



# IMPACT OF PESTICIDES ON REPRODUCTIVE BEHAVIOUR OF VERTEBRATES: A REVIEW

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## Abstract

Pesticides have been widely used in various fields of science. So, there is a need of understanding their hazardous effects on the growth, development, and reproduction of various organisms. There are different types of chemicals like insecticides, fungicides, and herbicides are used for pest control but simultaneously they are proved as a source of threat to the reproductive health of Vertebrates. Certain current reports have suggested that many pesticides and related chemicals are persistent in the environment and assembled in the fatty tissue of organisms and grow in concentrations as they move up via the food web and ultimately cause ill effects by interrupting with hormone system of the body. This review revolves around the adverse effects of Pesticides on the reproductive health of Vertebrates.

**Keywords:** - Pesticides, enzymes, hormones, mammals, birds, fish, reptiles and amphibian.

## Introduction

Pesticides are the substances or mixture of substances or mixture of substances that are intended for preventing, destroying, or lessening the damage of any pests. They can also work as plant regulators, desiccants, or defoliant. Pesticides are broadly classified into different categories such as Fungicides, Herbicides, and Insecticides that show effectiveness to particular pests, fungal diseases, and different weeds. The grouping of pesticides can also depend upon their chemical composition namely Organochlorines, Organophosphorus, Carbamates, Pyrethrin, and Pyrethroids.

Pesticides have advantages as well as disadvantages. They can restrain pests but can also kill other organisms. The advantages of pesticides are; they help in improving the crop quality and supply. They also help in preventing diseases that are found in fresh fruits and vegetables. The disadvantages include the promotion of genetic resistance and the creation of new pest species.

There has been a concern concerning the effect of chemical pesticides on organisms and the environment. Although Pesticides are beneficial, they are proved hazardous to organisms as well as to the environment.

The endocrine system consists of a series of glands that generate and secrete hormones that the body uses for a variety of functions. It regulates development, growth, reproduction, etc. In case an event interrupts the endocrine system, several organs will not receive the correct number of hormones and might not function accurately. In this view, some low levels of pesticides in the environment have diminished the endocrine system (*Bergman A et al., 2012*). Therefore, Pesticides and some related chemicals are the substances that adversely affect by interrupting the body's hormones in some ways. Hence these pesticides are called Endocrine disruptors or Hormone disruptors.

As we know hormones play a vital role in the developmental processes so, the vulnerability towards endocrine-disrupting substances in the womb or egg in the case of mammals has changed the normal procedure of development. Later on, it was seen that most of the observations were concentrating on estrogens; the synthetic or natural compounds that extract a feminizing impact by linking to the cellular estrogenic receptor in organisms, and this interaction caused several developments and reactions.

Certain problems related to the environment concerning estrogenic compounds were seen to occur primarily in aquatic habitats like male fish feminization (*Jobling, S. et al., 1998*).

The Pesticides and the related chemicals that have emerged from human activities like agricultural farming are released either directly or indirectly into water bodies. And the presence of such chemicals in the environment has become a serious global concern. Various studies have shown that these chemicals interact with the endocrine system and have affected the growth and development of invertebrates including amphibians, reptiles, birds, fish, and mammals.

According to Ewing, R.D it was observed that pesticides can also interfere with certain other hormonal processes like thyroid and its impact and its impact on the development of bone (*Ewing et al., and R.D et al., 1999*).

Pesticides have toxic effects on a variety of animal species and they are associated with different diseases like endocrine disruption, defectiveness in the growth of the fetus, and the chances of abnormalities in the sperm. The organisms which are vulnerable to pesticides are likely to have more chance of change in the behavior of an organism which influences its capability of survivorship. Many endocrine disruptors can cause hormonal changes in the body of an organism influencing its fertility rate and other reproductive problems.

This paper reviews the adverse impact of pesticides and related chemicals on the hormone system in amphibians, reptiles, birds, fish, and mammals.

## Impact of pesticides on Reproductive health

Due to the widespread use of pesticides in various fields of science, there is a need to investigate their adverse effects on the growth and development of various organisms. Therefore, it is very necessary to assess the toxic effect of pesticides on the reproduction of various vertebrate species. So, in this review, we will understand the harmful effect of pesticides on reproduction against various vertebrates.

