

Research on Soil Pollution Channels and Remediation Methods in Farmland

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Abstract

Soil pollution on arable land is a major factor that leads to a decline in the quality of arable land, a decrease in land use efficiency, and a threat to national food security in China. Starting from the current situation of soil pollution in China, this article analyzes the main sources of soil pollution on arable land, and focuses on the main causes of soil pollution in the industrial and agricultural fields. Based on this, soil remediation measures are proposed through physical, chemical, biological, and joint repair technologies, in order to provide some ideas for the protection of arable land and the effective improvement of arable land quality in China.

Keywords

Cultivated Land; Soil Pollution; Heavy Metals; Repair Measures.

1. Introduction

After decades of development, China has achieved remarkable development results, but at the same time, according to the results of the third national land survey, China is facing the dilemma of reducing the total amount of arable land resources, insufficient retention of high-quality arable land resources, and multiple pollution of arable land quality. About 70% of the existing arable land area is medium to low yield farmland. Cultivated land resources are the material guarantee and basic carrier for human agricultural production activities, and an important reliance for ensuring China's food security. The cultivated land resources are facing various impacts from industry, agriculture, ecological environment, and other aspects, resulting in soil pollution of cultivated land, which poses a significant threat to the stability of human living, human health, and food security. In addition, in the process of agricultural cultivation, the lack of necessary land safety knowledge and scientific management system among local people has also led to problems such as low utilization rate of rural land resources, unreasonable application of pesticides and fertilizers, and soil pollution caused by rural household waste discharge. As a major agricultural production and consumption country, the importance of soil safety in cultivated land is self-evident. Polluted soil can not only make large areas of arable land unusable, but also reduce the quality of arable land, causing large-scale crop reduction or crop failure. More seriously, some soil pollutants carry toxic side effects, which can seriously harm human health after entering the human body through biological circulation. Therefore, how to fundamentally understand the sources of soil pollution in arable land and develop effective soil remediation measures will be a key research direction to improve and improve soil pollution in arable land in China.

2. The Current Situation of Soil Pollution in Cultivated Land

Based on the investigation and analysis of the soil pollution situation and degree of rural farmland, it is known that the main sources of soil pollution in rural farmland are natural factors and human factors. The main source of natural factor pollutants is that pollutants generated by certain mines in nature accumulate in the soil through atmospheric, groundwater, and other

channels, causing excessive levels of heavy metals or certain toxic substances in the soil, leading to serious soil pollution. The anthropogenic soil pollution of cultivated land mainly comes from heavy metal pollution caused by industrial development, excessive application of fertilizers and pesticide abuse in agricultural production activities, as well as solid waste and domestic sewage generated by rural residents in their daily lives. Especially in the current context of food production and food security, various toxic substances enter the soil of cultivated land through different ways, which not only reduces and weakens the fertility of the soil itself, but also reduces the land utilization rate, leading to a decrease in cultivated land production capacity. In addition, dust, particulate matter, wastewater, and waste generated by metal smelting and coal combustion during industrial development in some regions can cause varying degrees of soil pollution. Moreover, such pollutants have various characteristics such as concealment, persistence, and complexity, making them quite difficult to control. They not only require high control costs but also require significant technical operability, which brings great pressure to the prevention and control of soil pollution on arable land. According to the "National Soil Pollution Survey Announcement", the soil pollution in arable land areas in China exceeds the standard by about 20%, and the problem of soil pollution in arable land has become very serious. The resulting reduction in crop yields poses a serious threat to China's food security and is not conducive to the steady improvement of the living standards of the Chinese people.

