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Use Of Pesticides In North Tamil Nadu (Namakkal)-Impacts On Human Health And Persistence In Environment

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Abstract: *The present review paper highlights the toxic effects of chlorpyrifos, an organophosphate (OP) pesticide on the living systems such as human beings, animals, plants, insects, fishes etc. due to its indiscriminate use. Majority of the farmers are unaware of pesticide types, level of poisoning, safety precautions and potential hazards on health and environment. Pesticide users such as farmers in developing nations like India are at a much higher risk of pesticide exposure due to lack of adequate safety measures and awareness. According to the latest estimate, the annual import of pesticides in India is about 0.6 Kg/ha and the average pesticides use in Tamilnadu is 5% only, which is very low as compared to other Indian states. In Namakkal district 39345 kg/year and 77690 l/year of pesticide was consumed for pest management. Cotton, paddy and cereals is the major pesticide consuming crop, in Namakkal 0.93% of cotton, 2% of paddy and 23% of cereals is produced. Mainly organophosphate are used as a pesticide, in this chlorpyrifos is frequently used pesticide. The knowledge of not only farmers and also peoples was limited regarding pesticide purchase, application and safety. Agricultural agency needs to be addressed properly for the pesticide nature. Pesticide misuse is being a serious concern mainly in the commercial crop production areas of agricultural products, where farmers are incidences of poisoning is also increasing because of intentional, incidental and occupational exposure and suffering from environmental pollution. The use of chlorpyrifos in India illustrates an ambiguous situation in which people are undergoing life-long exposures. There is an urgency to develop health education packages based on information, aptitude and practices and to propagate them within the wider reaches of the community in order to minimize the harmful exposure of chlorpyrifos in developing countries. Many studies showed that the chemical pollution of the environment has long-term effects on human life. It is therefore essential that manufacture, use, storage, transport and disposal of chemical pesticides be strictly regulated and create the awareness about the pesticide usage.*

Keywords: *Chlorpyrifos, leaching, persistence, dissipation, toxicity, impacts.*

I. Introduction

In modern agricultural process, chemical fertilizers and pesticides play an important role in increasing crop yields and productivity. As a result these chemicals play a major role in increasing the productivity, yield and in sometimes concomitant with the occurrence and persistence of pesticide residues in soil and water due to the intensive and indiscriminate use of pesticides[1]. Pesticides are chemical substances used to kill insects and pests in agricultural, domestic and institutional settings. They can also create a negative impact on human health and the ecosystem if their production and use are not properly managed[2]. Several reports have indicated the presence of different groups of pesticide residues in soils from several parts of India and the world. Pesticides are considered hazardous chemicals and no strict compliance of pesticide regulation particularly in developing countries, remains a health risk. Pesticides have chemical classes such as organophosphates, organochlorines, synthetic pyrethroids, carbamates, in which OP's are said to have high Lethal Dose (LD)-50[3].

In India, the production of pesticides started in 1952 with the establishment of a plant for the production of BHC near Calcutta, and India is now the second largest manufacturer of pesticides in Asia after China and ranks twelfth globally. The World Health Organization reports every year that there are 3million pesticide poisonings, most of them were OP related, and 200,000 deaths worldwide that are attributed to either self-poisoning or occupational exposure[4]. Globally 4.6 million tons of pesticide are annually sprayed into the environment, out of which only 1% is effective to target plants and rest 99% is released in non-targeted ecosystem like soil, water bodies and atmosphere (Global pesticide pollution).A vast majority of the population in India is engaged in agriculture and is therefore exposed to the pesticides used in agriculture. Although Indian average consumption of pesticide is far lower than many other developed economies but the problem of pesticide residue is very high in India. Pesticide use raises a number of environmental concerns. The main groups of commonly used pesticides include herbicides, insecticides, fungicides, fumigants and rodenticides. Organochlorine, organophosphate and carbamate insecticides are of major concern because of their toxicity and persistence in the environment[5]. Most of the pesticides used on the sample farms belonged to the moderate risk (category II), followed by high risk (category I) and low risk (category III) groups as classified based on acute dermal LD50 for Rabbits/Rat (Table 1). Over 98% of sprayed insecticides and pesticides reach a destination

other than their target species, including non-target species, air, water and soil. Studies have shown that not all applied pesticides may actually reach targeted pests and the remaining have potential to get into the soil, water and the atmosphere[6].

