

The Effectiveness of Unmanned Aerial Vehicle (UAV) on Farmlands with Artificial Intelligence (AI) System

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ABSTRACT

As the development of electric technology and artificial intelligence, the utilization of unmanned aerial vehicles gradually increases. Unmanned aerial and artificial intelligence are applied to replace human force and enhance the productivity in many fields including agriculture. In 1950, America began to employ UAV in agriculture. In 2000, America began to extensively utilize UAV to spray pesticide and fertilizer, sow seed, and map. The purpose of this study is to explore the improvement of American agriculture brought by UAV and AI after the use of UAV. This paper demonstrates how technology innovation is indicated in American agriculture and UAV and analyses the benefits brought by technology innovation. The analysis of data in the tables about the income of farmland in America and in China after 1950 is performed. This analysis concludes that with the increasing utilization of UAV in farmland, the income of America agriculture increases exponentially, and with the further development of UAV and the combination of UAV with AI, the productivity of American agriculture further developed. Thus, the technology innovation of UAV is essential to the development of agriculture.

Keywords: *Unmanned Aerial Vehicle, technology innovation, agriculture, the United State*

1. INTRODUCTION

1.1. Background

As technology develops by leaps and bounds in the U.S. since the end of World War II, kinds of new machines and intelligence are made. Because the U.S. was founded on the great fundamental of Britain, it quickly became the most developed country due to the abundance of sources. UAV, the unmanned aerial vehicle, which was invented in 1783, as a hot balloon, was becoming modernized in 1935 [1]. Looking back to the history of the UAV, it was invented as the form of plane in the first World War for military use by the British, which was a great success in weapon advancement.

In 1997, drones were firstly formally applied to agriculture [2]. UAV with an AI system can help farmers with spraying pesticides, making maps of farmlands, taking photos of farmlands, supervising the surrounding environment, fertilizing the vegetation, and even pollinating. AI cooperated with UAV so that it can easily replace human labors to do things such as taking

targeted pictures and special recognition of plants just like freeway surveillance, and accurate calculation of the use of pesticides and fertilizers, and pollen.

Besides, it does something better than humans such as that AI can work permanently without break.

This passage is going to look back at the development of farmlands in the U.S. from 1950 to 2020, while the appearance of UAV is thought to be a turning point. Therefore, it would be clear about the efforts of the UAV to the farmlands. The U.S. is one of the countries that produce the most corns, which took place of 38% in 2011, so it would be easier to analyze the changes of it, which were more obvious [3]. Nearly 21st century were the decades for innovation- a brand new period. For instance, the internet was developed in 1983; MP3 was invented in 1993; the first smartphone was invented in 1994. After 2000, the brand-new innovations just appeared in forms that previous people could hardly believe or adapt to. Only a few people in the generation around the 1950s can flexibly use what teenagers are using today. Everything changes so rapidly. UAV with AI system, however, caught the

fashion of innovation of 21st and sky rocked to the farming market since almost everything is getting change so rapidly during that period.

1.2. Research Gap

Global Market Insights forecasts that the agricultural drone market size will exceed \$1 billion & 200,000 units of devices will be shipped by 2024 [4]. In addition, more than 64% of the farmers in the U.S. are considering using or have already used agriculture drones instead of hiring enormous laborers. There have been researches about UAV in the farmland: kinds of UAV farmers are using, functions that UAV has for farming, the efficiency of UAV compared to human-laborers, possible negatives effects of using UAV, the increase in the harvest of crops, and so on. Although there is abundant, even comprehensive, information online, it's still hard to find a source that directly acknowledges farmers or people about to what extent will the application of UAV change the profits of farmers and how can landowners ensure UAV give them access to win. Nevertheless, this question is decisive to farmers of whether should they buy UAV or not, which relates not only to farmers' profits but also the markets of UAV and farm products, so does the laborers. This problem is caused by the lack of secondary research since events were not happening at the same time, so data must be analyzed to get a conclusion. Although it was ensured by researchers that UAV would benefit the farmland, they were focusing on the primary research and providing accurate numbers rather than suggestions, but data are not convenient enough for people to refer to when making decisions.

The study, through making details of the functions of both AI and UAV, nevertheless, will tell the answer. From my perspective, before doing any analysis, UAV with AI is able to run the functions to replace all the labors as the main hypothesis of this writing. Along the passage, the result might disprove or strengthen my idea. The methods and strategies the passage is going to use are confined to secondary research and analysis only. It will link the market change and the UAV -related-events with a single timeline. Therefore, it would be confirmed if the benefits farmers got was directly related to the appearance of UAVs. The passage will fill this gap by confirming and editing the data use of previous studies and combine the conclusions from the fields of UAV and AI and the farmlands so do the market. It will introduce the part of the AI system applied on the UAV in detail, and the innovations that are taken, so do the clearer definitions of AI and UAV.

