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Innovative Internet Solutions for Suburban Community Farm Practices: A Study in Lowland Communities of Hangzhou, China

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Abstract: The development of permaculture follows the principle of respecting nature and protecting ecology, which is of great significance to the development of modern urban agriculture. Community planning combines urban life with traditional agricultural production, so that agricultural development and suburban urban life have symbiosis and complement each other. On the one hand, it alleviates the contradiction between the city and ecological environment protection and guides ecological and green development in the suburbs of the city. On the other hand, it creates a better living environment for the city and promotes the sustainable development of urban–rural integration. This paper combines the sustainable design concept of permaculture with the resource conditions and advantages of the comprehensive project base and applies the concept of permaculture to the development of the "air vegetable plot" urban farm. At the same time, we use the integration strategy of agriculture and tourism, through the "Internet + Agriculture" path, to build a multi-functional industry of life, production and ecology; to promote the sustainable development of rural industries with the digitization of agricultural industries; to promote the common prosperity of rural areas; and to open a new model of "Internet + Future Agriculture".

Keywords: air vegetable plot; Internet; permaculture; urban agriculture

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1. Introduction

Under the background of accelerated urbanization in China, in order to adapt to the challenges of rapid urban growth and social change, it is necessary to effectively carry out urban elastic transformation. The emerging challenges in the process of urban transition provide guidance for how to operate the city for more flexible future development and ensure that the community can be in the center of the city. Weidner, Yang and Hamm argued that urban farms should be self-sufficient, and they investigated the transformation of urban agriculture to improve the sustainability of urban agricultural development by combining agriculture with buildings and waste-conversion sites, taking into account existing conditions [1]. To investigate the impact of urban agricultural landscape change on urban development, scholars used a cultural treatment to study the Italian island of Sardinia, where they focused on rural habitats and the prospect of conservation, despite the shrinking population and irreversible aging of many residential centers throughout the region, and promoted urban renewal and development through sustainable urban agriculture [2].

With the rapid development of urbanization in China, the existing form and development mode of urban agriculture are also constantly changing. The development of urban agriculture in China has been constantly transformed into new industries such as multi-functional services, green ecology and informatization [3]. Chinese scholars have mainly focused their research on urban agriculture on its industrial extension, regional development and functional expansion. The expansion and innovation of urban agriculture can effectively promote the green, ecological and sustainable development of Chinese

cities, and play an important role in accelerating the process of urban–rural integration and promoting the development of agricultural modernization in China [4]. An urban farm is located in the suburbs of the city, which fully combines the modern agricultural industrial park with the multi-function of agriculture, and provides better living environments for urban residents through landscape design [5]. Moreover, the concept and method of permaculture has been introduced into the development of urban farms in China, which not only helps to alleviate the problems of environmental pollution and resource waste, but also helps to improve the rural environment and enhance the quality of life of rural residents [6]. However, current urban agriculture has two problems in the development of industrial transformation. First, it has caused negative impacts on the urban environment and spatially contradictory relationships with urban ecology due to insufficient theoretical guidance and technical limitations. Second, the lack of certain expertise in the planning and development of urban agriculture has led to the serious homogenization of industrial development [7]. At present, modern agricultural production is beginning to take advantage of emerging technologies such as the Internet and intelligent technology, but there is still a relative lack of a more scientific and systematic integrated planning path, which has gradually become a new exploration and research direction for the sustainable development of urban agriculture in China as a new entry point for urban farm design.

2. The Concept and Development of Permaculture

2.1. The Concept of Permaculture

"Permaculture" is a compound word composed of "permanent"," culture" and "agriculture", which is usually translated as "sustainable culture" or "sustainable agriculture". It was founded by Bill Mollison and David Holmgren in the 1970s [8]. According to Bill Mollison's description, permaculture is a conscious design of the agricultural ecosystem, so that it has the stability, elasticity and sustainability of the natural ecosystem, enabling people to obtain the material and non-material elements needed from the agro-ecosystem through sustainable development [9]. Through the comprehensive design system of permaculture, a composite system that organically unifies the three major benefits of nature, economy and society is constructed [10], enabling the development of agriculture to achieve a sustainable and ecological ideal by combining the comprehensive benefits of natural elements, the ecological environment and all aspects of society.

2.2. Development and Present Situation of Permaculture

Permaculture was founded in the 1970s. Bill Mollison proposed the design concept of permaculture and published *Permaculture One*, which was then revised and deepened the concept through planning practice [11]. The earliest starting point was to build an agricultural system that can produce permanently, so as to deal with the destructive and predatory contemporary industrial agricultural production mode [12]. Although the Keyline system, proposed by Yeomans at that time, did not have a great response in the academic community, it was of creative significance to the agricultural landscape, which laid the foundation for Bill Mollison to create the design concept of permaculture [13].

In the 1980s, Holmgren published a design manual of permaculture, and scholars also began to study all aspects of permaculture, and its practice was mainly developed in Europe, Africa, Asia, and Latin America [14]. In 1983, Strange and Penny proposed that permaculture was a sustainable development form of agriculture. Hankins and Markl also studied the design method of permaculture [15]. In the 1990s, people began to pay attention to the expansion and application of permaculture and its practice in various countries. Seabrook believed that permaculture was an experiment for the sustainable development of human society, and Makus also carried out practical research on permaculture under mountain conditions, etc. [16].

In the 20th century, scholars carried out more in-depth and comprehensive research on permaculture. Based on the principle of the design concept of permaculture, its practical application has gradually been extensive, and many new forms of the design concept of

permaculture have emerged. Nowadays, permaculture has fully integrated and absorbed all aspects of ideology, and its application has gradually developed from a small-scale family garden to a large-scale community garden, ecological community and ecological conservation of the natural environment [17], studying its impact on urban development and ecological protection, as well as the social and cultural connotations of permaculture principles [15].

While the theoretical research and practical planning of sustainable agriculture are relatively mature internationally, development in China has been slow and research is relatively late. In the 1990s and the beginning of the 21st century, Chinese scholars began to introduce sustainable agriculture in the *Journal of Taiwan Agricultural Exploration*, but this is only an introduction to permaculture, which has not been deeply discussed [15]. Subsequently, Chinese scholars have carried out in-depth study on permaculture. Wu Dan conducted in-depth research on the combination of permaculture principles and landscape design [18]. Based on the principle of sustainable culture, Zhang Yuan studied the construction of ecological villages from social, ecological, cultural and other dimensions [19]. Huang and Jin constructed the urban permaculture based on the ecological implications of permaculture in terms of governance structure, collective consciousness and individual action for the practice of ecological steering [20]. Yuan used the three principles of care for the earth, care for people, and added distribution of surplus in the permaculture design concept to design a sustainable agricultural tourism experience model [21].

At present, the research on permaculture is still in the initial stage, but scholars are also engaging in in-depth exploration and research on the design of permaculture and its application in specific project planning. Liu Yuelai at Tongji University, through the integration of productive landscape and horticultural therapy in Shanghai, has created a community garden that can improve the urban ecological environment and humanistic qualities [22]. It not only improves the quality of urban public space, but also uses the land resources of the community [23]. At the same time, it also mobilizes the enthusiasm of the community people to participate in the construction and management of the community garden [24]. However, it is closely linked to building a community environment where people and nature coexist. In 2012, The College of Forestry and Biotechnology, Zhejiang Agriculture and Forestry University, established the "Hangzhou Permaculture" based on the research on permaculture principles, creating an environmental protection, low-carbon, organic agriculture, high-efficiency and sustainable agricultural development project [6].

3. Literature Review

3.1. Data Sources and Research Methods

Web of Science (hereinafter referred to as WOS) is the largest platform for obtaining foreign periodical literature. The foreign data in this paper are obtained from the Science City Index Expanded and Social Sciences City Index in the core collection of WOS. We selected "subject = * Permaculture * or * Editable Landscape *or * Urban Farming *" for retrieval, and further screening and retrieval were conducted based on "Environment Sciences", "Environment Studies", "Urban Studies" and "Development Studies". The initial literature was obtained from 1980 to 2020. After duplication, screening, combing and integration, 1711 relevant studies were finally obtained.

