticides ($p < 0.001$), pesticide container used to mix the pesticides in the field ($p < 0.001$) and safety measures followed by female workers 42% and 33% in male. Also, acute symptoms of pesticides were higher in female workers than male workers. Therefore, creating awareness among on gender difference of farming community through proper education and guidance programs will ensure proper handling and safety measures.

Keywords: Pesticides, Farming community, improper safety measures, gender differences, Theni District.

INTRODUCTION

Constant uses of synthetic organic chemicals are causing environmental pollution. It is one of the world's leading challenges of sustainable development. Millions of synthetic organic chemicals are used in developed and developing countries, according to its diverse uses in various sectors¹. In India about 54% of total pesticides are used in agriculture².

Increasing demand for food production at global level led to the introduction of sophisticated agricultural technologies for controlling and preventing the damage of food crops caused by pests³.

The widespread usage of pesticides in agricultural sector accounts for the major contamination of our environment and their exposure either by inhalation, ingestion and dermal contact is highly toxic to non - target organisms such as human beings, animals and insect species like honey bees⁴.

Agricultural workers are more prone to acute and chronic toxicity due to occupational exposure to the pesticide compounds and are associated with endocrine, developmental, immune and neuropsychological disorders.⁵⁻⁹

Major reasons accounting for ill effects of pesticide usage include unregulated packing of pesticides, careless

handling, improper disposal, and accidental spilling of toxic compounds and the pesticide residues stays in the environment for a variable period of time causing serious environmental pollution¹⁰.

In addition, farming activities also poses serious risks of pesticide exposure, such as land preparation for cultivation, storing, mixing, preparing and spraying of pesticides, loading and cleaning of spraying equipment¹¹.

The residue concentration of some Organochlorine and organophosphate pesticides have also been detected in the directly exposed spray workers.

The later one is an inhibitor of cholinesterase enzymes act as a neurotransmitter, including acetylcholinesterase, butylcholinesterase, and pseudocholinesterase.

The inhibition of an enzyme activity is performed by the binding of Organophosphate and Carbamate compounds at the active site of these enzymes (U.S. EPA, 2010).

Toxicological studies in spraying communities has shown that the common mode of action for the major pesticide products is by disrupting the neurological function.^{12,13}

The present investigation was aimed at studying the usage of pesticides, protective equipments used, safety precautions followed and symptoms of pesticide



exposure were studied on both male and female workers in agricultural fields in and around Theni district.

MATERIALS AND METHODS

The occupation and economy of Theni District are mostly based on agriculture. The principal crop cultivation includes tomato (*Lycopersicon esculentum*), bitter gourd (*Momordica charantia*), cabbage (*Brassica oleracea var. capitata*), cauliflower (*Brassica oleracea var. Botrytis*) paddy (*Oryza sativa*), sugar cane (*Saccharum officinarum*), grapes (*Vitis vinifera*), banana (*Musa acuminata*) and cereals. The local farmers depend on synthetic pesticides for crop protection from pest damages, infectious diseases and better yields. The present investigation was confined to villages such as Silamalai, Kohilapuram, Pulikuthi, Rayappanpatti, N.T. Patti and K. K. Patti, falling under Theni district. The information about pesticide usage and associated health risks were collected from randomly selected farm workers (Figure 1).

