Impact of Pesticide Use in Indian Agriculture - Their Benefits and Hazards

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1., INTRODUCTION

The term pesticide covers a wide range of compounds including insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators and others. Among these, organochlorine (OC) insecticides, used successfully in controlling a number of diseases, such as malaria and typhus, were banned or restricted after the 1960s in most of the technologically advanced countries. The introduction of other synthetic insecticides – organophosphate (OP) insecticides in the 1960s, carbamates in 1970s and pyrethroids in 1980s and the introduction of herbicides and fungicides in 1970s - 1980s contributed greatly in pest control and agricultural output. Ideally a pesticide must be lethal to the targetted pests, but not to non-target species, including man. Unfortunately, this is not, so the controversy of use and abuse of pesticides has surfaced. The rampant use of these chemicals, under the adage, “if little is good, a lot more will be better” has played havoc with human and other life forms.

1.1, Production and Usage of pesticide in India

The production of pesticides started in India 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[9]. There has been a steady growth in the production of technical grade pesticides in India, from 5,000 metric tonnes in 1958 to 102,240 metric tonnes in 1998. In 1996-97 the demand for pesticides in terms of value was estimated to be around Rs. 22 billion (USD 0.5 billion), which is about 2% of the total world market.

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The pattern of pesticide usage in India is different from that for the world in general. As can be seen from Figure 1, in India 76% of the pesticide used is insecticide, as against 44% globally[9]. The use of herbicides and fungicides is correspondingly less heavy. The main use of pesticides in India is for cotton crops (45%), followed by paddy and wheat.

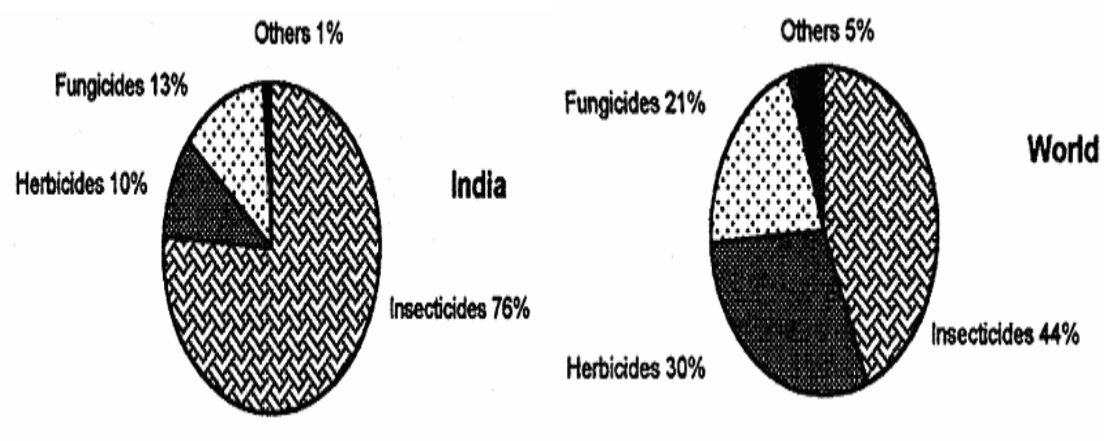

Figure 1. *Consumption pattern of pesticides*

2., BENEFITS OF PESTICIDES:-

2.1, *Improving Productivity:-* Tremendous benefits have been derived from the use of pesticides in forestry, public health and the domestic sphere - and, of course, in agriculture, a sector upon which the Indian economy is largely dependent. Food grain production, which stood at a mere 50 million tonnes in 1948-49, had increased almost fourfold to 198 million tonnes by the end of 1996-97 from an estimated 169 million hectares of permanently cropped land. This result has been achieved by the use of high-yield varieties of seeds, advanced irrigation technologies and agricultural chemicals[1].

Similarly outputs and productivity have increased dramatically in most countries, for example, wheat yields in the United Kingdom, corn yields in the USA. Increases in productivity have been due to several factors including use of fertiliser, better varieties and use of machinery. Pesticides have been an integral part of the process by reducing losses from the weeds, diseases and insect pests that can markedly reduce the amount of harvestable produce. Warren (1998) also drew attention to the spectacular increases in

crop yields in the United States in the twentieth century. Webster *et al.* (1999) stated that "considerable economic losses" would be suffered without pesticide use and quantified the significant increases in yield and economic margin that result from pesticide use. Besides this, most of the pesticides, in environment, undergo photochemical transformation to produce metabolites which are relatively non-toxic to the human beings as well as environment.[47]

2.2, *Protect Crop losses/yield reduction:-* In medium land rice even under puddle conditions during the critical period warranted an effective and economic weed control practice to prevent a reduction in rice yield due to weeds that ranged from 28 to 48% based on comparisons that included control (weedy) plots[43].Weeds reduce yield of dry land crops[43] by 37-79%. Severe infestation of weeds particularly in early stage of crop establishment ultimately accounts for a yield reduction of 40%. Herbicides provided an economic and labour benefit too.

