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Impact of Pesticide Exposure on Environment and Biodiversity: A Review

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ABSTRACT

The use of pesticide in modern agriculture and public health sector has been increased tremendously. Only 0.1% of pesticide applied to crops truly reaches the target, the rest of it enters into the environment. Several pesticides can persist in an ecosystem for longer periods accumulate in the body tissues of organisms and cause more health problems. Pesticide exposure generally occurs through ingestion, inhalation and skin contact or absorptions by intentionaly or unintentionaly which leads to acute and chronic health problems in non target organisms such as animals, birds, aquatic animals and human. A total of more than 100 articles related to impact of pesticide exposure were reviewed. To review the literature, we reviewed a number of studies, report and abstract between 1950 to 2020 using key words effect of pesticide on animals, birds, human, environment we used this term to search in in PubMed, ResearchGate and google scholar. Searching strategy also include cross-referencing of research and review article Improving epidemiological studies, metabolic studies, residue monitoring and experimental research on pesticide exposure can reduces human health risks of pesticide exposure. This article clearly explains how the pesticide enter into the atmosphere, soil and water and its adverse effect on birds, animals and human, major incidence regarding pesticide exposure and effort should be taken prevent the pesticide poisoning.

Key words: Animals, Birds, Effect, Environment, Human, Pesticide exposure.

In India pesticides are mainly used in agriculture and public health sector (Gupta, 2004). In Asia India is the second largest manufacturer of pesticides and ranks twelfth in world. Worldwide pesticides consumption is about 2 million tonnes per year, in that about 24% is consumed in the USA, 45% in Europe and 25% in the rest of the world. India's share is only 3.75% (Gupta, 2004). Total pesticide consumption in India is about 62,193 MT in (2020) (DPPQS, 2021). In India 1999-2000 out of the total consumption of pesticides 60% are in the form of insecticides, 14% are herbicides, 21% is fungicide and less than 5% are others (Agnihotri, 2000). Pesticide exposure to the human body happens through ingestion, inhalation, skin contact and skin absorptions which results in acute and chronic health problems (Damalas and Koutroubas, 2016). About 64% of global agricultural land (approximately 24.5 million km^2) is at risk of pesticide pollution by more than one active ingredient, in that 31% is at high risk (Tang, 2021). In India, National Occupational Health Centre (NIOH) and Indian Council of Agricultural Research Institute (ICAR) are responsible for monitoring of health status and pesticide-residues in various samples. Roughly 5 billion kilograms of pesticides are applied worldwide per year, which has serious effects on biodiversity, nontarget organisms, and the food chain, risks to the environment and human health (Verger and Boobis, 2013). According to WHO estimates about 3 million cases of acute poisoning occur each year due to the unsafe handling and use of pesticides with 220,000 deaths (WHO, 1990; Blair *et al.,* 2015) 70 % of these deaths are mainly due to occupational exposure (Yerena *et al.*, 2005). The term *"occupational exposure"* refers to a potentially harmful exposure to hazards chemicals in the occupation place (Doxtader, 1992). Occupational exposure to pesticides occurs in agricultural workers in open fields and greenhouses, workers in the pesticide industry and eradicator of house pests. Non-occupational exposure to pesticides happens through eating food and drinking water contaminated with pesticide residue. Environment exposure is via water, soil and air contamination from leaching, runoff and spray drift, which has harmful effects on wildlife, fish, plants, and other non-target organisms (Damalas and Eleftherohorinos, 2011).

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Environmental exposure

The intensive use of pesticide leads to an enlarged risk of contamination of the environment and harmful effects on biodiversity, food security and water resources (Malaj *et al.* 2014; Queyrel *et al.,* 2016). It is estimated that less than 0.1% of pesticide applied to crops truly reaches the target, the rest of it enters into the environment (Pimentel and

Levitan, 1986). Attention to the impacts of pesticide use on the environment and ecosystems is due to the book *Silent Spring* written by Rachel Carson published in 1962. Several pesticides can persist in an ecosystem for longer periods. for example, organochlorine insecticides, for instance, are still detectable in surface waters 30 years after their use and had been banned (Larson, 2019). In the food chain, pesticide meet with nontarget organisms and accumulate in the body tissues of organisms and cause more health problems (Lancet, 1989). Pesticide fate in the environment occur in different environmental compartments, such as air (Bedos *et al*., 2002), soil (Barriuso *et al.* 2008), plant (Fantke *et al.,* 2011) and surface and groundwater (Baran *et al.,* 2008). Although pesticides are directly applied in soils and plants, only 1% of pesticide sprayed is delivered to the intended target. For proper management of pesticides, it is essential to accurately assess the status of their contamination in soil, water and air (Knapton *et al.,* 2006).