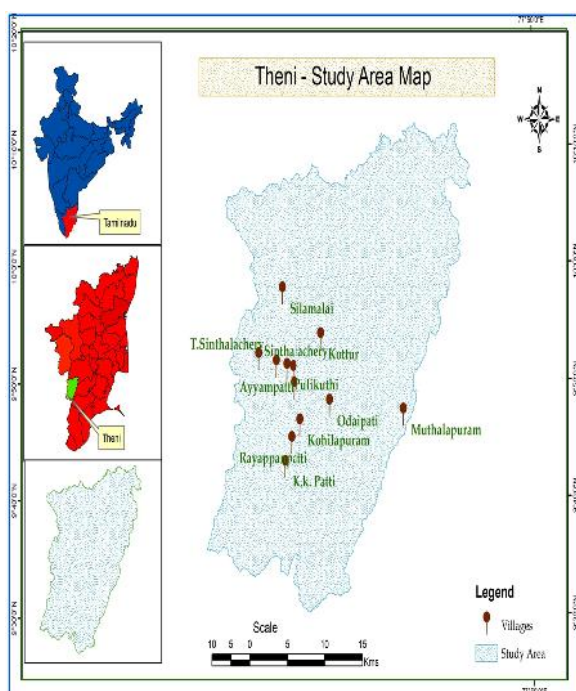


Figure 1: Study area

Basic design and sample size

A cross sectional study design was adopted for investigating the health status of farm workers (male and female) exposed to pesticide usage in the agricultural field. Current investigation was focused in selected villages to study the type of pesticides used in a population of 200 female workers, including 159 field workers, 41 farmers, 38 pesticide applicator and 200 male workers, including 69 farmers, 47 field workers, 58 spray workers and 26 workers in pesticide shop.

The study was carried out to compare signs, symptoms and susceptibility following pesticide exposure among 200 males and 200 female farm workers in agro field.

Socio – demographic study

Information about their name, gender, age, education qualification, year of exposure to pesticides in the field, kinds of pesticides and recommended concentrations used, protective apparels employed during land preparation and application of pesticides and their knowledge on impact of pesticide and precautionary measures.

Questionnaire

The questionnaire was prepared based on the literature review and designed to comprise following information. Questions were posed in English and Tamil, for the convenience of the local farming community.

- Preparative methods of pesticides in pesticide shop
- Precautionary methods adopted by workers while spraying
- Signs & symptoms experienced by pesticide sprayers and other farmers working nearby.
- Field workers maintaining pesticide sprayed crops, till harvesting.
- Nature, Category and trade name of the pesticides used

The details were collected in person orally during the month of December 2014 to June 2015. Based on the information collected and depending upon the history of exposure to different classes of pesticides and risks involved, they were categorized as 10 years, 11 – 20 years, 21– 30 years, 31 - 40 years and above 40 years.

Data Analysis

The coded data were entered in Microsoft Excel and data analysis was done in SPSS statistical software version 21. Frequencies, Mean, Range value were calculated and chi square test at probability level of 5% was performed to measure the association between qualitative variables.

RESULTS AND DISCUSSION

In this study, we have assessed the knowledge of pesticides and its health effects on both female and male workers in the agro field. It was the comparative assessment between both male and female workers in the farm. We examined the participant's levels of knowledge in relation to demographics and interpersonal factors, such as practices of pesticide usage in Theni District villages.

In this present study, both female and male workers actively responded to personal questions regarding knowledge of pesticides. In this study both workers were compared to analyze the susceptibility and ill effects of pesticide usage.

The response rate of workers to this questionnaire, interview in the present study was relatively higher than that in similar studies. Both male and female workers

actively responded to each and every question indicating good intention between farming community. In the present study, 51.5% of the female workers and 68% of male workers were aged between 50 years and above. Similar results were reported earlier.^{6,15}

Age group of farm workers

The experimental population was organized under five classes categorized as age group belonging to below 30 years, 30 – 39 years, 40 – 49 years, 50 – 59 years, and 60 years and above. The study revealed that 2% of females and 1% of male workers were below the age group of 30, 16.5% of females and 8% of males were between 30 – 39 years, 30% of females and 22% of males were placed under 40 – 49 years, 21.5% of females and 27.5% males fell under 50 – 59 years and 30% of females and 41% of male workers were over the age group of 60 years. On an average, maximum female workers under age 50 and male workers under age group of 55 were found to be working under the farming community, when compared with other age groups (Table 1).

The age factor of females in field workers, farmers, pesticide sprayer and pesticide sellers were below 30 to above 60 years and the numbers of female workers in medium age are more than the male workers. The female workers started to enter in the field when they are 15 years old, but in male workers they entered into the field from 25 years of age. Like this the age factor from 15 - 79 years were working as farmers.²⁰

Education level of farm workers

The investigation revealed that both male and female workers had minimal educational qualification. They had meager or no knowledge about pesticide usage and handling. 47% of males and 63 % of the female workers were found to be illiterate. About 23.5%, 12.5% and 1% of the female community had received primary, secondary and higher secondary education respectively with nil undergraduates. 47 % of male workers were reported to be illiterate, while 36%, 13% and 2.5% of males were educated at primary, secondary and higher secondary levels respectively and 1.5% of males were qualified at the graduate level (Table 1).

