
# Content Analysis of the Challenges of Using Drones in Paddy Fields in the Haraz Plain Watershed, Iran

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***Abstract***

*Drone technology has gained popularity in recent years as a sustainable solution to changing agricultural conditions. Using drones in agriculture provides many advantages in farm management. However, the use of drones in paddy fields in Iran is a new phenomenon facing numerous challenges. This study aims to explore the challenges for using drones in paddy fields and provide practical guidelines to solve the challenges facing the their application. This research was conducted with a qualitative approach and through content analysis in four stages, including material collection, descriptive analysis, category selection and evaluation. Using the non-probability sampling method and a combination of judgmental and referral methods, a sample of 15 experts in the field of agricultural drones was identified, and the necessary information was collected after about 12 hours of interviews. The results of analyzing the challenges of using drones in paddy fields indicated six categories consisting of "complexity and time-consuming", "hardware and software limitations", "unfavorable access", "ethical-social concerns", "lack of macro and integrated approach", and "safety issues". An understanding of these challenges can help policy-makers, specialists, extension agents, and farmers to define appropriate practical procedures for the use of drone innovation in paddy fields.*

***Keywords.*** *Food security, Agricultural drones, Challenges, Paddy farming.*

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## Introduction

The world's population, especially in developing countries, is constantly increasing until it is expected that about two billion people will be added to the world's population by 2050 (Mahroof et al., 2021). Despite the faster growth of agricultural production than population in the last four decades, the agricultural sector is facing challenges to feed this population as well as improve the livelihood of farmers (Karamidehkordi, 2010). At the same time, the excessive use of chemical fertilizers and poisons has destructive and adverse effects on the environment (FAO, 2013; Koocheki et al., 2016). Due to environmental concerns as well as the risk of reduced crop yields due to the impact of climate change and sudden events including Covid-19, there has been a significant demand for a sustainable approach using innovative technologies (Christiaensen & Martin, 2018).

In Iran, rice cultivation has a special place among crops, providing two-thirds of human needs (Yaghouti et al., 2021). The cultivated area of rice is about 7.01% (854,874 hectares) of crop production in Iran, which is cultivated in more than 19 provinces. Mazandaran province with 269,963 hectares (31.58% of Iran's cultivated area) and having the largest rice cultivated area plays a key role in the production of this strategic product in Iran (Ahmadi et al., 2021). The central areas of Mazandaran province, known as Haraz Plain Watershed, have occupied more than 61% of the area under rice cultivation in this province (Agricultural Jihad Organization, 2018). Despite the key role of this product in creating food security and employment, the excessive use of inputs and the lack of control in the use of inputs such as chemical poisons leave many harmful environmental effects (Homauini et al., 2018). Therefore, dealing with the problems of the agricultural sector requires changes in production methods and attention to new technologies in the direction of production sustainability, food security and environmental protection (Yazdi Samadi, 2017). Drone technology is one of the emerging technologies that has been used in recent years to carry out agricultural operations in a sustainable manner (Rani et al. 2019; European Court of Auditors, 2018).

Drone technologies, which are based on information and communication technology, can play an important role in the agricultural sector by providing reliable, accurate and timely data (Radoglou-Grammatikis et al., 2020). Drones make the production of products more economical and efficient. Compared to farm workers, drones perform tasks such as spraying liquid fertilizers and pesticides relatively quickly and more accurately. They are effectively replacing skilled manpower and laborers in the fields, and have also brought about farm automation so that in the future, larger farms can be easily managed with fewer farmers (Krishna, 2018). The use of drones can overcome the challenges related to manual agricultural operations, even in small-scale farms - including rice fields in northern Iran - it can be easily used. Investment and operational costs are relatively low compared to other mechanized technologies, and drones can be used to perform a wide range of agricultural operations in a precise manner (Wachenheim et al., 2021). Despite the importance of this technology, the extension and development of the use of drones in agriculture (rice farming) has not developed as expected (Freeman & Freeland, 2015). On the other hand, few studies have been done in the world and Iran regarding drone technology in the agricultural sector. Therefore, this research has been conducted with the aim of analyzing the challenges of using drone technology in paddy fields. Therefore, the results of this study are a suitable platform for decision-makers, experts in the agricultural sector, as well as rice farmers to know about the challenges of using drones in paddy fields, and finally, it will contribute significantly to the developing of the use of this technology in paddy fields.

