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Review

Effect of Modern Agricultural Practices and The Use of Toxic Pesticides On Environment

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ABSTRACT

Agriculture has been the backbone of the Indian economy and it will continue to remain so for a long time. In the mid 1960 s the crop production was largely increased in India with a new strategy popularly known as 'Green Revolution'. This strategy involves the use of modern technology including high yielding variety (HYV) seeds, chemical fertilizers, irrigation facilities and improved farm implements. The promotion of High Yielding Varieties that marked the green revolution has led to large scale use of chemicals as pesticides. Improper and unsafe use of agrochemicals, especially pesticides is not only harmful to environment but also human health. In this paper we have focused on the modern agricultural practices and the use of chemical fertilizers and toxic pesticides, their adverse impacts on the ecology and environment.

Keywords: Modern agriculture, Toxic Pesticides, Environmental Pollution.

INTRODUCTION

There are many problems faced by modern agriculture which includes urbanization of farmland, water rights and usage, environmental concerns, and the procurement of government subsidies. The environmental impacts of ecological diseases have been associated with the intensification of food production. They may be grouped into - erosion, loss of soil fertility, depletion of nutrient reserves, salinization and alkalinization, pollution of soil and water systems, loss of fertile field lands to urban development, loss of crop, wild plant, and animal genetic resources, elimination of natural enemies, pest resurgence and genetic resistance to pesticides, chemical contamination, and destruction of natural control mechanisms [1]. Sometimes environmental conditions effect to agricultural practices, agricultural practices also have effects on environment. Namely; agriculture affects to global flowing of greenhouse gases. The main reason for the destruction of forest land is to obtain agricultural land. As a result, after agricultural land obtaining, greenhouse gases are also created at the same time. Fertilizers play a vital role in the modern agriculture technology and also a variety of pesticides are used in agricultural practices for higher productivity. Pesticides that are used for the elimination of harmful insects, microorganisms and other pests which mix with soil, water, air and food and affect both human health and natural balance, so finally they become an environment problem. Pesticide runoff is an important contributor to surface-water contamination [2]. There are four main classes of insecticides viz organophosphates, carbamates,

chlorinated hydrocarbons, and insecticides derived from plants (botanical). Organophosphate and carbamate insecticides act by inhibiting acetyl cholinesterase, the enzyme that degrades acetylcholine (the messenger of the parasympathetic nervous system). As a result, acetylcholine levels remain high, exaggerating the normal functions of the parasympathetic system. Effects such as salivation, lacrimation, urination, defecation, twitching of the skeletal muscles, and in severe poisoning, death from respiratory depression occur. Every farmer knows that pesticides cost money. But there are other costs the farmer may not consider when he buys pesticides. There is the cost to the health of the farmer and other people affected by pesticides. There is the cost of polluted water and soil. And there is the cost to the environment, fish, animals, and other wildlife [3].

If we take our nation India into consideration, majority of the Indian population are engaged in agriculture and are therefore exposed to the pesticides used in agricultural practices. Farmers in India are using wide ranges of chemical pesticides to limit the losses from pests and diseases, in which insecticides account for 73 per cent, herbicides 14 per cent, fungicides 11per cent and others 2 per cent [4]. India is the fourth largest producer of agrochemicals globally, after United States, Japan and China [5]. 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 [6]. The adverse effects of modern agriculture and use of pesticides which are directly associated with the direct and indirect impacts to the environment is not only a nation's problem but also considered as a major problem at global level. The risks related to the pesticides exposure by humans is un predictable and still now studies are going on and research is being done by the scientists to sort out the exact pit falls of the use of pesticides.

MATERIALS AND METHODS

To withdraw the considerable effects of modern agricultural practices and the use of synthetic toxic pesticides, a schematic search has been done with the available literature from different sources. The possible effects have been briefed out in the following discussion and suggestions have made to get rid from the negative impacts on environment.

The adverse environmental and social impacts of modern agriculture: The adverse environmental and social impacts of modern agriculture are universal. Pretty (1995) summarized them as follows

- Contamination of water by pesticides, nitrates, soil and livestock wastes, causing harm to wildlife, disruption of ecosystems and possible health problems in drinking water.
- Contamination of food and fodder by residues of pesticides, nitrates and antibiotics;
- Damage to farm and natural resources by pesticides, causing harm to farm workers and public, disruption of ecosystems and harm to wildlife.
- Contamination of the atmosphere by ammonia, nitrous oxide, methane and the products of burning, which play a role in ozone depletion, global warming and atmospheric pollution;
- Overuse of natural resources, causing depletion of groundwater and loss of wild foods and habitats and their capacity to absorb wastes causing water-logging and increased salinity;
- the tendency in agriculture to standardise and specialise by focusing on modern varieties, causing the displacement of traditional varieties and breeds;
- New health hazards for workers in the agrochemical and food -processing industries. [7]

