

Liu Zeyi
Shijiazhuang Foreign Language School
Shijiazhuang, Hebei
China, Factor 6: Sustainable Agriculture

China: The Rational Use of Chemical Fertilizers in the North China Plain

Introduction

The past decade witnessed the incessant decrease of arable land. In order to use 7% of the world's arable land to feed 22% of the world's population, China regards productivity as the core of agricultural development. Therefore, the strength of agricultural development was enhanced, chemical fertilizers and pesticides were widely used, which resulted in the continuous improvement of agricultural productivity. However, the resulting environmental problems appeared gradually and displayed a deteriorating trend. Agricultural non-point source pollution has become a significant issue which does harm to the agricultural ecological environment, impeding the agricultural sustainable development and affects the quality of agricultural products.

Among agricultural non-point source pollution, the pollution caused by chemical fertilizer use is particularly serious. The excessive and unscientific use of chemical fertilizer for a long period of time has led to serious non-point fertilizer pollution, causing great damage to the ecological environment. Since the 1970s, fertilizer used in agricultural production in China increased rapidly years on end. From 1967 to 1986, China's fertilizer usage increased by 5.2 times while the foreign fertilizer usage at the same time only increased by 1.6 times. In 2002, with a fertilizer usage of 43.215 million tons, China became the country which applied the greatest amount of chemical fertilizers throughout the world. In 2015, the fertilizer usage in China accounted for 35% of the world's usage, which is equivalent to the sum of that in America and India.

The North China Plain, known as the second largest plain in China, is located in the northeast of the country. It covers 270.135 thousand square kilometers of arable land, which is 1/5 of the total amount of arable land in China. As an important agricultural base with a long history of farming, the North China Plain has a great number of advantageous conditions of agricultural production. In 2014, the total amount of grain output in Henan Province reached 57.72 million tons which was the second largest grain output throughout China. However, the total amount of chemical fertilizer used in Henan reached 7.06 million tons, which was far larger than any other province in China. The same situation also happened in other provinces in the North China Plain. The overuse of chemical fertilizer often leads to severe agricultural environmental pollution, not only soil pollution, but also air and water pollution. The deterioration of ecological environment often causes the declining in agricultural productivity and economic benefits.

Moreover, inorganic fertilizer is used far more widely than organic fertilizer, which can also

cause severe environmental pollution and waste of resources. Among chemical fertilizers, the use of nitrogen fertilizers is far more often than the use of phosphate and potash fertilizers. In 2014, the use of nitrogen fertilizer in China reached 23.93 million tons, which is almost 40% of the total amount of chemical fertilizers used throughout the country.

Therefore, the overcharge of fertilizer and the unreasonable utilization structure are the two main obstacles for the agriculture production in North China Plain and need to be deliberated.

Defining A Typical Farm Family

Liu Shaochen's family, located in Tongzhou County (suburb area of Beijing) , can be accurately adduced as a traditional farm family in the North China Plain. There are four people in the family, two parents and two children. Both the parents stopped school after high school while the elder brother studied in a local private middle school and the younger sister attends school in a public primary school. Under the positive policies and persuasion from his children, Liu Shaochen and his family joined the NCMS (new rural cooperative medical system). The family possesses a winter-wheat field of about 6000 square meters. In order to balance the family's diet and obtain more nutrition, Liu also grows some vegetables on a small piece of land near his house. Through the sale of winter-wheat and some business on agricultural tools, the family receives a net income of about 12000-22000 RMB every year. The family has already applied to robot hands to seed and harvest. Under the positive policies and persuasion from his children, Liu Shaochen and his family joined the NCMS (new rural cooperative medical system).

When I asked Liu about the usage of chemical fertilizers in his field, he told me that he applied a conventional method of fertilizing (using large amount of chemical fertilizers but never use any organic fertilizer). He didn't know to what extent chemical fertilizers are harmful to the environment; he told me he just wanted his crops to grow well and bring home the bacon since raising two children with a relatively modest income can be very hard. However, he added that another reason for his irrational use of fertilizers was the lack of instructions and suggestions from experts because he was not well-educated and he didn't know much about fertilizers; as a result, he stuck to the traditional fertilizing method even though he found the method was harmful to both the environment and the crops.

