


Chapter 23

Agricultural Runoff and Treatment Methods

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ABSTRACT

Increasing global population intensifies the food demand pressure while meeting the increasing environmental legislation. To cater for such demand, agriculture sector shifts for mass food production accompanied with the use of a large amount of agrochemicals such as fertilizers, pesticides, antibiotics, and growth hormones. As a result, these agrochemicals' residues pollute the ecosystem and environment through surface runoff. It has been a great challenge in treating agricultural runoff due to its contaminant loadings and wide variability of different compounds in the wastewater to meet the stringent standards in an economically feasible manner. This chapter delineates the current state-of-the-art of wastewater treatment methods for agricultural runoff.

INTRODUCTION

As the global demands for food is increasing rapidly, the necessity for agricultural research is assured to discover more effective techniques in improving crop production to meet such demand (Tilman et al., 2011). Modern agriculture requests a variety of agrochemicals and sophisticated techniques to more intensive use of available resources of water, land and energy for high crop productions within short period. The innovation of agricultural machinery and genetic biotechnology and application of agrochemicals

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such as fertilizers, pesticides, antibiotics and growth hormones are indispensable agents of the modern farming or industrial agriculture (Edgerton, 2009).

The first recorded use of fertilizers and pesticides in agriculture was around 4000 years ago when first farmers used livestock manure as the nutrient source and sulfur, mercury and arsenical compounds for controlling insects and mites (Unsworth, 2010). For centuries, farmers used easily obtainable or available materials derived from animal, plant or mineral nature. However, the growth in application of synthetic fertilizers, pesticides and steroid hormones accelerated since 1940's and the products such as organochlorines (DDT) and 2,4-D became very popular as an effective and inexpensive pesticides. At first, there was little concern about environmental consequences of agrochemicals application. However, after a decade, there was a growing public awareness about the deteriorate effects of agricultural chemicals on both environment and human health (Kellogg et al., 2002). Although the application of these agrochemicals leads to profound beneficial impact on the plant functions, they are now recognized as potential sources for adverse environmental impacts (Bhandari, 2014).

Since agriculture is the largest user of surface water resources, the main concern is the contamination of waters from agricultural runoff to the surface water. The pollutants containing pesticide residues, fertilizer as well as suspended sediments can be transported over land and through the soil by water and ultimately find their way into rivers, lakes and groundwater, affecting the environmental quality which is much far from their application sites. Additionally, agriculture expansion to support increasing food demand related to global population growth and changes in dietary patterns may further reduce the surface water dilution capacities. Therefore, there is an urgent need to study on the agricultural discharge properties and their appropriate management to protect ecological security and human health in ensuring sustainable economic and environmental development.

AGRICULTURAL RUNOFF CHARACTERISTICS

Agricultural runoff is identified as one of the main diffuse and non-point sources of pollution. It is typically enriched with sediments, nutrients, phosphorus, pathogens, pesticides, steroid, heavy metals, hormone and antibiotics (Kato et al., 2009; Lefrancq et al., 2017; Zhu et al., 2015). Globally, the leaching and runoff from agricultural activities such as dairy, potato processing, sugar processing and so on has contributed to the most widespread environmental threat in recent years (Kim et al., 2014). The runoff severity is closely linked with hydrological conditions (rainfall frequency and rainfall magnitude), anthropogenic alterations (types and changes in land use) and the interactions (Li et al., 2015; Zhu et al., 2015).

One of the most indicative aspects of agricultural runoff is overloading of nutrients in the surface water. Excessive fertilizer applications and intensive livestock productions in the agricultural land is the principal factor of increasing N and P loading in most agricultural basins. It is reported that the increase of mean N concentration in Arizona groundwater is mainly contributed by increased N fertilizer application rates (Xu et al., 2007). Another study also shown that around 80% of total N input to 23 California basins were caused by the use of inorganic fertilizers, legumes and manure in agriculture (Sobota et al., 2009). Meanwhile, livestock generation also causes serious impact on water quality as animal manures are often recycled as organic fertilizers on farmlands (Kato et al., 2009) and occasionally discharge directly into water bodies without any treatment (Ying-Xin et al., 2007). Kato et al. (2009) noted that the high livestock density watershed led to 2-6 times higher average concentrations of different N species in the surface water as compared with those in the receiving water from moderate livestock production

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