Agriculture effect on carbon dioxide emissions: According to studies, carbon dioxide from agriculture has been found to be one of the causes that lead to increasing levels of CO2 in the atmosphere. Since the mid-1800s agriculture has been increasing carbon dioxide emissions and has been the main source of the emission since before the 1920's. Today, the main source of carbon dioxide emissions is fossil fuel usage; nonetheless, the second largest cause of increased carbon dioxide emissions is due to land conversion for

agriculture. This is so because the conversion of land for agriculture involves the destruction of plant life which leads to the release of carbon dioxide into the air. With respect to the world's total anthropogenic carbon dioxide emissions, agricultural activity is responsible for 20% of the total. Agriculture adds carbon dioxide to the atmosphere through the burning of biomass by processes such as deforestation. These activities increase decomposition rates of organic carbon in soil. The burning of plants releases the carbon stored in the biomass and allows oxidation to occur, creating carbon dioxide. Agricultural expansion, which primarily takes place in temperate regions of the tropics, is another activity that leads to widespread clearing of land and losses of organic carbon in vegetation and soils. These activities result in atmospheric increases of carbon dioxide and since carbon dioxide is a greenhouse gas, an increase in carbon dioxide levels will result in an average global temperature increase [8]

Adverse environmental impacts of Pesticides: Pesticides are unique among other environmental contaminants. Pesticides released into the environment may have several adverse ecological effects ranging from long-term effects to short-lived changes in the normal functioning of an ecosystem. Despite the good results of using pesticides in agriculture and public health, their use is usually accompanied with deleterious environmental and public health effects. Pesticides hold a unique position among environmental contaminants due to their high biological toxicity (acute and chronic). Pesticides by definition are toxic chemical agents. A pesticide is usually capable of harming all forms of life other than the targeted pest species. On account of this behavior then, they can best be described as biocides (capable of killing all forms of life). Although some pesticides are described to be selective in their mode of action, their range of selectivity is only limited to the test animals [9].

First, pesticides affect soil quality. Pesticides decrease biodiversity in the soil because they do not just kill the intended pest; they often kill many of the other small organisms present. When life in the soil is killed, the soil quality deteriorates and this has a knock-on effect upon the retention of water. This is a problem for farmers particularly in times of drought. At such times, organic farms have been found to have yields 20-40 per cent higher than conventional farms. Soil fertility is affected in other ways too. When pesticides kill off most of the active soil organisms, the complex interactions which result in good fertility break down. Plants depend on millions of bacteria and fungi to bring nutrients to their rootlets. When these cycles are disrupted plants become more dependent upon exact doses of chemical fertilisers at regular intervals. Even so, the fantastically rich interactions in healthy soil cannot be fully replicated by the farmer with chemicals. So the soil - and our nutrition - is compromised. We get large but watery vegetables and fruits, which often lack taste and nutrients and may even contain pesticide residues [10].

Pesticides have other adverse effects on the eco-system. The misuse of pesticides can cause valuable pollinators such as bees and hover-flies to be killed and this in turn can severely affect food crops. Bees have been suffering a serious decline in recent years for reasons which are not yet clear (but pesticides are thought to be implicated). Without bees, many food crops would simply fail to grow; they pollinate the plants so that they can produce fruits and grains. There are fears (and some evidences) that through natural selection; some pests may eventually become quite resistant to pesticides. Farmers may then try to increasing amounts use of excessive pesticides, making the problem worse. Many pesticides contain chemicals which are persistent soil contaminants. Their effects may last for years. Amphibians such as frogs are particularly vulnerable to concentrations of pesticides in their habitat. Atrazine, one of the world's most popular weed killers, has been found to feminize frogs, leading to sterility in males. It is still in use in the US, with about 80 million pounds being applied annually, but has been banned in the EU countries since 2004. It may also affect male fertility in humans and is a known endocrine disruptor. This is a fairly typical example of pesticides and pollution which results, affecting the lives of people and wildlife alike. Because of the profits to be made most companies are slow to accept responsibility and the problem is hidden by the use of numerous trade names for the one chemical.