### A) Fish

It was demonstrated by the researchers that the species of fish are found to be sensitive towards enzyme and hormone disruptors. Chronic exposure to low levels of pesticides may have a more significant impact on fish populations rather than acute poisoning. According to Kegley, it was assessed that the doses of pesticides that are not enough to kill the fish are linked with subtle changes in behavior and physiology that reduce both reproductions as well as survival (Kegley *et al*, 1999).

It was also seen that the biochemical changes that were induced by pesticide stress lead the way towards metabolic disturbances, reduction in fecundity and longevity of species, inhibition of important enzymes (Murty *et al.*, 1986). The organs like the Brain, Kidney, Liver, and gills were found to be the most vulnerable organs of a fish revealed to the medium accommodating any type of toxicant.

Evidence suggests that the fish showed restlessness, swift body movements, excess mucous secretion, color change, and loss of balance while exposing to a mixture of pesticides (Haider *et al.*, 1986). Although certain agrochemicals affected the fish directly in interrupting their food supply or altering the aquatic habitat even when the concentrations were too low to affect the fish directly.

It was also assessed that interference with endocrine hormones impacted the reproduction of fish. In the case of fish, it was seen that the endocrine disruptors interrupted normal development and therefore caused male fish to have female characters. Many researchers have determined that due to the mimic's effect of pesticides there is a decrease of sex steroid hormones which ultimately results in the suppression of the synthesis of endogenous estrogen (Folmar *et al.*, 1996).

It was also observed that both the testosterone and estradiol hormonal levels were different in consonance with the reproductive cycle of fish (Rothbard *et al.*, 1987). Evidence suggests that the exposure of *Heteroneptus* fossils to a sublethal amount of Malathion almost for 72 hours; reduced the estradiol hormone (Dutta *et al.*, 1994).

It was assessed by the previous studies and experiments that Malathion and dimethoate have a significant role in the semen quality of *O. niloticus* after 24-day treatment. It was seen that there was a notable increase in the concentration of sperm cell and sperm motility with significant extension in tail deformity (Eman *et al.*, 2011).

It is therefore concluded that our aquaculture is at high risk from these endocrine-disrupting pesticides that are evacuated to water through direct or indirect ways and affect the reproduction of fish. So, the agricultural drainage water containing these pesticides should be avoided.

**Table 1: Effect of pesticides on Fish**

Pesticide	Result
Malathion and Dimethoate	It lowers sex steroid hormones (estradiol and testosterone).
Chlorpyrifos (CPF)	Cause behavioural, endocrine and other effects at low doses

## B) Amphibians

There has been a huge concern over the decline of amphibians all over the world that has spotlighted the importance of operating this group as a bio indicator of climate change and Environmental contamination. It has been seen that Pesticides and fertilizers are responsible for the amphibian decline and ultimately cause chemical pollution. It has also been seen that the health of amphibians has suffered from exposure to pesticides (*Lips et al., and K.R et al., 1998*).

It has been seen that due to the semipermeable skin of amphibians the development of eggs and larvae in water and their position in the food web they are prone to adverse effects of waterborne and airborne pollutants in the breeding and foraging habitats (*Bishop et al., and C.A et al., 1992*).

The researchers have also assessed that the pesticides have affected amphibians in several ways as they have killed individual amphibians either directly or indirectly through various changes in neurological or immune systems. Certain pesticides like herbicides and nematocysts are documented to have endocrine-disrupting effects (*Crain et al., 1997*).

According to the studies it has been determined to date that there are no reports found that link the endocrine dysfunction with amphibian malformations. However, it is seen that pesticides and related chemicals are proved a major threat to aquatic wildlife and ultimately result in diminishing productivity and fecundity.

It has also been assessed that the normal growth and development of amphibian larvae depend upon functional and uncontaminated aquatic systems. The water resources are found to be at risk of contamination of pesticides due to the accumulation and distribution of contaminating substances. So, the endocrine-disrupting hormones that were accumulated in aquatic systems have adversely affected the amphibian reproductive process.

According to some previous studies it has also been determined by the researchers that the tadpole stage of Ranna species is sensitive to Organochlorine pesticides and the toxic effect of these pesticides are evident during metamorphosis (*Cooke AS et al., 1971*).

