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China, Vertical farming

A Brief Introduction of Vertical Farming

Summary

Recently, the person in charge of the Ministry of Agriculture and Rural Affairs said that farmland is the foundation of grain production when interpreting opinions on preventing farmland from "non-grain conversion" to stabilize grain production. The total amount of cultivated land in China is small, the quality is not high as a whole, and the reserve resources are insufficient. This puts forward higher requirements for protective development of cultivated land: can vertical agriculture play a role in land protection and utilization and what kind of role can it play? How should vertical agriculture develop position, to what direction develop? What role can vertical agriculture play?

Based on the development of vertical agriculture at home and abroad, this paper takes Tongfu Group Agricultural Industrial Park in Shijiazhuang Tayuan Village as an example to explore the feasibility of vertical agriculture development in Hebei Province and analyze the future development direction of vertical agriculture. This paper mainly involves the following parts: first, the concept and significance of vertical agriculture; second, research progress and limitations at home and abroad; third, research problems and innovations; fourth, the necessity of developing vertical agriculture in Hebei Province; Finally, take Shijiazhuang as an example to analyze the feasibility and challenges of vertical agriculture development in Hebei Province.

【Key words】 Vertical farming Innovative development feasibility

1. Concept and Significance of vertical farming

1.1 Background of the appearance of vertical farming concept

①As the economy and society develops, conflicts between humans and land as well as food safety issues stick out.

②Problems of resources, environment and global changes are obvious and keep on influencing people's daily life.

1.2 Connotation of Vertical Agriculture (concept, type and function)

Li (2013) argued that as one of the important manifestations of urban agriculture, vertical agriculture not only combines agriculture and construction industry, but also includes knowledge and technology in bio-energy, environmental science, botany, zoology, waste management and urban planning,

materials science, public health and many other fields. Liu (2010) argued that it is a set concept of interdisciplinary cooperation.

Based on practical practice, there are three types of vertical farms: (1) Indoor three-dimensional planting. At present, modern agricultural industrial parks are gradually developing, and their main characteristics are facility agriculture. (2) Building skin agriculture, that is, agricultural planting on the building roof, balcony, or even the wall. (3) By integrating the characteristics of indoor three-dimensional planting and skin agriculture, a more high-end vertical farm with more diversified functions can be formed. In addition to agricultural production, it can also treat urban waste and wastewater with environmental protection (Zhang Jianguo et al., 2016).

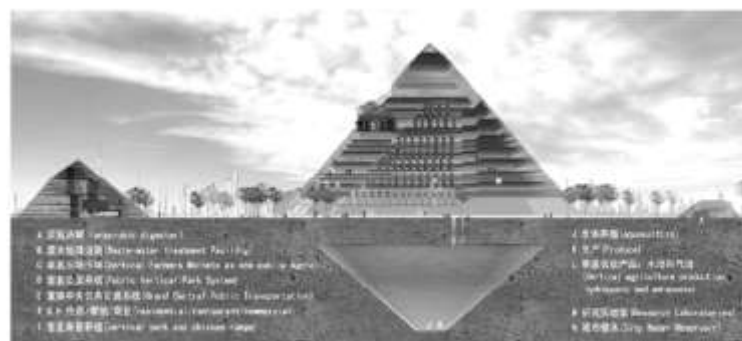
Ideal vertical agriculture can simulate the way of "food chain" in natural ecosystem to match plants, animals and microorganisms, forming a scientific layout of producer, decomposer and consumer, relatively complete biosphere, and maximizing material and energy utilization in a mutually promoting system. Its function is not only to meet future food demand, return arable land to nature to enhance the ability of ecosystems to cope with global change, but also to realize the resource utilization of urban organic waste and wastewater, and improve the deep material and energy flow of the city.