There are some other problems impeding the family's grain output from increasing.

1. Serious water shortage in North China Plain. Haihe provides most of the water resource for Tongzhou County. However, because Beijing and other nearby cities need to consume a large amount of water, the exploitation rate of Haihe has already reached 94%. However, the average possession of water is only 292cubic meters per person per year. Although the south-north water diversion project to some extent eased the tension of water resource in Haihe, problems such as high price of water also come along.

2. Expansion of large city. Tongzhou lies on the Southeast of Beijing. Such geographical position helps Tongzhou to acquire the radiating effect of Beijing. However, pollution (especially water pollution) caused by the city makes the shortage of water in Tongzhou even worse. The development of city also affects the soil in Tongzhou, most of which is sandy soil.

3. Weather condition and disasters. Abnormal low temperature in spring delays the heading stage of wheat and even causes death of winter-wheat. Moreover, Tongzhou locates on a low alluvial plain with an elevation below 100 meters. It is, therefore, also prone to flooding. Winter-wheat has a variety of diseases, which can lead to cuts and loss of output without timely prevention.

Apart from these barriers, the overuse of chemical fertilizer is a latent and chronic threatening factor.

Air pollution

Chemical fertilizer itself is easy to decompose and volatile. Nitrogen fertilizer, for instance, will directly evaporate into ammonia from the ground surface. High concentration of Ammonia, however, is not only harmful to human's respiratory system, but also detrimental to the growth of grains.

Soil Pollution

1. Long-term use of chemical fertilizers will give rise to the accumulation of heavy metals and toxic elements in the field. There are always some harmful elements in chemical fertilizers (phosphate fertilizer can be a good case in point). Once the soil was polluted by heavy metals, it will be hard to eliminate the pollution. The increasing amount of heavy metals in the soil will do harm to crops and human.

2. Excessive use of chemical fertilizers will cause nitrates in soil to accumulate, accelerating soil acidification. Additionally, it will reduce the soil microbial activity. In Liu Shaochen's field, nitrogen fertilizer is given prior to while potash fertilizer; phosphate fertilizer and compound fertilizer are relatively less applied. He said: "I thought my crops would be more productive after I improved the mechanic technology in my field; however, I discovered that the soil was less fertile than before." This was because his inappropriate usage of chemical fertilizers.

Water Pollution

Chemical fertilizers can jeopardize both surface water and underground water. Chemical fertilizers used in agricultural production will be drained into rivers and lakes, which will cause eutrophication and damage water environment.

Through irrigation and natural precipitation, nitrates and other harmful substances will enter the underground water and then affect human's health.

If chemical fertilizers can be put to rational use, firstly, the quality of crops can be improved and food safety can be ensured. Secondly, it can increase productivity and save fertilizer resources. Finally, it will have more long-term benefits as it is environmental friendly and sustainable to field resource.

Currently, the situation of chemical fertilizer pollution is getting better due to the policies made by governments, awareness raised by farmers etc. However, there is a long way to go if we want to achieve our goal: “zero growth” in chemical fertilizer usage.

Solutions

The practical solution of the issue can be divided into two aspects.

I. Technological solutions

Fertilization Technology

a. Test the soil and make plans about the usage of chemical fertilizers according to the soil property. According to the characters of the soil like the fertility, acid-base property or micro-organism number, the composition and amount of chemical fertilizer needed in the area can be ascertained. The method helps to use chemical fertilizer in a scientific way and make better use of chemical fertilizers to improve soil fertility with little wasting and pollution.