It has been observed that due to the excessive use of pesticides in some countries from the past few years the mortality rate of amphibians is at very high risk for their decline (*Mann RM et al., and Hyne RV et al., 2009*). Hence there is a need for precautionary measures to control the mortality rate of amphibians.

**Table 2: Effect of pesticides on Amphibians**

Pesticide	Result
Organochlorine Compounds	They result in damaging the health effects especially liver and reproduction system.
Pyrethroids	Drastic effect of CNS.
Herbicides, Nematocides	Endocrine disrupting effects.

### C) Reptiles

As we know some reptiles do occur in agricultural landscapes. It is seen that there are very few studies on reptiles, but the studies that exist propose that pesticides can cause toxic effects on reptiles as well. Therefore, the possible endpoints are summarized for reproductive toxicity and endocrine dysfunction in reptiles.

It was determined by the researchers that the status of freshwater turtles in Southeast Asia resulted in growth in a number of these species. It was found that there was a decline in the population of an alligator in Apopka Lake due to contamination by Organochlorine Pesticides. It was also documented that there were certain abnormalities in Juvenile and hatchling alligators which include some modifications of enzyme activity, sex hormones, etc (*Guillette et al., 1994*).

It was assessed that the Pesticide related chemicals are found to be weak androgen receptors, the hypothesis that the individual and population-level effects that are noticed in alligators due to endocrine function seems appropriate (*Ankley et al., 1998*).

According to the previous studies are done it was seen that the lakes contain contaminants which include PCB, furans, dioxins, and Organochlorine Pesticides. The incidences of unhatched eggs, abnormal development were found at high rates in those sites which were most contaminated (*Shirose et al., 1995*). The correlation between contaminated eggs and decreased developmental success was also seen (*Bishop et al., 1991*).

### D) Birds

As we know birds are very distinct in the landscape. So, the injuries to populations of birds from various environmental pollutants, pesticides, and other related chemicals are obvious signals of environmental damage. In the case of birds, the initial organization of the gonad is similar with an indifferent gonad developing as a genital ridge protruding into the dorsal body cavity cranial to kidneys. Primordial germ cells (PGC) which originate as extraembryonic cells in the yolk sac of both birds and mammals migrate into indifferent gonads at mid-gestation. So, in the case of birds, the PGC migrate into the default location of seminiferous tubules in the case of males (*Romanoff AJ. et al., 1960*).

It was also seen that the development of ovarian architecture takes place when the estradiol is synthesized by the gonad leading to localization of PGC in the cortex of the left ovary rather than in the presumptive seminiferous tubules (*vom Saal FS et al., 1992*).

It was observed that the notorious effect of environmental pollutants on birds was thinning of eggshells due to DDE; this ultimately results in crushed eggs and the breeding failure of many birds (*Gress F et al; 1973*) (*Hickey JJ et al., 1968*). The thinning of eggshell is related to DDE inhibition of shell gland calcium ATPase (*Kojala GJ et al., and Lundblom CD et al., 1979*) and the species most vulnerable to eggshell thinning appears to have reduced ability to metabolize organochlorines (*Schwarzbach et al., 1990*).

It was also observed that the Organochlorine pollutants and Organophosphate's pesticides also affected the breeding behavior of exposed birds.

Later on, studies showed that the effects of pollutants on reproduction were mediated at many different physiological levels. The variety and range of effects have been impossible to predict due to biochemical mechanisms of side effects of agricultural chemicals that were unrelated to specific mechanisms of action of the designed use.

Hoffman has summarized that the direct application of toxicants at high levels to wild bird eggs mostly occurs rarely in the wild, but it was also seen that it may occur through transfer of contaminants like spilled petroleum oil from the plumage of contaminated incubating birds or the direct application of the agricultural chemicals to eggs in nests adjacent to agriculture.

It was also found that the positive value of monitoring wild populations of birds demonstrated with the observations of ecological injury that have emerged due to the misuse of pesticides and irresponsible pollutant disposal. Therefore, the adverse effects of chemicals on wildlife have been signs for implementation of new laws and regulations to avoid its toxic effects on different species, but only through continued wildlife monitoring will new, unexpected side effects of chemicals in the environment be observed and corrected.

