Social Cost Analysis of Biological Control Technology for Crop Diseases and Insect Pests

Jie XIE[1], Lingling XIAO[2]*, Jinyu ZHAO[2], Shoumei WAN[2], Jian TANG[2], Xiaolei JI[2], Jing PENG[2]

1. Guiyang Customs Logistics Management Center, Guiyang 550081, China; 2. Guizhou Light Industry Vocational and Technical College, Guiyang 561000, China

Abstract With the rapid development of modern agriculture, the prevention and control of crop diseases and insect pests has become an important part to ensure the safety of agricultural production, the quality of agricultural products and the safety of agricultural ecological environment. Although the effect of traditional chemical prevention and control technology is remarkable, the health risks and environmental problems brought by it should not be ignored. As a green and environmentally friendly means of prevention and control, biological prevention and control technology has gradually become a hot research topic and a trend of agricultural production. This paper is intended to comprehensively evaluate the social costs of biological control technologies for crop diseases and pests, including the health risks reduced, environmental improvements, economic benefits, and barriers to promotion, and put forward corresponding policy recommendations.

Key words Crops, Diseases and insect pests, Biological control, Social cost

1 Introduction

Crop diseases and insect pests are prominent problems in agricultural production, posing a serious threat to the growth and yield of crops. With the continuous growth of the global population and the increase of food demand, the prevention and control of crop diseases and insect pests have become increasingly prominent. In addition, they may also be transmitted through the food chain, causing more far-reaching food safety problems, such as excessive pesticide residues, pathogenic bacteria contamination, *etc.*, all of these problems pose a potential long-term threat to public health[1]. Furthermore, the prevalence of pests and diseases also aggravates the vulnerability of agricultural ecosystems, leading to the loss of biodiversity and the destruction of the ecological environment, forming a vicious circle.

For a long time, traditional chemical prevention and control technologies, especially the widespread application of pesticides, have been regarded as an important means to control pests and diseases and ensure agricultural production. These chemical agents play an irreplaceable role in agricultural production and effectively curb the spread of pests and diseases with their efficient and rapid characteristics. However, with the passage of time, its negative impact has gradually emerged and attracted wide attention. The problem of pesticide residues is becoming more and more serious, which not only threatens the health of consumers, but also may lead to the pollution of environmental factors such as soil, water and air, and further aggravate the ecological crisis. At the same time, the overuse and abuse of pesticides also promote the resistance of pests and diseases, which gradually weakens the effect of prevention and control, and forms the dilemma of "the more pesticides used, the more problems there will be".

Biological prevention and control technology refers to the integrated prevention and control of crop diseases and insect pests by giving priority to agricultural control, ecological regulation, biological control, physical and chemical control and scientific and precise medication for the purpose of reducing the use of chemical pesticides, minimizing the use of pesticides, reducing pesticide residues in agricultural products, and ensuring agricultural production, agricultural product quality and ecological environment safety[2]. In this context, exploring and promoting biological control technology to reduce the dependence on chemical pesticides has become an important way to protect public health and promote sustainable agricultural development. Biological control technology follows the principle of interaction between organisms, through the introduction of natural enemy insects, the use of microbial agents, the development of botanical pesticides and other ways to achieve green pest control. This technology can not only effectively control the occurrence of pests and diseases, but also reduce environmental pollution and damage to the ecosystem, so it has significant ecological and social benefits.

To sum up, the prevention and control of crop diseases and insect pests is an important part that can not be ignored in agricultural production. While ensuring the safety of agricultural production, we must fully consider its potential impact on public health and ecological environment. Therefore, it is an inevitable choice to promote biological control technology and reduce the use of chemical pesticides to protect public health and promote sustainable agricultural development.

2 Overview of biological prevention and control technology

Biological control technology refers to the use of organisms or their metabolites to control crop diseases and insect pests. Com-

Received: June 20, 2024 Accepted: August 2, 2024

Jie XIE, bachelor's degree, intermediate title, research fields: integrated pest management and its related economics, modern enterprise economic management.

* Corresponding author. Lingling XIAO, master, intermediate title, research fields: integrated pest management, synthesis of green compounds.

pared with traditional chemical pesticides, biological control technology reduces the negative impact on ecosystems and non-target organisms[3]. Biological control is the use of natural enemy insects, pathogenic microorganisms, botanical pesticides and other biological factors to control pests and diseases; it has the advantages of green environmental protection, strong sustainability and little impact on non-target organisms, and is an important direction of green development of modern agriculture[4].

