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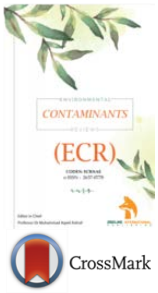

REVIEW ARTICLE

A STUDY ON AGRICULTURAL EFFLUENTS: A HAVOC TO WATER BODIES

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ABSTRACT

Agriculture production has been amplified to overcome the threat of global food security caused due to burgeoning population. Agriculture intensification has led to the intensive use of inputs such as pesticides and chemical fertilizers. Large quantities of agrochemicals, organic matters, drug residues, sediments have been transferred to water bodies through strategic irrigation and rainwater runoff. The trending excessive use of synthetic chemicals by unskilled practitioners in agriculture especially in the case of rural areas of developing countries has resulted in deleterious effects to water bodies. The escalating rate of environmental pollution and pesticide poisoning has engendered dreadful complication in the aquatic ecosystem, which corroborates the loss of the primary producers like phytoplankton, and biotopes equilibrium. The convergence of pesticides and different chemicals are detrimental in bio-concentration and bio magnification. The judicious use of agricultural inputs has been the matter of prime concern to prevent the incurring impacts in the lentic and lotic water bodies. The possible menace, causes and preventive measures of the threats caused due to haphazard use of chemicals in agriculture, inflow to water bodies and their cumulative effects is presented in paper. An attempt is also made to emphasize on rational use of synthetic chemicals to mitigate the devastating impact on water bodies.

KEYWORDS

Intensification, synthetic chemicals, aquatic ecosystem, bio magnification

1. INTRODUCTION

Large portion of the land and water managed are devoted for Agriculture. Agriculture production has been amplified to overcome the threat of global food security caused due to burgeoning population growth and its intensification has led to the exhaustive use of inputs. Production of better yield per unit area has accompanied by significant intensification of production system, creating new problems for human and its surrounding. The upward push in global fertilizer production and use over the last century has enabled agricultural production to grow and satisfy ever increasing demand for food, fiber and energy of growing population (FAO, 2017a). Expansion of Agricultural land through conversion of wetlands into crop production, deforestation and development of the irrigation infrastructure is at its peak. The area equipped for irrigationhas more than doubled in latest decades (from 139 million hectares in 1961 to 320 million hectares in 2012; FAO, 2014). The amplified trend of expansion of agriculture land, with irrigation is playing strategic role in enhancing production and rural livelihoods whilst transferring agricultural pollution to water bodies.

Livestock sector is growing and intensifying faster than crop production in almost all countries. Progressive and scientific animal husbandry practice has brought a miracle in livestock production sector. Domestication of various animals, their intensive culture system has fueled the livestock production. The overall number of livestock has more than tripled (from 7.3 billion units in 1970 to 24.2 billion units in 2011; FAO, 2016a). A new class of agricultural pollutants has emerged in the form of veterinary medicines (antibiotics, vaccines, and growth promoters [hormones]), which move from farms through water to ecosystems and drinking-water sources. (FAO, 2017b) Zoonotic waterborne pathogens are another major concern (WHO, 2012). Associated waste from livestock, including manure, has serious impactions for water resources. There has been dramatic and rapid increase in aquaculture worldwide in marine, brackish and freshwater environments. Aquaculture has become one of the swiftly growing segments of agriculture around the whole globe, but many people have been unaware of its existence until latterly (Nash, 2010).

Aquaculture has grown more than 20-fold since 1980s, especially inland fed aquaculture and particularly in Asia (FAO, 2016b). As this growth continues to be experienced, there is a subsequent increase in use of resources including land, water, feed, fertilizer, energy and chemicals. Each type of resource used by aquaculture affects the environment and has implications for sustainability of the sector (Verdegem, 2013). The significant increase in production is combined with the inordinate use of antibiotics, fungicides and anti-fouling agents. The waste produced by the use of each these resources are potential pollutants which in turn evokes environmental concerns. All agriculture practices produces the

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residues and their safe management has been the issue for today's world. Agriculture effluents, has been accused of having many terrible environmental impacts including destruction of wetlands and mangrove forests, eutrophication, reduction of biodiversity, alteration of water quality, displacement of people benefitted from eco-system services, complete waste of resources, loss of riparian vegetation, loss of fishing grounds and plenty of others.

