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## **RESEARCH AND PRACTICE ON INTELLIGENT AGRICULTURAL MACHINERY PRODUCTS AND SUSTAINABLE BUSINESS MODEL DESIGN**

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### **ABSTRACT**

Under the new situation, the transformation of China's agricultural machinery field is imminent. Facing the challenge, it is necessary to improve the intelligence level of agricultural machinery equipment, design sustainable business model of agricultural machinery services, and promote the transformation and upgrading of agricultural machinery industry. This paper designs an intelligent agricultural machinery product based on the development pain point and market trend of intelligent agricultural machinery products. Starting from the theory of sustainable design, product service system and shared economy, this paper establishes a sustainable business model of intelligent agricultural machinery products under the new situation, and explores the way of realizing sustainable development of intelligent agricultural machinery service system model in Chinese market.

Key Words: Sustainable Design, Agricultural Machinery, Intelligence, Product Service System

## 1. INTRODUCTION

China is a big agricultural country. The healthy development of agriculture is related to the national strategic security. With the application of many agricultural machinery, the level of agricultural production in China has been greatly enhanced. However, the development level of agricultural machinery in China is not sufficient. The shortcomings of the existing agricultural machinery products, such as high cost, heavy environmental pollution, low power efficiency and poor user experience, have been criticized by consumers. At the same time, the utilization rate of agricultural machinery resources in China is not high, which will cause a large number of agricultural machinery idle. Only in the underdeveloped northwest of China, the idle period of agricultural machinery reaches an average of 4-6 months per year, while long-term idle and short-term high-intensity work will bring difficulties in the maintenance of agricultural machinery. At present, the after-sales service of agricultural machinery is not at the same level as the sale of agricultural machinery. Many agricultural machinery can not be guaranteed after-sales, which is very unfavorable to the development of agricultural mechanization. In this context, we need to improve our agricultural products and service system in order to constantly adapt to the development needs of the times.

## 2. ANALYSIS OF THE DEVELOPMENT AND MARKET SITUATION OF AGRICULTURAL MACHINERY PRODUCTS

### 2.1 Development Status of Agricultural Machinery Products

Agricultural mechanization in China has gone through four stages. They are: 1) the initial development process from 1949 to 1980; 2) the process of institutional transformation from 1981 to 1995; 3) the process of market guidance from 1996 to 2003; 4) the process of rule of law guidance since 2004. In this historical period, China's agricultural machinery has been fully developed, the level of development of agricultural machinery from scratch, from big to strong, is growing step by step.

In the new era, China's agricultural machinery development is not perfect, its development still faces many problems. One is the high cost of use. Existing agricultural machinery is powered by internal combustion engine, which has high energy consumption. Taking 18 kW tractor as an example, the average traction specific fuel consumption is 344.4g/kWh [4], that is, the rated working hour consumes about 7.3L diesel oil, which is about 46.8 yuan (standard: 6.42 yuan/L diesel No. 0, Beijing, February 26, 2019). The high use cost is not conducive to the sustainable development of agricultural machinery. Secondly, the environment is seriously polluted. Internal combustion tractors emit exhaust gas continuously during operation, which seriously pollutes the air environment. It is one of the biggest sources of air pollution in rural areas. Thirdly, the internal combustion engine is defective. For every 1000 meters above sea level, the power loss of internal combustion engine is about 10.8%. This means, for example, in the Qinghai-Tibet Plateau, the tractor with power of 18 kWh can only exert about 10 kWh, resulting in serious power loss. Finally, it is extremely unfriendly human-computer interaction, complex buttons and gears, ordinary farmers are difficult to get started, and need professional agricultural mechanics to drive.

### 2.2 Market Demand







The transformation and upgrading of agricultural machinery and equipment can not be separated from government policy support. The Ministry of Agriculture and Rural Areas, the Ministry of Industry and Information Technology and the National Development and Reform Commission jointly issued the Action Plan for the Development of Agricultural Machinery and Equipment (2016-2025), which clearly defined the guiding ideology, basic principles and action objectives for the development of agricultural machinery industry in the next 10 years. December 21, 2018. The State Council promulgated the Guiding Opinions on Accelerating the Transformation and Upgrading of Agricultural Mechanization and Agricultural Machinery Equipment Industry.

From a series of policy measures of the government, the transformation and upgrading of agricultural machinery and equipment is imminent. The government hopes to promote the transformation and upgrading of agricultural machinery and equipment through policy guidance and market promotion to attract the investment of state-owned capital and social capital. Moreover, the rapid popularization of new energy vehicles since 2015 has stimulated the enthusiasm of related industries, and the trend of new energy will gradually extend to the field of agricultural machinery and equipment.