3 Economic cost evaluation

3.1 Direct costs The direct costs mainly include the cost of biological agents and the cost of technology promotion and training. Biological agents are the core input of biological prevention and control technology. According to the data released by the National Agricultural Technology Center, the cost of biological agents varies with the type and dosage. Taking the control of *Chilo suppressalis* as an example, the cost of using 20% chlorantraniliprole · indoxacarb SE ranges from hundreds to thousands yuan/ha. Compared with traditional chemical pesticides, although the initial investment is higher, the overall cost is lower due to its advantages of continuous control effect and reduced frequency of use[5]. The research and development of biological control technology requires a lot of manpower, material and financial resources, including the salary of scientific researchers, the purchase of experimental equipment, the rental of experimental fields, the organization of expert lectures, on-site guidance, and the compilation of technical manuals. Although these costs are one-time investment, they can significantly improve farmers' prevention and control skills and awareness, and reduce misuse and waste.

3.2 Indirect costs Indirect costs mainly include ecological environment costs and health costs. Chemical pesticide residues have led to the decline in the quality of agricultural products and frequent food safety problems, which have brought huge losses to agricultural producers. Biological prevention and control technology can reduce pesticide residues, improve the quality and safety of agricultural products, and increase the added value and market competitiveness of agricultural products. In addition, the pollution and damage to the environment caused by the traditional chemical prevention and control technology are enormous. According to relevant research, the cost of ecological environment such as soil pollution and water pollution caused by pesticide use is as high as tens of billions of yuan every year. Biological prevention and control technology can significantly reduce these costs and protect the ecological environment and biodiversity.

The harm of pesticide residues to human health can not be ignored. According to the statistics of the World Health Organization (WHO), hundreds of thousands of deaths are caused by pesticide poisoning every year. According to the national plant protection professional statistics, the annual average number of poisoning is about 70 000[6]. Pesticide residues may also cause long-term health problems such as chronic diseases, which are difficult to quantitatively analyze due to the lack of statistical data. It has been reported that pesticides account for 60% of carcinogenic factors[7]. Because of the extensive chronic diseases caused by pesticide exposure and the long-term and persistent impact on people's health, it is speculated that the social cost may not be less than that caused by pesticide poisoning. The implementation of biological prevention and control technology effectively reduces the use of traditional pesticides, significantly reduces health costs, and protects the health rights and interests of farmers and consumers.

4 Ecological benefits and social benefits

4.1 Social benefits Biological prevention and control technology can effectively control pests and diseases, reduce crop losses, and improve the yield and quality of agricultural products. Studies have shown that biological prevention and control technology has a positive effect on improving crop yield and quality[8]. Although the initial investment of biological prevention and control technology may be high, in the long run, its sustainable control effect and low toxicity and environmental protection characteristics can significantly reduce the overall cost. Farmland using biological prevention and control technology can reduce the frequency and amount of pesticide use every year, thus reducing the cost of pesticide purchase and use. In addition, biological prevention and control technology also helps to reduce indirect costs such as the cost of quality and safety of agricultural products and the cost of ecological environment restoration.

The popularization and application of biological prevention and control technology can also bring significant social benefits. Firstly, it helps to improve the quality and safety of agricultural products and protect the health rights of consumers. Secondly, it can promote the green development of agriculture and the construction of ecological civilization, and enhance the image and brand value of agriculture. In addition, the use of biological prevention and control technology can also reduce the occurrence of safety accidents such as pesticide poisoning and ensure the safety of farmers.

4.2 Ecological benefits The application of biological prevention and control technology helps to maintain ecological balance and biodiversity, and reduce the pollution and damage of chemical pesticides to the environment. According to the relevant research, the biodiversity index of farmland using biological prevention and control technology can be improved to a certain extent, and the soil quality can also be significantly improved. The use of biological prevention and control technology plays a significant role in maintaining ecological balance and biodiversity, and can effectively reduce the pollution and destruction of chemical pesticides to the environment. The application of this technology achieves the purpose of controlling pests and diseases by using the interaction mechanism between organisms, thus avoiding the possible negative effects of using chemical pesticides in large quantities. According to relevant studies, the biodiversity index of farmland using biological prevention and control technology has been significantly improved. This improvement is not only reflected in the increase in

the number of species in the farmland ecosystem, but also in the increase in species diversity and ecological complexity[9]. The increase in biodiversity means that the stability and resistance of farmland ecosystem have been enhanced, and it can better cope with the disturbance and change of external environment. In addition, the use of biological prevention and control technology has a positive impact on soil quality. By reducing the use of chemical pesticides, beneficial microorganisms in the soil are protected, soil structure is improved, and soil fertility is enhanced. These changes are not only beneficial to the growth of crops, but also lay a solid foundation for the long-term development of farmland ecosystem.

