The situation and research progress of agricultural non-point source pollution in China

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Abstract. Agricultural non-point source pollution has become an important factor affecting the quality of water environment, and it is also one of the major environmental problems facing in China. This paper analyzed the current situation of agricultural non-point source pollution, summarized the existing research progress and put forward the development trend and tasks in the field of agricultural non-point source pollution in the future, so as to provide reference for government management and researchers in related fields.

1. Introduction

Agricultural non-point source pollution refers to the pollution of water, soil, air and agricultural products caused by the pollutants (sediment, nutrients, pesticides and other pollutants) produced in agricultural production and residents' activities, which not disposed reasonably and discharged through surface runoff, soil middle flow, farmland drainage or underground leakage during the process of precipitation or irrigation. These pollutants mainly come from farmland fertilization, pesticide, livestock and poultry, aquaculture and rural residents' life. With the growth of population, the increase of people's demand for material life and the acceleration of agricultural intensification, the situation of agricultural non-point source pollution is still severe, which has become an important factor causing global environmental pollution, especially the water quality, which is one of the major environmental problems facing in the world.

As agricultural non-point source pollution has the characteristics of dispersion, randomness, concealment and lag, the government and scientific workers pay more and more attention to the treatment of agricultural non-point source pollution. At present, a lot of researches have been carried out on agricultural non-point source pollution in China, which are mainly reflected in the analysis of agricultural non-point source pollution, quantitative research on pollution load, pollution risk assessment and prevention and control technology research. This paper analyzed the current situation of agricultural non-point source pollution, reviewed the existing research progress, and put forward the future research and development trends and tasks in the field of agricultural non-point source pollution, in order to provide reference for government management and researchers in related fields.

2. Situation of agricultural non-point source pollution in China

2.1. The pollution load of planting is still heavy

In 2015, China put forward “the action plan for zero growth of chemical fertilizer use by 2020”, “the action plan for zero growth of pesticide use by 2020”, as well as the “guidance opinions on fertilizer
and pesticide reduction”, “organic fertilizer substitution” and “green development of agriculture” issued by various regions. The overall use of fertilizer and pesticide in China is on the decline trend.

According to the data from the National Bureau of Statistics (Figure 1) [1], the application amount of chemical fertilizer in China (converted into net amount, the same below) showed an upward trend, from 55.62 million tons in 2010 to 60.23 million tons in 2015. Under the control measures such as "zero growth action of chemical fertilizer", it then turned to a downward trend, which dropped to 56.53 million tons in 2018, a decrease of 6.13%.

From the perspective of fertilizer application intensity (Figure 2), the application intensity of nitrogen fertilizer has shown a certain downward trend since 2010, and the application intensity of compound fertilizer has shown an obvious upward trend. However, the total application intensity of chemical fertilizer has been maintained at 318.00-336.10 kg/ha, which is 1.41-1.49 times of the internationally recognized safety limit (225 kg/hm²), and the chemical fertilizer intensity is still very high. The pesticide use in China decreased from 1.78 million tons in 2015 to 1.54 million tons in 2018, a decrease of 15.67%.

The input of agricultural chemicals has been significantly reduced, and the pollution load from non-point sources of planting industry has been reduced to a certain extent. However, there still exist the problems of inadequate technical training, popularization and publicity, and the phenomenon of blind application of fertilizer in some areas, especially in the vegetables, fruit trees and other economic crops. The use of chemical fertilizer and pesticide per unit area (intensity of chemical fertilizer and pesticide) is on the rise, and the risk of environmental pollution is still severe.

Figure 1. Fertilizer application in China during 2010-2018

Figure 2. Application intensity of different fertilizer in China during 2010-2018
2.2. Prevention and control of animal husbandry source pollution is still difficult
Animal manure is the main pollutant in animal husbandry. A large amount of nitrogen, phosphorus, antibiotics, heavy metals and other substances left in livestock manure, if not properly managed, it will bring serious harm to soil, water, atmosphere and even human health. According to the data \cite{1}, there are 243 million tons of feces and 163 million tons of urine produced in animal husbandry in China. The discharge amount of main water pollutants is 12.68 million tons of chemical oxygen demand, 1.02 million tons of total nitrogen and 160400 tons of total phosphorus. In recent years, intensive animal husbandry has gradually developed. As a result of centralized breeding, the discharge of fecal sewage has increased dramatically, and the discharge is not standardized, the treatment technology of fecal sewage is weak, the utilization rate of resources is low, and the discharge can not be used locally; there are also problems such as large volume, large amount of consumption, inconvenient transportation, and no convenient use of application, which make the environmental pollution from animal husbandry quite serious. At the same time, some farms around large and medium-sized cities implement strict "prohibition and restriction" policy, which makes some livestock farms move from the surrounding areas of cities to the countryside, bringing more challenges to the rural environment and agricultural non-point source pollution prevention and control.

