

# Analysis of Changes in Insecticide Consumption at Home and Abroad in Recent 30 Years

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**Abstract** The paper analyzes the changes in insecticide consumption and the proportion of insecticides in pesticides in the world and several typical countries in the past 30 years, in order to provide a reference for scientific treatment of pesticide and further implementation of China's "double reduction" policy.

**Key words** Insecticide; Consumption; Reduction

## 1 Introduction

Agricultural development can not be separated from insecticides, which have magical effects on pest control and plant yield increase. Since 1935 when researchers of the United States Department of Agriculture developed the world's first chemical insecticide, phenothiazine, insecticides have been used for more than 80 years up to now. Over the past 80 years, agriculture in various countries has developed rapidly, and insecticides have also brought many environmental issues. Many countries have carried out relevant measures to reduce the consumption of insecticides, which has also triggered a lot of thinking: Whether insecticides will decrease with the development of agricultural technology? Whether the proportion of insecticides in pesticides has been lower than that of herbicides and fungicides? How much insecticides are used in developing and developed countries? There have been no relevant reports. This paper analyzes and compares the insecticide consumption in the world and the use of insecticides in developing and developed countries from 1990 to 2020, in order to give a correct and reasonable view of insecticides by drawing lessons from Italy, South Korea, Japan and other countries.

## 2 Overall use condition

As of 2020, there were 4 139 kinds of pesticides, 4 979 kinds of fungicides, 1 924 kinds of herbicides and 2 318 kinds of plant growth regulators in the world<sup>[1]</sup>. The main crops for which insecticides were used worldwide included rice, corn, soybeans and oilseed rape. Insecticide varieties were only 840 fewer than fungicides, far more than herbicides and plant growth regulators. The global consumption of insecticides from 1990 to 2020 is shown in Fig. 1. The results showed that the global insecticide consumption generally showed an increasing trend, with the minimum consumption of 1 662 278 t in 1991, the maximum consumption of

2 748 890 t in 2017, and the total consumption of 70 316 057.5 t in the 30 years. The growth rate of insecticides from 1990 to 2020 was 54.79% when compared with herbicides, and 33.02% when compared with fungicides. Hence, the growth rate of insecticides in these 30 years was the second largest, and was in the middle level. From the point of view of average annual consumption, the average annual consumptions of insecticides, herbicides and fungicides were 2 343 868.58, 1 102 707.32 and 551 900.14 t, respectively, and the average annual consumption of insecticides is far higher than that of herbicides and fungicides.

From 1999 to 2010, the consumption of insecticides generally increased, showing a trend of stable growth, rapid rise, stable growth and rise, and remained stable in the last 3 years. From 1990 to 1999, the consumption of insecticides steadily increased, with an increase rate of 18.87%. During this period, neonicotinoid insecticides gradually emerged. As an efficient insecticide with new structure, neonicotinoid insecticides have strong conductivity and unique insecticidal mechanism, mainly acting on the nicotinic acetylcholine receptor of insects. It can be used as a substitute of some organophosphorus, carbamates, pyrethroids and organochlorine insecticides<sup>[2]</sup>.

After 2000, due to the rise of transgenic technology, transgenic crops such as insect-resistant cotton and insect-resistant corn began to be planted in a large area, and the consumption of insecticides was significantly reduced compared with ordinary crops. The consumption of insecticides rose sharply from 2 042 878 to 2 280 626 t from 2002 to 2005. After several years of planting transgenic insect-resistant crops, the harm degree of secondary pests was basically similar to or even exceeded that in ordinary crops, and the consumption of insecticides for controlling secondary pests increased. The consumption of insecticides reached 2 493 892 t in 2008, and a turning pointed appeared in 2009. Compared with 2008, the consumption of insecticides in 2009 decreased by 7.66%, and then tended to be stable in 2010–2020. After 2017, due to the elimination of some highly toxic pesticide products and the development of pesticides with low toxicity and low residue and biopesticides, the consumption of insecticides, herbicides and fungicides first decreased slowly and then gradually

Received: July 10, 2023 Accepted: September 29, 2023

Supported by Agricultural Joint Special Project of Yunnan Province (202301BD070001-130).

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became stable, and the consumption of insecticides was 2 602 517 – 2 748 890 t.