In summary, the use of biological prevention and control technology has played an important role in maintaining ecological balance and biodiversity, and reducing the pollution and destruction of chemical pesticides to the environment. The application of this technology not only improves the biodiversity index of farmland, but also significantly improves the soil quality, which provides a new idea and way for the sustainable development of agriculture.

5 Conclusions and prospects

5.1 Conclusions In conclusion, biological prevention and control technology of crop plant diseases and insect pests has significant advantages in economic cost, which can reduce direct and indirect costs and improve economic, ecological and social benefits. Therefore, it is recommended that agricultural producers should actively adopt biological prevention and control technology, strengthen technical training and promotion, and enhance the effect of prevention and control and market competitiveness. In addition, government and various circles of society should also increase their support for biological prevention and control technology and jointly promote the green development and construction of ecological civilization of agriculture.

5.2 Prospects With the continuous improvement in people's awareness of food safety and ecological environmental protection, biological prevention and control technology will play a more important role in agricultural production in the future. In the future, it is recommended to strengthen the research and development and innovation of biological prevention and control technology, and promote the transformation and application of technological achievements. Besides, it is necessary to strengthen technical training and guidance for farmers and improve their application ability and level. In addition, it is also necessary to strengthen the exchange and cooperation with international advanced technology, introduce and absorb international advanced technology achievements, and improve the overall level of biological prevention and control technology in China. It is believed that with the joint efforts of all parties, biological control technology will make greater contributions to the realization of the strategic goals of green agricultural development and rural revitalization.

References

[1] GAO HY, MAO HX, ZHANG T, *et al.* Research on crop diseases and insect pests control and green prevention and control technology[J]. Southern Agricultural Machinery, 2024, 55(11): 68 – 70, 100. (in Chinese).

[2] GAO JT, ZHANG TZ. Application and development countermeasures of green prevention and control techniques in China[J]. Modern Agricultural Science and Technology, 2019(9): 115 – 117. (in Chinese).

[3] NIE N. Study on the application of biotechnology in the control of plant diseases and pests[J]. Agricultural Development and Equipment, 2024(7): 184 – 186. (in Chinese).

[4] DAI PH, JIA ZG. Analysis of green prevention and control techniques for high quality vegetable cultivation and plant diseases and insect pests[J]. Hebei Agriculture, 2024(6): 65 – 66. (in Chinese).

[5] LIU SS. Application of green prevention and control technology in the control of maize diseases and insect pests[J]. Agricultural Development and Equipment, 2023(6): 178 – 179. (in Chinese).

[6] National Agricultural Technology Extension Service Center. Plant Protection Statistics Database[DB]. 1968 – 2017. (in Chinese).

[7] ZHANG XL. Study on the causes and impacts of pesticide residues in agricultural products in China[D]. Wuxi: Jiangnan University, 2013. (in Chinese).

[8] PENG Y, GUO J, WANG X. Research and integrated demonstration of green prevention and control technology for rice diseases and insect pests[J]. New Farmers, 2024(18): 66 – 68. (in Chinese).

[9] YANG PY, LI CG. Social costs analysis of chemical management technologies on crop pests in China[J]. China Plant Protection, 2019, 39(4): 21 – 25,69. (in Chinese).

(From page 13)

[4] NIU SD, LU X, SHI YY. Spatial-temporal pattern of sustainable intensification of agricultural land-use in Shandong Province, China[J]. Chinese Journal of Applied Ecology, 2018, 29(2): 607 – 616. (in Chinese).

[5] REN AQ. Analysis on regional discrepancies of farming land productivity in China[J]. China Economist, 2021(11): 38 – 39, 42. (in Chinese).

[6] YANG ZS, LI YH, ZOU Z, *et al.* Research on land resources development and utilization planning of Yunnan Province in China's western development[M]. Kunming: Yunnan Science and Technology Press, 2003: 24 – 29. (in Chinese).

[7] YANG ZS. Land resource science[M]. Beijing: Economic Management Press, 2021. (in Chinese).

[8] ZHANG GS, DING ZW. Spatial-temporal pattern evolution of urban-rural income gap at province, city and county scale in China from 2000 to 2015[J]. Henan Science, 2019, 37(10): 1708 – 1720. (in Chinese).

[9] Heilongjiang Bureau of Statistics. Heilongjiang statistical yearbook[M]. Beijing: China Statistics Press, 2023. (in Chinese).