In this study, 63% of females and 47% of males were illiterate. No one completed any graduation in females, but 1.5% of males have completed degree. Similar study¹⁶ reported that most interviewees were illiterate in their study or had only completed primary school. The illiteracy has been identified in most developing countries, as which results in higher risks for those individual's health.

Occupation

The farming community was categorized as farmers, field workers, spray workers, Farmers carrying out fieldwork, Farmers performing pesticide sprays, farmers and field workers exposed to pesticides indirectly. The hazards possessed by pesticide exposure were assessed based on the nature of work carried out by the farmers in the field.

The study showed that about 20.5% of female farmers and 34.5% of male farmers were land owners, involved in farm visiting and purchase of pesticides from the market. The investigation recorded a higher population of 79.5% of female field workers, out of which about 14.5% were involved in pesticide application and 4.5% of female farmers were also involved in the same work. The male field workers recorded a minimum of only 23.5%. The field work included preparation of land for cultivation, removal of weeds and harvesting. 29% of male spray workers were reported to be involved in mixing and spraying of pesticides and no females were found to be involved in spraying (Table 1).

The survey denoted that farmers comprised of 12% of female and 11.5% of male workers, who in addition also carry out field works. About 10.5% of the male farmers were involved in the pesticides spray works, as they own their own sprayer pumps and don't employ spray workers. The exposure rate was recorded to be 4% of female and 12% of male farmers. About 5% of female and 22% of male field workers were reported to be present at the site of spraying. The study revealed that about 13% of male workers in pesticide shops experienced sign and symptoms while handling the same and no female workers were placed in pesticide shops (Table 1).

Year of exposures to pesticides in the agriculture field

The experimental groups consisting of both male and female workers were categorized as below 15 years, 15-24 years, 25 – 34 years, 35 – 44 years and above 45 years based on the working experience in the field. Among the pesticide exposures 15.5% of female and 21.5% of male workers were below 15 years. The majority of the female workers (27.5%) was between 15 – 24 years experience, when compared to that of 23.5% of male workers. 27.5% of female and 25.5% of male workers under 25 – 34 years, 23.5% of female and 18.5% of male workers fell under 35 –44 years and 6% of female and 10.5% of male workers were above 45 years (Table 1).

In this study both female and male workers having work experience from below 5 years to 50 years. Similar results were reported by K. R. Dey as the period of exposure of farmers' ranges from less than 1 year to 50 years with an average duration of 11.8 years.

The above pesticides are frequently used in and around Theni District were presented in Table-2. Among these pesticides, organophosphates are placed at the higher risk and moderate risk category. Carbamate and Pyrethroid are considered to be at moderate risk category.

The investigation revealed that about 23 pesticides most frequently used by the subjects were reported as Organophosphates, Carbamate and Pyrethroid. Out of these, Dimethoate is the widely used insecticide (67%), followed by Monocrotophos (62%), Copper hydroxylchloride (59%), Copperoxy chloride, Chlorpyrifos (58%) and Profenofos (48%) (Table 2).



The survey revealed that only a smaller population pesticide exposed individuals showed interest to wear the protective apparels. The gender difference study showed that around 10 % of male workers were interested in wearing boots, with nil % of women ($p < 0.001$). 8.0% of males showed interest in wearing gloves and 2.5% of females ($p = 0.13$). The study further showed that none of the workers were interested in wearing masks, but 25.5% of females and 53% of males ($p < 0.001$) covered their nose and mouth with cloths. Among the farming community, 59% of females and 43% of males with ($p < 0.0013$) covered their heads with cloths and did not used aprons. Also, there was no interest in farming community to wear goggles while working with pesticides or exposed to pesticides; even though this study denoted that the female workers were not having the enough knowledge about the usage of wearing the protective apparels when compared to that of male workers (Table 3).