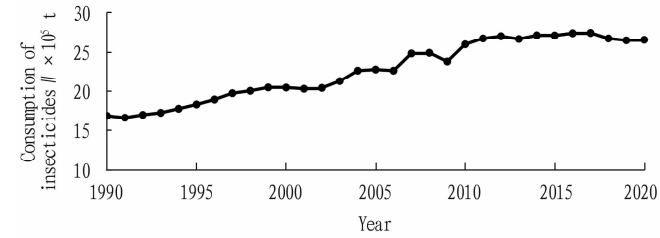


Fig. 1 Total global consumption of insecticides

### 3 Overview of consumption in various countries

**3.1 Typical countries with increased consumption** The consumption of insecticides in China, the United States and Canada during 1990 and 2020 is shown in Fig. 2. The total consumption of insecticides in the United States was 12 609 406 t, far more than that in China and Canada. The total consumption of insecticides in China was 8 442 540 t, and that in Canada was 1 613 633 t, which was only about 10% of that in the United States and 20% of that in China. The consumption of insecticides in the three countries showed an increasing trend. Canada showed the largest fluctuation, with an annual increase of 2.33%, followed by China with an annual increase of 1.86%. The consumption of insecticides fluctuated greatly from 1990 to 1999 and from 2000 to 2014. The United States, as the country with the largest arable land and the most developed agriculture in the world, had a stable consumption of insecticides with an annual growth rate of only 0.58%, and the consumption of insecticides was 358 337.7 – 434 540.8 t. In 2010, the consumption of insecticides was the least of 358 337.7 t. In 2009, the consumption of insecticides in the United States and China was the closest. The three countries are agricultural powers, ranking in the world's top ten in arable land and rich in natural resources. Therefore, both developed and developing countries are inseparable from insecticides, and the consumption of insecticides is closely related to the arable land area of each country. Insecticides, as traditional pesticides, have not been completely eliminated with the development of agriculture, and still play a vital role.

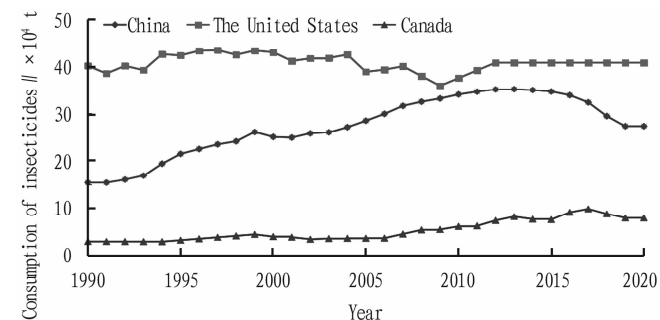


Fig. 2 Typical countries with increased consumption of insecticides

**3.2 Typical countries with decreased consumption** The consumption of insecticides in Italy, Japan and South Korea has decreased and stabilized over the past 30 years (Fig. 3). The three countries are all developed countries with small land and large population and relatively scarce natural resources, but highlighting advantages of agricultural development. The consumption

of insecticides in Italy was only 48 567 t in 2019. Although the consumption fluctuated greatly from 2004 to 2014, it decreased linearly from 2014 to 2019. Italy attaches great importance to the sustainable development of agriculture, where pesticides are not allowed to be purchased by private individuals and units, and must be approved by agricultural science institute before use, which is also one of the reasons for low pesticide residues in Italy. From 1990 to 2012, the consumption of insecticides in Japan ranged from 787 735.45 to 79 821.18 t, then gradually showed a decreasing trend after 2012, and stabilized at 51 006 – 51 970 t in 2017. Japan also has very strict restrictions on the use of pesticides, and the consumption of insecticides is uniform. In the past 30 years, the consumption of insecticides in South Korea has been close to a straight line between 16 278 and 27 416 t, which reached the maximum in 1991 and decreased to the minimum by 2020. The three countries are lacking in resources and attach great importance to the protection of resources, so they are more intensive in agriculture and strictly control the use of pesticides, which is worth learning for most countries.

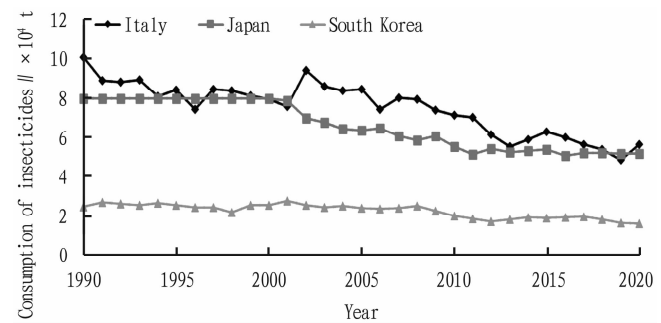


Fig. 3 Typical countries with decreased consumption of insecticides

### 4 Analysis of consumption of existing registered insecticides in China

The insecticides in China are mainly carbamates, organophosphorus and pyrethrin, *etc.* Organophosphorus insecticides are still the mainstream, accounting for 68% of the total market, and there are mainly six varieties, such as omethoate, monocrotophos, methamidophos and parathion<sup>[3]</sup>. By 2014, the proportion of highly toxic insecticides in China was less than 3%, and there were about 110 kinds of effective ingredients. Insecticides are mainly products with high efficiency, low toxicity and low residue, and microbial-derived pesticide products such as emamectin, ivermectin and pleocidin are constantly emerging<sup>[4]</sup>, while insecticides with high toxicity and high residue are gradually eliminated.

