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Impact of pesticide use on the health of farmers: A study in Barak valley, Assam (India)

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A study was carried out in the three districts of Barak valley (Cachar, Karimganj and Hailakandi) Assam, India to ascertain the variety of pesticides that are used in the agriculture sector and their probable impact on the health of farmers. The study revealed that the farmers often use pesticides ranging from high to extremely hazardous categories like Organochlorides, Organophosphates and Carbamates. Various signs and symptoms of diseases/ physiological disorders were observed; and the relative risk (RR) was also observed to be high. Lack of adoption of adequate protective measures were noticed to have increased the declining state of the health of farmers in the region.

Key words: Agriculture, Barak valley, health hazard, pesticide, relative risk.

INTRODUCTION

Pesticides are applied to the environment with the aim of suppressing the impact of plant and animal pests and to protect agricultural and industrial products. For sustainable agriculture and protection of the environment and human health, the importance of using safe pesticides has assumed global importance subsequent to the 'Earth Summit' in 1992. However, majority of the pesticides act like blunt weapons that kill organisms, in addition to target pests. Many of these substances are not easily degradable; they linger in soils, leach to ground water and contaminate the environment to a great extent. They can also enter the body of organisms, bio accumulate in the food chains and consequently affect the human health. There exists a direct relationship between the extent of pesticides used and signs and symptoms of illness due to exposure among farmers (Kishi et al., 1995).

In modern agriculture, pesticides are inevitable inputs in agro-ecosystems in spite of the variety of problems associated with them. In the world 44% of the insecticides, 30% of herbicides, 21% of fungicides and others 5% are used; while in India, 76% of insecticides, 13% of fungicides, 10% of herbicides and 1% others are used. Most pesticides used in agriculture today are synthetic organic chemicals that act by interfering with a vital metabolic process in the organisms to which they are targeted (Mathur et al., 2005)

The public health effects of pesticides have long been known and the undesired effects of chemical pesticides have been recognized as a serious public health concern during the past decades. According to a market survey report, approximately 5,684 million pounds of pesticides (active ingredients) are applied annually throughout the world (Anon, 1986). Many of these chemicals are mutagenic (Galloway et al., 1987) and linked to the development of cancer (Leiss and Savitz, 1995) or may lead to birth defects (Colborn, 1996; Arbuekal et al., 1998). Giri et al. (2002) reported genotoxic effects of Malathion, Cypermethrin and Carbosulphan in chromosomal aberration, sister chromatid exchange

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(SCE) and sperm abnormality in mice as potential germ cell mutagens.

Sataka et al. (1997) mentioned that agriculture is the main destination for all the chemicals sold with 83% of all different types of pesticides, herbicides etc. as the most commonly used in the agricultural industry. The risk to users, consumers and the environment remain and may be higher depending on the specific action required and the chemicals chosen. Sivepalan (1999) mentioned that the newer chemical approaches are harnessed so far only to augment the efficacy of other control strategies, especially in specific situations when the latter are by themselves inadequate to maintain the target pest levels below the established damage threshold level.

The World Health Organization estimates that there are three million severe acute poisoning worldwide each year and out of this, approximately 2,20,000 deaths are attributable to pesticides, out of which, 1% of these deaths occur in industrialized countries (Sataka et al., 1997). The same workers have further reported that human immune system may also be damaged as well as over-stimulated by the variety of pesticides.

The pattern of pesticide usage in India is different from that of the world in general. In India 76% of the pesticides are used as insecticide, as against 44% globally. The use of herbicides and fungicides are correspondingly less. The main use of pesticides in India is for cotton crops (45%), followed by paddy fields and wheat farming (Relyea and Diecks, 2008). However, the use of pesticides in tea and vegetable crops in India is not negligible. Moreover, repeated low dose application has caused large impact in the agro-ecosystems than single exposure.

Exposure to pesticides results in both acute and chronic health problems, which range from short term effects to chronic diseases like cancer, reproductive and developmental disorders etc. (Yassi et al., 2001). An investigation in this line was carried out by Manchini et al. (2005), who looked into the health effects of acute pesticides among the cotton growers of India. Barring few scattered works, there has been very scanty works carried out in India to study the residual effect of pesticides on human health. Intensive research is being carried out in this aspect in China and Japan. In view of this, specific and more elaborate studies dealing with the agricultural practises of the farmers regarding pesticide use and its health impacts is urgently required to make informed policy decisions to bring about changes in the agricultural practises in India in particular. From most of the works mentioned above, there is no denying the fact that exposure to pesticides causes a range of human health problems. It is estimated that nearly three fourths of deaths due to pesticides occur in developing countries (Horrigan et al. 2002). At present, India is the largest producer of pesticides in Asia and ranks twelfth in the world for the use of pesticides with an annual production of 90,000 tonnes (www.teri.res.in / pesticide.htm).