2. LITERATURE REVIEW

2.1. Unmanned Aerial Vehicle

2.1.1. Invention

The invention of drones can be traced back to 1783. The first aircraft without a human pilot was a hot-air balloon. In 1858, as the technology of photographs developed, Gaspar Felix Tournachon takes the first aerial photograph from a hot-air balloon. In 1898, Alfred Nobel, famous for the invention of dynamite, launches a rocket with the camera on it. Nobel's experiment marks the first time cameras were placed on an unmanned system, which had a significant contribution to the UAV-monitoring system. For the United States, the drone program began in 1936. U.S. Admiral William Harrison Standley witnessed a test flight of the Queen Bee, developing a program similar to the UK's [1]. Since then, UAVs have been widely used in various fields in the United States over time including in agriculture.

2.1.2. Previous Drawback

Recent decades have witnessed the development of technology. As a result, the application of UAV widely diffused. There is a large volume of published studies describing the role of UAV in farmlands in the US. In 2014, Johnny Clark stated that aerial drones, a technology perhaps best known for helping hunt terrorists, may soon begin helping U.S. farmers monitor what's happening in their fields. Since 2009, a group of state and federal officials in Georgia has been working to develop a drone that can save a farmer's time and resources during the growing season [5]. However, the limitation of using UAV is obvious. The early challenges of drones in agriculture can be boiled down to two things: cost and usability. For starters, in 2012, a fixed-wing UAV equipped with a high-definition camera was able to fly over medium distances for \$10000 to \$30000. The computer hardware and stitching software needed to process UAV maps cost thousands of dollars more. Except for a few major agronomist companies and cooperatives, this is a difficult price tag, especially for a technology that proves its worth to ordinary farmers [6].

2.1.3. Development and Innovation

With the continuous development of technology and investment, previous problems about the price of computer hardware now are extremely released. The cost of application of UAV is also far more accessible to the average agriculture professionals. Quadcopters are easier to produce, motors are more efficient, and battery life has increased [7]. Now the utilization of UAV becomes more and more widely in farmlands, and UAV

can help agriculture in many aspects. To strengthen and demonstrate the role of UAV in farmlands, Jeongeun Kim et al. published an article in 2019 to state that agricultural UAV has a strong capability, and its application scope has been extended to all agricultural fields, including pesticide and fertilizer spraying, seed sowing, growth evaluation and mapping [8]. For mapping, the 2D or 3D map of farmland drawn by UAV can provide useful information. For example, farmland area, soil conditions, and crop conditions can be used for model enhancement and efficiency improvement [9]. For spraying, compared to a speed sprayer or a wide-area sprayer, UAV can reduce pesticide use and maximize efficiency. UAV can realize large-scale purification of up to 50 hectares per day, and it takes only about 10 minutes to work every 0.5 hectares. Therefore, UAV research aims to reduce labor demand [10]. They also indicated the hardware components of UAVs and modeled UAVs to illustrate the function and cost-efficient designation of UAVs, emphasizing the practicality of modern UAVs.

As UAVs are employed in agriculture more frequently, in recent years there has been an increasing amount of literature on the development of UAVs and the progression of UAV capability. In recent years, one of the most popular scientific and technological topics is artificial intelligence. The combination of artificial intelligence and UAV can further reduce the cost of the application of UAV and enhance the efficiency of UAV. For instance, in the past, one of the biggest risks and challenges of UAV-CSS (camera surveillance systems) is the limitation of analyzing, processing, and transmitting data, especially the overload of computational capacity, storage, and transmission bandwidth. Concerning the traditional methods, almost all the data collected from UAV is processed and transmitted, consuming huge energy. Nonetheless, in 2021, Minh T. Nguyen et al. showed that an efficient algorithm of AI can optimize the transmission and reception of data of UAV, which can reduce up to 80% of storage capacity and transmission data [12]. The market of UAVs continuously expands. Technology always promotes the development of UAVs. The future trend of the progression of UAV is unquestionably the comprehensive combination with AI to achieve fully automated management.

2.2. Technological Innovation

2.2.1. Definition

Based on the conventional understanding of technological innovations in general as defined in the Oslo-Manual of the OECD and Eurostat in 1997 which distinguishes between product and process innovations, technological innovation is a new or improved product or process whose technical characteristics are

significantly different from the previous ones [11]. The implemented technological product innovation refers to a new product (product innovation) or application of process (process innovation) that has been brought to the market. If the product or process achieves specific advantages for the company, the product or process is regarded as innovation; from the perspective of other companies or the market, these are not necessarily new.

