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Pesticides use and their impact on environment and health in Uttar Pradesh: A review

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Abstract

Pesticide use rate increases tremendously in crop production all over the world. In the recent years, pesticide related issues have been extensively highlighted in the media including public, research journals, and attracted wider debate and sharp focus among the interested groups in India. It is obvious that indiscriminate and excessive use of pesticides pollutes not only environment and agriculture but also food chain, thereby affecting health of farmers, public, and the end users. The present paper is an attempt to review research studies focusing on the pesticide use and its impact on environment and health focusing Uttar Pradesh, India. This analytical study infers that pesticide use has increased manifold, obviously due to many complex factors. Research findings reveal that pesticide residues have been found in the environment many times higher than the maximum permissible limit.

Key words: *Pesticide residue, rodent, ecological equilibrium, ecosystem, food chain*

Introduction

Pesticides are chemicals used to control crop pests, insects, rodents, weeds and fungi, etc. They are commonly called insecticides, fungicides, bactericides, weedicides or rodenticides, etc. Some pesticides are able to kill a wide range of pests while some are specifically developed against particular pests. In general, every pesticide is designed to disrupt the normal physiological activities of an organism, against which it is applied. It may even act as a repellant to keep the pest away. Pesticides were created on the basis that a pest is an unwanted organism in an unwanted place that deserves to be eliminated or rendered physiologically dysfunctional. But this ignored the fundamental fact of nature that a pest is an organism living in an ecosystem with its life process closely linked to other components of the ecosystem. The ecological equilibrium between various organisms is disturbed when a pest is killed. In the natural process, other organisms replace the pest or the pest itself will produce a variant strain, which may or may not be affected by that specific pesticide. As each pest is a part of the food chain, the reduced pest population may also induce reduced population of organisms feeding on such pests at the higher trophic level. However, studies by Joshi, 2005 and Mitra *et. al.* 2011 show that many pests have developed resistance to pesticides with suitable physiological modifications to their bodies. Pimentel *et. al. (*1993) observed that the use of pesticides is hazardous to many physical components of the ecosystem like water, air, and soil because more than 99% of a pesticide that is applied reaches untargeted spots of the ecosystems. Further they estimated that only 1% of applied pesticide is actually used to kill pests. The pesticide reaching untargeted spots can cause damages to physical and chemical equilibrium when soils are repeatedly exposed to pesticide application. It is also reported by the Ministry of Agriculture, Govt. of India (2013) that pesticides are retained in plant tissues and can act as a source of human food pollution. Contaminated plant tissues become a part of the food chain, as many animals eating such plants or drinking polluted water carry them forward. They ultimately lead to innumerable health hazards to both human and animal life. Similarly, the Centre for Science and Education (CSE) conducted a case study in 2003 to detect the pesticide residue in the bottled drinking water. In their research findings, it was found that 'clean

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bottled water' is pesticide contaminated and this water is unsafe. CSE reported in this study that many of the popular brands of bottled water of India have pesticide residues much above the permissible limits and such pesticide residues cause health disorders for the human body over the years.
In a study by Mitra (2011), it has also been observed that pesticides can directly eliminate many beneficial organisms like predators, parasites of pests, earthworms, etc. and others useful for nitrogen fixing, phosphate solubilizing, nitrifying, ammonifying and decomposing bacteria/fungi. Interestingly most of them receive pesticides from untargeted areas.

Materials and Method

To collect literature from across the world, relevant to the topic systematic review was done on pesticide impact on environment and health. The major literature search was restricted to studies done in Uttar Pradesh, India. Data were collected from the worldwide web (using Google), retrieved papers cited in publications sources and personal collections of papers and books. The key words used were "Pesticide and Environment", "Pesticide and health", "effect of pesticide on environment in Uttar Pradesh" etc.