Classification	Name of the Pesticide	Recommended level	Category
Organophosphates	Chlorpyrifos	50% EC	I
	Profenofos	50% EC	II
	Methyl Parathion	50%EC & 2% EC	I
	Monocrotophos	36% SL	I
	Quinalphos	25% EC	II
	Acephate	75% SP	III
	Carbofuran	3%G	I
Carbamates	Indoxacarb	14.5% SL	II
	Carbosulfan	25% EC	II
Pyrithroids	Cypermethrin	25% EC & 10% EC	II
	Fenvalerate	20% EC	II
Organochlorines	Endosulfan	35% EC	II
Others	Fipronil	5% SL	II
	Imidacloprid	17.8% SL	II
	Spinosad	2.5% SL	III

Table 1. Types of pesticides used by farmers

Pesticide Consumption

By 2006, global pesticides sales reached to US $ 32.9 billion, and are expected to grow by 0.8% per annum[7]. Asia dominates the global market for agrochemicals accounting for 43.1% of global agrochemical revenue in 2008[8]. China is the world's biggest user, producer and exporter of pesticides[9] and India is the second largest pesticide producer in Asia after China and ranks in the 12th position globally with a value of US $ 0.6 billion, which is 1.6% of the global market[10, 11]. In India the Registration Committee (RC) has registered 260 technical grade pesticides and 585 pesticide formulations. The total chemical pesticide consumption was 57353 Unit in the year of 2014-2015 (Table 2), very low when compared to other countries[12]. The per capita consumption of pesticides in India is 0.6 Kg/ha which is the lowest in the world. The per capita pesticide consumption in China and USA is 13 Kg/ha and 7 Kg/ha, respectively. The year wise pesticide consumption was slowly decreased when compared to the past of years (Figure 1). In this Tamil Nadu consume 5% of the pesticide usage (Figure 2). In Namakkal district 39345 kg/year and 77690 l/year of pesticide was consumed[13]. As per Indian Journal of Ecology report, major crop losses due to non-usage of pesticides were about 17.5% of the yield amounting to ~INR90000 Cr per annum. It is estimated that the present food grain production can jump from 3 Trillion to 4 Trillion by using crop protection products[14]. Therefore, right usage of crop protection agents is essential in increasing agricultural production by preventing crop losses before and after harvesting.

Year	Quantity (Unit: MT Technical Grade)
2012-13	45619
2013-14	60282
2014-15	57353

Table 2. Consumption of pesticide was given by year wise (Source: States/UTs Zonal Conference on inputs (Plant Protection)).

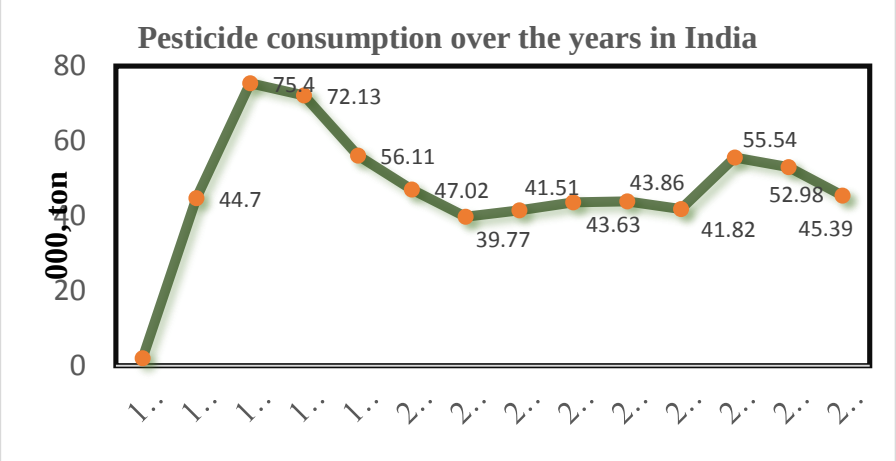

Figure 1. Consumption of pesticide over the years in India (Ministry of Agriculture, 2015).