2. Composition of agriculture effluents

The major composition of Agricultural effluents are Nutrients, pesticides residues, organic matters, Sediments, pathogens, metals and salts. Primarily nitrogen and phosphorus present in chemical and organic fertilizers as well as animal excreta which are normally found in water as nitrate, ammonia or phosphate wherever intensive agriculture constitutes a significant portion of the landscape (Daniel et al., 1998). In addition to phosphorus, eroded sediment in agricultural runoff may carry pesticides, pathogens, heavy metals, and other pollutants (Blann et al., 2009).

Many agricultural pesticides and herbicides are now regularly detected at low levels in rivers, streams, and groundwater (Coupe et al., 1995; Hatfield, 1998). Herbicides, insecticides, fungicide and bactericide including organophosphates, carbamates, pyrethroids, organochlorine pesticides and others are also present in the drainage water from agricultural land. The herbicide atrazine is the most commonly detected agricultural herbicide or pesticide in surface waters, and is consistently detected in samples from rivers, streams, groundwater, lakes, and reservoirs (Cox, 2001; Gilliom et al., 2007).

Chemical or biochemical oxygen demanding substances (e.g. organic materials such as plant matters residues and livestock excreta), which use up dissolved oxygen in water when they degrade reach water bodies in the form of runoffs in irrigated water or by the rain water. Soil structure of the agricultural land has been deteriorated by tillage. Sediment in the runoffs is the major nonpoint source pollutant of surface water in North America both by mass and effect (Waters, 1995; Zaimes et al., 2004). Heavy metals like mercury, copper, selenium, lead, arsenic etc. and salts like ion of Sodium, chloride, potassium, magnesium, sulphate, calcium and bicarbonate reach to the water bodies by leaching from the agricultural land which are found in water bodies as dissolved solids. Pathogens and bacteria, drugs residues, antibiotics and vaccines are also produced in the livestock farms and aquaculture practiced area as the emergent pollutant which have prodigious impact on water bodies.

3. Effects of agricultural drainage

Several studies has been carried out to evaluate the empirical effects of the pollutants that reach water bodies through various means. Industrial waste, chemical residues as well as urban sewage are the subject of major concern for the environmentalist who are trying to assess pollution of the water bodies. Many tools has been developed in this period of time to access the pollution level of the aquatic environments. Agriculture has been mechanized vastly which has added the production as well as impacts on environments. Agricultural effluents and its impact particularly in water bodies will be a new field to scrutinize for the aquatic ecologists and environmentalists. Fertilizers applied in the crop field are fixed by plant uptake or are washed off from soil surface before plant can take them up. Excess nitrogen and phosphates leach into groundwater or carried by surface runoff to the water bodies.

Phosphates gets adsorbed into soil particles and enter water bodies through soil erosions which are the limiting nutrients of the aquatic system. Pesticides are boon for farmers as they boost agricultural productivity and keep pest away from agricultural commodities. The overwhelming attraction of farmers to the pesticides has raised serious global concern due to their toxicity and long persistency in the environment. A group researchers considered pesticides as the integral part of our society and are being used for diverse activities ranging from crop protection from insect pest, rodents, and fungal disease to animal husbandry and public health applications (Zhou et al., 2006). Most pesticides are persistent organic pollutants (POPs) which are not usually target specific and may cause harm to non-target organisms (Chopra et al., 2010). The stable structure and the lipophilic nature of pesticides especially organochlorines, are toxic to biological organisms and has threaten the ecosystem integrity.