2. Research progress and limitations at home and abroad

2.1 Progress at home and abroad

2.1.1 Development of vertical farming around the world

(1) **Pyramid farm:** the vertical farm as early as in 1999 by the US environmental hygiene and microbiology professor emeritus at Columbia University Dickson, pearl mill is put forward, and in 2001 published the "pyramid" farm narrated in this concept, main functions including agricultural production, recycling of organic waste water waste and vertical agricultural research commercial function of three parts. The vertical farm illustrates not only the internal functional components of the farm, but also the urban distribution network composition of the vertical farm.

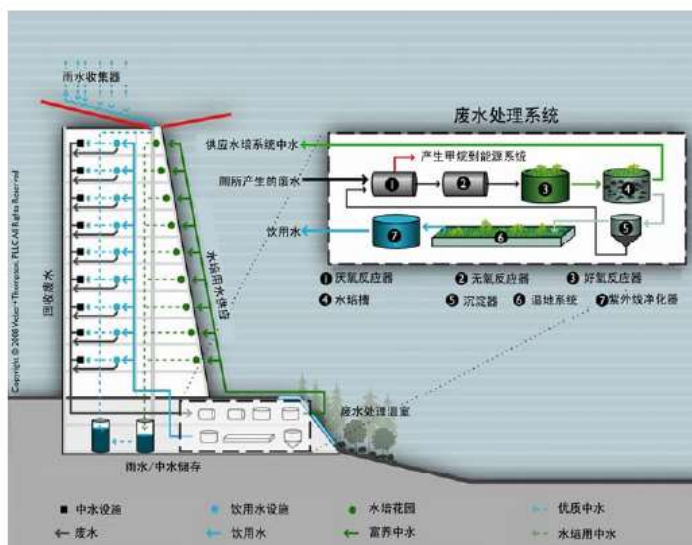


(2) **O vertical farm:** Oliver Foster of Queensland university of technology for the first time to respond to the position of the vertical farm in the city, has been clear about the farm site selection standard, according to the local food supply and the data analysis of population, puts forward the type

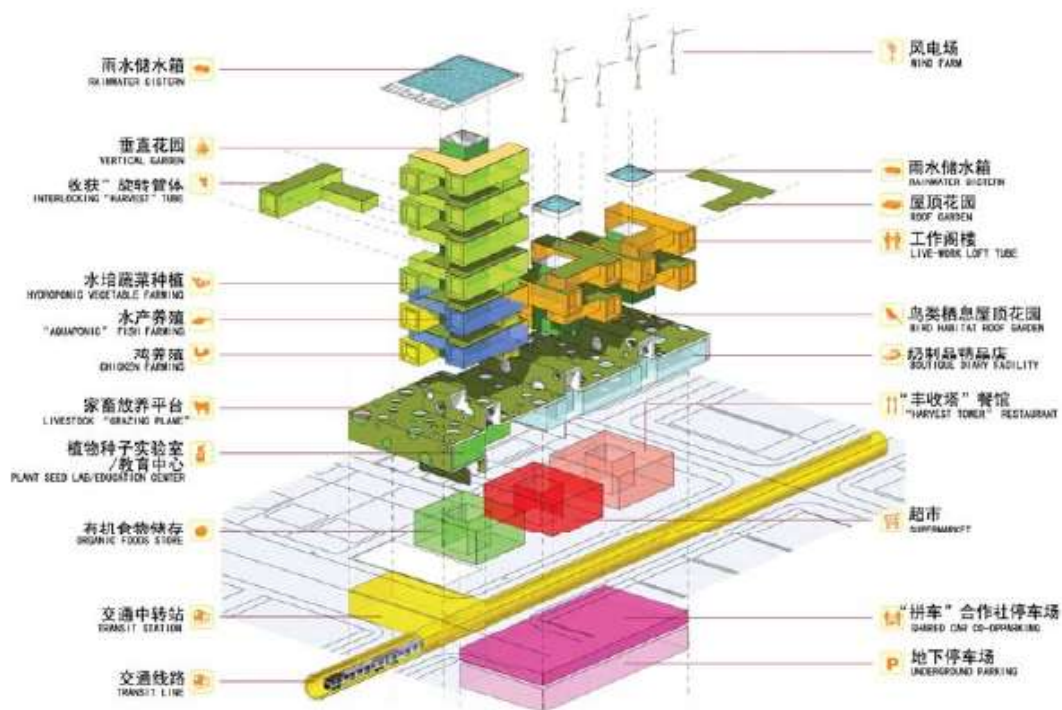
O vertical farm, but main body function and Desmir vertical farm, the same in essence is the development of the concept of the vertical farm.



