

Wang Jialei
Shijiazhuang Foreign Language School
Shijiazhuang, Hebei, China
China, greenhouse

China: frontier technology and limitations of vegetable greenhouse production in north China

Abstract: In order to explore the current situation of vegetable greenhouses in north China, through visiting Shouguang district in Shandong province and Yongnian county in Hebei province, we've learned about the cutting-edge technology of vegetable planting. However, the vegetable planting is rich in science and technology, but lacks practicality due to high costs, which requires the active guidance and help from the government and the agricultural academy.

Vegetables have always been an integral part of the human diet culture. Before the ministry of agriculture proposed the "vegetable basket project" in 1988, the average person was still in a state of "temporary shortage" and "only consuming radish and cabbage during winter." With the continuous progress of the project, the "vegetable basket project" has gone from nothing to something and is now required to be excellent. At the same time, the reform and opening up over the past 40 years has brought an enormous enrichment of material civilization, which has also increased people's pursuit of food. In addition, vegetable yields have continued to rise in recent years. According to China industry information network, total vegetable production increased to 706 million tons in 2013, which surpassed total grain production and became China's largest agricultural product. By 2017, the annual production of vegetables had reached 820 million tons and vegetable greenhouses account for 95 percent of the industry.

Vegetable greenhouses are a kind of frame mulch structure with excellent heat preservation performance and allow people to eat off-season vegetables. In general, vegetable greenhouses are made of bamboo or steel frames covered with one or more layers of insulating plastic film, thus forming a greenhouse space. The outer membrane can prevent the loss of carbon dioxide produced by the growth of the inner vegetables, so that the greenhouse has a good effect of heat preservation. Compared with traditional agriculture, the annual output of greenhouse agriculture is more than ten seasons, it is not affected by external factors such as the changing seasons, and the labor input is relatively small. In recent years, with the attention and support from the agricultural sector to greenhouse agriculture, the scientific and technological strength of greenhouse agriculture has been increasing.

Developing greenhouse agriculture is an inevitable process to meet people's dietary requirements and realize the sustainable development of vegetable planting. Therefore, in this paper, the forefront of science and technology in recent years are summarized and the limitations in the process of popularization are analyzed respectively in order to promote agricultural technology popularization and vegetables production.

Key words: agriculture, greenhouse, vegetables, cutting-edge technology, limitations

1. Location conditions affecting the production of greenhouses

1. 1) Natural conditions

Vegetable greenhouses in China are mainly distributed in the north of Yangtze river, such as north and northwest China, Hebei and Yellow River area.

Among them, the planting advantage of north China is particularly outstanding. North China is located in the temperate zone, with enough light, quantity of heat and the plain terrain, which are suitable for large-scale vegetable greenhouses construction.

1. 2) Social conditions

Although north China has a rare natural advantage in vegetable cultivation in all aspects, it was still dominated by food cultivation until the reform. By the 1880s, as the winter sun cultivation technology breakthrough took place, the Shouguang government seized the opportunity in time, which allowed the vegetable industry culture to become the dominant industry of the local agricultural industrial structure and introduced a series of supporting policies. Among them, the establishment of the Shouguang wholesale market in 1984 is a great example. This solves a series of issues such as the poor transportation and circulation of vegetables, which resulted in the Shouguang vegetable industry and gradually becoming the largest vegetable distribution center.

2. Cutting-edge technology of vegetable planting

The following introduction is about the advanced technologies of vegetable planting that are currently being used, which make the production of greenhouse agriculture more industrialized and large-scale. This alleviates the food safety problems of pesticide use and saves space and soil resources, which improves the yield. The scientific and technological information was obtained by the investigation at the exposition of vegetable high-tech demonstration garden in Shouguang district, Weifang city, Shandong province.

2. 1) Vertical column cultivation

Column cultivation is the different shapes of cultivation by an erect device that acts as the carrier of plant growth and gives productive potential for growth with limited ground space, which saves the land resources and agricultural sustainable development to provide suitable cultivation mode. It makes effective use of space and solar energy, saves land, and achieves a larger output ratio per unit area, which can increase the utilization rate of land by 3-5 times and increase the output per unit area by 2-3 times.