Pesticides and the atmosphere

Outside the food chain, the atmosphere is possibly the most important medium for long-distance dispersal of pesticides. Drift and evaporation during aerial application, volatilization from crops and agricultural soils, wind erosion of contaminated soils, and emissions from manufacturing and disposal processes repetitively add of pesticides level in the atmosphere. Prevailing air currents transport these pesticides and their alteration products to a great distance (Durham, 1976; Wolfe, 1976).

Spray application

Massive amounts of pesticides are released into the atmosphere while spraying to crops. The amount of a pesticide that grasps a target depends on a number of factors like the amount of material sprayed, the physicochemical properties of the pesticide and dispersion vehicle, the particle size distribution, the height at which the material is released, wind speed and atmospheric turbulence (Polyrakis, 2009). Spray droplets of less than 30-mm volume mean diameter drift great distances (Yeo, 1959; Murray and Vaughan, 1970). According to (Woodwell *et al.,* 1971) during aerial application of DDT to forests, less than 50% reached the target area. More than 40% of the original aqueous spray volume from an air-blast sprayer has been lost by evaporation before the droplets had fallen 11 m (Cunningham *et al*., 1962). According to (Ware *et al.,* 1970) less than 50% of aerially applied pesticides were deposited on agricultural targets in Arizona, during summer months. During spray application spray man, helper and bystander are exposed to pesticide due to drift. so they are advised to wear protection equipment.

Volatilization from crops and soils

Pesticides mainly enter into the atmosphere is through volatilization from treated agricultural soils and plant foliage. This process competes with direct input during spray application. over 90% of the pesticide contamination of the air is only by these two routes (Lewis and Lee, 1976). Factors determining the volatilization process include physico chemicals properties of pesticides, environmental conditions, and agricultural practices. Pesticides sprayed on to fields and used to fumigate soil can give off chemicals called volatile organic compounds, which can react with other chemicals and form a pollutant called tropospheric ozone. Pesticide use accounts for about 6 per cent of total tropospheric ozone levels (UC IPM). Volatilization may leads to the inhalation exposure of toxic chemical which lead to many health problem.

Entrainment as dust

Later reports of pesticide residues in airborne matter collected in non-agricultural areas shows long-distance transport of pesticides in the atmosphere (Tabor, 1965). Collected airborne dust on the coast of Barbados during 1965-1966 and found airborne dust contain 1-164 ng/g of chlorinated pesticides. The dust had originated in west coast of Africa, entrained in the atmosphere, and was transported about 4,500 km by the northeast trade winds (Costa, 2008).

Manufacturing and formulating processes

Atmospheric pollution is mainly associated with the manufacture, formulation, and packaging of pesticides. Rarely, large amounts of pesticides are released into the atmosphere from chemical manufacturing processes due to accidents or carelessness. Table 1 summarizes some incident of pesticide poisoning occur during pesticide manufacturing.

Pesticides and soil

Generally, most of the pesticide comes into contact with soil, which is a major “incubation” chamber for the decomposition.

Table 1: Effect of pesticide during manufacturing.

Year	Place	Chemical	Causes	References
1964	Fort Valley	DDT (formulation plant)	DDT in the air after spraying season 0.004 g/m	(Tabor, 1965)
1970	Chattanooga	Atmospheric emissions of benzoic acid herbicides from a manufacturing plant	Extensive plant damage	(Heggestad, 1974)
1976	Seveso	About 3,000 kg of chemicals was Released into the air. (2,4,5-Trichlorophenol)	Cancer in experiments with animals	(Bertazzi *et al.* 1997)
1984	Bhopal, India	40 ton of methyl isocyanate escaped into the air, spreading 8 km downwind	2500 people killed 4000 animals died cause damage to crops, fishes	(Lancet, 1989)