A vast majority of the population (56.7%) in India are engaged in agriculture and are therefore, exposed to the pesticides used (Gupta, 2004; Government of India, 2001). Pesticides that are being used in agricultural fields disseminate into the environment and come in human contact directly or indirectly. Humans are exposed to pesticides that are found in the environmental by different routes of exposures like inhalation, ingestion and dermal contacts. Keeping these in the backdrop, a study among the farmers of Barak Valley (Cachar, Karimganj and Hailakandi districts), Assam India was carried out to look into the various aspects of pesticide use in agriculture and its probable impact on human health.

METHODOLOGY

Study area

The study was carried out mainly among the agricultural communities of Barak Valley (Cachar, Karimganj and Hailakandi districts of Assam, India) (Figures 1 and 2A-C). The important crops growing in the area are rice, vegetables, betel-nuts and beverages (mainly tea).

Interview questionnaire

The interview questionnaire was designed following the modified set as proposed by Kishi et al. (1995) and Murphy (1997) to find out the details on the time duration of use of pesticides, variety of pesticides used, exposure to these pesticides, precautions taken, the source of information, signs and symptoms of illness related to pesticide exposure etc. Some of the signs like tremors, skin lesions, wheezing (which might be chronic in nature) were observed at the time of the interview. In a cross-sectional survey, details on signs and symptoms were collected as reported *suo moto* by the farmers. Each interview took about 30 to 40 min to be completed and lastly the cumulative data was analysed. As described by Kishi et al. (1995), these collected data were compared with the pattern of pesticide usage to see if there exists any relationship between the signs and symptoms of farmers and the exposure to pesticides.

A total of 390 farmers (336 men and 54 women) from three districts of the valley (148 from Cachar, 119 from Karimganj and 123 from Hailakandi district) were interviewed. All of them were actively engaged in the application of pesticides and therefore, were directly exposed to them. Most of them used “moderate” or “highly hazardous” pesticides and while handling them, they were not using any form of protective gears. Farmers spray different brands of pesticides, and sometimes blend different formulations in a single spray for better results (Table 3).

Relative risk (RR value)

The relative risk (RR) is the probability that a member of an exposed group will develop a disease relative to the probability that a member of an unexposed group will develop that same disease. In the present study, Relative Risk between the two groups of farmers (sprayers and non-sprayers) was calculated by dividing the percentage of one group (Sprayer, which is more affected) by the other, non-sprayer, which is less affected. RR = % (disease exposed) / % (disease unexposed).