They tend to bio concentrate, bio accumulate and bio magnify and are transferred to higher trophic levels through several food chains, leading to vertebrate and non-vertebrate toxicity in non- target organism and even humans (Ali and Khan, 2018; Nowell et al., 1999; Zhou et al., 2006; Ize-Iyamu et al., 2007; Ogunfowokan et al., 2012; Masia et al., 2013). In the report of WWAP (2017) 80 percent of the municipal waste water is untreated and is ultimately discharged into water bodies, and millions of tonnes of heavy metals, solvents, toxic sludge and other wastes from industries are dumped. Agriculture accounts for around 70 percentage of water abstractions globally and plays a critical role in water pollution (FAO, 2018). Agrochemicals, organic matters, drug residues, sediments and saline drainage from the farms and its resultant pollution loads in river, lakes, aquifers and coastal waters poses demonstrated risks to aquatic ecosystems, human health and productive activities (UNEP, 2016).

4. Impacts on water bodies

The core of development of irrigation facility and drainage from the agriculture land is associated with a loss of water quality caused by the contaminants, pesticides, and fertilizers runoff and leaching. Discharge of excess nutrients forms a major environmental concern because they can cause eutrophication of receiving water bodies such as lake, river, or sea (Cripps and Bergheim, 2000). Eutrophication can lead to numerous other effects which may be more sensitive and pertinent indicators such as changes in: energy and nutrient fluxes, pelagic and benthic biomass and community structure, fish stocks, sedimentation, nutrient cycling, and oxygen depletion (Gregory and Zabel, 1990; Feng et al., 2004; Cao, et al., 2011).

Suspended sediment and turbidity induce physiological stress in many aquatic organisms, reduce water clarity/visibility, and reduce the amount of sunlight available to aquatic biota (Newcombe and Jensen, 1996). A group researcher argue that anthropogenic nutrient enrichment of rivers and oceans might stimulate carbon sequestration (Subramaniam et al., 2008). However, the benefits of carbon sequestration do not outweigh the negative effects of eutrophication of surface and coastal waters (Verdegem, 2013). Smith outline the negative effects on water bodies due to eutrophication (Smith, 2003);

- Increased productivity and biomass of phytoplankton and suspended algae.
- Shifts in phytoplankton composition to bloom-forming species, many of which may be toxic, or which may not be consumed effectively by aquatic grazers.
- Increment in Productivity, biomass and species composition of periphyton.
- Threats to endangered aquatic species.
- Decrease in water column transparency, taste, odour and filtration problems in drinking water supplies and depletion of deep-water oxygen.
- Decrease in the perceived aesthetic value of the water body.
- Negative economic impacts, including decreased property values and reduced recreational uses.
- Productivity, biomass and species composition of aquatic vascular plants can change
- Reduced yields of desirable finfish and shellfish species.
- Health degradation and depletion in size of marine coral populations.

Aquaculture has become one of the swiftly growing segments of agriculture around the whole globe, but many people have been unaware

of its existence until latterly (Nash, 2010). Environmental nitrogen and phosphorus loading is one of the major issue that is jeopardizing the sustainability of fisheries sector. Nitrogenous compounds (ammonia, nitrite, and nitrate) are considered as major contaminants in aquaculture wastewater which are also drained in natural water bodies (Cao et al., 2007). A group researcher sighted that the accumulation of these pollutants deteriorates water quality and increases the incidence of diseases in fish (Amirkolaie et al., 2005). Surface water acidification also causes direct mortality to acid-sensitive fish and aquatic organisms and increases the toxicity of other naturally occurring elements such as aluminum (Blann et al., 2009). Apparently, increasing amounts of wastes affects fish production in water bodies.

Fishes are often at the front line of manifesting toxicological effects when exposed to pesticides in aquatic ecosystems, hence are suitable bio indicators of environmental pollution (Mahboob et al., 2015). Once heavy metals are released into aquatic bodies they persist and can cause bioaccumulation, reaching concentrations in the aquatic ecosystem, particularly in sediment, that could be harmful to humans and other organisms (Gupta et al., 2009). The major concern for pesticide exposure is because of its adverse effects such as reproductive impairment and suppression of the immune system, which can have long-term consequences for fish population viability and transfer to the human consumers (Aguilar et al., 2002).