As of January 2023, 18 645 kinds of insecticide products had been registered in China. There were as many as 23 618 expired products, including wetttable powder, aerosol, original medicine, micro-emulsion, suspension agent, water agent and other dosage forms. There were 2 869 kinds of sanitary insecticide products, and 2 118 kinds of highly toxic products, while avermectin, avermectin · triazophosphorus, avermectin · chlorpyrifos and other products accounted for large proportion. There were 11 185 kinds of low-toxicity products. These products are relatively friendly to the ecological environment, and have little harm to human and animal health, being the inevitable trend of pesticide development in China. In addition, there were 12 427 kinds of registered herbi-

cides and 11 806 kinds of fungicides, far less than insecticide products, indicating that China's insecticide market has broad prospects for development.

The transformation of agricultural development to green ecology is an urgent need to improve water and soil resources and environmental quality, an objective requirement to ensure the quality and safety of agricultural products, a fundamental requirement to ensure the physical health of Chinese people, and an inevitable requirement to enhance the international competitiveness of agricultural products<sup>[5]</sup>. China pays more and more attention to the green development of agriculture, and high-toxic pesticides are gradually eliminated with the adjustment of the market. The use of highly efficient and low toxic pesticides and consumption reduction are the requirements of green agricultural development in China. China is constantly exploring and practicing a modern agricultural development path featuring efficient agricultural output, safe quality, resource conservation and environmental friendliness<sup>[6]</sup>.

## 5 Development issues of insecticides

With the development of international economic integration, the demand for insecticides is also increasing, and whether developing countries or developed countries are inseparable from insecticides. Relevant international measures have been introduced to reduce the consumption and improve the efficiency of insecticides. The United Nations has put forward the 2030 strategic goals for sustainable development, and FAO, as the lead unit of global pesticide management, can reduce pesticide risks while protecting crops through scientific and rational use of pesticides, appropriate medication, and a variety of prevention and control methods. The Strategic Approach to International Chemical Management (SAICM) puts forward higher requirements for chemical management; strengthening environmental protection, attaching importance to biodiversity, vigorously developing ecological agriculture, and building a co-governance pattern of food safety. China's Ministry of Agriculture and Rural Affairs has also responded positively. Since 2015, the organization had implemented the zero-growth action of fertilizer and pesticide by 2020, aiming to improve the utilization efficiency of pesticides and fertilizers, and decrease their consumption, so as to obtain the best economic, social and ecological benefits.

In 2020, the global sales volume of crop pesticides reached 62.036 billion USD, with a year-on-year growth rate of 2.7%. If non-crop drugs are included, the global total sales volume reached 69.886 billion USD, with a year-on-year growth rate of 2.5%, and insecticides accounted for 25% of the market<sup>[7]</sup>. In recent years, insecticides with high toxicity and high residue such as organophosphorus and carbamate still have a share of the market, and insecticides have fallen to the third place among the three major pesticides<sup>[8]</sup>. In addition, the introduction of "subtraction" has brought new development opportunities for the insecticide industry, and enables it to achieve efficient, low-toxicity and environmentally friendly development, which has become the focus of common attention of the industry. With the adjustment of the market, the problems have also emerged, and the safety and environmental friendliness of products are also constantly improving. Resistance to conventional insecticides is increasing, and the control

of some pests is not as effective as before, making existing products unable to effectively deal with pest problems. To solve this problem, it is necessary to constantly introduce new insecticide products, preferably to replace some of the original products. On the other hand, it is necessary to scientifically use existing products, and formulate efficient and reasonable resistance management strategies according to local conditions and characteristics of related crops and pests<sup>[9]</sup>.

With the in-depth study of insecticides in countries around the world, low-toxicity and harmless insecticide substitutes constantly emerge on the market, such as insecticidal lamps, insect traps, biological pesticides, environmentally friendly pesticides with high efficiency, low toxicity and low-residue, biological missiles, sex attractors, weeding cloth and other new insecticidal technologies. We can learn from the relevant measures of South Korea, Japan, Italy and other countries. For example, Japan's agriculture-related laws and regulations system is relatively perfect; although Italy is a pesticide country in Europe, it has been leading the policy of "combining characteristic agriculture with environmental protection"; South Korea also learned from the experience and strengthened the control of pesticides. The three countries attach particular importance to the food safety and human health problems caused by pesticides, so the requirements for pesticides such as insecticides are relatively high. In the process of accelerating the comprehensive green transformation of agriculture and accelerating the process of reducing the consumption and increasing the efficiency of fertilizers and pesticides, China has formulated the *Action Plan for Chemical Pesticide Reduction by 2025*. We should continuously learn from the use of pesticides in these countries, constantly optimize comprehensive control technical measures, and treat insecticides correctly and reasonably.

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