(3) Ecological Laboratory: In 2008, The ecological laboratory designed by Weber Thomson integrated the use of a variety of energy and ecological technologies. In addition to clearly expressing the organic wastewater treatment process of vertical farms, it also made a system design for the utilization of renewable energy common in vertical farm design, which is a model of environmental energy treatment in vertical farms. The relationship between vertical farm and nature, vertical farm and society is coordinated.



(4) Agribusiness tower: The agribusiness tower of the Green Harvest Program has complete agricultural production functions, including not only common chicken and fish farming, but also large livestock farming such as cattle and sheep. In the functional layout, different requirements of light environment for different agricultural products are fully considered. The functional unit of plant planting is higher than that of animal breeding. Meanwhile, the area of natural light transmission is creatively increased in a way of uneven appearance. In addition, the integration of the agricultural tower with urban public transportation is one of the highlights of the design.



2.1.2 Research progress of vertical agriculture in China

"Shenzhen Green Beauty" is China's first vertical farm development projects, being put forward by Mr Zheng Jianping, borrowing the image of the tang dynasty Yang for vertical farm shape, setting the vertical farm, air garden hotel and green ecological tourism as a whole, the year continuously planting, harvesting, operation, and has more than a dozen high-tech technology (solar energy, wind energy, fertilizer fermentation, clean water regeneration). To provide sustainable economic and ecological support for us is a positive attempt by mankind to cope with the problem of increasing grain output and decreasing arable land.



Zhejiang "Sky Gardens" in 2016, is a professor at Gao Ning lead students to Zhejiang university of science and art design experiment roof into a system circulation and intelligent ecological garden, a total construction area of about 800 square meters, the project, the concept of sustainable development of resource to the real project, for the schools offer plenty of vegetables. It also provides teaching staff and students with teaching experience demonstration sites and comfortable and environmentally friendly leisure activity space.



2.2 Limitations

Vertical agriculture alleviates the pressure of traditional agriculture on nature to the greatest extent with its science and technology. However, huge capital investment and energy consumption are also severe challenges currently faced. Some scholars believe that vertical agriculture has high requirements for science and technology, and the current level is difficult to meet. Moreover, the price cost of a high-rise is over 100 million yuan, and the short-term profit and cost expenditure are not balanced. In addition, the upper and top floors of tall buildings are easy to receive light, but the lower floors need to be replaced by light-emitting diodes (LEDS). However, this way has a surprising amount of empty electricity, and the energy resource limitation is also the core problem of vertical agriculture. At the same time, the innovation of this model will also lead to the unemployment of some workers such as packaging and transportation.

3. Analysis of the current situation of vertical agriculture development in China -- Taking Hebei Province as an example

3.1 Necessity of developing vertical agriculture in Hebei Province

Hebei province is one of the main grain-producing provinces in China and undertakes the important strategic task of national grain security. At the same time, as an important source of water conservation, clean air filtration and green energy supply in Beijing and Tianjin, it is the support to expand the capacity space of ecological environment in Beijing and Tianjin. In recent years, with the accelerated development of cities and towns and the rapid concentration of population, the pressure on resources and environment in the region is increasing day by day. The smog, water shortage and pollution have become the common concerns of the government and the public. Therefore, the development of vertical agriculture provides a new way to solve the contradiction between population, development and resources and environment in Hebei Province.