Pesticides: Indian Scenario

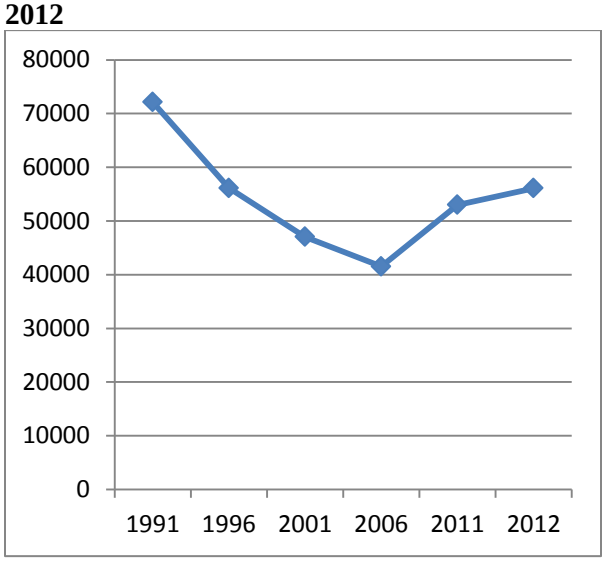
Agriculture is the essential component of the Indian economy and as per the Indian Pesticides Industry-Business Market Report (2012); agriculture contributes nearly 18% to country's Gross Domestic Production (GDP). This report says that India has achieved a five-fold increase in food grain production, to an all-time record of 257.4 million tons in 2011-12. Ensuring food security for more than 1.27 billion Indian populations with diminishing cultivable land resource is a herculean task. This necessitates use of high yielding variety of seeds; balance use of fertilizers, judicious use of quality pesticides along with education to farmers and the use of modern eco-friendly farming techniques. From the study of Shetty (2010), it is found that the greater number of the literate farmers have strong perceptions on the negative impacts of pesticides on soil, water, air and beneficial organisms. It is well known that a number of factors take a heavy toll on the agricultural produce including insect pests, diseases, weeds, fungi, rodents etc. In the year 2013, the Ministry of Chemicals informed the India's parliamentary panel as cited in a media report to justify pesticide production: "Every year in India, pests and diseases eat away, on an average, 20-30% of food, worth about Rs. 45,000 crore, produced by the farmers. In order to protect the crops from such damages and achieving the target, pesticides play an important role in Indian agriculture. Studies that documented the serious consequences of the indiscriminate use of pesticides for the health of farmers while those of Mancini *et. al.*, 2005 and Khan *et. al.*, 2013. It is estimated that on an average, one rupee spent on pesticide use gives the yield of approximately five rupees (Indian Agricultural Research Institute, 2008). Now, as the cultivable land becomes a scarce and inelastic commodity, due to population growth, the situation will be aggravated in the years to come especially in highly populated countries like India as far as the use of pesticides is concerned. In this context, another significant aspect i.e. consumption rate of pesticides and its trends over the years in India becomes important to be considered. According to the Department of Agriculture and Cooperation, Govt. of India statistics, as shown in the table-1, a peculiar trend in the consumption of pesticides is noticed. A graphical representation of this data shows that in the year 1991, the pesticides consumption was 72130 tones. The consumption of pesticides gradually decreased till 2006. But surprisingly in the year 2011, it again increased (52980 tones) and remained more or less similar (56091 tones) till 2012. Although the overall consumption of pesticides exhibits decreasing trend over the 22 years' time period. This can be considered as a good sign that Indian agriculture is by and large consuming less quantity of pesticides and indirectly it means that our country is gradually becoming less dependent on pesticides. The reasons of such an interesting trend needs to be studied. One of such reasons may be that the people have understood the consequences of excessive use of pesticide and hence they are now exploring other methods of crop protection from pests and diseases. Year wise consumption of pesticide use in India is reported in the table-1. The line graph (Fig. 1) clearly shows the trend of consumption of pesticides in India during the 1991 to 2012 period.

Table-1: Year-wise consumption of pesticides in India

Sl. No.	Year	Consumption of pesticides (in tones)
1.	1991	72130
2.	1996	56110
3.	2001	47020
4.	2006	41510
5.	2011	52980
6.	2012	56091

Though it shows that pesticide consumption trend is declining up to 2006, but surprisingly it has increased from 2006 onwards, which is certainly a serious issue to be considered. Did people not know about the harmful effects of the use of pesticides, or there are some other reasons?