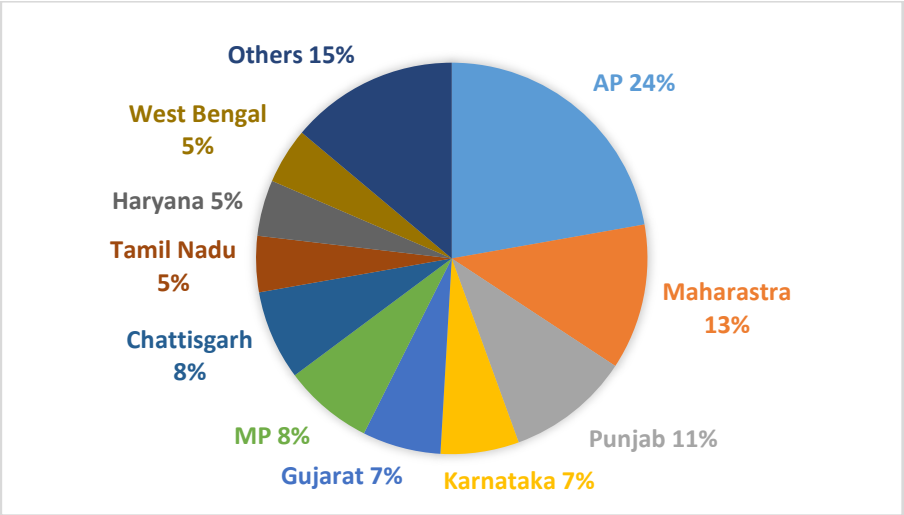

Figure 2. State wise Consumption of pesticide in India.

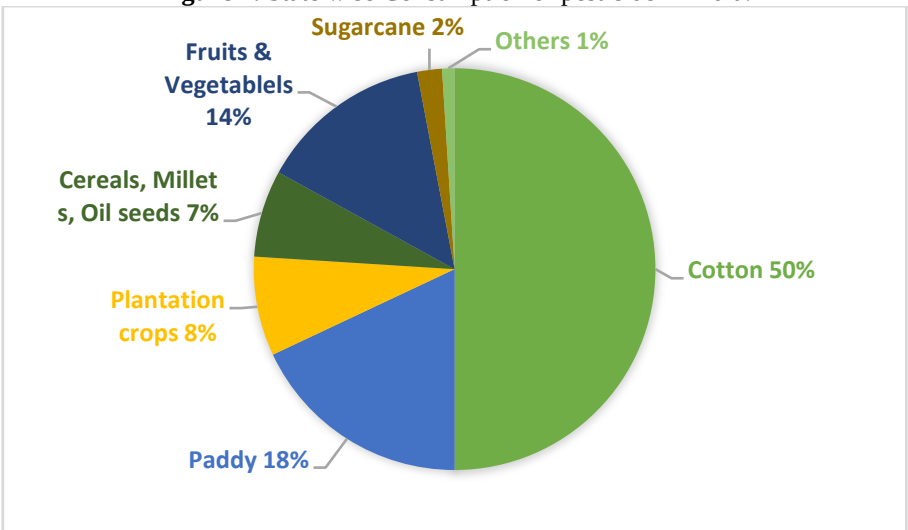

Figure 3. Crop wise Consumption of pesticide in India.

Namakkal District overview

Namakkal District consists of 5 Taluks namely Namakkal, Rasipuram, Tiruchengode, Paramathi Velur and KolliHills. The district is bounded by salem on the north, Karur on the south, Trichy and Salem on the east and Erode on the West.The Geographical area of the district is 3363, 35 K.m. Which lies between 11.00 and 11.360 North Latitute and 77.280 and 78.300 East Longitude. Nearly 90 percent of the cultivated area is under food crops. The principal cereal crops of this district are paddy, cholam, cumbu and ragi etc. The total irrigated area was 74318 Ha, this was decreased and the crop productivity also decreased due to morden life style of human beigns and the source was given by Department of Economics & Statistics, Govt. of Tamil Nadu[15]. In Namakkal District Chlorpyrifos was used broadly as a pesticides. Agriculture and the poultry farming was the back bone of this district. One of the reason for decreasing of irrigated area was high pesticide usage and soil contamination.

Organophosphate usage and Environmental problems

Since the restriction of organochlorine insecticides in 1970's, organophosphate (OP) compounds have become widely used in agriculture, home gardens, and in veterinary practice. OP's are widely used in developing countries due to their cheap cost and effectiveness in controlling pests. They were first used as agricultural insecticides and later as potential chemical warfare agent. Majority of pesticides belong to organophosphorus group. Organophosphates are largely used due to their effectiveness against variety of pests. Organophosphorus poisoning remains one of the major health issue in developed and especially in developing countries and its frequency is increasing over the years[15]. The major organophosphate compounds, which are available and used today, include parathion, malathion, methyl parathion, chlorpyrifos, diazinon, dichlorvos, phosmet and fenitrothion[17]. The main use of pesticides in India is for cotton crops (45%), followed by paddy