**Table 3: Effect of Pesticides on Birds**

Pesticide	Result
Endosulfan	Cause abnormalization of embryos of both males and females by accumulating into the egg yolk.
Organochlorine	Affect the survival and hatchability of eggs with bioaccumulation of dioxins and silinium and also causes hormonal disruption of breeding birds and abnormalities in their off springs.
DDE	This results in the thinning of egg shells which causes the crushing of eggs breeding failure of many sensitive raptorial and fish-eating birds.
PCB's	GLEMEDS (Great lakes embryo mortality, edema and deformity syndrome). Cause consistent pattern, beak malformations, cardiac edema and skeletal malformations.

### E) Mammals

The hormonal and cellular systems of animals; under chronic exposure play an important role in reproduction and are affected adequately. It was determined by the researchers that various pesticides are related to environmental affairs and giving rise to various reproductive problems in the case of humans. It was also seen that certain insecticides act as endocrine disruptors and damage the reproductive hormone pathways. Originally some endocrine disruptors cause hormonal changes in the body ultimately leading to an impact on steroid hormones. According to the studies it was assessed that Organochlorines have adversely impacted the testosterone level and sperm count (*Sai L et al., 2014*).

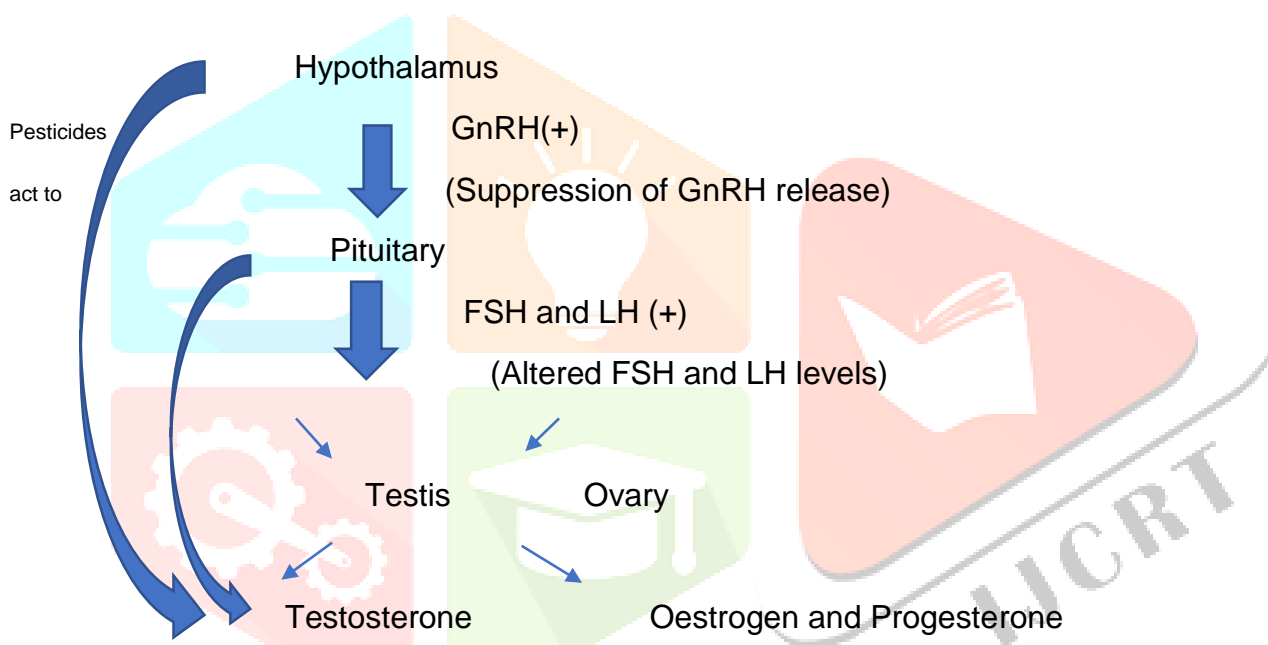
According to the previous works done by the researchers it was assessed that organochlorine has a source of impact on the health of humans especially the reproductive system for both men as well as women. According to Frazier LM. In the case of men, there are chances of abnormalities in the sperm, the reduced fertility rate, and the defectiveness in the growth of the fetus. (*Frazier LM et al., 2007*) There is also an adverse effect on the reproductive health of human females due to the night work shifts like in the case of the staff of nurse which ultimately gives rise to the disorders in endometriosis (*Albert- Sabater et al., 2016*) (*Marino JL et al., 2008*).