Fig. 1: Line graph showing the trend of pesticide consumption in India during the period 1991-2012



(Source: Directorate of Economics and Statics, Department of Agriculture and Cooperation, Govt. of India)

In fact, the objective of pesticide use has been to control pests and enhance mankind's food security interests. But, it is also a fact that the use of pesticides in the last 40 years has not been able to curb crop losses to the extent desirable. Pesticide usage in India is vastly different from that in many developed countries. In Indian context, poor literacy among the farmers (users of pesticides) is very serious concerns because of which many of them are unaware of the perils of pesticides and hence they are using the pesticides. In such a situation, the farmers' education and awareness regarding the impact of pesticides on our health and environment can play a vital role in diminishing the impact of pesticides. As per the report of the Centre for Environment Education in special reference of pesticide residues from villages of Punjab, India (2005), public awareness about the hazardous effects of pesticides is more in western countries rather than Asia. In fact, their extensive usage has been banned in many western countries. India can also follow this trend and implement some effective policy intervention in this direction.

Pesticides Consumption in India:

Pesticide production in India begun in 1952 from a Benzene Hexa Chloride (BHC) plant near Kolkata, West Bengal. Annual Report (2012-13) of Department of Fertilizers, Ministry of Chemicals and Fertilizers, Govt. of India revealed that in our country the overall pesticide consumption has shown many ups and downs during the period of 1954-2012. In the phase of first five year plan, the pesticide utilization in India was 2350 tons which reached 7500 tons by the end of the 1990s. Till 1990, there was a consistent increase in pesticide consumption and this could happen due to the policies pursued by the Indian Government to promote the sale of pesticides. On the other hand, during 1991-2001, the pesticide consumption has shown reduction trend. In the year 1991-92 the consumption of pesticides was 75000 metric tons and it again got reduced in 2009-10 to 41822 metric tons. The main cause behind this reduction in pesticides consumption could be the increased awareness about the consequences of use of pesticides, various popularization programmes and application of some eco-friendly and least harmful alternative methods like Integrated Pest Management (IPM), bio-pesticides, organic farming etc. According to Bhardwaj and Sharma (2013), the consumption of pesticides is highest in Andhra Pradesh, followed by Punjab, Karnataka, Tamilnadu, Maharashtra, Haryana, Gujarat, Uttar Pardesh.