The research method of this paper is the use of CiteSpace software for relevant research and analysis. It is a visual analysis software in a Java environment. It can carry out research network analysis according to the relationship between various documents, such as cluster analysis, keyword co-occurrence analysis, co-citation analysis, etc. [25]. According to the data of the periodical literature derived from the above database, CiteSpace software is used to sort out the relevant literature on permaculture, understand their research hotspots and frontiers, and construct the corresponding knowledge map.

3.2. Descriptive Analysis

3.2.1. Time Distribution Law of Research

The amount of documents issued in each time period can reflect the research trend and dynamics in the form of time node visualization [26], as shown in Figure 1. The international research on this topic started earlier and the number of articles published gradually increased, which can be divided into three stages:

1. From 1980 to 1991, the number of articles published was less than 10, and the increase was small;
2. From 1992 to 2010, the growth trend of the number of documents issued fluctuated more than in the previous stage, showing a slow growth trend;
3. From 2011 to 2021, the growth rate is greater than that in the first two stages.

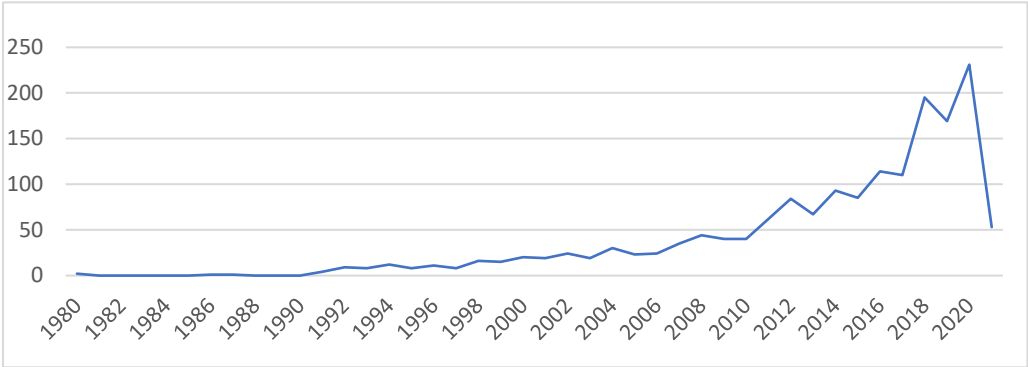


Figure 1. Time trend of the number of papers.

3.2.2. Research Network and Characteristics

Through cooperation network analysis, authors and institutions in disciplines or fields and their cooperation intensity can be identified [25]. The larger the node and the more connections, the higher the cooperation intensity between the countries/authors/institutions that the node refers to. Figure 2a and Table 1 clearly show that the United States, China, the United Kingdom, Italy and Germany have large nodes, and especially the United States, China and the United Kingdom are high-yield countries in the field of research. This result shows that the research is mainly distributed in Europe, Asia and North America, with the United States, China, Britain, Italy and Germany as the main research areas. Research scholars and experts are the basis of the research field [25]. The larger the nodes in the analysis spectrum, the greater the contribution of the corresponding researchers and experts in the research field. The more connections, the closer the relationship between researchers. Figure 2b shows that the cooperation between researchers in the world is relatively scattered, and there is no large-scale cooperation among research scholars. Among them, Jerzy F and Grazyna J have made great contributions to the research field. The analysis of institutional cooperation networks is the same as that of countries and authors. The larger the node is, the greater the contribution of institutions. The more connections between institutions, the closer the cooperation is. In Figure 2c, the institutions cooperate closely, and the Chinese Academy of Sciences is the most prominent one. The statistical results in Table 1 also show that CAS has made great contributions in this field and is an important research force.

3.2.3. Research Hotspot and Foundation

Keywords are the refinement of research content. High-frequency keywords are the research hotspot and core part, which can reflect the key content of the research field [25]. The larger the nodes and the more connections in the analysis spectrum of research hotspots, the more research content there is for this keyword. Agronomy, land use, impact, managers and urbanization are high-frequency keywords, indicating that the research content is

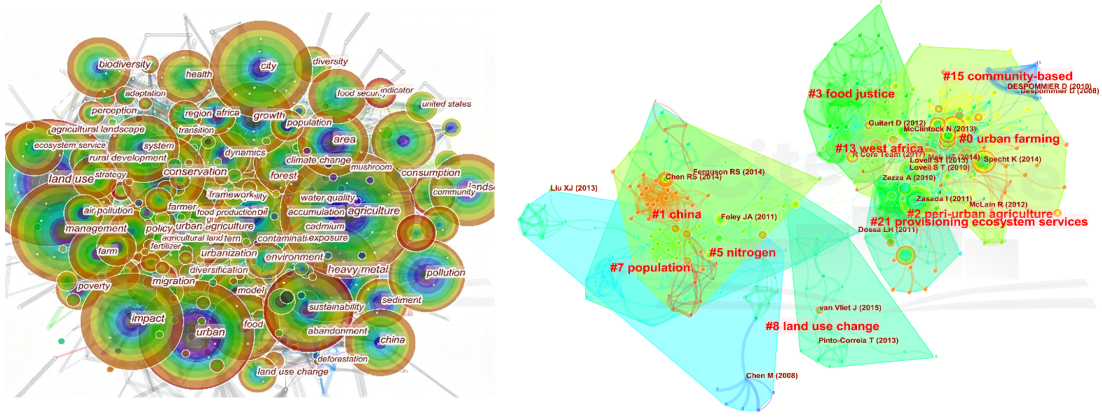
extensive and hot, as Figure 3a. According to the analysis results in Figure 3b, these research topics can be summarized as follows:

1. Urban agriculture, including farms, food, etc. Brenda found that urban farms can be used as productive green infrastructures to provide important environmental and social services beneficial to urban communities [27];
2. Urbanization, including management, urban landscape, land use, etc. He's research on the attitude and behavior of Chinese emerging urban community residents on building community gardens and edible landscape shows that most people are willing to participate in community gardening activities [28];
3. Impact status, including health status and biodiversity change. Bures proposed that plants can improve building energy efficiency and thermal insulation, improve air quality and increase biodiversity, and contribute to urban sustainability [29].

The cited literature constitutes the research frontier, and the highly cited literature or highly central literature in the cited literature reflects the research knowledge base [25]. Figure 3b shows the characteristics of multi-disciplinary and multi-field research, which shows that the research foundation is good and has high research value. Among them, the most frequently cited literature found that multi-functional agriculture has been widely recognized in the surrounding areas of cities. Based on this, the policies and planning methods to support multi-functional agriculture in suburban areas are discussed [30]. The most intermediary central study reviewed the growth of urban agriculture in developed countries and believed that urban agriculture is meaningful to food security and social welfare [31].

(**a**) (**b**) (**c**)

Figure 2. Analysis map of cooperation network. (**a**) analysis of national cooperation network; (**b**) analysis of author cooperation network; (**c**) analysis of institutional cooperation network.



(**a**) (**b**)

Figure 3. Network Atlas of Research Hotspot Analysis. (**a**) Keywords co-occurrence network; (**b**) Clustering of co-citation network.

Table 1. Statistical table of research institutions and authors.