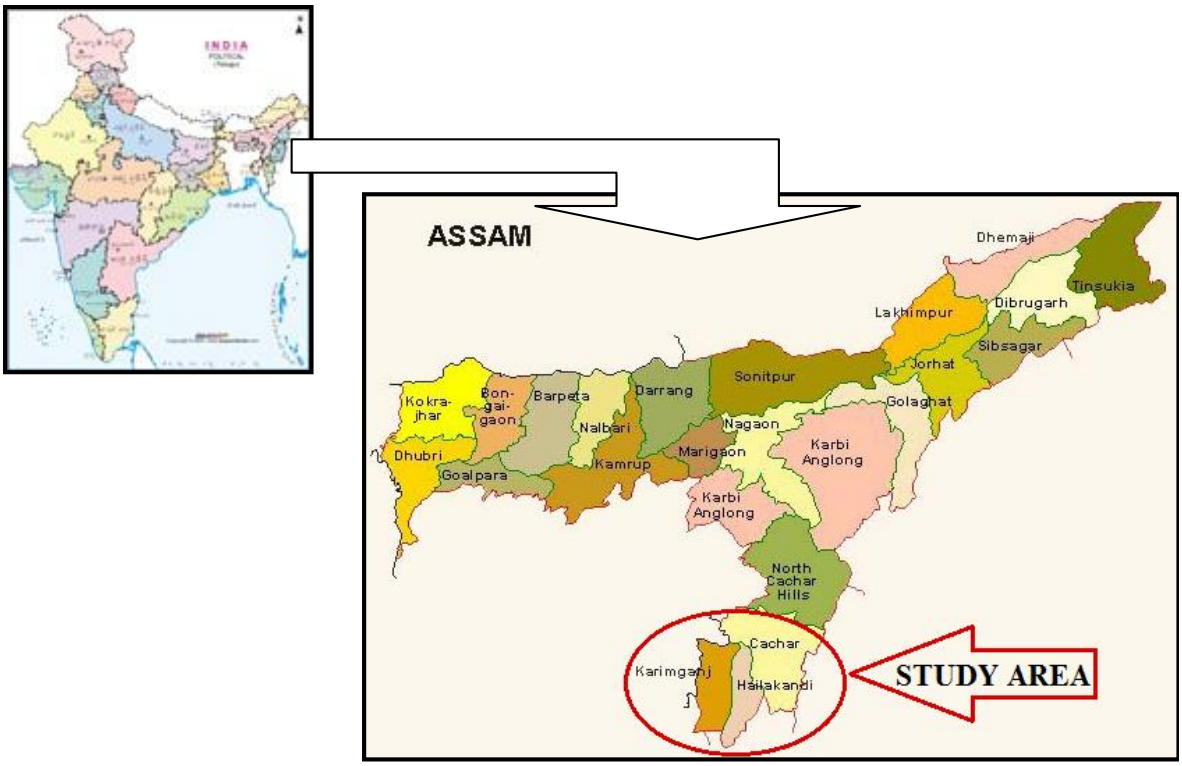

Figure 1. Location of the study area and the areas under three district.