Impact of pesticides on environment with reference to Uttar Pradesh

Like other countries, India also has been depending on the use of pesticides and other chemicals for protection and increased yield of crops. The consumption of pesticides began in India primarily for malaria control and later gradually extended to agricultural and domestic purposes. Dichloro diphenyl Trichloroethane (DDT) was the first synthetic insecticide used in our country (Joshi, 2005). In India, 234 pesticides are registered for use at present (Centre for Science and Environment study, 2013). Long persistence of some agrochemicals in the environment sets in a series of undesirable effects through contamination of food and feed. The 30 million non-target bioforms, so far safe in the cradle of nature, are rocked with threat of extinction and their numbers are reducing. Bioaccumulation of pesticides and bio-magnification processes has become the weak links in the food chain.Among the pesticides that have acquired notoriety, DDT and BHC (HCH, Gammaxane, Lindane) are particularly important. In India, DDT and BHC were the two major chemicals used in agriculture and public health programs. Although now partially banned, they are still very much in use because of their wide spectrum of activity and ready availability at low cost. Our biggest concern is that these molecules are stable in the environment. It is suspected that most of our water bodies and soils are contaminated with these chemicals or with their degradation products. Currently India is the largest producer of pesticides in Asia and ranks 12th in terms of consumption. Despite their enormous benefits the unregulated and indiscriminate application of pesticides has raised serious concerns about environment. Residues of organochlorine pesticides (OCPs) namely, isomers of HCH and endosulfan, DDT and its metabolites, aldrin, dieldrin, were analysed in water of river Yamuna along its 346 km stretch passing through Haryana–Delhi–Haryana and the canals originating from it. β-HCH, *p.p′*-DDT, *p.p′*-DDE and *p.p′*-DDD had maximum traceability in test samples (95–100%) followed by γ-HCH, α-HCH and *o.p′*-DDD (60–84%) and *o.p′*-DDT, δ-HCH and *o.p′*-DDE (7–30%) while aldrin, dieldrin, α and β endosulfan remained below detection limits (BDL). The concentration of ΣHCH and ΣDDT at different sites of the river ranged between 12.76–593.49 ng/l (with a mean of 310.25 ng/l) and 66.17–722.94 ng/l (with a mean of 387.9 ng/l), respectively. In canals the values were found between 12.38–571.98 ng/l and 109.12–1572.22 ng/l for ΣHCH and ΣDDT, respectively (Kaushik *et. al.*, 2008). Mahantesh, N and Singh, A. (2012) in their findings on Groundwater quality assessment in the village of Lutfullapur Nawada, Loni, District Ghaziabad, Uttar Pradesh, India resulted that levels of electrical conductivity (EC), alkalinity, chloride, calcium, sodium, potassium and iron exceeding their permissible limits. Except iron, the other metals (Cr, Cd, Cu, Ni, Pb, and Zn) were seen to be below the permissible limits. The pesticide residue was major cause of these abnormalities in ground water quality.Chaudhary and Chaudhary (2012) assessed ground drinking water in some parts of Meerut District, Uttar Pradesh, India. This study reveals some ground water samples had marginally high concentration of sodium, calcium, potassium and magnesium. These high cationic ions in ground water might be due to unsafely discharges of effluents from sugar mills, paper and pulp mills, distillery, waste water from villages and cities and rapid use of pesticides and fertilizers in agriculture. The ground water in the study area is moderately hard to hard in nature and unsuitable for domestic purpose. Bankar et al (2012) investigated pesticide residues in market foods in Uttar Pradesh, India. A total of 120 samples of four different fresh vegetables from domestic production were analyzed. 58.33% of the samples no residues were found, 28.33% of samples contained pesticide residues at or below MRL, and 13.33% of samples contained pesticide residues above MRL. Brinjal was the most positive followed by cabbage, tomato and lady's finger. The most commonly encountered Organochlorine pesticides in surface water were of Sharda river region in Lakhimpur kheeri, Uttar Pradesh-India was dieldrin, heptachlor epoxide, isomers of hexachlorocyclohexane and DDT. In some cases the concentrations detected were higher than the qualitative target levels set by the European Union, especially for γ-hexachlorocyclohexane & pp'-DDT. The occurrence of these compounds in Sharda river region surface waters can be attributed to intense use of chemical pesticides in agricultural activity as well as to transboundary pollution (Maurya & Kumar, 2013). Yadav *et al.* (2013) assessed levels of different heavy metals like Iron, Cadmium,

Nickel, Lead, Copper and Zinc in vegetables irrigated with water from different sources industrial area of Naini Allahabad. The order of heavy metal concentration was found in Fe > Zn > Cd > Pb > Ni > Cu in irrigated water and Fe > Ni > Zn > Cu > Cd > Pb was observed in industrial contaminated sites of soils. Uptake and translocation factor of heavy metal from soil to Edible parts of vegetables were quite distinguished for almost all elements examined. Although the practice of growing leafy vegetables using wastewater for irrigation is aimed at producing socio-economic benefits but study reveals that heavy metal-contaminated vegetables grown in wastewater-irrigated areas may pose Public health hazards which is not safe and may not be sustainable in the long-term. Gupta and Kanaujia (2014) studied about impact of pesticide on *Milvus migrans govinda* (*a helpful raptor)* in Bundelkhand region of India. Twelve *Milvus migrans govinda* found dead between 2007-2011 in Bundelkhand region. Death of three *Milvus migrans govinda* attributed to contamination of pesticides (organochlorine contaminants) found in lethal concentration due to bioaccumulation in food chain. Thus, lethal concentrations found in present study may be contribute a serious environmental factor affecting the survival of considered population.

Tiwari *et. al.* (2015) assessed ground water quality of Hamirpur District, Uttar Pradesh, India and found high values of heavy metals (Cd, Cu, Fe, Pb, Ni and Co). Assessment of physicochemical characteristics of hand pumps water of Banda city revealed that the values of pH, TDS and hardness were 7.8 to 8.3, 320 to 370 and 200 to 341 mg/L respectively. It was observed that values of chloride, iron and alkalinity were 28 to 36, 0.11 to 0.23 and 120 to 240 mg/L respectively (Gupta *et al.* 2014). Ground water contamination by the heavy metals has become a striking problem for last two decades as results of discharge of industrial effluent, untreated domestic waste and increasing the use of Agrochemicals, i.e. fertilizers and pesticides in our farming.