Pesticides do not remain stationary in the soil, but they move within the soil. They move by both diffusion throughout the medium and mass flow of the water in the soil (Polyrakis, 2009). Usually, nonpersistent pesticides disappear in less than 1 month from soil, while moderately persistent chemicals take from 1 to 3 months. Persistent pesticides are present for many months after application (Doxtader, 1992). Applied pesticide can be completely degraded by chemical degradation, photodegradation, degradation by soil microorganisms, leaching, adsorption-desorption, uptake by higher organisms and aerial movement. Common landscape herbicides disrupt this process: triclopyr inhibits soil bacteria that transform ammonia into nitrite (Pell *et al.,* 1998), glyphosate reduces the growth and activity of free-living nitrogen-fixing bacteria in soil (Santos and Flores, 1995) and 2,4-D reduces nitrogen fixation by the bacteria that live on the roots of bean plants(Arias and de Peretti, 1993), reduces the growth and activity of nitrogen-fixing blue-green algae (Singh and Singh, 1989) and inhibits the transformation of ammonia into nitrates by soil bacteria (Frankenberger and Tabatabai, 1991). The growth of certain species of mycorrhizal fungi were inhibited by oryzalin and trifluralin. (Kelley and South, 1978).

Pesticides and water

The main purposes of water used by human beings is for public water supply, aesthetics and recreation, agriculture, industry and aquatic life. The applied pesticides might reach surface and groundwater through runoff, run-in and leaching (Bicki, 1989).

1. *Runoff* means pollutants are physically transport over the soil surface by rain or irrigation water that does not soak into the soil. Pesticide runoff can occur either with the pesticide as a solute or pesticide as adsorbed soil particles (soil erosion).
2. *Run-in means* pollutants are physically transport directly to groundwater in areas of karst carbonate (limestone) aquifers, which contain sinkholes and porous or fractured bedrock. Rain or irrigation water can take pesticides through sinkholes or fractured bedrock directly into groundwater.
3. *Leaching* the greatest potential for pollution effects of pesticides is through contamination of the hydrological system. Through primary pathway water pesticides are transported from the site of their first application to other areas of the environment.

Pesticides and surface water

Pesticides can reach surface water through runoff from treated plants and soil (Kole *et al.,* 2001). Pesticides were detected in all samples from major rivers with mixed agricultural and urban land use influences and 99% of samples of urban streams (Bortleson and Davis, 1987) The surface water pollution by pesticides consists of two main categories, *i.e.*, intentional and unintentional. Intentional includes the direct application of pesticides to water to control harmful insects or waterweeds. Unintentional pollution of water occurs in some cases, *e.g.*, during the spraying of crops near streams, lakes, dishes, etc. Also, pesticides frequently volatilize into the air. They may then return to the ground through rainfall, Organophosphorus insecticides and carbamates, and generally the new generation of compounds will not create side effects like chlorinated hydrocarbons and degraded in a period of 2–4 days in lakes and marshes. Also, the pyrethrin deltamethrin has an active life of 1 h in water (Polyrakis, 2009). Pesticide pollution that occurred in surface water are discussed in Table 2.

Pesticides and groundwater

Pesticides applied to a site moved downward along with rain or irrigation water, reaching the water table below is known non-point source pollution. Pesticides may enter directly into ground from spillage or back-siphoning is called point source pollution. Pesticides continue to break down slower rate after reaching groundwater because of less available light, heat, and oxygen. When groundwater becomes contaminated, the polluted water may eventually appear in the surface water of streams, rivers, and lakes. Even if the contamination is stopped, it may take years before an aquifer can purify itself through natural processes (Polyrakis, 2009).

In India, 58% of drinking water samples drawn from various hand pumps and wells around Bhopal were contaminated with organochlorine pesticides above the EPA standards (Kole and Bagchi, 1995). Whether a pesticide to reach groundwater determine by three major factors. They are pesticide properties (persistence and adsorption), soil properties (permeability, organic matter, soil texture, structure, and moisture), and site conditions (including rainfall, irrigation, and depth to groundwater.

Pesticides and biodiversity

Biodiversity means variety of life (plants, animals, and microorganisms) exist in the surrounding environment also consider the number of species present, the amount of genetic variation within a species, and the habitats in which the species live (Polyrakis, 2009). About 25-50% of aerially

Table 2: Pesticide pollution on surface water.