2.3, *Vector Disease Control:-* Vector-borne diseases are most effectively tackled by killing the vectors. Insecticides are often the only practical way to control the insects that spread deadly diseases such as malaria that results in an estimated 5000 deaths each day (Ross, 2005). In 2004, Bhatia wrote that malaria is one of the leading causes of morbidity and mortality in the developing world and a major public health problem in India.

2.4, *Quality of Food:* - In the countries of first world, it is now observed that a diet containing fresh fruit and vegetables far outweigh potential risks from eating very low residues of pesticides in crops.[27] Increasing evidence (Dietary Guidelines, 2005) shows that eating fruit and vegetables regularly reduces the risk of many cancers, high blood pressure, heart disease, diabetes, stroke, and other chronic diseases.

Lewis *et al* (2005) discussed the nutritional properties of apples and blueberries in the US diet and concluded that their high concentrations of antioxidants act as protectants against cancer, heart disease. Lewis attributed doubling in wild blueberry production and subsequent increases in consumption chiefly to herbicide use that improved weed control.

2.5, *Other area-Transport, Sport Complex, Building:-* The transport sector makes extensive use of pesticides, particularly herbicides. Herbicides and insecticides are used

to maintain the turf on sports pitches, cricket grounds and golf courses. Insecticides protect buildings and other wooden structures from damage by termites and wood boring insects.

3., HAZARDS OF PESTICIDES:-

3.1, Direct Impact On Human Being:- If the credits of pesticides include enhanced economic potential in terms of increased production of food and fibre, and amelioration of vector-borne diseases, then their debits have resulted in serious health implications to man and his environment. There is now overwhelming evidence that some of these chemicals do pose potential risk to humans and other life forms and unwanted side effects to the environment [17-19]. 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[20]. The world-wide deaths and chronic illnesses due to pesticide poisoning number about 1 million per year[21].

The high risk groups exposed to pesticides include the production workers, formulators, sprayers, mixers, loaders and agricultural farm workers. During manufacture and formulation, the possibility of hazards may be more because the processes involved are not risk free. In industrial settings, the workers are at increased risk since they handle various toxic chemicals including pesticides, raw materials, toxic solvents and inert carriers.

In India, the first report of poisoning due to pesticides was from Kerala in 1958, where over 100 people died after consuming wheat flour contaminated with parathion[2]. This prompted the Special Committee on Harmful Effects of Pesticides constituted by the ICAR to focus attention on the problem[3]. Further, Carlson in 1962 warned that OC compounds could pollute the tissues of virtually every life form on the earth, the air, the lakes and the oceans, the fishes that live in them and the birds that feed on the fishes[4]. Later, the US National Academy of Sciences stated that the DDT metabolite, DDE causes eggshell thinning and that the bald eagle population in the United States declined primarily because of exposure to DDT and its metabolites[5]. Certain environmental chemicals including pesticides termed as endocrine disruptors are known to elicit their

adverse effects by mimicking or antagonising natural hormones in the body and it has been postulated that their long-term, low-dose exposure are increasingly linked to human health effects such as immunosuppression, hormone disruption, diminished intelligence, reproductive abnormalities and cancer[6-8].

A study on workers (N=356) in four units manufacturing HCH revealed neurological symptoms (21%) which were related to the intensity of exposure[22]. The magnitude of the toxicity risk involved in the spraying of methomyl, a carbamate insecticide, in field conditions was assessed by the National Institute of Occupational Health (NIOH) [24]. Significant changes were noticed in the ECG and the levels of serum LDH and ChE activities in the spraymen indicating the cardiotoxic effects of methomyl.

Observations confined to health surveillance in male formulators engaged in production of dust and liquid formulations of various pesticides (malathion, methyl parathion, DDT and lindane) in industrial settings of the unorganised sector revealed a high occurrence of generalized symptoms (headache, nausea, vomiting, fatigue, irritation of skin and eyes) besides psychological, neurological, cardiorespiratory and gastrointestinal symptoms coupled with low plasma cholinesterase (ChE) activity [23].

Data on reproductive toxicity were collected from 1,106 couples when the males were associated with the spraying of pesticides (OC, OP and carbamates) in cotton fields[25].
A study in malaria spraymen was initiated to evaluate the effects of a short term (16 week) exposure in workers (N=216) spraying HCH in field conditions[26].

3.2, Impact through Food Commodities:-The UK Pesticide Residue Committee annual report (2002) showed that over 70% of the food in the UK contained no pesticide residues at all and only 1.09% contained residues above the statutory maximum residue levels (MRLs). It concluded that “none of these residues caused concern for people's health”. Yet these very small quantities of chemicals in our food, detected at ever lower levels due to increasingly sensitive laboratory equipment, are now easy targets for the media. In India, a study revealed that 50% of the vegetable samples taken from farm gate were found contaminated with various pesticides (0.01-2.23 ppm) of which 16% were above MRL.[48]

3.3, Impact on Environment:-Pesticides can contaminate soil, water, turf, and other vegetation. In addition to killing insects or weeds, pesticides can be toxic to a host of other organisms including birds, fish, beneficial insects, and non-target plants. Insecticides are generally the most acutely toxic class of pesticides, but herbicides can also pose risks to non-target organisms.