According to the previous studies it was observed that due to the advancement in the industrial sector more women started participating in the different work zones and thus vulnerable to the physiochemical and biological constituents. Therefore, the impact of these disrupted the reproductive system leading to changes in the levels of hormones, menstrual cycles, ovarian problems and complications during the pregnancy, and reduction in the fertility rate. The decline in the environmental factors was prone to reproductive disorders (*Rzyski P et al., 2015*). It was also observed that the endocrine-disrupting chemicals (EDCs) perform through the hormone receptors like progesterone, estrogen, and the non – steroid receptors. It was seen that the endocrine-disrupting

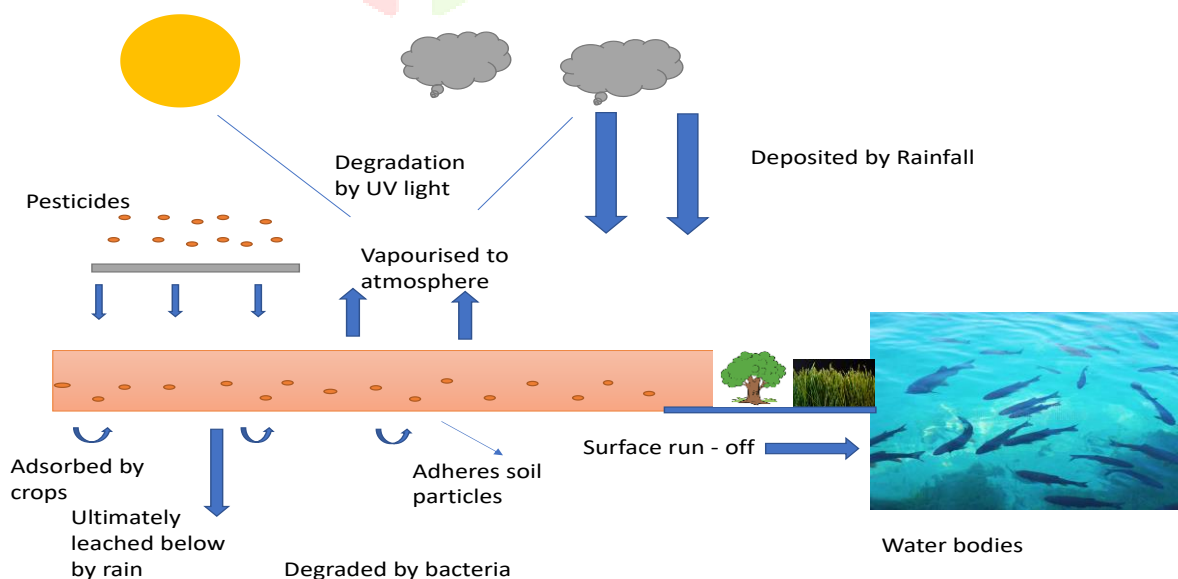
chemicals altered the process of synthesis pattern of hormones. It was also determined that almost the major reproductive health-related issue found in males was infertility due to the diminished semen quality and the quality of semen alters over time. The vulnerability to pesticides has hazardous effects on the rate of human fertility as certain agents are associated with fertility.

**Table 4: Effect of Pesticides on Mammals**

Pesticide	Result
MHC and its metabolized product HPTE.	Target follicles of mammalian ovary.
Organochlorines	Abnormalities in sperm, reduction in fertilization ability.



**Figure 1: Reproductive Toxicity of Pesticides**



**Figure 2: Origin, fate and disposal of Pesticides and their effect in different ecosystems**



## Conclusion

As we know reproduction is one of the most important biological activities and due to the presence of certain harmful pesticides in the environment that imbalances the hormonal level and cause disruption in reproductive health of organisms and has finely turned this delicate system under threat. Therefore, it has been determined that pesticides are responsible for the damage of the reproductive health of organisms in various aspects.

Although it is not possible to completely put an end to the harmful effects related to the use of pesticides we can at least avoid their use in one or another way. If the pesticides are used in minimized quantities only when required then only the possibility of threats can be diminished.

This review summarises the adverse effects of pesticides on the reproductive health of vertebrates. And further studies need to be done to confirm the stability of pesticides in the environment and their ill effects on organisms.

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