Technological innovation is one of the two types of innovation in the typology of the technological organization that is popular in innovation research [12]. In the classic definition, technological innovation focuses on implementing ideas in the form of processes or achieving final results in the form of products and/or services. Organizational innovation focuses on improving management practices to help companies achieve their organizational goals [13].

In an organization, technological innovation is crucial because it is the key to survival and development. In addition, technological innovation also plays an important role in shaping the industrial structure and global trade. Technological innovation is a function of three factors, including the internal characteristics of the enterprise, the characteristics of the enterprise's environment, and the flows between the enterprise and its environment [14]. The application of technological innovation varies from one organization to another. An example of technological innovation is creating or significantly improving a new product, improving an existing product, introducing information and communication technology (ICT) for the production process or automation in operations [15].

2.2.2. Impact

New technologies are completely changing the world of work. They have become an indispensable part of organizations around the world, driving the growth of the two most powerful new forces in the global economy-cyberspace and computing power. In turn, these technological innovations are bringing huge new changes to the organization and employees [16]. A technology or a process will be implemented in an organization, either because of performance gaps that cause management to need to change the technology or process (ie management pull) or because of the emergence of promising new technologies (ie technology pull) [17].

In recent years, our work and family life have indeed been invaded by technology. This invasion is just a precursor to more radical changes because the nature of the organization and even the "work" in the Taylorist sense have undergone irreversible changes. Observing the possible impact of these changes, Tom Peters said: "Thanks to technology, the world is going crazy. And there will be more crazy people along the way" [18].

Technology will no longer be "external". It will become furniture, walls, urban fabrics, the clothes this paper wear, and even part of our body. Intelligent networks will connect all aspects of our lives. This research may soon be able to enhance our memory and learning ability by designing "thinking" drugs and intelligent entities and do more management work for us; or "technical guidance"[16].

2.2.3. Technological Innovation in Agriculture

Technological innovation can directly contribute to the increase of productivity of agriculture. Technological innovation is considered now an integral part of the reform package needed to stimulate agricultural growth and poverty [19]. Many studies on agricultural research have emphasized the importance of technological innovation and policy. Therefore, technological innovation can benefit the poor in many different ways: First, it can directly help poverty alleviation by increasing the income of poor farmers who adopt the resulting technological innovation. Second, technological change can indirectly help reduce poverty through the impact of poor and non-poor farmers' adoption on other people's real income, mainly by lowering consumers' food prices and increasing employment and wage effects in agriculture and other

economic activities through production, consumption, and savings links with agriculture [20].

2.2.4. Technological Innovation In UAV

To apply UAV in agriculture more efficiently and with lower cost, technological innovation in UAV is essential. As a result, a significant part of the research community has started to integrate intelligence at the core of UAV networks by applying AI algorithms in solving several problems in relation to drones. In 2021, Mohamed-Amine Lahmeri et al. published an article to provide a comprehensive overview of some potential applications of AI in UAV-based networks. In this article, we can see the unsupervised and supervised ML techniques that have been applied in UAV networks [21].

Access to technological innovation is essential to the development of the application of UAV in agriculture. It can make agriculture more responsive, dynamic, and competitive.

3. RESULT AND DISCUSSION

Now, looking at some data of the U.S. farmlands comparing with China.

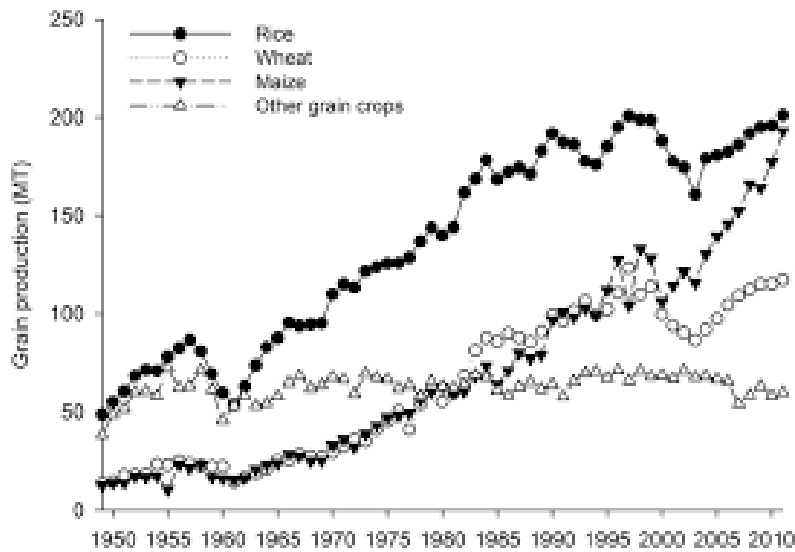


Figure 1 1952 China grain production [22]