Pesticides also affect human health. Pesticides endanger workers during production, transportation or during and after use. Bystanders may also be affected at times, for example walkers using public rights of

way on adjacent land or families whose homes are close by crop spraying activities. One of the main hazards of pesticide use is to farm workers and gardeners. A recent study by the Harvard School of Public Health in Boston, discovered a 70 per cent increase in the risk of developing Parkinson's disease for people exposed to even low levels of pesticides. Children are particularly vulnerable to the toxic effects of pesticides. Studies have found higher rates of brain cancer, leukaemia and birth defects in children who suffered early exposure to pesticides. (National Resources Defense Council study) [11].

Fate of pesticides: When a pesticide is used in the environment, it becomes distributed among four major compartments: water, air, soil, and biota (living organisms). The fraction of the chemical that will move into each compartment is governed by the physico-chemical properties of that chemical. An example is BCF (bioconcentration factor), which is a measure of the amount of pesticide that will accumulate in aquatic organisms. Pesticides are distributed in the environment by physical processes such as sedimentation, adsorption and volatilization. They can then be degraded by chemical and/ or biological processes. Chemical processes generally occur in water or the atmosphere and follow one of four reactions: oxidation, reduction, hydrolysis and photolysis. Biological mechanisms in soil and living organisms utilize oxidation, reduction, hydrolysis and conjugation to degrade chemicals. The process of degradation will largely be governed by the compartment (water, soil, atmosphere, biota) in which the pesticide is distributed, and this distribution is governed by the physical processes. Fate processes fall into three major types: adsorption, transfer, and degradation (Fig.2). The three major fate processes of pesticides in the environment are adsorption, transfer and degradation [12].

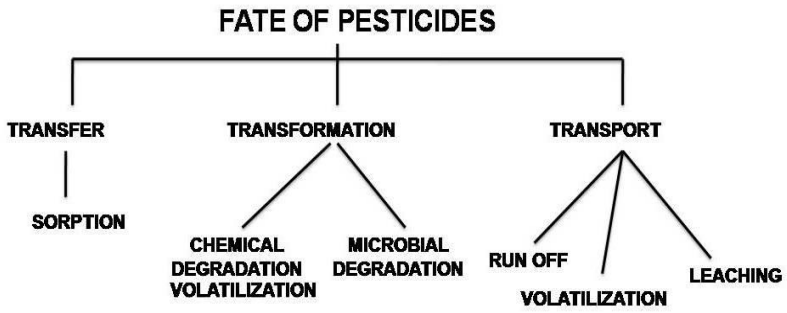

Fig.1. Fate of Pesticides

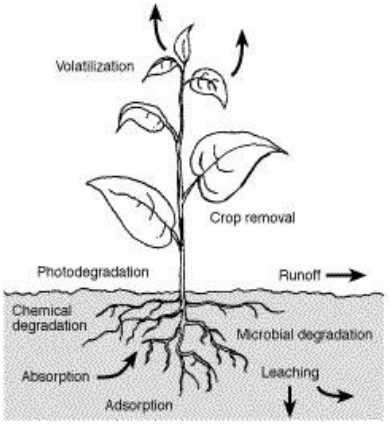

Fig.2. Fate Process of Pesticides

RESULTS AND DISCUSSION

Modern agricultural practices use many kinds of chemicals such as fertilizers, pesticides, cleaners, crop preservatives to produce and keeping large amount of high-quality food. But every single of these chemicals has dangerous and unforeseen side-effects as like toxicity to non target organisms which causes ecological imbalance [13]. Wrong agricultural practices and extensive use of synthetic organic pesticides in the crop fields leads to environmental pollution. Technological advancements have made the things easier and use of various simple techniques in the farm lands has also showed considerable impacts to the environment in the past few decades. Modern agricultural techniques are typically wasteful in their use of fertilizers. Often, many farmers add large amounts of fertilizer or manure at the time of sewing in order to cover and protect the young plants. This technique is inefficient, since the young plants are unable to absorb most of the nitrogen. Therefore, much of the nitrogen is lost to the environment in a number of ways [14, 15]. Exposure to pesticides over long period of time could result in tumors, reproductive failures, growth inhibition, and even cancer. The standard for individual pesticides has been described at 0.001 mg L^{-1} and for total pesticides at 0.0005 mg L^{-1} as per BIS (IS 10500: 1991) guidelines. WHO has proposed guidelines for some pesticides, however there are no guidelines for majority of pesticides [16]. The pesticide residues in food in India, especially vegetables, are the highest in the world. Chemical pesticide residues have often been detected in food grains, vegetables, fruits, oils, cattle feed and fodder in most parts of the country. About 72 per cent of food samples in India have shown the presence of pesticide residues within tolerance levels while in 28 per cent of samples they are above the tolerance level. As a consequence, India accounts for one third of all pesticide poisoning cases in the world [17]. Distribution of pesticides in different environmental compartments is shown in fig 3 and the overview of agricultural technologies and impacts on ecosystem services is given in table 1.