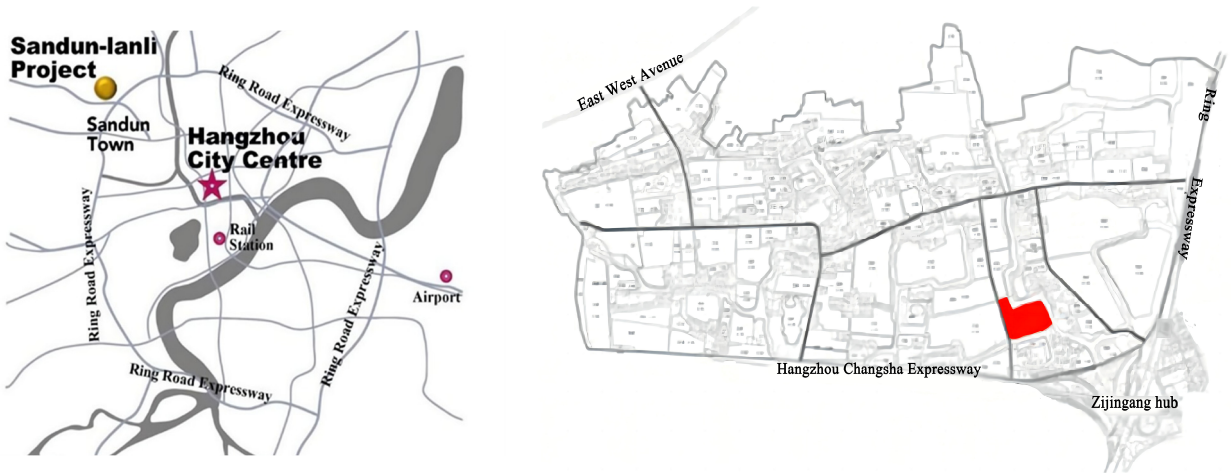
High Yield Country	High Yield Institution	High Yield Author
United States (395)	Chinese Academy of Sciences	Falandysz J
China (260)	University Of California	Long HL
UK (153)	Wageningen University	Ma L
Italy (119)	French National Institute of Agriculture, Food and Environment	Drechsel P
Germany (113)	Consultative Organization for International Agricultural Research	Jarzynsha G
Spain (93)	French National Center for Scientific Research	Silibello C
Canada (83)	Institute of Natural Resources, Institute of Geographical Sciences, Chinese Academy of Sciences	Zhang Y
Australia (80)	United States Department of Agriculture	Ge D
Netherlands (80)	University of Copenhagen	Lovell S
France (74)	China Agricultural University	Specht K

4. Introduction and Analysis of "Air Vegetable Plot" Project

4.1. Project Development: Advantages of the Project

4.1.1. Location Conditions of the Project Base

The "air vegetable plot" entity base is located in the village of Lanli Scenic Area, a national 4A scenic spot in the suburb of Hangzhou. It is only 15 km away from the Wulin Square in the center of the city. It has the location advantages of the suburban countryside, convenient transportation, complete supporting facilities, and is suitable for farming, as seen in Figure 4. Moreover, Lanli Scenic Area is originally a "Agriculture + Culture + Tourism + Research and Learning" location, so we set agricultural tourism, leisure and sightseeing, as the characteristics of Hangzhou urban agricultural research, as a new target.



(**a**) (**b**)

Figure 4. Study area: (**a**) Location of Lanli Scenic Area in Hangzhou; (**b**) Location map of project plot in Lanli Scenic Area.

4.1.2. Policy Support

In recent years, China has implemented the rural revitalization strategy, and the country has paid more attention to the development of agriculture, rural areas and farmers. The development of urban modern agriculture is conducive to the overall development, progress and upgrading of rural areas, which plays a very important role in promoting the rural revitalization strategy.

Hangzhou also launched the "Beautiful West Lake Action" to develop the tourism industry of the village, reshape the appearance of the village, and improve and optimize the

environment and landscape of the village, which can also contribute to the beautiful West Lake. Similarly, Hangzhou community also supports the development of agriculture. With the improvement of the modern city level, people gradually need a living environment that can relieve pressure and relax mood, is slow, and will return them to natural life experiences in the tense and rapid pace of urban life and work.

This project can not only increase farmers' income and citizens' leisure, but also maximize the benefits of investment enterprises and realize the sustainable development of modern agriculture.

4.1.3. Village Tourism Resources

The project product base is located in a national 4A-level scenic spot on the outskirts of the city; it already has a certain amount of tourist flow and is in the suburbs of the city, which also attracts urban people to come here for leisure and experience farm life and has certain advantages for the revitalization of rural tourism resources. This is a multi-functional agricultural project suitable for the integration of three industries (Figure 5), including the planting, cultivation and harvesting of food crops and vegetables, and fully exploiting rural tourism resources through multi-functional industrial development of the whole growth cycle.

As a modern agricultural industrial park, the product base not only has the advantages of modern industrial development, but also has the unique charm of the countryside. The project base is a provincial beautiful countryside demonstration village with good rural landscape and environmental conditions and a simple folk culture, which can attract more urban tourists, while tourism and sightseeing can offer the experience of rural idyllic life (Figure 6).

(**a**) (**b**)

Figure 5. Current situation of modern agricultural planting in the product base. (**a**) Rice planting experience field; (**b**) Vegetable planting and picking garden.

(**a**) (**b**)

Figure 6. Rural landscape of product base. (**a**) Green crop planting in rural areas; (**b**) Rural buildings and farmland landscape.

4.2. Feasibility Analysis of the Project

According to the survey of 500 questionnaires, due to the proximity to the city and the great demand for rural tourism in the suburbs, most of the citizens with low income will choose to travel here, mainly tourists from the city and other cities in the province, while tourists from other cities in other provinces are relatively less; families with children and old people as well as young people will come here for sightseeing and leisure, to experience agricultural life and agricultural research.

According to the survey, the project is most suitable for the needs of groups with families and romantic relationships, mainly seeking the labor experience and sightseeing and leisure activities (as shown in Figure 7, Tables 2 and 3).

Table 2. Suburban rural tourism tourist project selection.

Tourism Projects	Number	Frequency
Ecological leisure	107	31.7%
Agricultural sightseeing	67	19.8%
Barbecue	35	10.4%
Fruit picking	52	15.4%
Fishing	31	9.2%
Folk	16	4.7%
Activities and labor experience	30	8.9%

Table 3. Population statistics of suburban rural tourism tourists.

Statistical Characteristics	Classification Index	Number of People	Proportion (%)
Gender	Male	165	48.8
	Female	173	51.2
Age	Under 20	67	19.8
	20–30 years old	75	22.2
	31–55 years old	113	33.4
	Over 55	83	24.5
Family relations	Yes	273	80.7
	No	65	19.3
Romantic relationship	Yes	210	62
	No	128	38
Occupation	Students	69	20.4
	Enterprises and institutions	171	50.6
	Liberal professions	33	9.7
	Retired employees	65	19.2
Domicile	Hangzhou	150	44.3
	Other cities in Zhejiang province	115	34
	Other provinces	73	21.6
Income level	Below 3000 yuan	107	31.6
	3000–5000 yuan	32	9.4
	5000–8000 yuan	86	25.4
	Over 8000 yuan	113	33.4

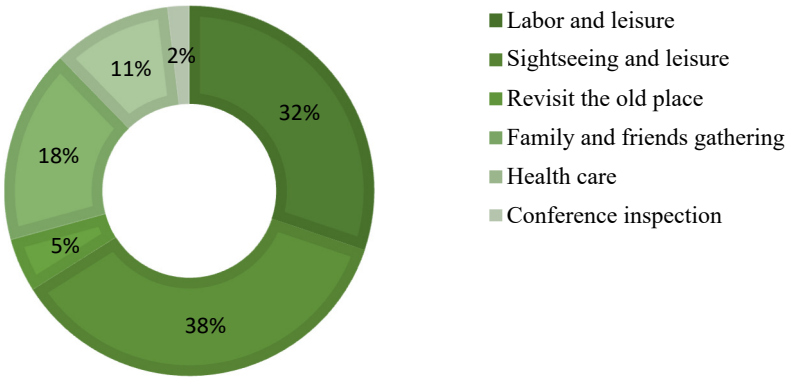


Figure 7. Behavior motivation analysis of suburban rural tourists.

4.3. Main Service Targets of the Project

The "air vegetable plot" mainly served families with children. As most of the children were in the urban environment, they had very little experience of planting. They lacked an understanding of nature. This project provides children with a place to observe, understand and explore nature through online and offline linkage, so that children can popularize the enlightening knowledge in the process of being close to nature, which is conducive to children obtaining a rich and full childhood and a healthy growth environment.

In the face of the fast-paced work and living environment of the modern city, this project could also relieve the work pressure of the young people to a certain extent and allow them find psychological relaxation and relief. At the same time, this industrial base was also a good place for couples to date on weekends. They could cultivate planting products online and offline and go to the industrial base for entertainment and leisure together.

This project was also attractive to the elderly. The rural life in the suburb of the city was very relaxed and comfortable for the elderly. On the one hand, the elderly needed the company of their children in their old age, and on the other hand, they also yearned for the slow countryside life. In this way, the industrial base of this project could not only meet the psychological needs of the elderly, but also help them with their health. At the same time, they could also experience some relaxation and pleasure when their children accompanied them.