Impact of pesticides on health

Indian records show first case of lethal death back in 1958 in Kerala while consuming contaminated wheat flour with parathion. After that many such cases have been reported from time to time. The latest case of health impact of pesticide has been reported in Saran district, Bihar where a tragedy happened in 2013 in which more than 30 children died because of consuming of monocrotophos, a deadly organophosphorus pesticide (Bhardwaj and Sharma, 2013). Srivastava *et al.* (2011) analyzed levels of select organophosphates in human colostrum and mature milk samples in rural region of Faizabad district, Uttar Pradesh, India. Frequency percentage (N%) of organophosphates analyzed was highest for ethion (23.1% or 6/26) in colostrum and chlorpyrifos (50% or 4/8) in mature milk samples. None of the samples exceeded acceptable daily intake standards set by Joint Meeting on Pesticide Residues (JMPR). Bhanti and Taneja (2005) analysed summer and winter vegetable samples during 2002–2003 for pesticide contamination and found that contamination levels of winter vegetables (average concentration of 4.57, 6.80 and 5.47 ppb respectively for Lindane, Endosulphan andDDT) whereas summer vegetables (average concentration of 4.47, 3.14 and 2.82 ppb respectively for Lindane, Endosulphan and DDT). The concentration of these organochlorine pesticides in summer and winter vegetables were well below the established tolerances but continuous consumption of such vegetables even with moderate contamination level can accumulate in the receptor's body and may lead to chronic effects that could be fatal. Srivastava *et al.* (2011) conducted on 20 vegetables including leafy, root, modified stem, and fruity vegetables like bitter gourd, jack fruit, french-bean, onion, colocassia, pointed gourd, capsicum, spinach, potato, fenugreek seeds, carrot, radish, cucumber, beetroot, brinjal, cauliflower, cabbage, tomato, okra, and bottle gourd. Forty-eight pesticides including 13 organochlorines (OCs), 17 organophosphates (OPs), 10 synthetic pyrethriods (SPs), and eight herbicides (H) pesticides were analyzed. Twenty-three pesticides were detected from total 48 analyzed pesticides in the samples with the range of 0.005–12.35 mg kg−1. The detected pesticides were: Σ-HCH, Dicofol, Σ -Endosulfan, Fenpropathrin, Permethrin-II, β-cyfluthrin-II, Fenvalerate-I, Dichlorvos, Dimethoate, Diazinon, Malathion, Chlorofenvinfos, Anilophos, and Dimethachlor. In some vegetables like radish, cucumber, cauliflower, cabbage, and okra, the detected pesticides (Σ-HCH, Permethrin-II, Dichlorvos, and Chlorofenvinfos) were above

maximum residues limit (MRL) (PFA 1954). However, in other vegetables the level of pesticide residues was either below detection limit or MRL. The presence of pesticide residues in vegetables has become a global phenomenon. Authors have reported the residues of OCs, OPs and SPs, along with fungicide and herbicides in fruit and vegetables from India (Bhanti and Taneja, 2005).