3. Inducing Factors of Soil Pollution in Cultivated Land

3.1. Soil Pollution Caused by Industrial Waste Discharge

Industrial production is the backbone of promoting China's economic development, and as an important pillar of industrial production, the extraction and consumption of a large amount of resources can cause serious environmental pollution and ecological damage. For example, in many areas, toxic substances generated from coal resource extraction and combustion can flow to farmland through channels such as atmospheric transmission, surface water, and groundwater, while in some areas, coal gangue generated from coal resource extraction and utilization, During the stacking process, not only will a large amount of waste gas be generated, especially the heavy metal pollutants it produces, which are difficult to migrate and have strong stability. They will accumulate in the soil for a long time, leading to the inability to use the arable soil. In addition, with the intensification of urban population growth and the rapid decline of available land resources in urban areas, many industrial enterprises have gradually relocated to rural areas and carried out corresponding production activities to alleviate the contradiction between living conditions and environmental pollution. Due to weak environmental awareness and high waste treatment costs, many enterprises have failed to strictly implement the necessary wastewater and waste treatment equipment for production. Allowing such untreated pollutants to be discharged will not only cause serious pollution to rural residential water sources, but also cause food pollution by entering farmland soil. Due to the large amount of toxic substances in the wastewater and waste discharged from industrial production, food safety issues arising from this are a serious obstacle to the construction of beautiful rural areas and the realization of an agricultural power.

3.2. Farmland Soil Pollution Caused by Agricultural Production

China has long been an agricultural country dominated by agricultural production. In order to ensure the food security of the national population, China has conducted decades of research. The research results show that the use of fertilizers, pesticides, agricultural film residues, and untreated straw return have caused continuous pollution of arable soil. In the early stages of agricultural production development, in order to increase crop yield and improve crop quality, various fertilizers and pesticides are generally used to supplement nutrients for crops, control the spread of pests and diseases, and control the growth of weeds. The amount of fertilizer used

in China is 2.6 times that of the United States and 2.5 times that of the European Union, respectively. However, the efficiency of N, P, and K fertilizers used in the main grain crops is only 33%, 24%, and 42%, causing great waste of fertilizers and polluting the soil of cultivated land. However, many people's inaccurate grasp of the use of pesticides and fertilizers will lead to excessive use of fertilizers and pesticides, and excessive fertilizer will enter the cultivated soil along with crop growth, irrigation and harvesting, which will have a negative impact on Soil structure, and will easily lead to soil quality degradation, soil hardening, soil erosion, shallowing of the soil tillage layer, and weakening of the ability of the soil to maintain entropy and premium, Some areas may even bring it into groundwater through irrigation, which not only pollutes arable soil but also seriously endangers groundwater resources. At the same time, China's pesticide usage far exceeds that of developed countries, but its utilization rate is only 61% to 73.2% of that of developed countries. After the application of pesticides, only about 30% can adhere to crops, while the remaining 70% can be spread to the soil through the air, exacerbating pesticide residues in farmland soil and causing soil pollution. The long-term pollution caused by pesticides will cause Soil acidification and reduce soil porosity through its composition, and may lead to the loss of soil nutrients. In addition, plastic film has been widely used in China's arable land. Although it has increased crop yield and increased public benefits to a certain extent, the plastic film remaining in the arable soil after crop harvesting will have a negative impact on the arable soil. As of now, the residual amount of plastic film in China's arable land is about $2\% \times 10^6$ t, the residual amount of plastic film in the farming layer is 60 kg/hm². The residual plastic film not only destroys the Soil structure to a certain extent, reduces the soil porosity, but also inhibits the passage of water and fertilizer through the soil pores through its special properties, and affects the microbial activity and the stability of flora, thus causing crop yield reduction.

4. Remediation Methods for Soil Pollution in Cultivated Land

4.1. Physical Repair Methods

As the most common soil remediation method, physical remediation mainly utilizes physical principles to achieve organic separation of soil and pollutants without changing soil properties, and then removes pollutants from the soil through technical means. Currently, the widely used soil physical remediation technologies mainly focus on electric remediation, vitrification remediation, and thermal desorption remediation. Among them, the electric remediation method is to insert electrodes into the soil and remove heavy metal pollution and some organic pollutants in the soil by means of Electromigration or Electro-osmosis. This method has a strong ability to eliminate heavy metal pollutants, but at the same time, it requires more power consumption. In the process of use, the staff needs to fully consider the advantages and disadvantages in combination with the specific situation before using it. The vitrification remediation technology mainly uses electrodes to remove organic pollutants and some inorganic pollutants from the soil by volatilization and pyrolysis under high temperature conditions. The inert solid glass produced by melting the contaminated soil is also good for the remediation of radioactive pollutants. The main principle of thermal remediation method is to volatilize volatile substances such as organic matter in contaminated soil through the heat generated by combustion, without damaging soil fertility. It can significantly remove chlorinated organic pollutants such as polychlorinated biphenyls, especially polycyclic aromatic hydrocarbons (PAH), with a removal efficiency of over 99.3%. The main characteristic of physical remediation is that although contaminated soil can effectively improve soil conditions after treatment, the removal effect of pollutants is also significant, and the time required is relatively short, its remediation cost is high, and secondary pollution and other

issues are easily caused during the remediation process, which cannot achieve the effect of large-scale soil improvement.