Chemical	Place	Causes	References
Lindane, 2,4-D	Spain and in Italy	Rainwater, 3% drinking water	(Polyrakis, 2009)
Chlorinated hydrocarbons	Greece	Drainage basin of the Pinions river about 1,800 tons of pesticides is rejected per year, and 200 tons of these compounds ends up in Pagasiticos Bay Detect in Salonica Bay and in the dead body of some mussels	(Chrysoyelos, 1988)

applied pesticides and 70-90% of ground-applied pesticides truly reaches the target area (WWF, 1999). The remaining chemicals cause potential to impact nontarget organisms (vertebrates, invertebrates, microorganisms and plants) and widely spread in the environment. by numerous ways pesticides can "drift" from the site of application which include transport of airborne particles *via* air currents, runoff from fields into surface waters, leaching through soils into groundwater, transport by ocean currents carrying the pesticides between continents, *etc*.). Some chemicals to persist in the environment for a number of years which the potentially affect an immense variety of wildlife, from birds feeding on infested seeds to polar bears feeding on saltwater fish, hundreds of kilo meters away mode of action is the most significant parameter for the potential impact of pesticides on nontarget organisms. The drawback is that in some cases the mode of action is completely unknown.

Birds exposure

Pesticides can harm or kill birds when they hurt their food resources contaminated with pesticide. Some pesticide cause anorexia or loss of appetite in birds causing them to starve to death. this effect is documented in several large bird that kills during migration. The U.S. Fish and Wildlife Service estimates that 67 million birds die from pesticide poisoning each year and more than 600 million birds are exposed (Pimentel *et al.*, 1992). Once a bird is killed by a pesticide, bird of prey or a mammalian scavenger, feed on pesticide-poisoned prey which can then in turn be poisoned. Raptors such as red-tailed hawks and great horned owls frequently feed on pesticide-poisoned prey. Many experts believe birds are amongst the most vulnerable species when it comes to pesticide exposure and serve as sentinels of the quality of the environment (Wildlife, 1947). According to (Costa, 2008) resident birds in India had the highest residues of HCHs compare to the migratory birds of South India. Major Impact of pesticide on birds include eggshell thinning and decrease in egg production. Various other incidence of bird's mortality due to pesticide exposure are summarized in (Table 3).

Aquatic exposure

Primary route of pesticide exposure to Fish and aquatic animals are dermally while swimming in pesticide-contaminated waters, breathing through gills, orally, by drinking pesticide-contaminated water or feeding on pesticide-contaminated prey. Secondary poisoning is by feeding on dying insects poisoned by insecticides may kill themselves if the insects they consume contain large quantities of pesticides or their toxic by-products (Helfrich *et al.,* 2009). Pesticide exposure to fish and other aquatic animals mainly depends on its bioavailability, bioconcentration, biomagnification and persistence of pesticide in the environment. Pesticides can decrease the availability of plants and insects that serve as habitat and food for fish and other aquatic animals. Sublethal doses of some pesticides can lead to changes in behaviour, inability to avoid

Table 3: Impact of pesticide on birds.

Year	Birds	Insecticide	Place	Effect	Reference
1967	British peregrines falcon	DDE, DDT	England	Caused local mass death of birds and Eggshell thinning	(Peakall, 1993)
1963 -1990	British sparrow hawk and kestrel	Dieldrin, heptachlor	England	Sharp declines in agricultural areas	(Kidd and James,1991
1997	Himalayan Grey headed Fishing Eagle	DDT	India	Eggshell thinning	(Naoroji, 1997)
2009	Japanese quail	Endosulfan	World wide	Lethargy, weakness and diarrhoea	(Prakash *et al.* 2009)
1980 and 2000	Birds	Organophosphates	US	The deaths of about 9,000 birds	(Fleischli *et al.* 2004)
2002	Birds	Monocrotophos	World wide	100,000 bird deaths	(Hooper, 2002)
1991	Mallards	Methyl parathion	World wide	Hatching success was reduced by 43% in comparison	(Bennett *et al.* 1991)
2008	Male roseringed parakeets	Methyl parathion	World wide	Impaired testicular function	(Maitra and Mitra, 2008)
1995-1996	Swainson's hawks	Monocrotophos	Argentina	6000 mortalities	(Goldstein *et al.* 1999)
1984	Songbird and waterfowl	Monocrotophos	louisiana	1100 mortality	(Flickinger *et al.* 1984)
1973	Black- backed gull	Fensulfothion	New zealand	394 mortalities	(Mills, 1973)
1985	Mallard duck	Dielderin	World wide	Affect the aggressive behaviour	(Peakall, 1985)
1991	Small birds	lindane	World wide	Reduce harmone level resulted in decrease egg production	(Herbst, 1991)
1977	Birds	OC	World wide	Chick shows malformed beak and skeleton	(Gilbertson and Fox, 1977)
1991	Birds	OP	World wide	Inability of birds to withstand cold	(Martin and Solomon, 1991)
2013	Water birds	Lindane residues	World wide	Eggs of water birds	(Walker and Livingstone, 2013)
1991	Birds	Diazinon to lawns	US	1000 of birds killed	(Tattersall, 1991)