Results and Discussion

Over the years, it has been found that the use of pesticides has increased many folds. Several research studies have been conducted first to identify the reasons of such increased use of pesticides and secondly the researches have also been conducted to study the environmental and health consequences of such chemicals. On reviewing the related literatures (Rajendran, 2013; Mitra *et al.*, 2011 and Khan *et al.*, 2013), it has been found that there are a number of reasons why people use the pesticides. Various researches have also been conducted to study the consequences of the increased use of pesticides and the results are quite alarming. It is a fact that because of pests, a large amount of crop yield is reduced every year. According to a study by Rajendran, 2003, in India pests cause crop loss of more than 6000 crores, of which 33% by weeds, 26% by diseases, 20% by insects, 10% by birds and rodents and remaining 11% is due to other reasons. So one of the main intentions of the application of pesticides has been to prevent and control insect pests and diseases in the field crops and of course, initially the use of pesticides reduced pest attack and paved the way for increasing the crop yield as expected. But at same time, increased use of pesticides has resulted in contaminating the environment and the long-term multidimensional implications on the society (Joshi, 2005). A research study by Mitra (2011) shows that pesticides have toxic effects like reproductive, mutagenic and carcinogenic on ecology including non-target host plants and animals. Though it has been noticed that pesticides are used on large scale for all crops under a market oriented farming system, but under subsistence farming scenario farmers tend to use less quantum of pesticides as they consider that production is sufficient to meet their domestic requirements. But it has also been found that when the intensity of production increases towards market orientation from subsistence level, invariably farmers use high dosage of pesticides for generating more income via production. Rajendran (2003) has found another interesting reason of using the pesticides. He found that when the land becomes scarce and the agriculture production moves towards market orientation (with scarce land), in that situation more chemicals including pesticides are required. Now, as the cultivable land becomes a scarce and inelastic commodity, due to population growth, the situation would be aggravated in the years to come especially in highly populated countries like India and China. Study by Khan *et al.* (2013) indicates that the liberal subsidies, extensive and intensive pest attack, shortsighted public policies, lack of legal framework, nepotism, strong campaigns favoring pesticides, poor alternative systems and farmers' attitude have contributed to increased pesticide use. Further, they have found that continuous and indiscriminate pesticide use contributes too many environmental and health problems. The findings of several research studies (Murphy *et al.*, 2002; Rajendran, 2003, Mancini *et. al.*, 2005; Mitra *et al.* 2011 and Centre for Environment and Education, Ahmedabad, 2013) indicate that the use of pesticides is highly hazardous to both environment and health of humans and animals. In the light of above, this issue needs serious attention and quick action for social, environment and economic considerations in the context of sustainable development. On the other hand, it is also found that there are alternative methods and mechanisms by which crop diseases and pests can be effectively checked (Rajendran, 2003). Joshi (2005) indicates that some of the pesticides (like endosulphan) that have been banned or restricted in their use in many countries have been liberally used in India due to lack of strict regulations and political will. In fact, the US Environmental Protection Agency classifies endosulphan as a category lb (highly hazardous) chemical as it is easily absorbed by the human systems like stomach, lungs and skin. This explains the facts that gross violations of environmental protection prevails in India as compared to its neighbors like Bangladesh and Sri Lanka. The research studies (Joshi, 2005) on the ill effects of pesticides by and large report that continuous application of chemical inputs have caused innumerable damage to the environment and living

beings. While some empirical studies like Pagiola (1995) found that pesticide use actually lowered the yields, others observed that there was an adverse impact on health (Antle & Pingali., 1995 and Mencher, 1991). Dismally the value of crop loss due to pests is invariably lower than the cost of pesticide related illness (Rola and Pingali, 2010) and the associated loss in farmer productivity (Antle & Pingali, 1994) for many Asian countries including India. Importantly some of the state run agencies have been promoting the use of pesticides in certain conditions despite grass roots agitation and research exposure on the adverse effects of pesticides. The classic example is that of the Kerala state's Plantation Corporation's role in aerial spraying of endosulphan on the cashew gardens in Kasargod district. According to the study conducted by Rajendran (2003), it is found that in Jaipur, Rajasthan, newborn children have neural tube defect (NTD), a deformity that results from the incomplete closure of the neural tube during early pregnancy. Alarmingly NTD takes a heavy toll of the order of half a million babies every year in the world and in Rajasthan alone about 8,000 babies are reportedly affected. According to the above study, the primary cause of NTD is the excessive use of pesticides on crop fields. Further, the study also notes that pesticides are mainly responsible for these as they are antagonistic to folic acid, a vitamin that is essential for the development of the brain. In our country, while folic acid given after pregnancy is detected – normally after four to eight weeks – the brain develops from the neural tube in the first four weeks of pregnancy. The pregnant women have to eat leafy vegetables and grains because they contain folic acid, (which is a vitamin B) that is essential for the development of the brain. Immediately after the harvest of rabi crop, farmers grow vegetables and greens and apply heavy dose of chemical pesticides, which are reservoirs of toxic heavy metals. Obviously, the pregnant women, who eat such contaminated and toxic vegetables and green leafs face complications. The physician contends that pesticide residue in food can prevent the availability of folic acid leading to the birth of children with NTD. Despite the fact that this study needs wider analysis and deeper examination across a cross section of pregnant women in diverse conditions, the findings does show that congenital malformations are due to pesticide use and abuse.