4.4. Planning Concept of the Project

Nowadays, the function of urban agriculture is more comprehensive, which not only optimizes the agricultural economic structure and increases the added value of labor, but also leads agricultural development towards diversification. This project creates a shared agricultural land on the basis of urban leisure agriculture combined with an Internet platform, integrates urban and rural resources, and forms a multi-functional industry integrating life, production and ecology. Using the strategy of the integration of agriculture and tourism, based on intelligent technology to achieve intelligent monitoring and management of agricultural production, and with big data technology as the core, we sought to deepen digital empowerment to promote agricultural production and open a new model of "Internet + Future Agriculture".

5. The Construction of Intelligent Agriculture Based on Intelligent Technology

5.1. Intervention of Intelligent Technology

5.1.1. Guidance of Science and Technology

The study was based on artificial intelligence technology to scientifically control the whole process of agricultural production, such as guidance on soil fertility analysis, seed quality identification and analysis of environmental elements, to ensure the smooth implementation of subsequent agricultural production work.

1. Seed quality identification. Using three-dimensional image analysis technology to identify the type and quality of crop seeds, effectively improving the quality of agricultural products.
2. Intelligent seed sowing and picking. Intelligent sowing of crops through drone equipment and the use of intelligent camera devices to determine the crops suitable for picking, and non-destructive picking through precise drone control.
3. Intelligent drip irrigation and spraying. Based on sensor technology and automatic control technology, the soil moisture condition is monitored in real time and the best irrigation strategy is selected based on the climate index obtained from the detection.
4. Crop growth monitoring. Incorporate machine learning technology and intelligent analytics in sensor devices to monitor and evaluate crop growth in real time.
5. Intelligent equipment control system. The artificial intelligence system unifies the management of the above involved equipment and realizes remote automatic control of the heating and humidifying system, shading and windproof system, and fertilizing and irrigation system, etc.

5.1.2. Improvement of Production Efficiency

The use of artificial intelligence technology in the agricultural production process can help farmers manage agricultural production more scientifically, improve yields and production efficiency, achieve economic energy savings as well as reduce operational human resources and production costs, and realize the transformation of agricultural production with mechanization, automation and intelligence.

1. Data sensing collection. By using wireless communication technology to transmit the collected growth environment data (indoor and outdoor environmental information, crop growth status and natural weather conditions) to the system service platform, the system completes the acquisition and analysis of sensor data.
2. Intelligent monitoring and analysis. The LED display shows the temporal and spatial distribution of crops in a visual format and provides historical data for reference analysis. It can also monitor and manage the collection equipment and provide a real-time view and control of its operation status.
3. Intelligent control management. According to the requirements set by users, there is real-time monitoring of environmental parameters such as temperature, humidity and light, and the use of the intelligent detection of automatic control systems to control the operation of various pieces of equipment, including ventilation control, roller shutter control and pump control, etc., to ensure that all environmental factors remain within the range suitable for crop growth.

5.1.3. Diversification of Industrial Development

Based on the Internet platform, intelligent technology and monitoring system, etc., we sought to expand the space for value-added agricultural efficiency, transform the resource advantages of rural areas into industrial advantages, and promote the green and low-carbon development of agriculture and service industries.

1. Integrating processing technologies. Transform the traditional single agricultural production model and guide agricultural production bases to create new technology development platforms and agricultural production innovation models. Through this approach, we sought to build an informatized, intellectualized and mechanized agricultural production system.
2. Constructing a diversified sales model. Based on the Internet platform, we will guide agricultural bases to accelerate the development of deep processing and cultivate the development mode of "Raw material base + Distribution", so as to expand the sales mode of products.

3. Establishing the whole agricultural industry chain. Based on the implantation of intelligent technology and intelligent IP, we will realize the wisdom transformation of the product base and build an agricultural digital industry that integrates production, treatment, sales, experience and service.

5.2. Construction of Intelligent Agriculture

5.2.1. "Air Vegetable Plot" Intelligent Agricultural Management System

The "air vegetable plot" intelligent agricultural management system relies on the deep integration of the Internet and agriculture, with intelligent sensing, monitoring, early warning and evaluation of the agricultural production environment to meet the diversified needs of intelligent agriculture and realize the networking, intelligence and efficiency of agricultural development. The management system monitors and collects environmental parameters such as temperature, humidity and light in the whole growth cycle online through a variety of intelligent agricultural sensing devices and a smart monitoring system and analyzes and records the results in a visualized manner with the monitoring system. At the same time, the intelligent management system calculates and simulates the most suitable environmental parameters to achieve automatic management and control of the facility (including irrigation, air release and humidification, etc.). In addition, monitoring and management is carried out during the growth of crops, and any abnormalities can be automatically alerted and uploaded to the management system. Users can also remotely monitor the environmental equipment and crop growth of the product base to achieve remote monitoring and intelligent management (as shown in Figure 8).

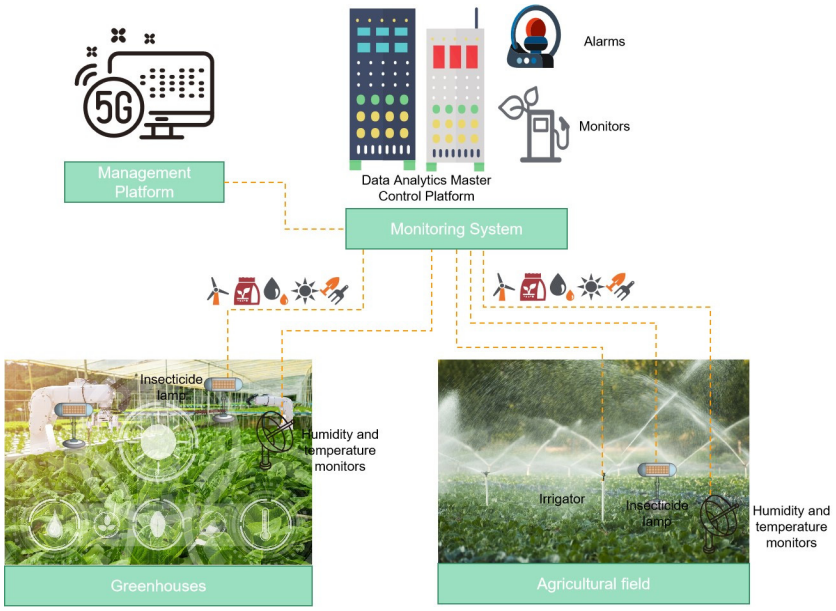


Figure 8. "Air vegetable plot" intelligent agricultural management system.

5.2.2. "Air Vegetable Plot" Online and Offline Agricultural Platform

The "air vegetable plot" is an online and offline agricultural platform integrating urban farming, experience, research, leisure, entertainment and cultural creation. It takes the offline agricultural industrial park as the actual operation base, combines online small programs to assist operation, and establishes the online and offline big data platform of the "air vegetable plot ", so that farmers, markets and citizens can connect information in real time; achieve the integration of data collection, summary, comparison and analysis; achieve the precise connection between production and demand; and help local farmers to revitalize farmland. An online applet allows citizens to choose their own plots for online cloud planting. Offline farmers can mark the selected plots for on-site planting according to the applet. Citizens can check the planting situation according to the applet and put

forward daily cultivation requirements to the planting personnel. They can also make an appointment to visit the "air vegetable plot" industrial park base for a personal experience and cultivate by themselves accompanied by professional planters (Figure 9). This realizes a two-way linkage in the form of online and offline. The offline platform of this project diversifies the operation of the industrial base with the assistance of the online platform to realize the matching of supply and demand. The villagers can plant agricultural products in the industrial base and make profits by selling agricultural products. Similarly, the industrial base can also be used as a base for citizens to visit and experience rural life on weekends. Online trading and ordering of agricultural products can be carried out through the applet, physical experience activities can be reserved, or cloud planting can be carried out online to meet the needs of consumers. The specific description is shown in Figure 10.