The survey revealed that most of the subjects do not wash their hands immediately after working with pesticides and pesticides sprayed field (Table 6). About 42% female and 33% male workers were habitual after washing hands and taking food during mixing, spraying pesticides and working in pesticide sprayed field. But 58% of female and 67% of male workers were not following this type of habits. Similarly the female workers did not involve in drinking alcohol and smoking habit but 15% of female workers were habitual to tobacco chewing while working in pesticide sprayed field. But in male workers 51.5%, 29.5% and 16.5% were habitual to drinking alcohol, smoking and tobacco chewing respectively during work with pesticides.

The results showed that 4% of the female workers and 40.5% of male workers had the knowledge of pesticide names they use. Of which 5(2.5%) of the female workers and 41(20.5%) of the male workers suggested the pesticide seller's opinion and 31(15.5%) of the male workers suggested the farmers' opinion. But 187(93.5%) of female and 47 (23.5%) of male workers have no adequate knowledge about the pesticide name and its application (Table 5).

The study revealed that most of the male candidates knew about the things used to mixing the pesticides in the field while compared with female workers. Plastic drums were most preferable things used to mixing purpose. About 67 (33.5%) of the female workers have the knowledge about plastic drums were used to mixing the pesticides compared to that of 155 (77.5%) of male workers. Totally, 66.5% of female workers and 22.5% of male candidates had no knowledge of handling pesticides in the farm. On the other hand, the female workers 4.5%, 11%, 10.5% and male workers 40.5%, 10.5% and 20% were reported to reuse the same container to other purpose, such as to store the other tools in the farm, to fill the water for household usage and only used for pesticide mixing purpose. But 67% of female workers

were not aware when compared with 29% of male workers. Similarly, 4.5%, 7.5%, 4.0%, 18% of female workers and 6.5%, 10.5%, 10% and 44% male workers were having the knowledge about empty pesticide container disposed as burning in the farm, buried in the farm, reuse in the home and leave the empty containers in the field after use respectively.

Among these workers 66% of female workers and 29% of male workers also lacked the awareness. Through these questions we knew about the female workers were having low knowledge regarding reuse of a pesticide container in comparison with male workers. (Table 6).

Knowledge of pesticides and pesticide container disposal method ($p < 0.001$), use of protective apparels ($p < 0.001$), safety measures ($p < 0.001$), followed by the female workers were significantly lower than the male workers. Similarly factor scores for use of personal protective equipment ($p < 0.001$), use of personal protective clothing ($p < 0.001$) and safe work habit ($p < 0.001$) in females were significantly lower than those in males.¹⁸

Gender difference on Signs & toxicity Symptoms:

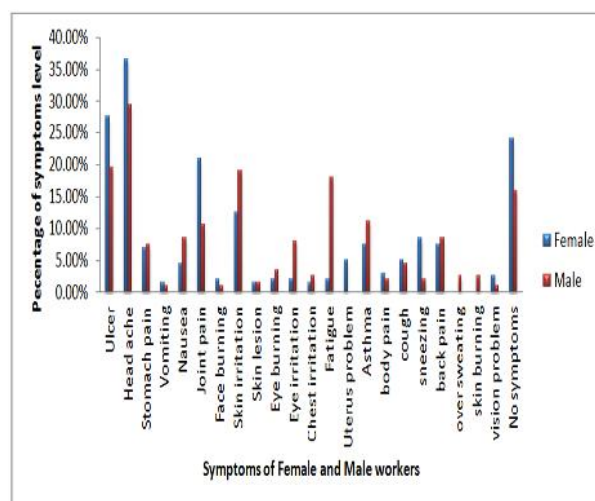


Figure 2: Symptoms of farming community during and after working with pesticides

The signs, symptoms and associated health risks following pesticide exposure as experienced by spray workers, farmers, field workers and pesticide sellers were recorded. Ulceration was experienced by 27.5% and 19.5% of females and males. The Headache was observed by 36.5% and 29.5% of males and females. 7.0% and 7.5% of female and male reported stomach pain, while vomiting was reported by 1.5% and 1.0% female and male workers. The Nausea was reported by 4.5% and 8.5% of females and males, 21% and 10.5% reported joint pains. 2.0% of females and males of 1.0% sensed face burning, 12.5% and 19.0% experienced skin irritation. 1.5% of both sexes reported skin lesions, whereas 2.0% and 3.5% had eye burning and 2.0% and 8.0% sensed eye irritation. Chest irritation was symptomized by 1.5% and 2.5% of females and males respectively.