and wheat. Chlorpyrifos is one of about 100 organophosphate (OP) insecticides on the market today. It is used to kill insect pests by disrupting their nervous system. Chlorpyrifos has an advantage over other products in that it is effective against a wide range of plant-eating insect pests. Chlorpyrifos is the common name for the chemical 0, 0-diethyl 0-(3, 5, 6-trichloro-2-pyridinyl-phosphorothioate. Chlorpyrifos is a colorless to white crystalline solid. Chlorpyrifos has a mild mercaptan (thiol) odor, similar to the smell of sulfur compounds found in rotten eggs, onions, garlic and skunks. Chemical formula of Chlorpyrifos is $C_9H_{11}C_{l3}NO_3PS$. Its melting point is 42° C (107.6° F), Decomposes below boiling point at 160°C, Density: 1.4 g/cm³ [18]. The production of chlorpyrifos was increased when compared to the previous year. It is used throughout the world to control a variety of chewing and sucking insect pests and mites on a range of economically important crops, including citrus fruit, bananas, vegetables, potatoes, coffee, cocoa, tea, cotton, wheat, rice, and so on. It is also registered for use on lawns, ornamental plants, animals, domestic dwellings as well as commercial establishments. In India the production was 9.88 MT in the year of 2014-2015, this was a confidential report from Ministry of Chemicals & Fertilizers[19].

Pest controllers use chlorpyrifos for protecting the foundations around buildings, yards, crevices through drilling, spraying etc., of these pesticides. The recommended dosage level was 1 L m^{-2} of 20% EC formulation by Centre for Science and Environment in different stages of treatment in foundations for household practices[20]. In agricultural practices, farmers use chlorpyrifos at high doses out of their ignorance for pest control either alone or with various cocktail of pesticides. As a consequence of chlorpyrifos widespread use in crop fields, it gets easily washed into surface water, enters the groundwater and aquatic environment in large quantities. It can easily enter the human food chain and has more victims to its credit than carcinogenic air pollutants such as polycyclic aromatic hydrocarbons[21]. The use of chlorpyrifos has been vastly restricted in US and some European countries, even for agricultural purposes. However, it is still widely used in many Asian developing countries such as India. In the year 2000, it was the fourth highest consumed pesticide after monocrotophos, acephate and endosulfan. The over usage of chlorpyrifos is alarming in view of high persistence and its toxic effects on the living system. With such high usage of chlorpyrifos, there is a possibility of soil and groundwater contamination through leaching of chlorpyrifos. Once soil and groundwater is polluted with toxic chemicals, it may take many years for the contamination to dissipate, degrade or be cleaned up. Cleanup of ground aquifers may also be very costly and complex, if not impossible[22]. Commercially, it is available in different brand names like Dursban, Lorsban, Agromil, Dhanwan, Dorson, Omexan to name a few. After the ban of Aldrin in India after its misuse as homicide by farmers, chlorpyrifos is only available as a cheap termiticide and since then its use has grown up significantly. Extensive use of chlorpyrifos contaminates air, groundwater, rivers, lakes, rainwater and fog water[23]. The contamination has been found up to about 24 kilometers from the site of application. In India, chlorpyrifos residues have been detected in water samples (0.003-0.006 µl L^{-1}) collected from Kaithal and Pant Nagar areas[24].

Impact on Human health

The potential adverse impact on human health from exposure to pesticides is likely to be higher in countries like India due to easy availability of highly hazardous products, and low risk awareness, lack of administration and enforcement resources, insufficient knowledge of and incentives for regulators, shortage of environmental standards, and weakness in cooperation, coordination, and consistency in implementing regulations among relevant authorities especially among children and women[25]. Overexposure to pesticides can occur before spraying because of easy access for children, lack of adequate labelling and during mixing, spraying and after spraying operations. Kumar et al. [26] reported that every day around the world almost 700 people die from the poisoning and several thousands more are affected by pesticide poisoning. India showed that 31% of farmers complained of headache, 27% eye irritation, 24% skin burning, 10% nausea and 9% dizziness associated with plant protection sprayers[27]. Kumar *et al* [26] said that many farmers do not care about the safe handling of pesticides. The effects on human health include cancer, birth defects, reproductive problems, tumors, and damage of liver, kidney and neural organs[28]. In many developing countries like India, most pesticides are associated with adverse effects on human health and environment due to inappropriate use and handling of pesticides by inadequately trained farm workers[24]. Majority of pesticides users, being unaware of pesticide types, their mode of action, potential hazards and safety measures[29]. Alavanja *et al*, said that Pesticide Applicators having the increased Cancer Burden among and others Due to Pesticide Exposure[30].