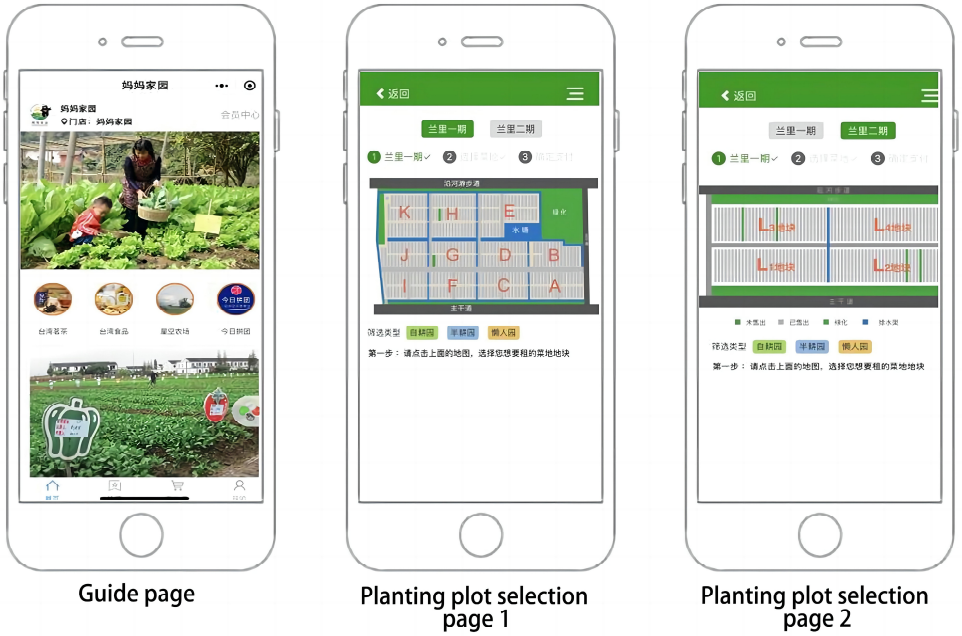


Figure 9. Applet function application of "air vegetable plot".

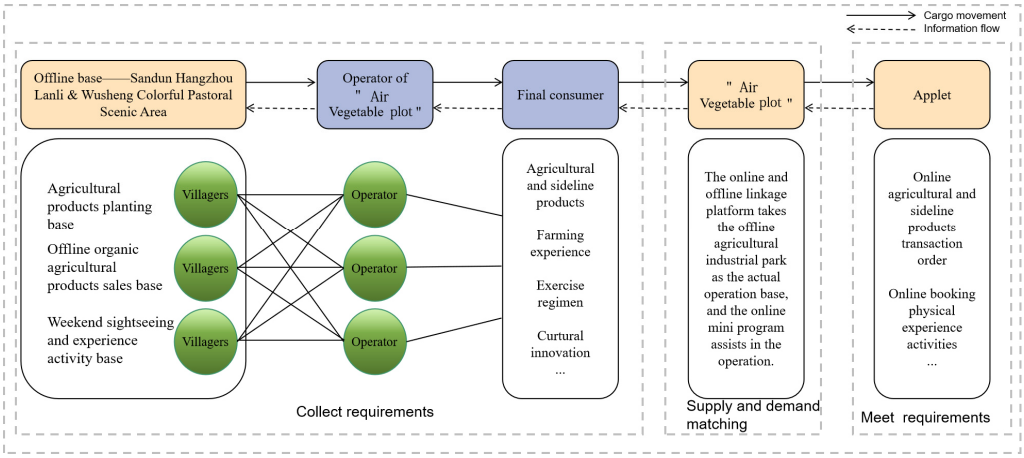


Figure 10. Operation and structure of "air vegetable plot" project.

5.3. Sustainability of Agricultural Carbon Footprint

Carbon footprint is derived from the concept of ecological footprint and has an important role in studying ecological sustainability issues. Greenhouse gases in agriculture are mainly composed of carbon dioxide (CO_2), nitrogen dioxide (N_{20}) and methane (CH_4), which account for about 10% of the total global anthropogenic greenhouse gas emissions.

In terms of the carbon footprint structure of agriculture, it includes the consumption of agricultural resources and energy, methane emissions from crops and the combustion and disposal of agricultural waste, among which the larger share is the methane emissions from farmland and the consumption of fertilizer production. Long-term traditional agricultural cultivation methods bring about emissions of different types of pollution from various parts of agriculture, which reflect carbon emissions directly or indirectly. Direct carbon emissions account for about 70% of total crop carbon emissions, including carbon released from greenhouse gases produced by crops, soil, and microbial production processes. Indirect carbon emissions account for about 30% of total emissions and include carbon released from agricultural production energy such as fertilizers, pesticides, and fuel oil in agricultural production. For example, the production of 1 kg of chemical fertilizer emits about 16 kg of carbon dioxide. Similarly, a large amount of carbon emissions is generated in the processing of agricultural products. The carbon footprint of the agricultural production process is shown in Figure 11.

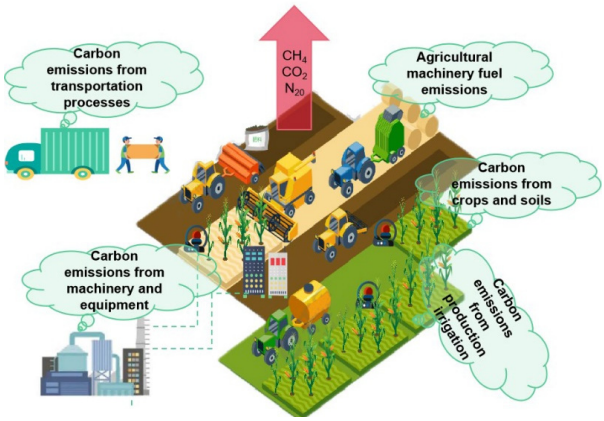


Figure 11. Schematic representation of the carbon footprint of agricultural production.

The industrial development of modern agriculture changes production management from the perspective of the carbon footprint, implements and applies the low-carbon ecological concept to low-carbon-emission reduction measures, and builds a whole life cycle carbon footprint measurement model suitable for different agricultural products. Through the management platform, we can obtain the precise input quantity of pesticides, fertilizers and machinery needed in the whole production process of agricultural products, so as to monitor and accurately manage the carbon footprint during the whole process, and further improve the energy consumption structure of agricultural production to achieve the reduction of rural carbon emissions. In this way, we can improve the energy consumption structure of agricultural production and reduce rural carbon emissions. Intelligent technologies and monitoring systems can monitor and control carbon emissions in all aspects of agricultural production and also simplify farming practices. Many agricultural activities can be automated, and a large amount of carbon emissions can be saved in terms of energy use, which achieves efficient energy use and ecological low-carbon emission reduction.

6. Practical Application of the "Air Vegetable Plot" Project

6.1. Operations Strategy of the Project

The "air vegetable plot" planning project has a multi-disciplinary professional team with full case operation experience, from project planning, planning and design to operation management, which can operate the industrial base more scientifically, professionally and comprehensively. Through the cultivation and care of professional staff, we have created a place to provide fresh vegetables and a farming experience for the public, so that they can obtain healthy, safe and green vegetables. Through the development mode of "Internet + Future Agriculture", we realize farmers' industrial transformation, scientifically scale up the whole cycle of industrial cultivation, and also build a diversified industrial

chain of agricultural products based on the Internet platform for diversified sales of agricultural products.

6.2. The Business Model of this Project

In consideration of the short-lived effects of the current agricultural industry, this project aims to achieve the sustainable development of permaculture by creating a long-term business model of "Internet+" with the support of government policies and the educational background, expertise and social experience of the operator. This planning project is led by experts in agricultural economic management from Zhejiang University and Zhejiang University of Industry and Commerce, as well as experts from the School of Design of the China Academy of Art, and it has been planned and developed in conjunction with grassroots communities in Hangzhou. There is no doubt that the project has very strong resources in terms of professionalism, and the design under the guidance of industry experts increases the added value of the project and attracts investment from enterprises and tourists. With 30 years of rich experience in agricultural cultivation and operation, the practical partners of "Agriculture + Tourism", including Taiwan Wu Xing Agricultural Company, Hangzhou Computer College, and the Big Data Research Center of Zhejiang University, provide the advantages of human and material resources for development. The villagers mainly provide the labor and technology for cultivation, while cooperating with construction companies for development. Through online and offline cooperation, we develop suburban and rural tourism and promote the integration of the three industries in the base.