Table 4: Impact of pesticide on Aquatic animals.

Insecticide	Place	Effect	References
Herbicide acrolein rid of weeds irrigation channel	Torrumbarry Irrigation Channel	Fish, yabbies and aquatic life dead	(Dalton, 2021)
Insecticide-treated mosquito nets (ITN) used as fishing nets	Sub-Saharan Africa	Endanger the health of fisheries as well as humans	(Chacko, 2021)
Carbaryl and 1-naphthol	India	Carp L. rohita very sensitive	(Madhuri *et al,* 2012)
Toxicologic impacts of 'pesticide mixtures'	US	Salmon and steelhead listed as threatened or endangered	(Laetz *et al.* 2009)
Organophosphate (OP) and N-methyl carbamate	US	Interfering with cholinergic neurotransmission in both human and fish	(Laetz *et al.* 2009)
Chloropyrifos	Niger delta water	Deleterious effect on survival, body, haematological process in tilapia guineensis fish	(Singh and Srivastava, 1992)
Savin, alachlor, roger	World wide	Increase in Erythrocyte sedimentation rate in clariasbatrachey ,heteropneusies fossilis	(Kumar and Benerjee, 1990)
Atrazine	World wide	Cause kidney damage in rainbow trout	(Oulmi *et al.* 1995)
Endosulphan residue soil	Cotton field	Use by local population to catch fish. toxic to fish	(Satyavani *et al.* 2011)
DDT dieldrin	Africa	Affect reproduction and has behavioural effect on African fish	(Saoke, 2005)
Expired pesticide	World wide	Alter PH leads to acute toxicity of fish	(Satyavani *et al.* 2011)
HCH isomers	Kara Sea	Tissue of ringed seals	(Nakata *et al.* 1998)
Endosulfan	Winam Gulf	Most polluted part of this lake and poisoning of fishes	(Sharma *et al.* 2019)
Endosulfan	Tadpoles	Kills the tadpoles and causes behavioural and growth abnormalities	(Raloff, 1998)
Atrazine	Frogs	Turn male frogs into hermaphrodites, decreasing their ability to reproduce	(Manea *et al.* 2017)
Glyphosate	World wide	Sublethal effects such as erratic swimming and laboured breathing	(Liong *et al.* 1988)
Heavy metals, organochlorine pesticides and polychlorinated biphenyls (PCBs)	Ganges river basin	River dolphins have been dwindling and face the threat of extinction	(Kannan *et al.*, 1993)

predators, lowered tolerance to extreme temperatures, weight loss and impaired reproduction (Helfrich *et al.,* 2009).

Current studies of major rivers and streams documented that 96% of all fish, 100% of all surface water samples and 33% of major aquifers contained one or more pesticides at detectable levels. The pesticide used for lawn treatments are most commonly found. pesticides at low level concentrations are highly toxic to aquatic wildlife and which decreased their populations by nearly 70 per cent. OC insecticides and pyrethroids PYs, especially synthetic ones, is the toxic group of insecticides to fish and aquatic invertebrates. PYs are highly toxic to aquatic animals because they are strongly absorbed to bottom muds (Anderson, 1989).

OP insecticides can bioconcentrate in tadpoles, frogs, fish, and toads to levels that stance hazards to their predators. OP and CB insecticides are water soluble and metabolized quickly. They generally have short persistence and so their residues do not long-term problems for aquatic animals. The CB insecticide is extremely toxic to wildlife and fish (Helfrich *et al.,* 2009). Fish kills occur when pesticides are improperly applied or mix in water bodies through drift or misapplication (Sharma *et al.,* 2012) accidental killing due to contamination in most common (Modra and Svobodova, 2009). Herbicide had more impact on aquatic animals. Table 4 lists various effect of pesticide on aquatic animals that occur in different part of world.