According to the Directorate of Economics and Statistics, Chennai, food grains, paddy and cotton was the main agricultural products. Rajendran [31] highlight that chlorpyrifos is used on agricultural food and feed crops, cattle ear tags, golf course turf, industrial plants and vehicles, non-structural wood treatments including processed wood products, fence posts and utility poles, and to control public health pests such as mosquitoes and fire ants. Chlorpyrifos is registered for indoor residential use only in the form of containerized baits. Uses for individual products containing chlorpyrifos vary widely. The accumulation of chlorpyrifos in soil has many adverse effects as at higher concentrations (10–300 mg Kg-1) it results in lowering the number of di-

nitrogenfixing bacteria as well as total bacterial population. This leads to decrease in nitrogen and phosphorus content of soil[32]. There have been reports of delayed seedling emergence, fruit deformities and abnormal cell division upon prolonged exposure to chlorpyrifos[33]. Although, solubility of chlorpyrifos is less in water even then its toxicity is prevalent in aquatic ecosystem[34]. In case of fish and aquatic invertebrates, chlorpyrifos is found to be moderately to high[35].

Pesticide residues on food

The problem of pesticide residues is common in many other countries, including developed ones. Baker et al. [36] in the USA found pesticide residues in 73% of the several thousand food samples tested. Similarly, Groth et al. [37] reported pesticide residues in 90% of the five crops (apples, peaches, pears, strawberries and celery) tested, and 37 different pesticides were detected in apples only. In India, 51% of food commodities were found contaminated with pesticide residues and of these, 20% had residues above the maximum residue levels[38]. The Central Government monitors pesticides residues in various agricultural commodities etc. under the central scheme "Monitoring of Pesticides Residues at National Level" (MPRNL). The annual report of MPRNL for 2014-15 shows that 2.6 % of all samples of commodities contained pesticide residues above the Maximum Residues Limits (MRLs) fixed by the Food Safety and Standards Authority of India. During the period (2011-12 to 2014-15), a total of 70,850 samples of various food commodities such as vegetables, fruits, cereals, spices, pulses, milk, butter, fish, meat, tea, honey etc. and environmental samples like soil and water were collected and analysed. Out of which 1778 (2.5%) samples were found to contain pesticide residues above MRLs[39]. The recent experiment was conducted to assess the effect of chlorpyrifos on seed germination and vegetative growth characteristics of Green gram vigna radiate L. The results show that chlorpyrifos was reduced the green gram seed germination percentage significantly when the increasing of concentration of insecticide[40, 41]. In Namakkal the egg containing the pesticide residues. In the north side of Namakkal cabbage was one of the economic crop, for this crop 50% of chlorpyrifos was used as a pesticide. Groundnut was one of economic crop in the Namakkal area. Anitha *et al* described that chlorpyrifos was used for the management of white grubs, as a result the groundnut also containing the pesticide residues[42]. The hematobiochemical and pathological alterations due to chronic chlorpyrifos intoxication in indigenous chicken have also been investigated. As a result the broiler chickens having the chlorpyrifos residues. So humans take this as a food, the chlorpyrifos residues transferred to human[43]. Even a mother's milk also containing the chlorpyrifos residues[44].

II. Conclusions and Recommendations:

The purpose of this review is multifold. It is focused on the possibility of soil and groundwater contamination through leaching by indiscriminate usage of pesticide through the extensive published literature and shedding light on the toxic effects of the organophosphorus pesticide on our living system as a whole. It also describes the current scope of knowledge with regard to the current usage, persistence, leaching and dissipation of chlorpyrifos in India. The sections that follow summarize the key observations and conclusions derived from the detailed review that can assist policy-makers, and risk communications in the development of targeted training and awareness-raising material for operators, workers, bystanders, and residents. The review provides suggestions for future research that is essentially needed so that governmental regulators will have a more thorough reference point, to determine the future of widely applied chlorpyrifos. The resultant effects on human health include cancer, birth defects, reproductive problems, tumours, and damage of liver, kidney and neural organs. In many developing countries like India, most pesticides are associated with adverse effects on human health and environment due to inappropriate use and handling of pesticides by inadequately trained farm workers. Majority of pesticides users, being unaware of pesticide types, their mode of action, potential hazards and safety measures. The pesticide regulation board should be well known about the procedure for the mechanism involvement in the environmental and health sectors. This could be achieved by organizing various training programs for farmers and also pesticide industrial workers. Also there is a need to develop modern techniques for farmers to apply pesticides with the purpose of reducing pesticide exposure and adverse health effects from pesticide application. Government and other related agencies should educate farmers and agriculture managers on Good Agricultural Practices (GAP). Farmers purchase and use pesticides which are even not registered due to the economic cost and high toxicity giving quick elimination of pests which in the long run causes detrimental effect on the environment. For above all the risk procedure, government should give the awareness for doing organic forming and should give the usage of biopesticide. The integrated pest management will give the information about which one pest was farmers friendly and how to control the unwanted pests by using biopesticide, this is the only solution to avoid the environmental pollution.

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