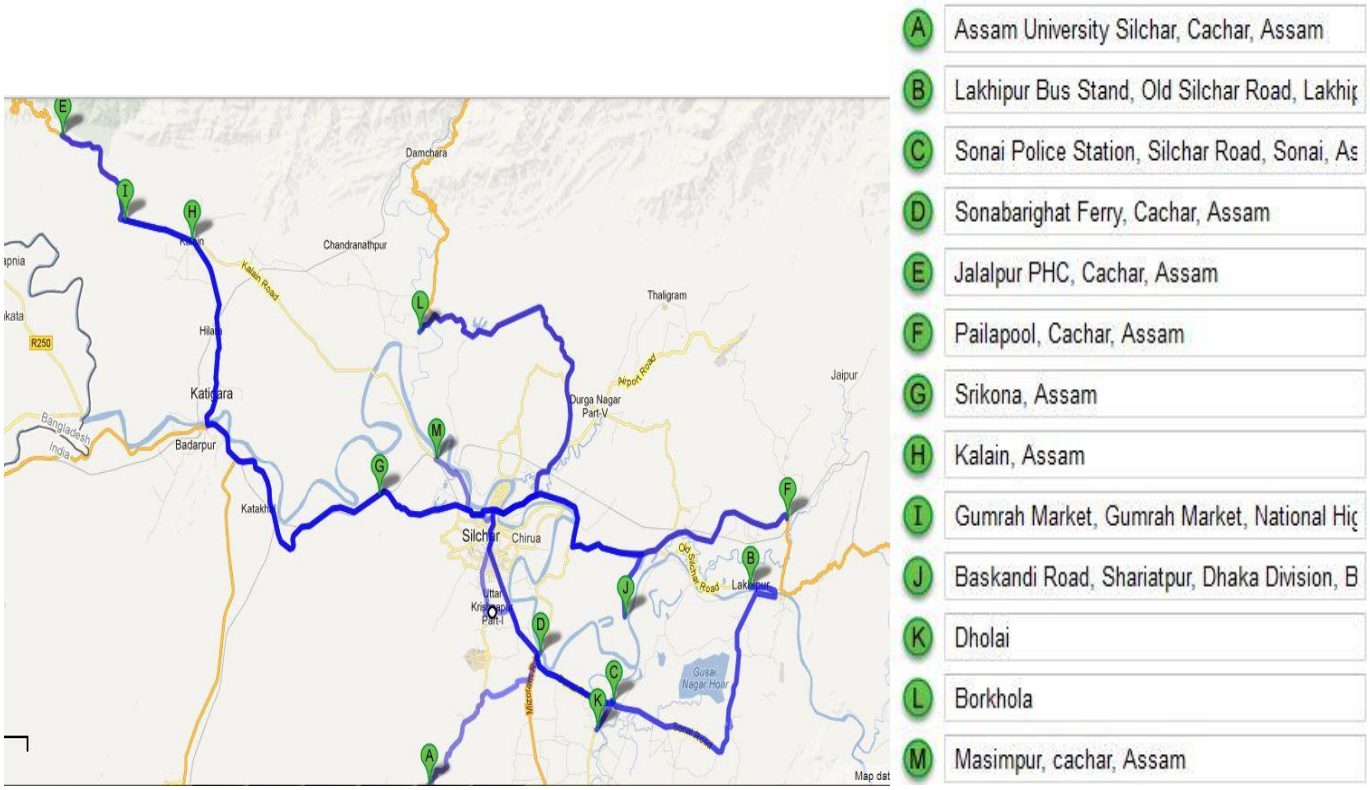

Figure 2a. Study sites in Cachar District.

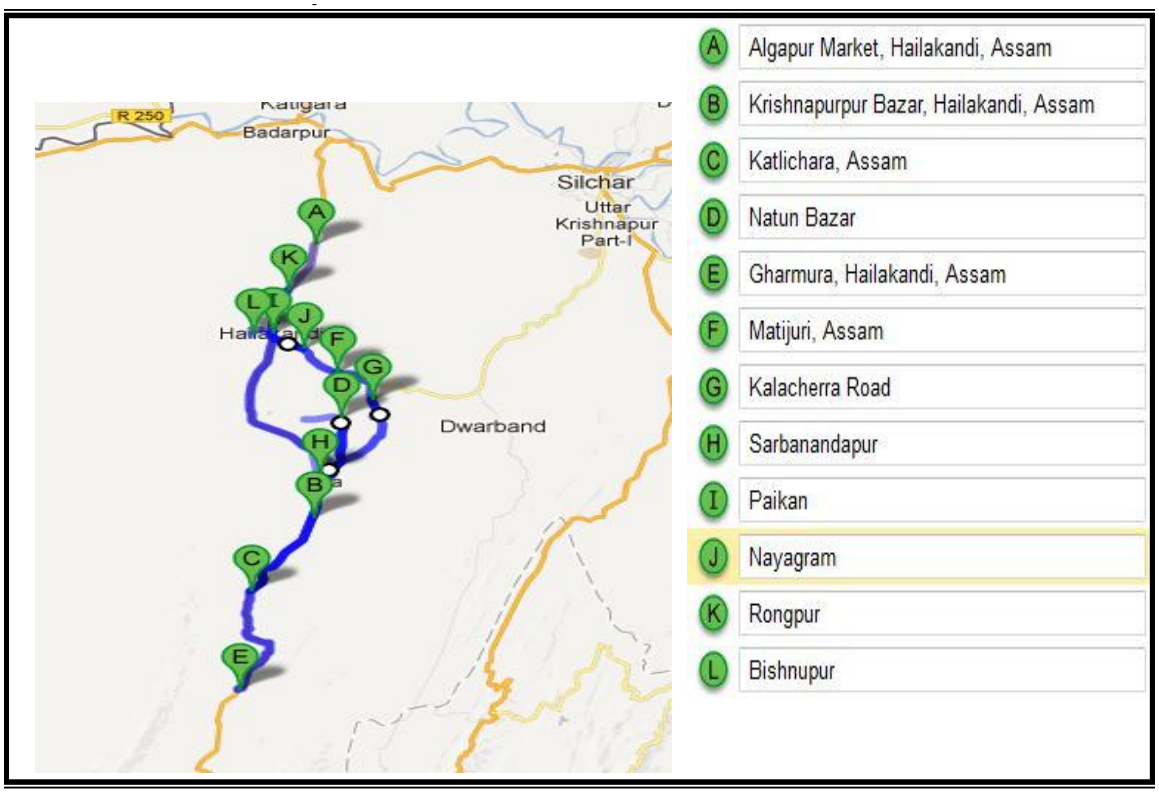

Figure 2b. Study sites in Karimganj District.