3.3.1, *Surface Water Contamination:-* Pesticides can reach surface water through runoff from treated plants and soil. Contamination of water by pesticides is widespread. The results of a comprehensive set of studies done by the U.S. Geological Survey (USGS) on major river basins across the country in the early to mid- 90s yielded startling results. More than 90 percent of water and fish samples from all streams contained one, or more often, several pesticides.[45] Pesticides were found in all samples from major rivers with mixed agricultural and urban land use influences, and 99 percent of samples of urban streams[28]. The USGS also found that concentrations of insecticides in urban streams commonly exceeded guidelines for protection of aquatic life [41]. Twenty-three pesticides were detected in waterways in the Puget Sound Basin, including 17 herbicides. According to USGS, more pesticides were detected in urban streams than in agricultural streams. [29]

3.3.2, *Ground Water Contamination:-* Pesticides, including herbicides, can and do leach to contaminate ground water. According to the USGS, at least 143 different pesticides and 21 transformation products have been found in the ground water, including pesticides from every major chemical class. Over the past two decades, detections have been found in the ground water of more than 43 states[30]. Contamination of ground water is of concern because ground water supplies 50 percent of the U.S. population with Drinkingwater[31]. During one survey in India it has been found that 58% of drinking water samples drawn from various hand pumps and wells around Bhopal are contaminated with Organ Chlorine pesticides above the EPA standards.[46] Once ground water is polluted with toxic chemicals, it may take many years for the contamination to dissipate or be cleaned up. Cleanup may also be very costly and complex, if not impossible [(32-34)].

3.3.3, *Soil Contamination:-* Pesticides have various characteristics that determine how they act once in soil. Mobility refers to how much a pesticide will move around in the soil. The half life of a pesticide refers to the length of time it takes for half of the pesticide

to degrade. Persistence refers to the length of time until all measurable residues of a pesticide are gone.

3.3.4, ***Effect on soil fertility (Beneficial Soil Microorganisms):-*** One spoonful of healthy soil has millions of tiny organisms including fungi, bacteria, and a host of others. These microorganisms play a key role in helping plants utilize soil nutrients needed to grow and thrive. Microorganisms also help soil store water and nutrients, regulate water flow, and filter pollutants[38]. The heavy treatment of soil with pesticides can cause populations of beneficial soil microorganisms to decline. Sometimes pesticides have a negative impact on the available NPK from soil.[49] According to soil scientist Dr. Elaine Ingham, "If we lose both bacteria and fungi, then the soil degrades. Overuse of chemical fertilizers and pesticides have effects on the soil organisms that are similar to human overuse of antibiotics. Indiscriminate use of chemicals might work for a few years, but after awhile, there aren't enough beneficial soil organisms to hold onto the nutrients." [40].

3.3.5, ***Contamination of Air, Soil, and Non-target Vegetation:-*** Pesticide sprays can directly hit non-target vegetation, or can drift or volatilize from the treated area and contaminate air, soil, and non-target plants. Some pesticide drift occurs during every application, even from ground equipment[35]. Drift can account for a loss of 2 to 25% of the chemical being applied, which can spread over a distance of a few yards to several hundred miles. There are thousands of reported complaints of off target spray drift each year in the U.S. [36]. Many pesticides can volatilize (that is, they can evaporate from soil and foliage, move away from the application, and contaminate the environment.)[38]. As much as 80-90 percent of an applied pesticide can be volatilized within a few days of application[39]. Despite the fact that only limited research has been done on the topic, studies consistently find pesticide residues in air. According to the USGS, pesticides have been detected in the atmosphere in all areas of the USA sampled[40]. Nearly every pesticide investigated has been detected in rain, air, fog, or snow across the nation at different times of the year[41]. Many pesticides have been detected in air at more than half the sites sampled nationwide.

3.3.6, ***Non-target Organisms:-*** Pesticides are found as common contaminants in soil, air, water and on non-target organisms in our urban landscapes. Once there, they can harm

plants and animals ranging from beneficial soil microorganisms and insects, non-target plants, fish, birds, and other wildlife.[37]

CONCLUSION:-

Pesticides are often considered a quick, easy, and inexpensive solution for controlling weeds and insect pests in urban landscapes. However, pesticide use comes at a significant cost. Pesticides have contaminated almost every part of our environment. Pesticide residues are found in soil and air, and in surface and ground water across the nation, and urban pesticide uses contribute to the problem. Pesticide contamination poses significant risks to the environment and non-target organisms ranging from beneficial soil microorganisms, to insects, plants, fish, and birds. Contrary to common misconceptions, even herbicides can cause harm to the environment. In fact, weed killers can be especially problematic because they are used in relatively large volumes. The best way to reduce pesticide contamination (and the harm it causes) in our environment is for all of us to do our part to use safer, non-chemical pest control (including weed control) methods.

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