The product base of this project included three activities: production, consumption and experience. The customer group was open to families with children, elderly families and young people. The brand IP (Mother's Vegetable Garden) was used to promote the production and construction of rural areas in the suburbs. The cost was about USD 2 million, which mainly included the cost of the use, maintenance and plant maintenance of the land, the operation cost of the public service activity of the market, the promotion cost of the activity online and offline, and the cost of the vegetable planting and landscape area. The income was about USD 5.2 million, mainly from various kinds of dishes and the rent of the "air vegetable plot", the income from the six major projects of the "air vegetable plot", and the investment income from advertising companies. The specific business model is shown in Figure 12.

<table>
<tr>
<td rowspan="2">Main partners:
1、Taiwan Wuxing Agricultural Company
2、Hangzhou Computer School
3、Big Data Research Center of Zhejiang University
4、Village collective (source of agricultural planting labor and technology, no profit distribution)
5、Cooperative operator (landscape company)
6、Project tenant (large agricultural planter)
7、Constructor (village infrastructure construction: agricultural project construction such as: building a greenhouse, hardening the ground)</td>
<td>Main activities:
1、Three activity sections: production module, consumption module, and experience module
2、Promote agricultural production and construction in suburban countryside by using brand IP (mother's vegetable garden)</td>
<td rowspan="2">Value proposition:
1、Integrated development of 1, 2, and tertiary industries
2、Development of rural tourism in suburbs</td>
<td>Customer relations:
1、Sales of primary agricultural products and agricultural derivatives
2、Agricultural project experience</td>
<td rowspan="2">Customer group:
1、Family with children
2、Family with elderly
3、young people</td>
</tr>
<tr>
<td>Key resources:
1、government policy
2、Operator (education background, professional knowledge, social experience)
3、Cooperative operator (planting technology, labor)</td>
<td>Way:
1、Online and offline linkage</td>
</tr>
<tr>
<td colspan="3">Cost structure (2 million yuan)
1、Maintenance of "Air vegetable plot" delicate vegetable garden facilities (land use, maintenance, seedlings, etc.)
2、Operating costs of "Air vegetable plot" Market (public welfare activities)
3、Promotion cost (online and offline)
4、Cost of vegetable planting landscape area</td>
<td colspan="3">Source of income (5.2 million yuan)
1、Income from various set meals and land lease of "Air vegetable plot" exquisite vegetable garden
2、Six projects of "Air vegetable plot"
3、Advertisers、franchisees</td>
</tr>
</table>

Figure 12. Business model of "air vegetable plot".

6.3. Zoning Planning of the Project Base

This project includes three activity modules: production module, consumption module and experience module, and has six product systems, as shown in Figure 13. The six product systems in Figure 14 not only set up colorful four-season flowers in the base, but also created an edible landscape planting area for children, linking planting with families, including the "air vegetable plot" delicate vegetable garden, vegetable planting landscape belt, "air vegetable plot" parent–child paradise, "air vegetable plot" market, shopping mall, and "air vegetable plot" education classroom.

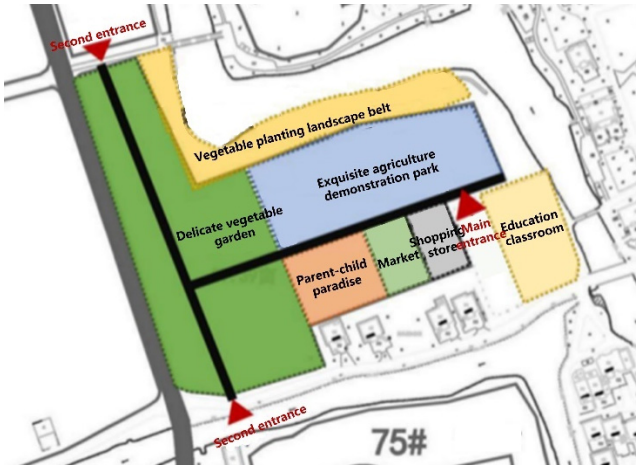


Figure 13. District planning of refined agriculture in community farm.

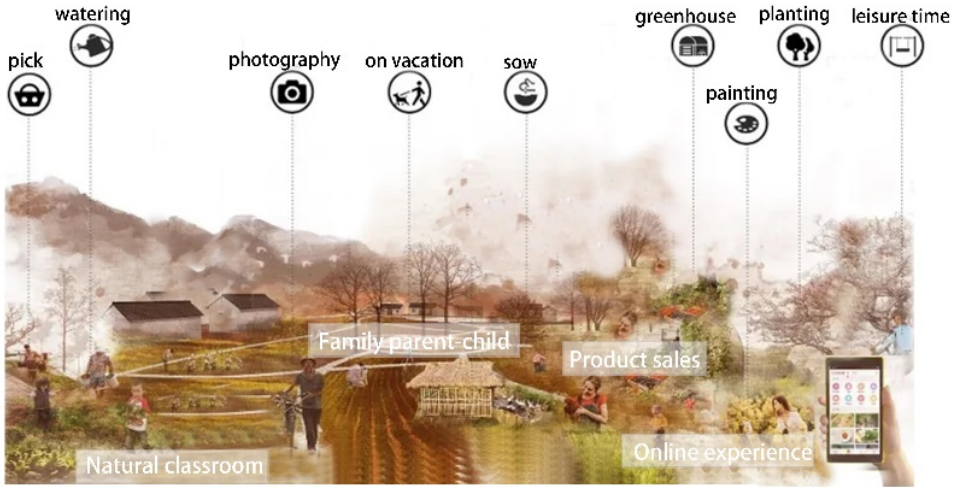


Figure 14. Schematic diagram of "air vegetable plot".

1. "Air vegetable plot" delicate vegetable garden.

This area is the main planting area, and the crops grown include seasonal foods in all seasons, with the specific vegetable plant configuration shown in Figure 15. This area is also the main area for people to experience farming culture, obtain harvest and learn planting technology. Online and offline product orders are planted here. The online consumption can be cultivated and planted by villagers, or they can experience planting in the product base themselves, so as to meet the needs of people who want to get close to nature, explore nature and enjoy the pleasure of the countryside. In addition, the smart agricultural management system is also used to monitor, manage and evaluate the growth of crops in the region, and achieve efficient agricultural production through automatic planting, sprinkler irrigation and fertilization.

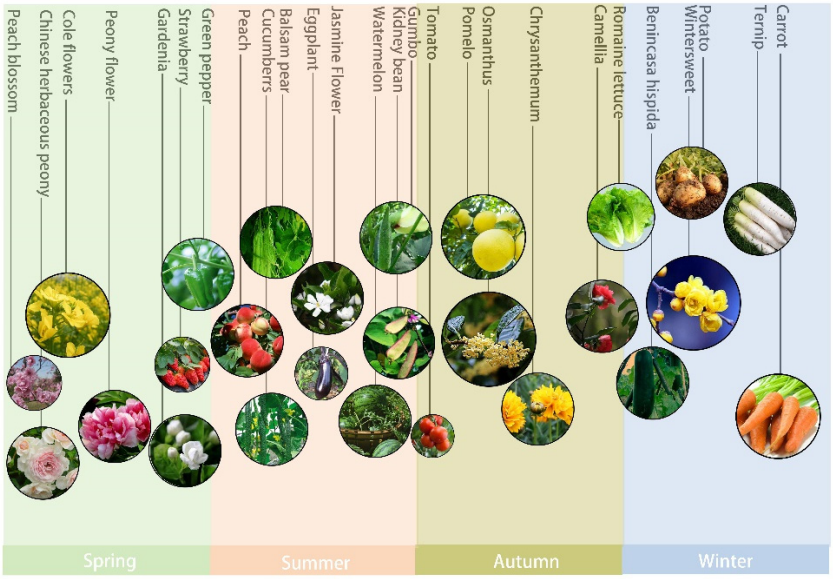


Figure 15. Vegetable plant configuration diagram.