Animals exposure

Poisoning is an important cause of wildlife mortality, and is responsible for extensive population declines (Green *et al.,* 2004) Primary exposure to poisons happens when wildlife is intentionally poisoned for hunting (Ogada, 2014) nor due to human-wildlife conflict (Venkataramanan *et al.,* 2008). Accidental poisoning may occur by secondary exposure to poisons in the environment or via contaminated food source. Amphibians are now considered the most threatened and rapidly decreasing species on Earth. (Brühl *et al.,* 2013) suggested that frogs are sensitive to the toxicity of pesticides that are currently used in agriculture. OCPs are among the

Table 5: Impact of pesticide on animals.

Chemical	Animals	Effect	References
Lindane	Rats	Residues have been found in liver, fat, blood, brain and muscle tissue	(DeJongh and Blaauboer, 1997)
Organochlorine pesticides	Endangered species, Humboldt penguins (*Spheniscus humboldti*)	Presence of organochlorine pesticides in blood	(Adkesson *et al.* 2018)
Imidacloprid	Chimpanzees and baboons in Uganda	Congenital deformities and reproductive problems	(Krief *et al.* 2017)
Warfarin	Four wild boars (*sus scrofa*)	Dead in kerela	(Radhakrishnan, 2018)
Trichlorfen	Guinea pig brain	Teratogenic effects	(Hjelde *et al.*, 1998)

Table 6: Incident of pesticide poisoning on human.

Year	Chemical	Place	Effect	References
1960	lindane	Nigeria	Many reported cases of human poisoning	(Osibanjo and Jensen, 1980)
1960	2,4,5-T herbicide for forest defoliation.	Vietnam war	High birth defect rates recorded	(Frumkin, 2003)
1962	Seed grains treated with hexachlorobenzene	Turkey	3000 people were poisoned and 330 died.	(Osibanjo and Jensen, 1980)
1968	Meal of bakery products contaminated with parathion	Mexico	Severe poisoning and deaths	(Osibanjo and Jensen, 1980)
1976	Malathion poisoning of 7 500 public health field workers;	Pakistan	5 deaths recorded.	(Osibanjo and Jensen, 1980)
1987	Flour contaminated with aldrin.	Peru,	Fourteen children and 1 man died and 260 people became ill	(Osibanjo and Jensen, 1980)
1958,	Wheat flour contaminated with parathion	Kerala	Over 100 people died	(Karunakaran, 1958)
2014-2018	Use monocrotophos in cotton	Maharashtra	272 farmer dead	(Mohan, 2018)
1995	Endosulfan cashew plantation	Kerala	500 deaths from 1995, The health of more than 9000 persons has been impaired	(Mathew, 2009)
2007 to 2016	Organophosphates	Jiangsu Province.	1705 deaths	(Wang *et al.,* 2019)
1999	HCH isomers	Asia, Africa, Europe and America	Human breast milk infants of humans may be exposed	(Sang *et al.*, 1999)

substances restricted or banned globally under the Stockholm Convention on Persistent Organic Pollutants (Programme, 2001). These compounds are environmentally persistent (Dimond and Owen, 1996), toxic and apt to bioaccumulation (Nakata *et al.*, 2002) and have adverse effects on animals (Doxtader, 1992). Even though these

Table 7: Human Diseases due to pesticide exposure.