An assessment of acute poisoning among cotton growers of India was conducted by Mancini *et al.* (2005). In this study, 323 events reported, of which 16.4% were asymptomatic, 39% led to mild poisoning, 38% to moderate poisoning and 6% to severe poisoning. Major symptoms of pesticides were excessive tearing, excessive salivation and tremor. In a case study conducted on Vietnam farmers by Murphy *et al.* (2002), it was found that the farmers of Vietnam use to have self-surveillance against pesticide poisoning. In this case, out of the total 1,798 spraying operations, 8% had no evident effect (asymptomatic) and 61% were associated with vague, ill-defined, or localized minor effects. Close to a third (31%) were accompanied by at least one more clearly defined sign or symptom of pesticide poisoning. The most common complaint was headache, which was associated with 51% of spray operations. The incidences of poorly defined, minor effects or conditions possibly related to heat and hard work in the spraying sessions ranged from 20% to 30%. These included dizziness (27%), insomnia (21%), itching skin (24%), sore throat (22%), excessive salivation (24%) and exhaustion (25%). In this study it is also revealed that on the analysis of past experiences, farmers became aware and started to take proper care from pesticide poisoning for the safety point of view. The recent study by Bhardwaj *et. al.* (2013) also supports the above consequences of the pesticides. From the review of literatures, it is found that there are many studies focusing especially on the environmental and health aspects of the use of pesticide in Indian context. In addition to this, there is no appropriate and alternative framework to the use of pesticides. Exposure to pesticides both occupationally and environmentally causes a range of human health problems. It has been observed that the pesticides exposures are increasingly linked to immune suppression, hormone disruption, diminished intelligence, reproductive abnormalities and cancer. There is now overwhelming evidence that some of these chemicals do pose a potential risk to humans and other life forms and unwanted side effects to the environment (Forget, 1993; Igbedioh, 1991; Jeyaratnam, 1985). No segment of the population is completely protected against exposure to pesticides and the potentially serious health effects, though a disproportionate burden is shouldered by the people

of developing countries and by high risk groups in each country (WHO, 1990). It is estimated that nearly 10,000 deaths annually to use of chemical pesticide worldwide, with about three-fourths of these occurring in developing countries (Horrigan *et. al.,* 2002). Pesticides being used in agricultural tracts are released into the environment and come into human contact directly or indirectly affecting human life (Wadhwani and Lall, 1972; Kasyap and Gupta, 1973). Humans are exposed to pesticides found in environmental media (soil, water, air and food) by different routes of exposure such as inhalation, ingestion and dermal contact. Exposure to pesticides results in acute and chronic health problems (Hollingworth *et. al.,* 1995; Hurley *et. al.,* 1998). The world-wide deaths and chronic diseases due to pesticide poisoning were numbered about 1 million per year (Environews Forum, 1999). Some of these are suicides, but most involve some form of accidental exposure to pesticides, particularly among farmers and spray operators in developing countries, which are careless in handling pesticides or wear insufficient protective clothing and equipment. Moreover, there have been major accidents involving pesticides that have led to the death or illness of many thousands. In India, the first report of pesticide poisoning was documented from Kerala in 1958, where more than 100 people died after consuming wheat flour contaminated with parathion. One instance occurred in Bhopal, where more than 5,000 deaths resulted from exposure to accidental emissions of methyl isocyanate from a pesticide factory. There are two types of the pesticide effects on human health: ***Chronic effects of pesticide exposure****:* Chronic health problems linked to pesticides include adverse neurological effects such as a fourfold increased risk of early-onset Parkinson's disease, shortened attention span, memory disorders, and reduced coordination, reproductive problems including miscarriages, reduced infant development, birth defects, depression and cancer. ***Acute effects of pesticide exposure****:* Acute health problems which are sometimes misdiagnosed or not recognized as being associated with pesticide toxicity, include blurred vision, headaches, salivation, diarrhoea, nausea, vomiting, wheezing, eye problems, skin conditions, seizure, coma, and even death. Mild to moderate pesticide poisoning mimics' intrinsic asthma, bronchitis, and gastroenteritis. Pesticides are especially harmful to children because of their developing physiology. And, relative to their size, they are exposed to higher amounts of pesticides. The increasing incidences of pesticide residues in the meat and milk are of a great concern for ensuring food safety and human health. Higher contents of organo-chlorine pesticide residues have been reported in meat (Nag *et. al.,* 2005) and milk samples collected from different locations of the country (ICMR, 1993). Agnihotri *et. al.* (1974) reported that most of the milk samples from Delhi market contained DDT in levels higher than MRL fixed by FAO-WHO.