Although vertical agriculture has many limitations in practice, it still attracts many countries to try this new agricultural mode due to the prominent contradiction between population and environment and its great advantages in theory. As the most populous country in the world, it is of great practical significance for China to explore the development potential of vertical agriculture. Therefore, this study adopts the method of literature metrology analysis of the vertical agricultural research hotspot and difficulty, at the same time in the provincial capital Shijiazhuang, Hebei province to select three typical vertical farming or prototype farms as the research object, using case analysis, proven technology foundation and bottlenecks, illustrate the feasibility of the vertical agricultural development in Hebei province, in order to promote the further development of urban agriculture in the province, realize the transformation and upgrading of agricultural industry in my province.

3.2 Development status of vertical agriculture in Hebei Province -- take Tongfu, Tayuan Village as an example

At present, Tayuan Village glass greenhouse as the experimental base, built a relatively rich and diverse vertical agricultural development system.

(1) Factory style



It looks like a bookshelf and is vertically stacked upwards. Double or even multi-layer agricultural planting space is constructed in the three-dimensional space, so as to make full use of the greenhouse area. The upper layer can also shade the lower layer from the sun and promote the growth of cool-loving crops. At the same time, plants can use the nutrient solution to sustain life and grow, effectively breaking free of soil.

(2) Rotary style



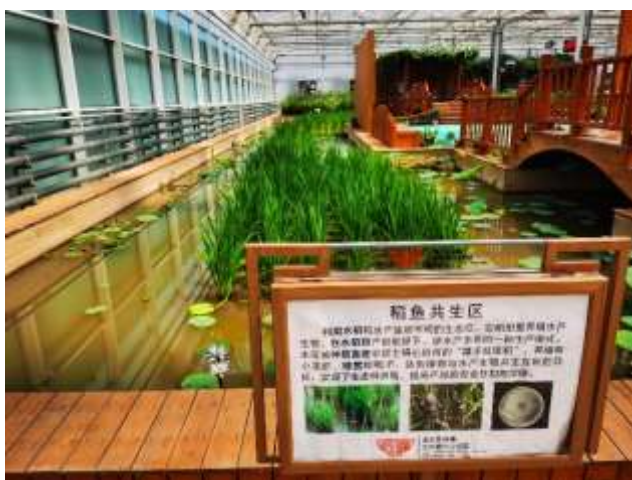
The six-layer crop rotates regularly under the control of rollers to better absorb sunlight and water and promote growth. This kind of vertical agriculture is more ornamental and has a wider development prospect than bookshelf agriculture to some extent.

(3) Combination of agriculture and entertainment



It's an agricultural system with fish at the bottom and crops at the top. The fish in the lower layer are very ornamental, grow and multiply, and the organic fertilizer generated by metabolism is sucked through the pipe to the root of the upper layer of crops as organic fertilizer, while the fallen leaves of crops (naturally or manually) also provide natural enough food for the fish, realizing the harmonious coexistence of the two.

(4) Fish-rice symbiosis



Fish and rice grow in the same pond. Under the premise of ensuring stable rice production, crayfish, crabs and ducks are organically arranged to promote the harvest of aquatic products and the symbiosis

and mutual benefit of plants and aquatic creatures, thus improving the safety and added value of products.

(5) Natural stratification



According to the type of crops, natural height and suitable planting conditions, follow the natural law of high and low layout of different crops, so as to make full use of land, provide good growth environment and conditions for crops, promote crop yield.

3.3 Positioning and limitations of vertical agricultural development in Hebei Province

3.3.1 Construction of vertical agriculture in Tayuan Village

As mentioned above, Tayuan Village agricultural layout mainly has five types. In this way, the advanced theory of scientific and technological innovation is practiced, the land space is fully utilized, the land multiple cropping index and unit yield of crops are effectively improved, and the bottleneck of agricultural development in Shijiazhuang -- light source (cold light source irradiation), water source (water circulation system) and so on are effectively eliminated. Its products on the basis of traditional agriculture has innovative points, effectively improve its social value, is conducive to promoting the growth of farmers' income.