2.3. There is still improving room for the utilization of tailing straw
China is a big agricultural country. Behind the high and stable yield of food and vegetables production, there are huge agricultural wastes such as tail vegetables and straw. At present, its utilization mainly includes five modes: fertilizer, feed, matrix, raw material and energy. Due to the different characteristics of straw and tailing, their utilization ways are also different. In particular, the tail vegetables are characterized by scattered resources, high cost of collection, storage and transportation, large water content, many fibers, difficult decomposition and utilization, and low utilization rate. Most of them may be mixed with domestic garbage for stacking. In addition, the original composting technology and biogas technology are not developing fast, the integration degree of agricultural machinery is not high, the centralized mechanized collection and treatment of tail vegetables in the greenhouse is difficult, the popularization and application of large-scale straw returning agricultural machinery and technology need to be improved, which brings inconvenience to the utilization of straw and tail vegetables. The technology of resource utilization needs to be further studied and widely popularized, and there is still a lot of improving room for resource utilization.

2.4. New pollutants increase the difficulty of prevention and control
Traditionally, agricultural non-point source pollution is mainly caused by environmental loss of nitrogen and phosphorus nutrients in agricultural production. In recent years, with the development of agriculture and industry and the deepening of research, some new pollutants have been emerging, such as organochlorine in pesticides, antibiotics and heavy metals brought by the application of organic fertilizer, microplastics brought by the use of agricultural film and polycyclic aromatic hydrocarbons brought by various sources. There are many kinds of pollutants, and the pollution way is complex, which bring more challenges to the monitoring and control of agricultural non-point source pollution.

3. Research progress in prevention and control of agricultural non-point source pollution in China
3.1. General trend of agricultural non-point source pollution control research in China
Bibliometrics is an important branch of information science. It uses mathematical and statistical methods to understand the development trend of various disciplines or research fields, and systematically summarizes the research status, main research directions and hotspots. In order to understand the work carried out in the prevention and control of agricultural non-point source pollution in China, with the help of China CNKI database, a retrieval mode was constructed with "theme = agriculture and (non-point source) and pollution", which was used to retrieve the published
literature related to agricultural non-point source pollution, and then analyzed the general development trend of this field, and obtained the hot research in this field through manual classification and interpretation research direction.

According to the retrieval statistics, there have been 5670 papers related to agricultural non-point source pollution since 2000. Through annual analysis and comparison, it was found that the research on agricultural non-point source pollution prevention and control by domestic scientific and technological workers showed a rapid upward trend before 2012, and then rose volatility, but the trend was slightly slow. It explained that before 2012, the research on agricultural non-point source pollution in China showed an explosive growth, with a high degree of concern; in recent years, it has entered a relatively stable period.

3.2. Research focus on prevention and control of agricultural non-point source pollution in China

Through the interpretation and classification of the research contents related to agricultural non-point source pollution, it is once again proved that agricultural non-point source pollution mainly comes from planting and animal husbandry, and the research focuses are mainly distributed in agricultural non-point source pollution load (18%) [2], research scale (37%), risk assessment (14%), prevention and control technology (31%) [3], etc.

4. Research tasks for prevention and control of agricultural non-point source pollution

In view of the current severe situation of non-point source pollution, combined with the existing research progress in this field, the prevention and control of agricultural non-point source pollution needs to start from the characteristics of pollutants, combined with the characteristics of agricultural production, topography, hydrology, soil, vegetation and climate, to explore the prevention and control technology and countermeasures of agricultural non-point source pollution according to local conditions. In the future, the main research trends and tasks in this field are summarized as follows:
In-depth analysis of agricultural non-point source pollution sources and research on pollution mechanism; study on improving dynamic monitoring and warning of agricultural non-point source pollution and pollution load; carry out risk assessment and system construction of agricultural non-point source pollution in an orderly way [4]; focus on key technologies for prevention and control of agricultural non-point source pollution; and strengthen the comprehensive management of prevention and control system of agricultural environment [5]. It is believed that agricultural non-point source pollution can be reduced through various measures of technology and management.

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