## 3. PRODUCT INNOVATION IN THE INTELLIGENT AGE

With the severity of environmental pollution and oil shortage, electric drive system has been studied by many enterprises, universities and scientific research institutes at home and abroad for its advantages of environmental protection, low transmission power loss, wide speed range and easy to realize intellectualization. John Deere SESAM, Fenter E100 and New Netherlands methane power tractors represent three development directions of environmentally friendly new energy tractors in the past 50 years.

In addition, Keith Magnum concept tractor represented by Keithner Netherlands Industrial Group, T8 NHDrive concept tractor and Oriental Red LF1104C unmanned tractor represent the development direction of agricultural machinery in the field of intelligent driving.

	New Energy for Environmental Protection			Intelligent driving		
Tractor	John Deere SESAM 	Finland E100 	New Netherlands Methane 	Case Magnum 	New Netherlands T8 NHDrive 	Dongfanghong LF1104-C 
Field	Field farm operation	Small and medium-sized farm	Small and medium-sized farm operations	Field farm operation	Field farm operation	Small and medium-sized farm
Power	Pure electric	Pure electric	Methane	Internal-combustion engine	Internal-combustion engine	Internal-combustion engine
Horsepower	380	68	180	367	340	110
Endurance	4hour	5hour	A day	No data	No data	No data
Charge	3hour(100% Electric quantity)	40minutes(80% Electric quantity)	Same as an internal combustion engine	Add fuel	Add fuel	Add fuel
Discharge	0	0	20% of internal combustion engines	Diesel Engine Emissions	Diesel Engine Emissions	Diesel Engine Emissions
Noise	70db+	50db+	50db+	80db+	80db+	80db+
State	Prototype	Test	Test	Concept machine	Concept machine	Prototype

[Figure 1] Contrast chart of Tractor Products

The above products have made beneficial exploration on the development of agricultural machinery and equipment, but each has its own limitations. In summary, from the practice of Tractor Research and development in the above enterprises, it can be concluded that the development of agricultural machinery in the future should be toward the two major trends of environmental protection, new energy and intelligent driving, but the existing conceptual models do not have both of these two trends at the same time. Therefore, on this basis, the design and manufacture of an agricultural machinery product with environmental protection, new energy and intelligent driving is also the inevitable trend of the development of agricultural machinery in the intelligent era.

#### 4. DESIGN OF INTELLIGENT AGRICULTURAL MACHINERY PRODUCTS

Designing an agricultural machinery product that can meet the needs of energy saving, environmental protection and intelligent driving, and can be accepted by the market, it is necessary to visit farms around the country and conduct field research on various agricultural participants. The team consisted of eight people, who went to farms around Changsha City and rural areas such as Shanxi, Anhui and Hebei. More than thirty farms were surveyed and more than ten farm workers were interviewed in depth, and a series of research materials were obtained.



[Figure 2] Farm Survey

According to the actual use of farms and network information, the project team conducted in-depth analysis of their needs, extracted the relevant pain points, and summarized these pain points. The results are shown in the table below.

[Table 1] Summary of Tractor Pain Points

Pain Point	Problem Solution
Pollution discharge	Use clean energy (e.g. methane) or clean power (e.g. electricity)
High cost of use	Reducing energy transfer process
Defects in Internal Combustion Engines	Replacement of power system, independent of air replacement
Poor user experience and high learning threshold	Reduce gear and control button
Scarcity of farm machinery	Using Intelligent Driving Technology
The shape of tractor is not beautiful	Increase investment in industrial design
Electric power is needed in the field	Tractor built-in power supply
Pedestrians do not know the intention of the tractor	Adding Pedestrian Reminder Device
Vehicle driving is unsafe	Using new technology can ensure vehicle safety

From the qualitative results of the research, we basically define the design category of a new type of intelligent agricultural machinery. That is, a fully functional and innovative intelligent agricultural machine, which can solve the core pain points of users, such as: lower cost of use, the average cost of use is less than one third of the traditional agricultural machinery; zero pollution and zero emissions, extremely friendly to the environment, in line with the