Table 1: Socio – demographic characteristics of farm workers

Age group of farming community		
Age	Female (%), N=200	Male (%), N=200
Below 30	4 (2 %)	2 (1 %)
30 – 39	33 (16.5 %)	16 (8 %)
40 – 49	60 (30 %)	45 (22.5%)



Field survey and pesticide usage in Theni District:**Table 2:** Farming community responsible for knowledge of pesticides using in the field

Technical name of Pesticides	Farmers	Spray workers	Field workers	Pesticide sellers	Total
	Female and Male 41+98=139	Male and Female 38+58=96	Male and Female 159+47=206	Male 26	Over all %
Dimethoate	102 (73.4%)	93 (96.9%)	Nil	25 (96.15%)	67%
Copperhydroxyl chloride	99 (71.2%)	56 (58.3%)	36 (17.5%)	23 (88.5%)	59%
Monocrotophos	99 (71.2%)	84 (87.5%)	Nil	24 (92.3%)	62%
Chlorpyrifos	95 (68.3%)	75 (78.1%)	Nil	22 (85%)	58%
Copperoxychloride	94 (68%)	65 (68%)	32 (15.5%)	20 (77%)	57.1%
Profenophos	93 (67%)	45 (47%)	Nil	20 (77%)	48%
Coppersulphate	50 (36%)	56 (58.3%)	28 (14%)	24 (92.3%)	50.15%
Lamdacyclothrin	Nil	69 (72%)	Nil	18 (69.2%)	35.3%
Metalaxyl	Nil	72 (75%)	Nil	14 (54%)	32.3%
Tebuconazole	Nil	37 (38.5%)	Nil	16 (61.5%)	25%
Hexaconazole	Nil	35 (36.5%)	26 (12.6%)	12 (46.1%)	24%
Ziram	Nil	68 (71%)	Nil	19 (73.1%)	36%
Triazophos	Nil	82 (85.4%)	Nil	21 (81%)	42%
Quinolphos	Nil	38 (40%)	Nil	13 (50%)	22.5%
Cypermethrin	Nil	76 (79.2%)	Nil	16 (61.5%)	35.2%
Methyl parathion	Nil	52 (54.2%)	Nil	15 (58%)	28.1%
Acephate	Nil	65 (68%)	Nil	20 (77%)	36.3%
Deltamethrin	Nil	53 (55.2%)	Nil	22 (85%)	35.1%
Zolone	Nil	32 (33.3%)	Nil	22 (85%)	30%
Fenvalerate	Nil	50 (52.1%)	Nil	15 (58%)	27.5%
Oxyfludrin	Nil	39 (41%)	20 (9.7%)	17 (65.4%)	29%
Methomyl	Nil	37 (38.5%)	Nil	17 (65.4%)	26%
Alfa-methrin	34 (24.4%)	73 (76%)	Nil	19 (73.1%)	43.4%
Imidachlorpid	28 (20.1%)	76 (79.2%)	Nil	19 (73.1%)	43.1%

Protective equipments used by farming community:**Table 3:** The responses of farm workers regarding the wearing of protective equipment

Using special boots	Female (%), N=200	Male (%), N=200	χ^2	P – Value
Yes	0 (100%)	20 (10%)	21.05	< 0.001
No	200	180		
Using gloves				
Yes	5 (2.5%)	16 (8%)	6.08	0.13
No	195	184		
Cloths using as Mask				
Yes	51 (25.5%)	06 (53%)	31.72	< 0.001
No	149	94		
Cloths using to cover the head				
Yes	118 (59%)	86 (43%)	10.24	0.001374
No	82	114		
Using special goggles	Nil	Nil		