Table 1 Overview of agricultural technologies and impacts on ecosystem services

Technology	Impacts on soil	Impacts on water	Impacts on biodiversity	Impacts on Air/Climate	Case example
Monoculture			Reduces habitat for insects and wildlife, leading to increased need for pesticides		Reduced bird populations in monocropped coffee fields in Colombia and Mexico
Continuous Cropping	Soil fertility declines due to nutrient mining		Reduces farmers ability to use natural pest cycles, leading to increased need for pesticides		Nutrient off take in reduced fallow cassava farms in Kenya and Uganda
Conventional Tillage	Reduces soil organic matter, leading to increased erosion			Contributes to CO2 emissions due to decomposition of soil organic matter	Soil compaction due to tillage in maize fields in Nigeria
Intensive Hillside Cultivation	Increases erosion, leading to soil degradation				Significant soil loss rates due to erosion in Ethiopian highlands
Intensive Livestock	Increases erosion	Untreated livestock	Degrades grassland	Contributes to CH4	Soil degradation and

Systems	and soil compaction due to overgrazing and hoof action	waste degrades water quality; water usage competes with other needs	habitat due to overgrazing	and N2Oemissions due to enteric fermentation and manure management	erosion caused by overgrazing in the Irangi Hills in Tanzania
Inorganic Fertilizers	Increases soil acidification due to nitrate leaching	Reduces oxygen levels due to runoff, Harming aquatic ecosystems; impairs water for human uses		Contributes to smog, ozone, acid rain, and N2O emissions	Eutrophic dead zones in the Baltic Sea, Black Sea, and west coast of India
Pesticides			Harms animal and human health by accumulating in soils and leaching into water bodies		Use of unauthorized pesticide recipes in maize fields in Ethiopia
Irrigation Systems	Inadequate drainage and over-irrigation causes waterlogging and salinization	Degrades downstream ecosystems due to polluted run-off and over-extraction of water			Shrinking of Aral Sea due to over-extraction for irrigation, particularly for cotton cultivation
New Seed Varieties	May increase need for inputs that negatively impact soils	May increase need for inputs that negatively impact water quality and quantity	Reduces maintenance of genetic diversity in landrace varieties	May increase need for fertilizer, leading to increased greenhouse gas emissions	
Intensive Rice Production	Inadequate drainage and continuous flooding causes water logging, salinization, and nutrient problems	Degrades downstream ecosystems due to polluted run-off and over-extraction of water		Contributes to CH_4 emissions due to anaerobic conditions in paddy fields	Over-extraction for rice irrigation in Tamil Nadu, India
Industrial Crop Processing		Degrades downstream ecosystems due to water requirements and discharge of untreated wastewater		Contributes to CO_2 emissions due to energy requirements of machinery	Water pollution near coffee processing plants in Mexico

Source: Compiled by Killebrew, 2010

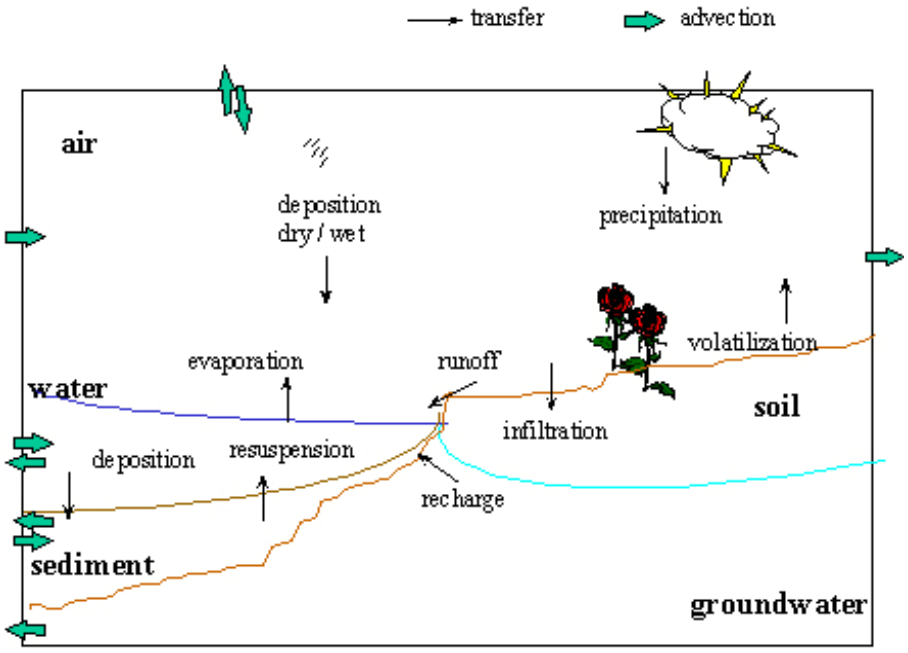

Fig 3 Distribution of pesticides in different environmental compartments [18]