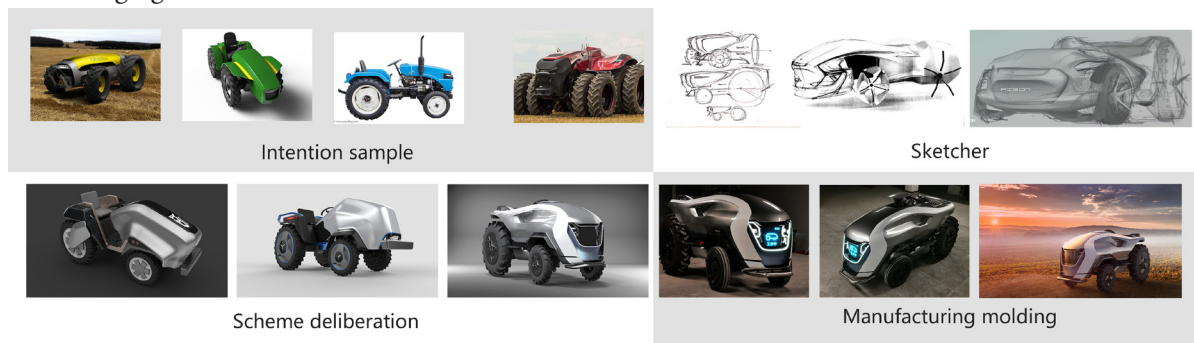
trend of environmental protection; extremely high power efficiency, even for plateau users can use normally; excellent user experience, ordinary farmers People can also start with ease and so on.

The following are the functional parameters according to the design:

[Table 2] Tractor Functional and Parameter

Function			
Pure electric drive	Excellent Interaction Design	RTK, ZGBEE RSSI Ranging and Location	Charging and discharging functions
Front LED Display Screen	4G and 5G remote control	10 kwh super high power	6-hour tillage time limit
Parameter			
Model			F 01
Contour dimension (mm)	long	3100	
	wide	1240	
	high	1310	
	Wheelbase	1440	
Front wheel spacing (mm)			930
Rear wheel tread (mm)			1020
Minimum turning radius (m)			2.8
Tractor quality (kg)	Structural quality		930
	Minimum quality of use		1160
Motor power (kw)			5
Battery capacity (kwh)			10
No load endurance (hour)			12
Working life (hour)			6

To sum up, a new industrial design scheme of intelligent agricultural machinery has been developed, as shown in the following figure:



[Figure 3] Derivative diagram of tractor industrial design

## 5. DESIGN OF SUSTAINABLE BUSINESS MODEL SYSTEM BASED ON AGRICULTURAL MACHINERY SERVICES

According to the innovative intelligent agricultural machinery products, it is necessary to explore and create a sustainable product service system around it. In the face of product service system, designers must link the interaction between people and products, people and people, people and society through various means including program innovation. The development of sustainable business model of agricultural machinery service in China can be divided into three stages: product, platform and system. In this business model, first of all, we design and manufacture intelligent agricultural machinery products, provide basic and reliable agricultural machinery, improve the basic performance of products, and make them become the basic tools to serve the vast number of agricultural workers. Secondly, it provides value-added services such as sharing farming and maintenance of farm machinery to meet the needs of farming and maintenance among users of the platform. Finally, it promotes effective interaction among multiple groups, creates a sustainable business model in the field of farm machinery services, and supports the transformation and development of China's agricultural machinery and equipment industry.

### 5.1. Firstly, a closed-loop sales system for tractor products is established.

China is vast and rich, so it is impossible to set up shops in villages and villages. In order to make driving test more convenient for users, it is necessary to develop an Internet car-buying platform, which allows users to test with 5G remote control. Customer satisfaction after logistics transportation, direct distribution to the village to home, to minimize the cost of distribution.

### 5.2 Then enter into the shared agricultural machinery market.

In 2018, the domestic agricultural machinery service market will reach 650 billion yuan. By 2020, it will exceed 10 billion yuan. Relying on the unique intelligent farming, navigation, positioning and remote control functions of