Possible Eco-friendly Alternatives of Pesticides

Under this scenario, it is important to understand the crucial issues like what are the environment and health costs of pesticide use? What alternative frameworks would help solve the problem?

Possible alternatives could be the application of non-toxic environment friendly formulations and solutions to combat pest for maintaining environment security and creating a healthy society for attaining overall development and well-being. In fact, there is a paradigm shift in agriculture towards low external input sustainable farming and subsequently (ecological) farming with only local inputs. Ecological or organic farming is considered as environmentally sustainable, economically viable and socially adaptable through which sustainable agriculture development is attained. Organic farming relies on local resources including plants that have pest repellent properties to control the pests. In India, it is estimated that around 3000 plants do possess pest repellent features, which need to be scientifically studied and utilized for promoting sustainable agriculture development (Rajendran, 2003). India is endowed with various types of naturally viable organic farm of nutrients across different regions of the country which will be helpful in organic cultivation of crops. This will help substantially in organic farming of crops. In addition to this, India's traditional farmers possess a rich kind of wisdom, based on long observations and practices, concerning soil fertility and pest control management which can be used to strengthen organic systems (Sharma *et. al.,* 2014).

The benefits of organic produce in terms of health and nutrition are well known. Bringing more farmers under organic farming especially through

training and awareness programmes, production of on-form organic inputs of such farms need to be encouraged to increase the quantity and quality of the produce and bring down its prices. Further proper marketing strategies need to be explored to ensure remunerative prices to the farmers for their produce. Kumar and Sankarakumar (2012) studied the level of attitudes of the farmers on ICT application in agriculture, impact of ICT application in agricultural activities and problems in accessing the ICT application in Ramanathapuram district of Tamil Nadu. The Indian Government has given various facilities to the farmers in which the ICT services is one among which is helping the farmers to understand the modern cultivation methods like organic farming, availability of agriculture inputs, irrigational sources, availability of pesticide and fertilizers for increasing the production and productivity of crops. Integrated Pest Management (IPM) is another eco-friendly approach of farming which uses a blend of cultural, mechanical and biological tools and techniques for keeping pest population below economic threshold levels. This approach attaches a high premium on the efficacy of bio-control agents and bio-pesticides (Gandhi *et. al.*, 2007 and Bond *et. al.*, 2007). However in IPM, need based and judicious use of chemical pesticides is also permitted. IPM helps in maximizing crop protection with minimum input costs, minimizing pollution in soil, water and air reducing health hazards, conserving ecological equilibrium and reducing pesticide residue loads in food (Jayanthi and Kombairaju, 2005).

Conclusion

Though a number of researches have been conducted to study the reasons of excessive use of pesticides, and their consequences on our health and environment, but very limited efforts have been made to popularize the findings of such studies among the stakeholders. In fact there is a need to study effectiveness of the findings of such studies and to assess how effectively such findings have been communicated at the grass root level. Besides strict implementation of the policies related to the use of pesticides, there is a great need of creating awareness among the farmers, and other stakeholders by both governments and non-government organizations (Dwivedi and Sheth, 2008). Economics of using pesticides and the expenditure on the health problems generated due to pesticide use also need to be studied. No doubt with the increase of population, there is a need for increased crop production. So far pesticides and other chemicals have been excessively used for this purpose. But keeping in view the harmful effects of pesticides on both our health and environment, it is now imperative to search for the safe and eco-friendly alternative methods of crop protection and for increased yield. Organic farming and IPM are two very effective alternatives of pesticides and hence there is a strong need for immediate steps to be taken by the individual, as well as by the government and non-government organizations to train farmers regarding the safe and eco-friendly methods of farming to secure health and conserve environment.

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