2. 2) Rock wool cultivation

Rock wool cultivation is the most advanced soilless cultivation technology in the world, which refers to planting in rock wools beforehand. Rock wools are made up of 60% diabase, 20% of the limestone and 20% of coke and are then melted under 1600 °C high temperature, which results in inorganic solid substrate. The water retention and ventilation properties of rock wool coincide with the relationship between fertilizer, water and oxygen. Also, it has the advantages of simple installation, convenient installation and use, and is free from the restriction of ground level. This unique cultivation mode is based on the physiological and growth characteristics of plants, and the species and concentration of fertilizers are adjusted to avoid the occurrence of soil-borne diseases and insects.

2. 3) Biogas energy cultivation

This technology is suitable for use of vegetable cultivation in facilities. Vegetable leaves, fruit residues and waste materials in the process of vegetable production can be fully used. Biogas is generated in the biogas digester to provide energy, and even biogas slurries and renewals can be used in the site. In addition to providing energy, biogas can also be used to install biogas heating lamp, which can increase the effects of air fertilizer and temperature and realize the simultaneous planting of gas and fertilizer in the same land. The construction of biogas is closely combined with ecological agriculture and vegetable cultivation in solar greenhouses.

2. 4) Aerosol culture

Aerosol cultivation is a kind of water cultivation method that uses a spray device to atomize the nutrient solution and spray it directly to the plant root system to provide the water and nutrients needed for plant growth. The artificial environment replaces the soil environment and identifies with

the "no-soil cultivation" mode, which solves the contradiction of water, oxygen and nutrient supply. As a result, it greatly increases the growth and biomass of plants. The yield potential of a single plant of melon and fruit increased by several times or even dozens of times. For example, the yield of leaf vegetables increased by 45% to 75%. Aerosol cultivation can be well combined with vertical column cultivation to facilitate automatic control and improve the space utilization rate of greenhouses. At the same time, it is far away from the soil, which reduces the occurrence rate of diseases and insect pests, which means that there will be no pollution caused by soil or other dirt.

2. 5) Transmission multi-layer three-dimensional track cultivation

It makes good use of vertical space with multi-layer structure design and automatic rotation, which makes sure that every plant can get enough light. This model combines the control of nutrient solution irrigation to ensure that every plant can be controlled through the technology. Meanwhile, automatic control with accurate positioning can be used for regular irrigation and fixed-point harvesting. The efficiency of planting was more than three times that of other planting methods.

2. 6) Aquaponics

This is a new type of compound farming system. Through ecological design, water planting and aquaculture realized scientific synergistic coexistence. The ecological symbiosis effect of "no change of water for raising fish, no fertilization for growing vegetables" was realized. Water is used as the medium to filter the water in the fish pond as the nutrient solution for vegetable growth. Then, the water will be absorbed by the vegetables and returned to the fish pond after getting rid of pesticides. At the same time, this method avoids the use of pesticides and realizes a virtuous cycle of fish and vegetables.

3. The relevant industries and influences to the local areas

There is a new concept called "greenhouse+" which means that the greenhouse vegetable planting can also be connected with other relevant industries (tourism, deep processing). Those are mainly for the economy increase and promote the industrial upgrading to make the economic structure more sustainable and reasonable.

3.1) tourism industry

Ecotourism has become an apparent phenomenon since the masses started to pay more attention to spirit consumption. To begin with, the government of Shouguang established the vegetable high-tech demonstration park in 1999 and held the first vegetable science fair successfully in April, 2000. Since then, preferential policies are issued on a large-scale by each street and town which combine with real situations. In that case, the sightseeing belt of greenhouses' production and tourism in rural areas named Baihuali along the both sides of Mihe River formed and completed constantly. People came to pick , have agritainment and get more agricultural knowledge. In 2005, the number of tourists throughout the world who choose to have rural trips was around 1260000 and the consolidated income reached at 280 million yuan.

3.2) deep processing

The export of products will always face a series problems of high costs and short shelf lives caused by the long-term transportation. Also, many consumers refuse some necessary vegetables (radish, shiitake, celery) because of the special tastes. Dried vegetables and vegetable powder solve these problems and provide a brand new form of eating fruits and vegetables. They make our way of eating more convenient, we can drink vegetables and eat them like chips. A company in Shouguang makes a big success with agriculture products in abundance.