However, the system has its limitations. As Tayuan Village is located in a second-tier city and close to Beijing, a large number of scientific research talents are lost, and there are too few agricultural-related

scientific and technological innovation enterprises nearby. Technological innovation is still an important problem plaguing Tayuan Village Agricultural Base, and of course there will be restrictions in the promotion and dissemination of such advanced technology. Economic problems, no matter from the early stage of the investment or medium-term operation, require a lot of cost of capital, for most enterprises, will there are difficulties in financing problem, at the same time, the light source needed most from LEDs, power consumption is big, air conditioning heating, ventilation, water pumps and other equipment also need to consume electricity, which is a big cost. According to statistics, for every dollar of vegetable production cost, electricity costs account for 20 to 25 percent. In addition, vegetables have a short growth cycle and are perishable. Delayed transportation or insufficient consumption will lead to the interruption or even bankruptcy of farm production, and the off-season of tourism in regions mainly focused on sightseeing will also increase economic risks. In addition, leafy vegetables with rapid growth, easy to accept artificial light source and low plants are mainly used. Large-scale cultivation cannot be carried out for plants with complex planting requirements (such as crops that need to be pollinated, etc.), and the failure to guarantee the diversified supply of crops will also affect the later income. Ecological benefits, waste matrices, waste water and waste that are not fully recycled and treated, how to safely discharge into the environment, avoid secondary pollution, and reduce nitrogen oxide and other greenhouse gas emissions, are the serious challenges facing vertical agriculture and even the global agricultural ecosystem.

Based on the above advantages and disadvantages, the development orientation of vertical agriculture in Hebei province is oriented towards culture and tourism. While promoting the development of agricultural technology and agricultural production, the park is fulfilling its mission by popularizing relevant knowledge and propagating the concept of agricultural development to tourists, and looking forward to the birth of innovative talents in the future

The significance of vertical agriculture is as follows:

(1) Ease the contradiction between urban expansion and food security and meet people's needs for a better life. The fifth Plenary Session of the 19th CPC Central Committee put forward the economic and social development plan for the 14th Five-Year Plan period and the long-term goal of 2035, stressing the new vision of innovative, coordinated, green, open and shared development to meet the people's ever-growing needs for a better life. Entering a new stage of development, new requirements have been put forward for the high-quality development of the food industry. First, in line with the bottom line requirements of food security, according to the high quality requirements of different varieties, different regions and different links of food, the construction of industrial belts, industrial chains, quality improvement, brand creation, from a higher level to achieve a strong industry, food security; Second, to meet the people's ever-growing needs for a better life, meet the needs of the people in terms of food quality, pursue food quality in terms of "eating well and eating healthily", and achieve high-quality development in terms of diversification, individuation and branding. Third, we need to build a higher-level food security system, increase training and promotion of agricultural technology, and increase farmers' enthusiasm for growing grain. Fourth, we need to mobilize the initiative of diversified market entities, grow grain with high quality, and adjust the mix of grain and oil varieties.

(2) To achieve sustainable ecological and environmental development and practice that clear waters

and lush mountains are invaluable assets. Building an ecological civilization is crucial to the sustainable development of the Chinese nation. We should firmly establish and faithfully practice the concept that lucid waters and lush mountains are invaluable assets, deeply understand the scientific connotation that protecting the ecology means developing productive forces, and achieve green development by treating nature well and protecting it, and achieve sustainable development by conforming to and respecting nature. On our journey in the new era, we must continue to promote ecological progress and embark on a path of civilized development featuring increased production, higher living standards and a sound ecological environment.

4. Main conclusions and initiatives

China has a large population, but its agricultural development has not been matched with it. Developing emerging agriculture is an important part of China's future development. With the continuous development of China's population and urbanization, food demand is increasing. Blindly relying on imports will only increase China's risk of food crisis. In the process of afforestation construction in Our country, more and more cultivated land has been rehabilitated, which makes it possible to improve the yield and develop modern vertical agriculture with restriction, as well as the real need of social development. Because vertical agricultural development mode is very suitable for the current situation of China's economic development and environmental governance, it may be better developed and promoted in the future.

5. Special thanks

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