2. Vegetable planting landscape belt.

By planting different varieties of vegetables, the planting landscape belt in the product base is formed, the concept of edible landscape is implanted, the natural green resources in the region are fully utilized, the landscape configuration in four seasons is realized through the seasonal planting of different plants and vegetables (Figure 15), and a network red landscape space with pleasant scale, leisure and entertainment is created under human intervention, as a network red punch-in point, it can also attract urban people to experience different landscape customs. In the cultivation mode, soil-less cultivation technology and the limited root cultivation mode of fruit trees are adopted to achieve safe production and pollution-free and efficient use of space. In addition, holographic 5D interactive experience facilities are used in the landscape belt of the base, where people can experience the development process from traditional farming to modern agriculture, experience the perfect combination of modern science and technology and agriculture, and form a distinctive online red space. The specific spatial structure analysis is shown in Figure 16. Through the combination of planting, leisure and ecology, the agricultural "Industry + Tourism" industry is the core for promoting the "integration of three industries", achieving industrial transformation and upgrading and helping rural revitalization.

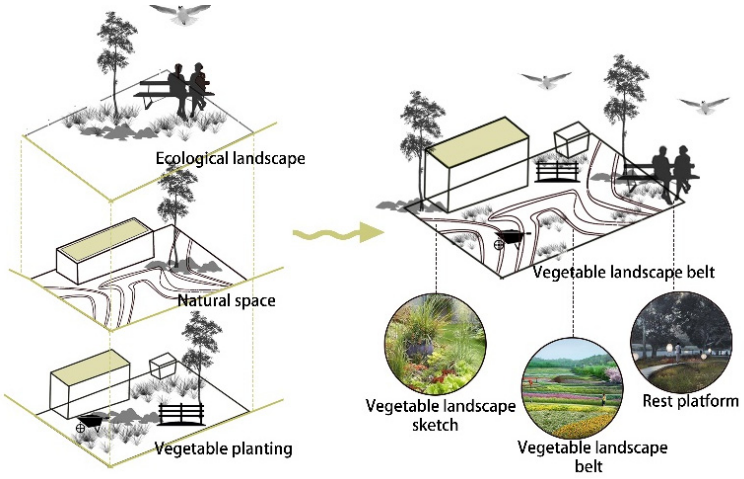


Figure 16. Spatial structure analysis of vegetable planting landscape belt.

3. "Air vegetable plot" parent–child paradise.

The interaction between parents and children not only shortens the spiritual distance but also promotes family harmony. At the same time, it can allow children to experience the whole process of planting, picking and harvesting, and enhance children's understanding and exploration interest in nature (Figure 17). Intelligent IP is also implanted in the parent–child paradise. For example, the intelligent display can identify and display information about the names and properties of plants to improve the interest of children in learning about nature.

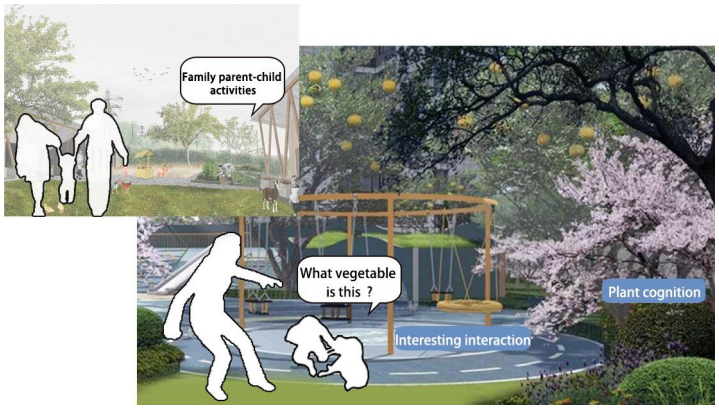


Figure 17. Scene intention map of "air vegetable plot" parent–child paradise.

4. "Air vegetable plot" market.

Simulate the market in the countryside, so that tourists can experience different market experiences while experiencing farming labor. They can sell vegetables they grow in the market and feel the hard work and the difficulty of a happy life, so that they can establish a correct consumption concept (Figure 18).

Figure 18. Scene intention map of "air vegetable plot" market.

5. Shopping store.

In the main shopping places of the product base, consumers can buy souvenirs, vegetables, etc. The information about vegetables and fruits in the shopping store is also updated in real time on the online platform of the "air vegetable plot", so that the public can make purchases online. Then, the goods are delivered by the staff at the base, broadening the diversified industrial chain of agricultural products.

6. "Air vegetable plot" education classroom.

Many young people and children in the city lack farming knowledge. Through the education classroom, they can experience the whole process from planting to harvesting more scientifically and enhance their interest in exploring and learning about nature. Compared with book education, it has more practical educational significance.

By integrating the location conditions of the product base of the project, permaculture principles maximize its agricultural development potential. According to the three activity modules and six product systems, it forms a "consumption closed loop" with urban pastoral characteristics, achieving the effect of high output and low energy consumption, so as to gain greater market economic benefits.

6.4. Module Architecture of Project Products

6.4.1. "Air vegetable plot" online and offline product module

1. Module architecture of the product.

"Online and offline product modules" and "revenue sharing chain" constitute the core revenue of the "air vegetable plot" product module. Through the background big data integration of online and offline data and the analysis of crowd consumption behavior, a dynamic basis to adjust the dishes of the product base and predict the income that can be obtained can be established. The specific architecture is shown in Figure 19.

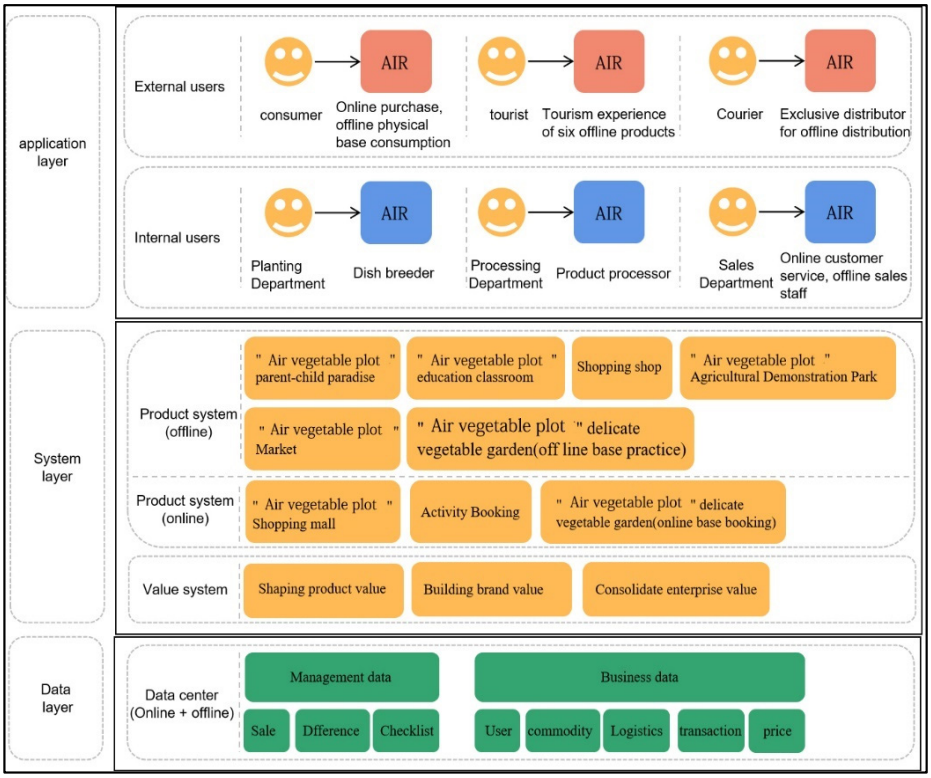


Figure 19. The project architecture of online and offline product module.

2. Platform order process.

At present, there are 2000 fixed vegetable garden owners and 100,000 agricultural tourism consumers. Users and businesses can receive two-way feedback "at the first time" through the platform. After consumers place an order through the platform, internal users will collect the order information and upload it to the "air vegetable plot" supplier. After receiving the order, the supplier will immediately prompt that the order is successful and give back to the consumer. The specific process is shown in Figure 20. The platform will also iterate and optimize according to user experience and feedback, so as to better serve consumers.