APPLICATIONS

By following and implementing the suggested strategies which are concluded, the problems associated with modern agricultural practices and the use of toxic pesticides can be solved. By a following good sustainable agricultural practice not only reduces the negative effects on environment and also gives higher productivity.

CONCLUSIONS

The unintended environmental consequences of intensive modern agricultural practices are varied and potentially severe. The use of synthetic fertilizers and the absence of sound crop rotation and cover cropping may encourage soil erosion and compaction, reduce the water- and nutrient-holding capacities of soil, and result in poor growing conditions for crops, leading to an increased susceptibility to both pests and pathogens. Intensive use of fertilizers, new pesticides, and tillage are then required to maintain productivity of such systems. This often results in further soil degradation and the unintentional exposure of agriculture workers, wildlife, and the general public to elevated levels of pesticides and nitrates in food and ground water.

To overcome the problems associated with modern agriculture and the use of toxic pesticides, strategic planning should be introduced in the farming systems and the farmers should be trained in such a way to opt for sustainable agriculture using organic manures instead of the synthetic chemicals. Sustainable agriculture which is a new agricultural technique seems environmentally friendly and it is supported by developed countries. Environmentally friendly agriculture has three common applications. These are good agricultural practices, organic agriculture and precision agriculture. Rotation of the crops and sowing of plants belonging to leguminosae helps in the fixation of atmospheric nitrogen reduces the negative effect of agriculture on climate change. Agriculture is one of the key aspects to the functionality of our society. Over the last few centuries we as a society have developed means to improve the efficiently of our agricultural practices which has increased the carry capacity of the earth and allowed for more people to

survive on our planet. With those advances, a great impact on our environment has come too. It is clear that actions need to be taken to prevent further irreversible damage from various sources. However, it will be difficult to find a balance that reduces the negative impacts that are plaguing our environment while still allowing for the practices that provide nourishment to so many in the world. To avoid the risks associated with modern agricultural practices agricultural policies must consider some new parameters such as, 1) massive reallocation of agricultural land use 2) Substitution of current food crops with energy crops 3) Potential contributions of agriculture to global economic development.

To avoid the adverse effects of pesticides on humans and wildlife there should be systems approach to reduce pesticide use. The concept of integrated pest management (IPM), which was first introduced in 1959 would be a better solution for the control of pesticide usage. This combines minimal use of the least harmful pesticides, integrated with biological and cultural methods of minimizing pest losses. There has been a growing concern recently on the promotion of organic farming which emphasize on techniques such as crop rotation, green manure, compost and biological methods of pest control to maintain soil productivity. Organic farming strictly excludes the use of manufactured fertilizers, pesticides, plant growth regulators, livestock antibiotics, food additives, and genetically modified organisms. To control the risks associated with the pesticides use, Pesticides manufacturers should conduct long-term studies on ecosystem-wide impacts to demonstrate that a pesticide has no adverse effects before allowing it to be registered for use in the environment. India had adopted the environment friendly integrated pest management (IPM) approach for combating pests and diseases as a cardinal principle of its plant protection strategy way back in 1985. By adopting the IPM technology on rice, they have not only saved on pesticides but also improved conditions for restoring ecological balance in rich agricultural belt. However, in most cases, farmers gave up this practice and reverted to pesticide use soon after the projects under which they took to it were over. Besides lack of necessary follow-up action on the part of the promoters, there are other reasons as well for the failure of interest in this technology to endure without official patronage [19].

It is recommended to enhance and implement the integrated pest management (IPM) in all the states of India without fail to overcome the problems related to pesticide pollution and exposure to humans and other life forms. Various studies concluded that the farmers particularly the women workers involved in the agricultural practices are being exposed severely to the toxic pesticides during the application of these pesticides in the crop fields. It is also recommended to use proper personal protective equipments during pesticides application in the crop fields and the concerned state governments should supply them with subsidies to the poor farmers under various schemes. Farmers have to be well trained and provided with proper awareness about the problems associated with the toxic effects due to the application of pesticides in the crop fields.

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