Chemicals	Effect	References
OC exposures	Transferred from maternal to fetal tissues through placenta and mother to infant through breast milk.Production of thyroid hormone is thought to be inhibited by cyhalothrin, amitrole, pyrimethanil, and fipronil.Fertility of both women and men may be decreased with increased pesticide exposure.	(Allsop *et al.* 2015)
Chlorpyrifos	Brain anomalies in children exposed prenatally	(Rauh *et al.*, 2012)
lindane and DDT	Hyper α lipoproteinemia	(Carlson and Kolmodin Hedman, 1972)
Chlordecone (kepone)	Anxiety and tremour, personality change, oligospermia, pleuritic and joint pains, weight loss and liver disease	(Cannon *et al.* 1978)
Dieldrin, toxaphane, chlordane and endosulfan	Estrogenic effects	(Soto *et al.* 1995)
OP	Turner's syndrome	(Recio *et al.* 2001)
OP's and carbamates	Inhibit cholinesterase (ChE) enzyme	(Summerford *et al.* 1953)
Organochlorine pesticides and organophosphate pesticides	Non-Hodgkin's lymphoma (NHL) cancers	(Koutros *et al.* 2019)
Carbamates, organophosphates and DDT	Leukaemia	(Monge *et al.* 2007)
Organochlorine insecticides	Prostate cancer	(Settimi, 2003)
DDT manufacturing workers	Pancreatic cancer	(Garabrant *et al.*, 1992)
Exposure to arsenical compounds vineyard workers	Lung cancer	(Lyon, 1994)
High-level exposure organophosphates (OPs), carbamates, Organochlorines, fungicides, andfumigants	Mild cases display symptoms including headache, dizziness, nausea, vomiting, pupillary constriction and excessive sweating, tearing and salivation. More severe Causes develop muscle weakness and muscle twitches, changes in heart rate, and bronchospasm convulsions and coma.	(Keifer and Mahurin, 1997)
Organophosphate	Induced delayed polyneuropathy (OPIDP) well-characterized syndrome involving sensory abnormalities, muscle cramps, weakness, and even paralysis, primarily in the legs.	(Lotti and Moretto, 2005)
Organochlorines, organophosphates, or carbamates	Parkinson's Disease At least one million Americans have PD and about 50,000 new cases are diagnosed each year.	(Xu *et al.* 2020)
Organochlorine pesticides and their metabolites (OCPs), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs)	Amyotrophic lateral sclerosis (ALS) 16,000 - 20,000 Americans are living with ALS.	(Filippini *et al.* 2020).
DDT or DDE	Alzheimer's disease (AD) 5.3 million Americans are living with Alzheimer's disease.	(Richardson *et al.* 2014)
Organochlorine (OC)	DementiaAccording to the World Health Organization (WHO), 50 million people are living with dementia, globally, with the syndrome affecting 10 million people every year.	(Lee *et al.* 2016)
OCPs, especially HCH.	Epilepsy and Seizures four million Americans live with the dysfunction	(Arora *et al.* 2013)
linuron	Multiple Sclerosis 250,00 to 350,00 people, with 200 new cases each week.	(Wheeler *et al.* 2019)
Ganophosphate insecticide, chlorpyrifos (CPF)	Huntington's disease	(Dominah *et al.* 2017)

substances are stored in the fat and muscles of the animals, some of them can also be found in the brain, lungs, liver, and other offal. Because milk and other dairy products contain a range of fat, these foods also contain a number of pesticides. Table 5 summarize the various effect of pesticide exposure on animals.

Humane exposure

Human are directly exposed to pesticide by missing personal protective equipment (gloves, goggles, respirator, long pant, cap) and drift while spraying. Indirect exposure is by work in pesticide treated area, drift from neighbor field, contact with residue from crop field. (Damalas and Koutroubas, 2016). Pesticide exposure causes acute health problems like *e.g.*, dizziness, headaches, nausea and skin problems. Chronic health effects like *e.g.*, asthma, allergies, hypersensitivity, cancers, hormone disruption, neurological disturbance and respiratory diseases. For women reproduction, fetal development, cause early menopause and development of the child in later life (van der Maden *et al.,* 2014). These substances are stored in the fat and muscles of the animals, some can also find in the brain, lungs, liver and other offal. Because milk and other dairy products contain a range of fat, these foods may also contain a number of pesticides. Different incidents that occur due to pesticide exposure on human are discussed in (Table 6). Intentional or unintentional exposure of pesticide to human may cause acute and chronic health problems. Organophosphate, organochloride, and carbamate insecticide plays major role in causing such disease (Table 7).

CONCLUSION

The evaluation of the occupational exposure of farm workers to pesticides is an essential part of the risk assessment for product safety and regulatory purposes. Exposure of toxic pesticide has detrimental effect on non-target organism. Pesticide exposure can be reduced by using personal protection equipment while spraying. training for farmer regarding how to handle pesticide. use of less persistent pesticide, Alternate method of pest control like IPM, biocontrol and biotechnological approach can be used to control pest and using robotics in pesticide spraying.

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