Safety precautions:**Table 4:** Safety measures during working in the farm

Safety measures	Female (%) N = 200	Male (%) N = 200
Wash the hand with soap and eat food items	84 (42%)	66 (33%)
Without using soap, washing hands and eat food items	116 (58%)	134 (67%)
Alcohol conception while working with pesticides	Nil	103 (51.5%)
SsNever	Nil	97 (43.5%)
Smoking while working with pesticides	Nil	59 (29.5%)
Never	Nil	141 (70.5%)
Tobacco chewing while working with pesticides	30 (15%)	33 (16.5%)
Never	170 (85%)	167 (83.5)

Knowledge of pesticides among farming community:**Table 5:** Pesticides name known to the workers

Known about names only	Female (%) N = 200	Male (%) N = 200	χ^2	P – Value
Yes	8 (4%)	81 (40.5%)	77.011	< 0.001
No	192 (94%)	119 (59.5%)		
Pesticide seller's suggestion				
Yes	5 (2.5%)	41(20.5%)	31.834	< 0.001
No	195 (97.5%)	159 (79.5%)		
Farmer's suggestion				
Yes	0	31(15.5%)	33.604	< 0.001
No	200 (100%)	169 (84.5%)		

Knowledge about other container used to mix the pesticides in the field:**Table 6:** Pesticide container knowledge, reusing and disposing method

Plastic drums	Female (%), N = 200	Male (%), N = 200
Yes	67 (33.5%)	155 (77.5%)
No	133 (66.5%)	45 (22.5%)
Reuse the same container to other purpose		
To store the other tools in the farm	9 (4.5%)	81 (40.5%)
To fill the water for household usage	22 (11%)	21 (10.5%)
Used only for pesticide mixing	35 (10.5%)	40 (20%)
No idea	134 (67%)	58 (29%)
Empty pesticide container disposed as		
Burning	9 (4.5%)	13 (6.5%)
Buried in the farm	15 (7.5%)	21 (10.5%)
Reuse in the home	8 (4%)	20 (10%)
Throw in the farm	36 (18%)	88 (44%)
No idea	132 (66%)	58 (29%)

Fatigue was reported in 2.0% and 18.0% of females and males, 5% uterus problem in females, 8.0% and 11.0% asthma in females and males, body pain 3.0% and 2.0%, cough 5.0% and 4.5%, sneezing 9.0% and 2.0%, back pain 7.5% and 8.5%, excess sweating and 2.5% skin burning during male was reported. 2.5% and 1% of Male and female reported vision problem respectively. Even though all symptoms were experienced by female and male workers, some of the workers (24.0% females and 16.0% of males) reported that they didn't observe any symptoms during pesticide exposure and while working in pesticide sprayed field. Except a few, all farming communities were affected by any of the three to four symptoms and are possessing health risks (figure 2).

11 acute symptoms such as ulcer, stomach pain, headache and other symptoms were highly experienced by most of the female workers rather than that of male workers. But in this study the spray workers were experiencing many toxicity symptoms compared to that of other workers. Likewise Women reported to have experienced symptoms after handling pesticides more often than males. They were seen significant differences in individual symptoms such as headache, vomiting, and dizziness/poor balance, which were more reported among the women, whereas men reported more respiratory symptoms.¹⁹

CONCLUSION

In this study most of the Theni District agricultural workers and pesticide sellers were not having enough knowledge about pesticides and their effects on health. Because, few of the male workers compared to that of female workers were having the knowledge but they ignore the safety precautions and protective apparels during and after working with pesticides or when exposed to pesticides containing environment. They are not only involved in a single work in the agriculture field, but also involving in multiple works such as field workers involving in land preparation for cultivation, vegetable harvesting and pesticide application. Farmers are involved in field visit, spraying the pesticides and harvesting vegetables. Some of the spray workers do only spraying of pesticides and they were not involved in any other work in the field. Likewise pesticide sellers they are not involved in other work, they are only involved in mixing and selling the pesticides. In this study, many of the female workers were illiterate and educated at primary level compared to those male workers. So they did not get enough knowledge and they did not attend any training programs. Therefore, it is strongly recommended to initiate special educational programs to promoting awareness about the use of safer pesticides and use of personal protective apparels. Such approaches are necessary to increase the low level of pesticide exposure and protect the farm workers from the harmful effects of pesticides in Theni District.

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