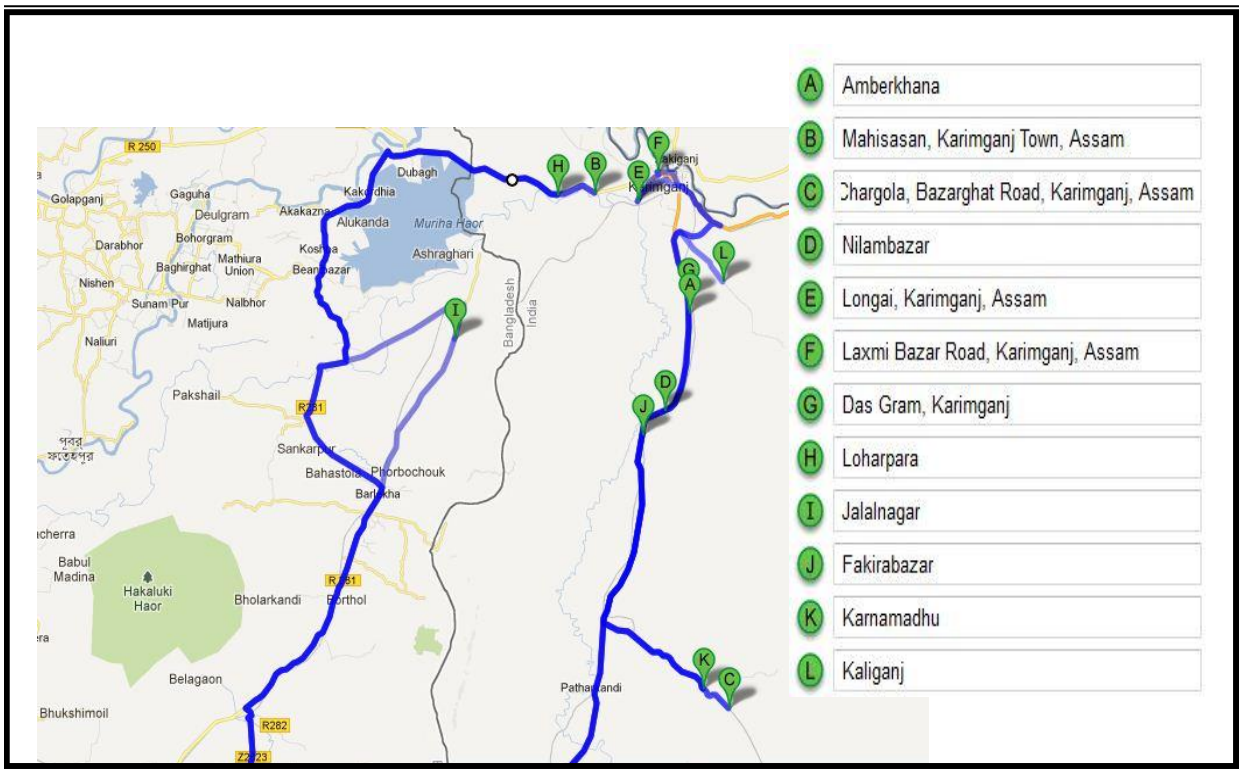

Figure 2c. Study sites in Hailakandi District.

Table 1. Characteristics of the sample population**.**

Age group	Male		Female		Total
	Sprayers	Non-sprayers	Sprayers	Non-sprayers	
<20	10	7	0	5	22
21-30	69	15	1	13	98
31-40	102	17	2	18	139
41-50	63	11	0	9	83
51-60	18	8	0	6	32
>60	12	4	0	0	16
Total	274	62	3	51	390

RESULTS

The first exposure to pesticides was based on whether the farmer sprayed pesticides or not. Out of the 390 farmers interviewed from the three districts, 277 (71.02%) farmers were involved in spraying pesticides (that is, sprayer group) and remaining 113 (28.97%) were involved in other agricultural activities like weeding, planting, watering etc. (that is, non-sprayer groups). Majority of the sprayers were male (Table 1). Many of them received no formal schooling. Among the farmers 143 (36.66%) were working on paddy fields, and the rest were involved in cultivation of other agricultural products such as Betel plantation, Brinjal, Banana, tea etc.

Commonly used pesticides

It was revealed through interview of the sprayers that the most commonly used pesticides in three districts of Barak Valley were Monocrotophos, Profenofos, Cypermethrin, Carbofuran, Dimethoate, Fenvalerate, Chloropyriphos, Malathion, Dichlorophos, Phosphamidon etc. Some of the pesticides used by the farmers are 'extremely hazardous'; many are 'highly hazardous' and few are 'slightly hazardous' (Tables 2 and 3). The farmers also used some other products like ash, cow dung, oilcake, kerosene and lime dust, Neem (*Azadirachta indica*) leaves, Neem (*A. indica*) cakes, mixture of tobacco leaves and washing soap, leaves of *Dillenis indica*, leaves of *Xanthium indicum* etc., in their farm land, but the use of these products were in very less quantities as compared to their inorganic counterparts.