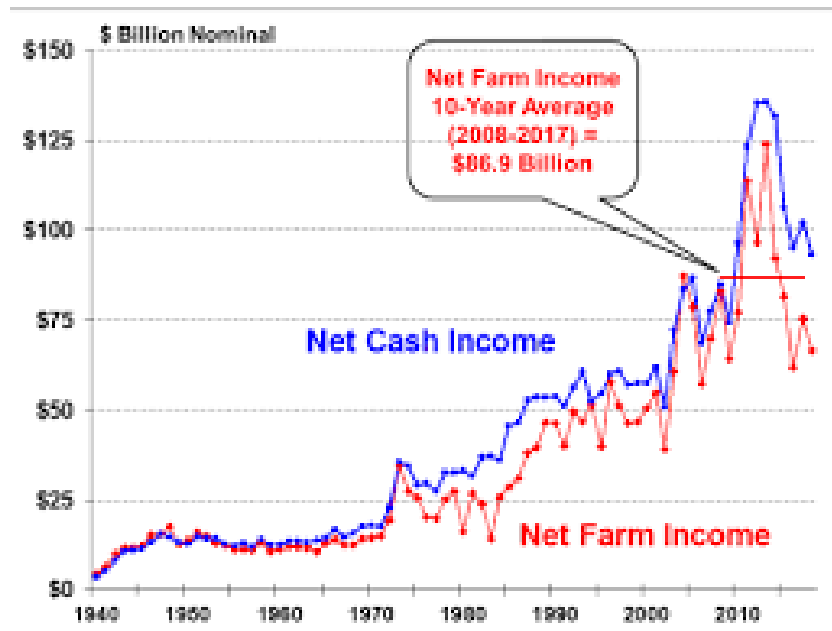


Figure 2 U.S. Farmland Income Outlook [23]

Since the 1950s, it was obvious that the agriculture in both countries was getting stronger. For one reason, it was because the over of World War II, which led to better situations for most countries. According to figure 1, close to the 21st, China met an economic reconstructing, from which the GDP began to grow steadily. Nevertheless, what happened to the U.S. at that time? Not any historical event. According to figure 2, the U.S. farmlands' income boomed after 2000. As everyone knows, the U.S. is a country that has a few people comparing with its field, and it was always a problem in the farmland. Therefore, it should be the UAV's effort. UAV could solve the situation of lacking labor according to the information provided above.

Looking back to big data now, the world is facing technological advancements in all areas. AI, robots are occupying so many works and replacing tons of easy labor. Following the trend, there is no reason for UAVs not to monopoly in the farmland. All of the information shows that it will benefit farmers to a big extend. To make an expectation, UAV will appear in every farmland, at least they should, just in decades. This study implied that the new techniques can quickly help the area get to a new level. Like all kinds of innovations mentioned above, the law of the development should be to follow the technology improvements. Therefore, it should be true that farmers should pay more attention to new chances like not only UAV but also something like modified vegetation. The matured AI and social background make the use of UAVs so reliable. The outcome will often be greater than input, and people just need to be patient. The content of this paper is matched with previous studies but just a clearer intensify. Besides, it should be one of a very few passages that suggest farmers will benefit from the UAV. UAV will

be the fashion in the farmland unless some legal issues, which are currently mild, appear in the future.

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4. CONCLUSION

The study of the innovation about the AI and UAV tends to close the gap of having no idea whether or not should farmlands in the U.S. apply the agriculture drones. By referring to the growth data and the historical time period, it's fair enough to say that the UAV was one of the major causes of that growth. Besides, according to the secondary research of the innovations, it's pretty clear that technology is so strong and advanced that it can support the leaps in the farmland. It's not cheap to buy a UAV or apply the AI system, but the costs of farming processes will far go down from what they used to be. In addition, there are also positive by-products such as free-time-consuming for the landowners and make the farms seem to be more reliable to the market. As our title is to what extend the farmlands can be benefited from the applications of UAV with AI system, the study shows that it's almost a guarantee to a higher chance to succeed in farming. People who should be concerned about this study are farmers or investors who decide to manage large areas of land rather than smaller ones or it might take too long for the lands to get to the break-even point of buying a

UAV. In conclusion, most the farmers should catch up the technique of UAV with AI system, since it's a common scene in the U.S. to have large fields, and this action will not only make the lives for farmers easier but also help them to earn money in a more efficient way. Human labors in nonintellectual fields will be or should be replaced by AI while humans are going to be at the back only.

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