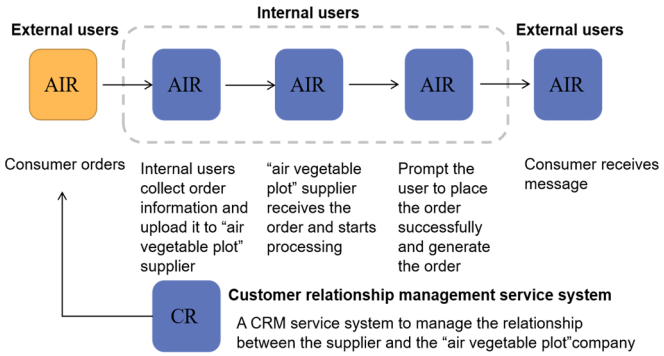


Figure 20. Flow chart of online and offline collaborative development.

6.4.2. "Air Vegetable Plot" Intelligent Agricultural Management System

The "growth environment parameter monitoring" and "artificial intelligence regulation" constitute the core management system. Through the big data system, the growth environment and cultivation are scientifically configured to effectively ensure the smooth development of subsequent agricultural production. The specific architecture is shown in Figure 21.

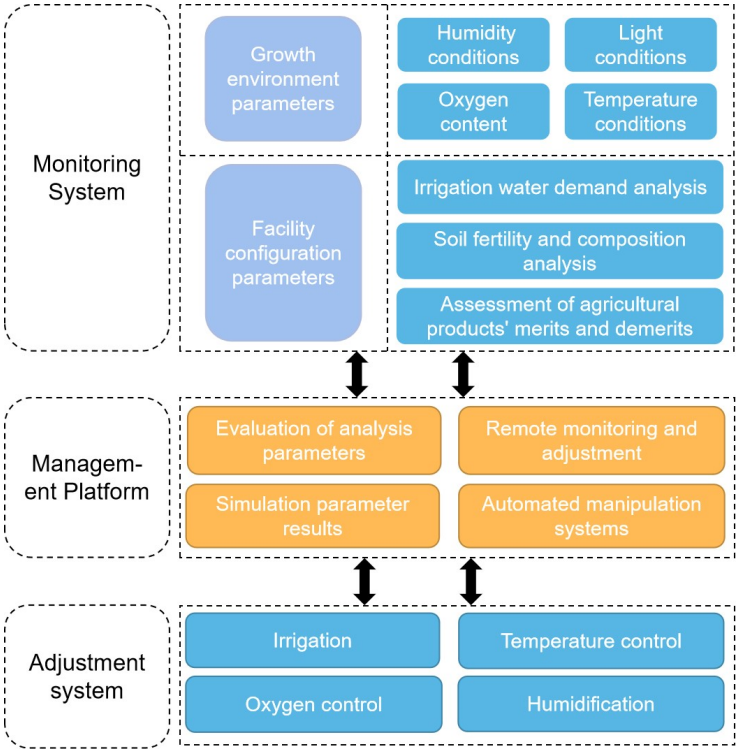


Figure 21. The project architecture of the intelligent management system.

6.5. Project Benefits

Based on the theory of permaculture, the project treats agricultural culture as a tertiary industry, promotes and disseminates agricultural culture with an Internet platform, and uses digital intelligence technology to realize industrial ecology, intelligent management, factor intensification and production standardization, bringing huge benefits in three aspects: economic, social and environmental, with cost efficiencies of more than 10%, labor consumption reduced by more than 10% on average, and yield and efficiency increased by more than 10% on average.

1. Economic benefits.

The development of this project can bring huge economic benefits; firstly, responding to national policy can bring positive publicity effects to the investing enterprise, and secondly, by fully exploiting and utilizing the rural resources to maximize the benefits of the enterprise. The original intention of this project is to increase the income of rural areas. It is to plant and integrate three industries, such as online and offline tourism and vegetable packaging, through this project to improve the economic income of rural areas.

2. Social benefits.

The project can provide 100 farmer jobs per 50 acres, which can help a lot to alleviate poverty in the surrounding villages. A large number of migrant workers can return to the rural areas and bring back a large amount of labor, and rural villagers can become professional planters and cultivators to manage the product base of the industrial base. Through the development mode of "Internet + Future Agriculture", it not only alleviates the poverty in rural areas, but also ensures the green and healthy industrial bases, re-energizes the economic development of rural areas and improves the happiness index of farmers' lives.

3. Environmental benefits.

The project follows the ecological principles in sustainable agriculture in spatial layout and planning design. Through farms, farmlands and rural residences to form an ecological green space, and with the Internet as the core, it makes efficient use of the rural landscape and idle resources to achieve a virtuous cycle and the sustainable development of the ecosystem.

7. Conclusions and Prospects

7.1. Conclusions

Based on the theoretical foundation of sustainable agriculture in permaculture, this study uses the Internet, big data technology and intelligent technology as the core to build a new model of urban agriculture development of "Internet + Future Agriculture", forming a modern agricultural complex that integrates life, production and ecology. In addition, we took the urban leisure agriculture in Hualian Village and Winding Village in Lanli Scenic Area as the practice base and carried out the practical application of the "air vegetable plot" project in terms of operation strategy, business model, base planning and product framework. During the project planning process, there were two puzzles: the sustainability of the project operation model and the degree of adaptation of intelligent technology in the project base. However, from the planning and design to the successful operation of the project base, the advantages of the countryside and the city, the promotion of intelligent technology and the opportunity of the rapid development of the Internet were fully utilized. On the problems of the short duration of the previous urban farm development model, the model breaks the restrictions of policies, funds, technologies and talents, and carries out integrated planning and design in terms of operation strategies, business models, product frameworks and practical applications to ensure the sustainability and longevity of urban agriculture development. At the same time, the new model of "Internet + Future Agriculture" provides a reference for the theory and practice of sustainable agriculture in permaculture, and provides a "scientific, modular, sustainable and low-carbon" path for the modernization and transformation of urban rural industries.

7.2. Prospects and Advice

Due to the instability of urban development and exploitation, the problem of over-exploitation and depletion of rural resources may occur in the subsequent development process, leading to partial service gaps in the urban rural development model in the development process. In response to these subsequent problems that may arise, we also need to make preparations to ensure that the development of urban rural areas can be promoted sustainably, and that the revitalization of rural areas can achieve substantial results. At the same time, we should pay more attention to exploring the path of sustainable

urban development from a scientific perspective and should think about the following aspects in our future planning and development.

1. The combination of urban agriculture and community governance will drive the construction of a green city in ecology, life and production.

Permaculture principles advocate the harmony between man and nature. By combining urban agriculture with community governance, it encourages citizens in the city to participate in the construction of urban agriculture. It can not only enhance the citizens' awareness of ecology and nature, but also stimulate the development vitality of ecological agriculture, enhance the public's attention to ecological agriculture, and promote the development of urban agriculture and its related aspects. Through community governance, the concepts and attitudes of being green, ecological and sustainable can be established in the ecological consciousness, production and life of citizens, so as to promote the green construction of the city in the aspects of ecology, life and production.

2. Improve the effect of urban land use.

The green space that can be used in the city can be developed and created through permaculture principles. For example, the community green space of the village in the city and the suburban joint area can be properly embedded into the small farmland, and the vacant green space at the edge of the city can be fully utilized to reduce the waste of land resources and improve the microclimate of the city and the living environment of the residents. At the same time, some economic benefits can be obtained through the planting and marketing of crops produced, and the effect of land compound utilization can be improved.

3. Use the Internet to connect the supply and demand sides of the market and promote the integration of urban and rural areas.

With the rapid development of science and technology, it is now the Internet era. Building a new form of market-contact platform through the Internet can effectively shorten the distance between supply and demand, closely strengthen the relationship between urban and rural areas, and achieve an orderly supply and demand market network platform. More scientific, convenient and humanized operations help the integration of urban and rural areas, narrow the gap between urban and rural areas, and bring convenience to the city, but they also promote the steady and rapid development of rural areas, to achieve the sustainable development of permaculture principles.

4. Build a humane community life.

Permaculture principles advocate for creating a positive and friendly living environment, in which the residents inside and outside the community can participate, experience the rural life of farm work in their spare time, enhance the relationship between family relatives and friends, and also provide the citizens living in the city the opportunity to be close to crops and increase children's interest in exploring nature. At the same time, it also provides people with a place for communication activities. The flow of people, materials, and capital inside and outside the community can promote communication inside and outside the community and promote the construction of a humane community life.

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