Information source for the farmers

Farmers involved in spraying used mainly the retail shop owners as the information source for knowledge regarding the pesticides they used (58.30%). 35.1% of the farmers consulted with other farmers and 6.6% of sprayers considered government or other agricultural authorities as their source of information. The study was carried out among the agricultural farmers of Barak Valley region, Assam (India). The sites selected were the three districts of the valley (Cachar, Karimganj and Hailakandi). A total number of 12 sites were selected in each district (Figure 2A-C and Table 4). The crop grown in the area included rice, betel nut, tea and vegetables. The vegetables include cabbage, cauliflower, beans, brinjal, tomato, kohlrabies, reddish, kidney beans, green chilli, potato, pumpkins, ladies finger, carrot, ridge guard, bitter guard leafy vegetables and the likes. On a rough estimate, use of pesticides appeared to be more than the desired quantity in all the study sites.

Factors affecting direct exposure to pesticides

Duration of spraying pesticides

The period of exposure of farmers ranges from less than 1 year to 50 years with an average duration of 11.8 years. Majority of them have been spraying pesticides for the past 8-10 years. 109 farmers (39.35%) had sprayed some kinds of pesticides within the last one month of study. Many of them spray pesticides twice a month.

Personal habits while spraying pesticides

Handling of pesticide and application of the same in recommended concentration in the field requires the use of appropriate personal protection equipment as a precaution against pesticide exposure. This involves the use of gloves, masks, protective personal hygiene, appropriate footwear, headgear etc.

It was observed that sprayers in the study area took no necessary individual protective measures while handling pesticides. It was also observed that the farmers mix different pesticides in a vessel with water or pour them directly into the spraying jars and mix the pesticides with water using bare hands. The ideal practise however, is to mix in a barrel, using a stick which is often not adhered

Table 2. Pesticides commonly used by the farmers.

Pesticide: Common name (WHO classification)	Chemical family	No. of farmers	% N=390
Extremely hazardous			
Phorate	Organophosphate	33	11.9
Highly hazardous			
Monocrotophos	Organophosphate	202	72.9
Profenofos	Organophosphate	196	70.8
Cypermethrin	Synthetic pyrithroids	277	100
Carbofuran	Carbamate	229	82.7
Fenvalerate	Synthetic pyrithroids	235	84.8
Endosulfan	Organochlorine	129	46.6
Dimethoate	Organophosphate	207	74.7
Choloropyriphos	Organophosphate	221	79.8
Deltamethrin	Synthetic pyrithroids	208	75.1
Permethrin	Synthetic pyrithroids	28	10.1
Alphamethrin	Synthetic pyrithroids	21	7.6
DDT	Organochlorine	114	41.1
Dichlorovos	Organophosphate	215	77.6
Phosphamidon	Organophosphate	185	66.8
Phosalone	Organophosphate	23	8.3
Carbosulfan	Carbamate	78	28.2
Slightly hazardous			
Malathion	Organophosphate	108	39

Table 3. Combined pesticides used by the farmers.

Chemical Name	Common Name
Chloropyriphos 50%+Cypermethrin 50% E.C.	Hamla
Profenofos 40%+cypermethrin 4% E.C.	Profex super
Chloropyriphos 50%+Cypermethrin 5% E.C.	Cheminova
Chloropyriphos 50%+Cypermethrin 5% E.C.	Bancyp 505
Profenofos 40%+cypermethrin 4% E.C.	Profigan Plus

to by the farmers in question. Very few of the farmers use old/ worn out cotton cloth materials as mask. While spraying pesticides, some of the sprayers were seen chewing betel-nut, tobacco etc. and some of them were even found smoking.

Factors affecting indirect exposure to pesticides

Other farming activities during pesticide spraying

Farmers reported that other usual farming activities continue in the farm, while pesticides were being sprayed. Consequently, women, children and others working in the same field have a chance of being exposed to these pesticides.