For example, in Iowa, USA, the condition of soil was divided into 5 levels, according to the content of phosphorous and potassium in the soil: very low, low, medium, high, and very high. According to different levels, different plans were made in the composition of chemical fertilizers to fertilize more efficiently and avoid mass pollution. In USA, more than 80% of arable land has implemented this method to reduce the pollution and improve efficiency.

b. Integration of water and fertilizers can be a suitable method not only to release the stress of water shortage in the North China Plain but also to use chemical fertilizers appropriately. In the past, broad irrigation was widely used in North China Plain, which caused the losses of chemical fertilizers in the field and also the increasing amount of chemical fertilizers emitted into rivers and lakes. However, in recent years the micro-irrigation technology has already been popularized in the North China Plain, so the usage of chemical fertilizers can combine with this technology to provide the crops with accurate composition and amount of chemical fertilizers.

c. Green fertilizers technology is another method to control the usage of chemical fertilizers by offering substitutes to chemical fertilizers. Organic fertilizers like bio gas manure are now promoted in a wide range of area in the North China Plain. The production of bio gas has reached 3.53 billion square meters in total in the North China Plain. In some areas, microbial fertilizers can also be developed to reuse chemical pollution caused by chemical fertilizers. Besides using organic fertilizer, straw incorporation is also an effective way to fertilize the

soil.

Information Technology

- a. Set up a supervision system based on 3S to obtain information like the amount of metal or chemicals inside the soil to provide directions for the later use of fertilizers and protection measures. Another system can be built to ensure the quality of chemical fertilizers and combat the inferior products which are harmful to the crops and the environment.
- b. Some farmers lack the knowledge to use chemical fertilizers scientifically. However, with the development of information technology, computers can be used to make out plans about fertilizer usage in view of many factors, like the plant species, climate change and soil condition. The plan made by computers is usually more intelligent and can more precisely fit a specific area.

II. Policy solution

1. Programs and researches can be worked on by institutions and universities to get first hand information of chemical fertilizer usage and develop ways to use chemical fertilizers reasonably. The country should encourage and promote the researches and investigations by funding.

Moreover, since the control over chemical fertilizers is a long and arduous work, all the people in the society, especially farmers need to improve their awareness of environmental protection and join in this work. Educating and training the farmers about new technologies developed to increase land productivity and the harmfulness the overcharge of chemical fertilizers can bring to prevent them from using chemical fertilizers blindly.

2. Enhance the legislation and regulation system on chemical fertilizers.

- a. Registration and random checks of chemical fertilizers can help to make sure the chemical fertilizers used by farmers are in standard quality.
- b. The government should offer subsidies for farmers who use more green fertilizers and less chemical fertilizers or those who use new technology to prevent fertilizer pollution in order to encourage them to use chemical fertilizers reasonably. What's more, a fine will be imposed if the farmers overuse chemical fertilizers without considering the environmental results.
- c. According to the conditions in particular areas, different criteria of fertilizer use can be determined. For example, there used to be serious nitrate pollution in drinking water in England caused by inappropriate fertilizer usage. Therefore, a clause came out that nitrogen fertilizer cannot be used within 10 meters around the rivers.

3. According to the condition of chemical fertilizer usage in different regions, different plans must be worked out. What's more, agricultural cooperatives and agricultural production bases should play a significant part in the promotion of new technologies and new policies. For example, in 2011, a large agricultural production base in Tongzhou County implemented the

method of testing soil and using organic fertilizers. With rapid growth in productivity and profit, the agricultural base has become a model for the farmers in the area to change their way of using chemical fertilizers.

4. International cooperation

The international world should work together to figure out new technologies or policies to deal with chemical fertilizers pollution and share the experiences with each other. Experts can also be sent to specific areas to do researches and offer suggestions to farmers.

Recently, a program has been launched in Tongzhou County over the usage of chemical fertilizers. Through the program, the Liu's family received a lot of advice from experts who hold lectures regularly in the area and started to apply new method of fertilizing, like using organic fertilizers or testing soil before fertilization. Liu also installed an application on his computer as his assistance to decide how to use fertilizers in the field. As a result of rational use of chemical fertilizers, the quality and quantity of winter wheat in his field improved considerably.

Conclusion

In general, the North China Plain is an important region which contributes to China's agricultural economy. However, in order to achieve the goal of sustainable agriculture and improve productivity in a long term, the control over chemical fertilizers is indispensable because the overuse of chemical fertilizers will not only do harm to the environment but also affect the quality of crops. Technological and political policies should both be used to combat the problem which is a serious obstacle for the agricultural development in Liu's family and the North China Plain. If the government, the farmers and the international world can strive together to prevent chemical fertilizer pollution, we will be closer and closer to the goal of "sustainable agriculture."

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