3.3) other benefits and downsides

Compared with the soil of open fields, the nutrients index of facility greenhouses' soil is relatively increasing. The fertility (of soil) is much higher than open fields' because of the long-term planting, pesticides and effective management. Also, much stalks, stubble and plant remains increase the soil organic matters.

In contrast, the heavy metal elements are higher in greenhouses but still not cause pollution, which means unreasonable using of chemical pesticides is the main factor.

4. Limitations of vegetable planting in the promotion process

Although the proportion of scientific and technological elements in greenhouse agriculture cannot be underestimated, the actual operation of these high-end technologies in real production and living practice is still unknown.

On China Shouguang vegetable science and technology international exposition, modified productive tomato, giant pumpkins and various kinds of fruits and vegetables, embody the development of scientific agriculture. Also, soilless cultivation and intelligent irrigation technology are really eye-opening. However, when asking a staff in the park, we understand the specific situation. He said "these facilities are primarily used for ornamental reasons and most of the farmers in the rural areas still adopt the traditional method, which refers to covering the plastic greenhouses with quilts to reduce cost." The gross income is about 60000-70000 yuan per greenhouse per year, two greenhouses of net income to gross income is worth a greenhouse. A shelf of vertical column cultivation costs more than 200 yuan to build.

A farmer in Yongnian of Hebei Province provided more information when doing a telephone interview. She said that individual farmers of greenhouse planting area are very small and for the output of the common vegetables such as celery, tomatoes and beans also only have 7-8 ripe seasons per year. Also, the output may often reduce by the extreme weathers (snow, frost, low temperature, etc.) and human factors such as management oversight. The application efficiency in technology is not high, and the planting methods and in Shouguang area have not been popularized well. Another big drawback is high costs. The average farmer earns around 50,000-60,000 yuan a year, and most of them cannot afford expensive equipment and smart systems.

Much of this is due to differences in production and sales patterns. In Shouguang, for example, the vegetable production base is of the large scale of production, agricultural form is given priority to greenhouse agriculture. Since the input of labor and the cost is relatively high, the radiation of product is throughout the country and even abroad. As for YongNian area, small production scale and agriculture form also still stay in grain crops, and the product sales is only located in the local vegetable wholesale market and morning market. The following chart illustrates the basic planting situation of this farming household in Yongnian.

Seasons	2		
Types	tomatoes	beans	celery
Yield(1kg/666.7m)	5000	1500-2000	7500

5. Anticipation of the solutions in the promotion of science and technology

The following is an introduction of solution anticipation to the limitations and obstacles encountered in the promotion of Shouguang mode. These limitations have greatly affected the rise of potential industries in less developed areas. Therefore, the following solutions are proposed.

5. 1) Government assistance

Governments in areas with advantages in vegetable production can seize the opportunity to help farmers and boost regional economic growth. The government may finance the construction of

facilities and greenhouses and provide them to farmers in the form of leasing, lending or contracting. They can also learn to import production experiences from other regions and combine them with local realities, sending an academy of scientific research personnel to guide agricultural production, increase publicity effort of planting method, promote science and technology, and guide farmers to choose the appropriate planting methods.

5. 2) Joint venture construction

Individual farmers can jointly expand the scale of the greenhouse, upgrade the production and sales model as a whole, and increase the radiation range of products. Shouguang region greenhouses plants originated from a former diplomat in Israel. After setting up a unique production mode, he found that due to the cost problem, the mode cannot be promoted in a large range. Therefore, he chose to contract to local farmers and actively encourage joint ventures in an effort to make millions of greenhouses.

References:

- [1] Fang Xinqi, “develop agricultural tourism, build unique brand of Shouguang”, *Shandong Economic Strategy Research*, 2006.
- [2] Zhou Yingheng, Lu Chao, Zhou De, “Analysis of the influencing factors of the formation of main vegetable production areas in China: A case study of Shouguang in Shandong Province”, *Geographical Research*, 2012-4.
- [3] Tang Mingxia, Yang Maochuan, “Study on the planning and design of greenhouse agricultural landscape --Take shouguang district in shandong province as an example”, *Science & Technology Information*, 2007.
- [4] Yu Xuefeng, Guo Xiaoying, Cao Chuanli, Dong Zhaorong, Zhu Jiang, “Study on Effect of Greenhouse Agriculture on Soil Fertility and Environment Quality”, *Journal of Anhui Agri. Sci*, 2017.