Signs and symptoms of illness among the farmers

The signs and symptoms related to pesticide exposure (Table 5) were included in the questionnaire. The sprayers were asked whether they have experienced these signs and symptoms during or immediately after pesticide spraying. Time of reference for the non-sprayers was while working in the field, during or after pesticide spraying. The signs and symptoms were reported by a large number of sprayers. 277 sprayers (71%) and 113 (29%) of non sprayers reported at least one of these sign and symptoms. Some of the signs and symptoms with a higher prevalence were excessive sweating (31.8%), stinging /itching eyes (33.8%), dry/sore throat (20.5%), skin redness/white patches (32.8%), numbness/muscle weakness/muscle cramps (30.5%),

Table 4. Number of farmers interviewed in each site of the three districts, Assam, India.

CACHAR (Site-I)			KARIMGANJ (SITE-II)			HAILAKANDI (SITE-III)		
Study Sites	**No. of farmers**	**% (N=148)**	**Study Sites**	**No. of farmers**	**% (N=119)**	**Study Sites**	**No. of farmers**	**% (N=123)**
Sonabarighat	15	10.1	Longai	10	8.4	Algapur	10	8.1
Sonai	12	8.1	Ambarkhana	10	8.4	Krishnapur	10	8.1
Dholai	12	8.1	Dasgram	10	8.4	Karicherra	13	10.6
Lakhipur	12	8.1	Loharpara	10	8.4	Katlicherra	10	8.1
Pailapool	12	8.1	Lakhibazar	10	8.4	Nayagram	10	8.1
Srikona	12	8.1	Jalalnagar	10	8.4	Rongpur	10	8.1
Masimpur	12	8.1	Fakirabazar	10	8.4	Nutunbazar	10	8.1
Borkhola	12	8.1	Mahisasan	9	7.6	Bishnupur	10	8.1
Kalain	12	8.1	Chorgola	10	8.4	Gharmura	10	8.1
Gumrah	13	9	Nilambazar	10	8.4	Matijuri	10	8.1
Jalalpur	12	8.1	Karnamadhu	10	8.4	Sarbanandapur	10	8.1
Banskandi	12	8.1	Kaliganj	10	8.4	Paikan	10	8.1

Table 5. Prevalence of signs and symptoms and relative risks among the population

Signs and Symptoms	Sprayers (N=277)	Non-sprayers (N=113)	Relative Risk
Excessive sweating	102 (36.8)	22 (19.5)	1.88
Burning/stinging/itching eyes	103 (37.2)	29 (25.7)	1.45
Dry/sore throat	64 (23.1)	16 (14.2)	1.63
Skin redness/white patches	98 (35.4)	30 (26.6)	1.33
Numbness/muscle weakness/muscle cramps	93 (33.6)	26 (23)	1.46
Running/burning nose	66 (23.8)	15 (13.3)	1.79
Blurred vision	68 (24.5)	15 (13.3)	1.84
Chest pain/burning feeling	105 (37.9)	28 (24.8)	1.53
Shortness of breath/cough	63 (22.7)	28 (24.8)	0.92
Excessive salivation	97 (35.0)	32 (28.3)	1.24
Nausea/vomiting	32 (11.6)	8 (7.1)	1.63
Stomach pain/cramps/ diarrhoea	29 (10.5)	15 (13.3)	0.79

chest pain/burning sensation (34.1%), excessive salivation (33.1%) (Table 5). As these signs and symptoms were *suo moto* reported by the farmers, it was difficult to confirm the occurrence of some of the specific signs or symptoms (like excessive sweating) occurring due to pesticide exposure

or because of the tropical hot weather prevailing in the area.

However, it was interesting to note that a higher frequency of most of the signs and symptoms were seen among the sprayer groups in comparison to non-sprayer groups (Table 1). Among the farmers the exposure factors of spraying pesticides was significantly associated with excessive sweating, dry/sore throat, blurred vision, nausea/vomiting with higher relative risk (RR Value= 1.5 and above) (Table 5). The other sign and symptoms with RR value within the range of 1 to 1.5 were seen among farmers with indications like burning/stinging/itching eyes, skin redness/white patches, numbness/muscle weakness, muscle cramps, running/burning nose, chest pain/burning feeling and excessive salivation and nausea/vomiting (Table 5). Most of the farmers suffered from chronic disease like diabetes, hypertension, asthma, tuberculosis etc. 46 farmers suffered from tuberculosis, 79 suffered from asthma, 64 from hypertension, 71 from diabetes and 119 farmers showed the sign of reduced vision.