A research has shown 95% of the sprayed pesticide don't reach to the target site which reaches to the other destination (Transhkent, 1998). Pesticide gets entered into earth surface water through different routes among them runoff due to rain water and irrigation are the major route (Schafer, 2001). From the study metabolites (p,p-ddd and p,p-dde) in muscles, liver, and the brain of Crucian Carp, Common Carp, and Pike from Podlasie province in Poland was reported (Kiziewikz and Czeczuga, 2003). A study has suggested organochlorine pesticide residue in zooplankton and phytoplankton of a tropical estuary of South India which is mainly due to the drainage from agricultural fields adjacent to the estuary (Rajendran et al., 1990; Joiris and Overlopp, 1991). A studied the pesticide bioaccumulation and plasma sex steroids in fishes during breeding phase from north India and reported that catfishes have a higher bioaccumulation of pesticides than carps (Singh and Singh, 2008).

Approximately 38 percent of water bodies are under significant pressure due to agricultural pollution in the European Union (WWAP, 2015). Same is in United States of America, where agriculture is the main source of pollution in rivers and streams, the second main source in wetlands and the third main source in lakes, alongside 90% of the water sources was found to be polluted by the pesticides (US EPA, 2016; Gillion, 2007). Agriculture is accountable for a large share of surface-water pollution and is responsible almost exclusively for groundwater pollution by nitrogen in China (FAO, 2013). There is major disparities between different parts of the world with excess of nutrients and insufficiency. North America, Europe, and parts of South and East Asia is more prone to excessive nutrients discharge in water bodies.

5. Impacts on Human Health

The two principal mechanism that explains the adverse impact of water bodies due to pesticide are bio-concentration and bio magnification. Bio concentration is the development of substance from the encompassing medium into a living being. The essential "sink" for some pesticide is greasy tissue ("lipids"). A few pesticides, for example, DDT are lipophilic, implying that they are solvent in, and collect in, greasy tissue, for example, consumable fish tissue and human greasy tissue. Different pesticides, for example, glyphosate is utilized and discharged. Bio magnification depicts the expanding convergence of a synthetic as sustenance vitality which is changed inside natural way of life. As littler creatures are eaten by bigger living beings, the convergence of pesticide and different chemicals are progressively amplified in tissue and different organs.

High focuses can be seen in top predator i.e. higher trophic level of natural way of life. Mercury, DDT, PCB's, Cyanide and Selenium are the poison that is imperiled to high bio magnification. Mercury is a characteristic substance that is found in little amounts in the water bodies. Human mediation with nature and over the top utilization of pesticide containing mercury has prompted more elevated amounts of mercury in the seas. Green growth reliably retains the mercury which is found in its living space. The zooplankton will devour the green growth and the mercury alongside it. The microscopic fish is then devoured by little fish, which thusly devoured by bigger fishes. Human utilization of such fishes comes about mercury harming. Comparable episode occurred in Japan amid 1932 to 1968 that resulted in the passing of around 1500 individuals due to methylmercury harming because of the consumption of debased shellfish and fishes (Harada, 1995).

6. Conclusion

More indirect and potentially more damaging impacts of the agriculture effluents is water quality degradation and toxicity. Increased nutrient addition, sediment run off are causing adverse impacts on water bodies. In the trajectory of land-use intensification, countries have increasingly adopted a pest management approach based on the use of synthetic pesticides. The fast rate of growth in chemical fertilizers and reliance on broad spectrum pesticide in developing countries is more common. The increase in demand for food with high environmental footprints, such as meat from industrial farms, is also contributing to unsustainable agricultural intensification.

Most of the water used in agriculture practice returns to the environment with considerable quantities of nutrients, oxygen depleting substances and pathogens and, in intensive systems, also heavy metals, drug residues, hormones and antibiotics. When agriculture practice is concentrated, the associated production of wastes tends to go beyond the buffering capacity of surrounding ecosystems. These changes are exerting growing pressure on water bodies. Conservational agriculture, organic farming and pesticide stewardship program can be lunched to minimize impacts on water bodies.

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