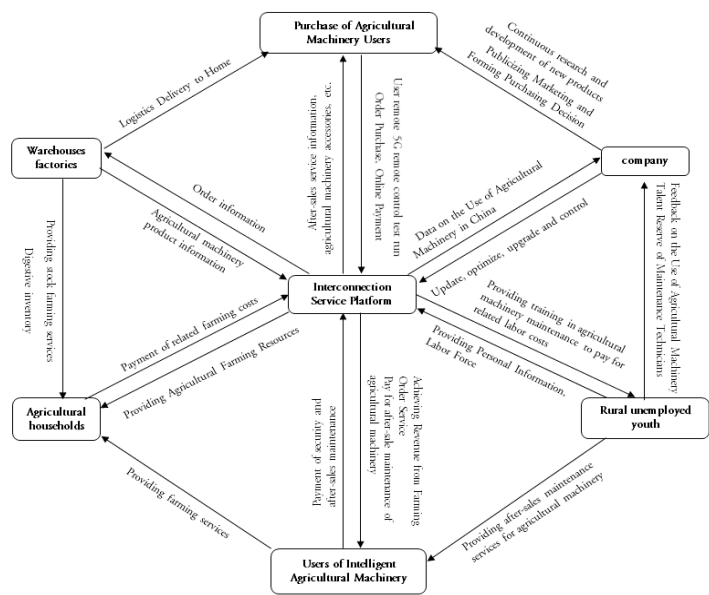
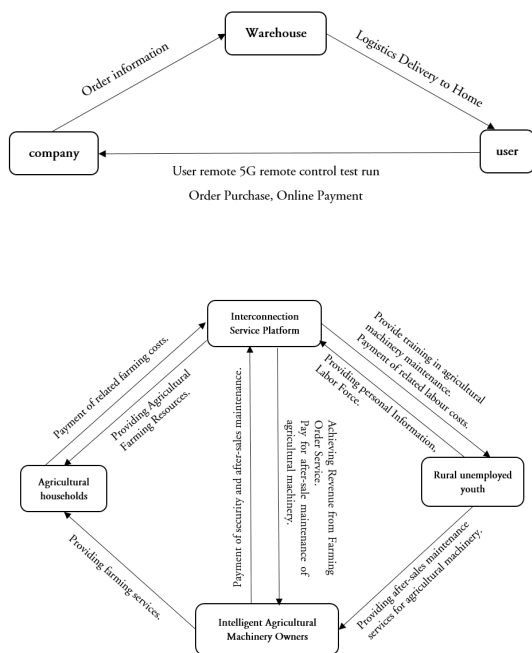
the company's intelligent agricultural machinery, it can solve the current service pain points of sharing agricultural machinery, develop the sharing platform and expand the market share in the field of sharing agricultural machinery service. At the same time, it can also create "shared maintenance" agricultural machinery services. There are a large number of unemployed young people in rural areas in China who have received basic compulsory education. The company gives them the basic maintenance skills of intelligent agricultural machinery, and they can use their maintenance skills to help the company establish after-sales maintenance system, not only to solve rural employment, but also to solve the worries of intelligent agricultural machinery users.

**5.3 With the expansion of platform scale and the increase of user groups, resources need to be integrated.**

Figure captions and table headings should be sufficient to explain the figure or table without needing to refer to the text. Reasonable use of interconnected service platform, the strength of companies and factories will effectively integrate all members of the agricultural work, so as to build a relatively perfect sustainable agricultural machinery service network. In this commercial ecological network, each member is responsible for different links, and interrelated and collaborative.

Based on the commercial network, the purchasers of agricultural machinery purchase intelligent agricultural machinery through the interconnected service platform and obtain after-sales service information; the company can obtain profits and use large data of agricultural machinery through the platform, while updating the management of the interconnected service platform; rural unemployed youth only need to provide personal information and labor force to obtain agricultural machinery maintenance skills and remuneration; intelligent agricultural machinery users In order to obtain farming orders and after-sales maintenance services; agricultural farmers can obtain farming services; warehouses, factories can obtain agricultural machinery sales orders.

Members do not exist alone, they create value for each other, thus driving the effective cycle of the whole agricultural work. It can be seen that through this business model, each member can play its maximum value, make full use of resources, improve the efficiency of agricultural cultivation and resource utilization, and form a sustainable service network based on agricultural machinery.



[Figure 4] Tractor Sales Process  
 [Figure 5] Tractor Shared Service Chart [Figure 6] Tractor Business Ecology Network Diagram

**7.CONCLUSION**

The green revolution of low-carbon farming of agricultural machinery and the technological revolution of automatic driving of agricultural machinery are the main trends of the development of agricultural machinery in the future. Sharing agricultural machinery services is the embodiment of the maximum value application of new energy intelligent agricultural machinery. Based on the theory of new energy intelligent agricultural machinery and product service system, this paper gradually realizes the deep integration between interconnected services and products. On the one hand, innovating intelligent zero-emission farming tools is conducive to protecting the environment and promoting the transformation of China's agricultural machinery industry. On the other hand, it provides diversified value-added services for users, farmers, unemployed youth and so on.

Of course, the sustainable business model of the whole agricultural machinery service is a new business model with strong innovation and risk. Internet interconnection is the future development trend of smart agriculture industry. Whether technological innovation or business model innovation are facing many unknown challenges, and there are many contents worthy of in-depth study.

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