DISCUSSION

Most of the pesticides used in the agricultural sectors in the three districts of Barak Valley ranges from moderately hazardous to highly hazardous categories, and thus, all of them have detrimental health effects as reported by various workers from time to time. Organophosphorous pesticides that work by disrupting the sending of nerve signals seem to cause this long term damage to myelin coating. The results are muscle weakness and paralysis. There is also evidence of chronic disruption of the acetylcholine mechanisms for carrying nerve signals from one nerve fibre to another, from the brain to the body (Sataka et al., 1997).

Cypermethrin, a very active synthetic pyrethroid insecticide and is used to control pests of a variety of crops. Giray et al. 2001 reported that cypermethrin exposure of rats resulted in free radical-mediated tissue damage and reduced the S-methylglutathione level by 20%. Cypermethrin has also been reported to induce gene mutations in male germ cells of Drosophila (Batiste– Alenton et al., 1986) and genotoxicity and sperm abnormality in mice (Bhunya and Pati, 1988). Malathion is a commonly used organophosphorous insecticides and has been employed in major eradication programmes in the metropolis (CDHS, 1991). The large-scale use of malathion in various eradication programmes has raised concern over its potential to cause genetic damage (Flessel et al., 1993). Fenvalerate, a third generation synthetic pyrethroid has been reported to inhibit intra cellular communication (Flodstrom et al., 1988; Warngard and Flodstrom, 1989). Fenvalerate-induced genotoxicity in mammalian tests systems have also been reported by Chatarjee et al. (1982) and Pati and Bhunya (1989). Carbamates (such as Carbofuran and Aldicarb) are also used in minute quantities to control root-knot nematodes in tea.

Chloropyriphos is one of the most widely used Organophosphorous pesticides and has been reported to be a developmental neurotoxicant, specially targeting the immune system (Pope, 1999 and Barone et al., 2000). Malathion is a known Cholinesterase inhibitor which leads to the hydrolysis of body choline-esters, including acetyl choline at cholinergic receptors. It has been shown to induce changes in the epithelium of rat mammary glands, influencing the process of carcinogenesis, such alterations occur in the nervous system by increasing cholinergic stimulation.

Most of the farmers in the study area are not aware of the health hazards caused by the above pesticides and also the consequences of their improper handling. The farmers as a precautionary measure use cloth masks made of cotton. This, in fact increases the absorption rate of pesticides (Kishi et al., 1995). To reduce the nauseating feeling, the practice of chewing or smoking while spraying is also hazardous to health. Combining more than one pesticide together should ideally be discouraged. This could be dangerous, because mixing of pesticides can alter their chemical properties, thereby increasing its detrimental effects on health, besides synergic effect on the ambient environment. Salameh et al. (2004) has already mentioned that the combined use of hazardous pesticides and the absence of appropriate precautions are detrimental to the farmers' health. The continuation of pesticide spraying and other farming activities concurrently in the field can lead to direct exposure to pesticides as they may still be dispensed in air (Antonella et al., 2002).

During the study, it was observed that women in the field continue to work, while pesticides are being sprayed. This exposure to pesticides could cause a variety of reproductive health problems of the reproductive age group. This aspect of women being prone to various ways of exposure to pesticides has been highlighted in the study done among the cotton growers of India by Mancin et al., (2005). These farmers have been spraying pesticides for more than a decade which implies that a large number of the farmers get exposed to pesticides over long durations. This may cause chronic health impacts to the farmers. Young people seem to be engaged in pesticides spraying more than the older people, which may affect their reproductive organs. Pesticide exposure has been found to be linked with chronic disease like diabetes, hypertension, ophthalmic disorders etc. Asthma, a chronic disease, was noticed to be prevalent among the farmers, who are associated with pesticides exposure (Hoppin et al., 2002). The data showed a higher prevalence of reduced vision among the farmers which could be associated with the prolonged exposure to pesticides. The farmers may not be aware whether they have other chronic disease like diabetes,

hypertension etc. because many of them are unaware of the necessity of having health check-ups/clinical tests.

The present findings are in accordance with the previous literature by Solomon et al. (2000) that farmers experienced a variety of signs and symptoms related to pesticides. Among populations, the prevalence of signs and symptoms related to pesticide exposure was higher among the farmers involved in spraying. The higher percentage of some signs and symptoms among the non sprayers could be due to their direct exposure to pesticide or due to previous exposure to pesticides. It can thus be suggested that due emphasis is required to be given on the adoption of protective measures among the farmers in the study area in particular and all agricultural field of the globe in general, where such practice is lacking.

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