4.2. Chemical Remediation Methods

For the field of environmental remediation, chemical remediation technology has a longer history of application than physical remediation technology. This technology can overcome the problem of deep soil pollution and achieve effective purification of deep soil. The advantages of chemical remediation technology include easy operation and good remediation effect, while the disadvantage lies in the high investment required and the risk of re-contamination caused by improper operation when dealing with contaminated soil. The leaching technology is a common technical method in chemical remediation technology, and its basic principle is to inject leaching agents into the soil to separate pollutants and organic substances in the soil, achieving soil purification [10]. However, due to the different removal efficiency of pollutants by different leaching agents, when using leaching technology for soil remediation, it is necessary to first conduct a comprehensive analysis of the pollution status of the soil and select a more suitable leaching agent based on the detection of soil texture. The chemical repair method is relatively fast and convenient, but its repair cost is relatively high. It is worth noting that due to the high moisture content in the components of the leaching agent, it may reduce the organic matter content while removing soil pollutants, which may have an impact on soil fertility. In addition, chemical leaching may also lead to leaching toxic substances in soil into deep groundwater, causing Groundwater pollution and other problems.

4.3. Bioremediation Method

As a new type of green environmental remediation technology, Bioremediation has become one of the commonly used remediation methods at present. The main principle is to absorb organic pollutants in the soil by using the biological characteristics of animals, plants and microorganisms. Its most important feature is that it can carry out effective remediation without changing the chemical properties of the soil. Compared with physical and chemical remediation methods, it has the characteristics of low cost but long cycle. Moreover, there is a high requirement for soil pollution. Once soil pollution exceeds the normal range of biological growth, you need to use other repair methods []. At present, many studies have focused on the remediation of soil pollution around earthworm, *Sedum alfredii*, centipede grass, *Solanum nigrum*, and blue cabbage, but most of them focus on the remediation of soil heavy metal pollution. The microbial remediation technology is mainly to biodegrade pollutants through the physiological metabolism of microorganisms in the growth and development process, transforming soil pollutants into H₂O, CO₂, inorganic salts and other substances. At present, many in-situ microorganisms are used. The methods of remediation and heterotrophic microbial remediation are to directly put the contaminated soil into the corresponding microorganisms or dig out the contaminated soil, and then conduct centralized degradation after microbial remediation. In addition, the use of organic acids generated during the normal physiological metabolism of microorganisms can effectively absorb heavy metal pollutants in soil, thereby achieving soil pollution remediation. However, it is worth noting that the metabolism of microorganisms in soil is a very complex physiological process, and whether there will be disturbances between their microbial communities or the death of microbial communities due to environmental changes, there is also a possibility of secondary pollution to the soil.

5. Conclusion

The main mechanism of soil pollution control is to repair soil pollution, restore the essence of the soil as much as possible, and achieve control of soil pollution. The basic method is based on physical, biological, ecological, and chemical principles. In 2016, China proposed the "Action

Plan for Soil Pollution Prevention and Control", which provides policy support for the development of soil pollution remediation technology for arable land. At the same time, in order to maximize the effectiveness of soil remediation, it is necessary to continue to increase the investment of scientific and technological level in soil pollution remediation work, with the government as the lead, and integrate the resource advantages of enterprises, universities, and the public, Coordinate the emission of pollutants between industrial and agricultural sectors, and fundamentally alleviate the problem of soil pollution in cultivated land. The article analyzes the causes of soil pollutants in cultivated land from the perspectives of industry and agriculture, and proposes several commonly used remediation technologies for soil remediation in a targeted manner, in order to better carry out soil remediation in cultivated land and effectively serve national food security.

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