## Methodology

The present research was conducted using a qualitative approach and through content analysis. Content analysis includes four stages of material collection, descriptive analysis, category selection and evaluation (Seuring & Gold, 2012; Chen et al., 2017; Duan et al., 2020). The first stage of this research includes the identification of experts in the field of agricultural drones in the Haraz Plain Watershed (including the township of Amol, Babol, Babolsar, Fereydonkenar and Mahmudabad). In many research - including the present research - it is very difficult to count population as a basic requirement in probability sampling. In these cases, the researcher uses the non-probability sampling method (Ary et al., 2010; Getz & Carlsen, 2000). One of the methods used in this field is purposive/judgmental sampling. Using this method makes the studied samples to be identified in the best way in line with the research objectives (Monette et al., 1994; Barbieri & Mahoney, 2009). Based on this, non-probability sampling and a combination of purposeful and chain methods were used in the sampling of agricultural drones experts. In this way, first a number of experts were identified and the necessary information was obtained from them. Then, with their help, other experts were also identified. This process continued until reaching theoretical saturation, and finally 15 experts in the field of agricultural drones participated in this study. In the interview process, an open-ended question regarding the challenges of using agricultural drones were raised. Then, this question was broken down into more detailed questions to obtain detailed information. During the presentation of information by experts, the necessary notes were taken by an assistant. At the stage of descriptive analysis, it is necessary to point out that the experts participating in this research include one academic staff member of the university, one academic staff member of the agricultural research institute, five drone users, six persons as user-advisers, and two people as consultants who are active in private drone companies. In the category selection, based on the notes taken, phrases with similar concepts were placed in a category and named. In the evaluation phase, in order to measure the validity of the findings, the categories and terms were again provided to the experts, and the validity of the findings was ensured by making some corrections.

## Results

As mentioned in the methodology section, 15 experts in the field of agricultural drones participated in this study. After collecting information based on the extracted concepts, finally 34 phrases were extracted (Table 1). Based on concepts, phrases close to each other are placed in a category, which were named based on concepts. In the category of "lack of macro and integrated approach", weak political will of the officials to expand and develop the use of technology, lack of framework and codified laws in line with agricultural drones and government strictures in the field of required licenses have been the most frequent. In the category of "unfavorable access"; inadequate knowledge and expertise in data analysis and interpretation by the user, unfavorable information, and insufficient number of agricultural drones were the most frequent. In the category of "ethical-social concerns"; security and privacy, misuse of data for specific purposes (agricultural terrorism), and fear and concern about the optimal performance of technology as a new phenomenon in the farm were the most frequent. In the category of "safety issues", among the extracted phrases, environmental obstacles such as trees, birds, buildings, irregular geometric shapes of the farm, etc., malfunction in the remote control system (communication link failure), and loss of control during the flight, and sensitivity to weather conditions (rain, wind, fire, etc.) and being affected by the results, including data processing and recording, have been assigned the most repetitions. Low battery capacity, persistence of low flight of the bird (limitation of flight time) in the field of spraying drones, lack of standards in the construction of tools and software for agricultural drones related to the category of "hardware and software limitations" were the most frequent. In the "complexity and time-consuming" category, which has the most frequency of phrases among the categories, the difficulty of analyzing and interpreting data, the entry of few companies into the field of agricultural drone technology, the difficulty of supplying and repairing

defective parts, and the high cost are the most frequent.

**Table 1. Categories and phrases of the challenges of using drones in paddy fields.**

| No. | Category | Phrases | Frequency |
|---|---|---|---|
| 1 | Lack of macro and integrated approach | Weak political will of authorities to expand and develop the use of technology | 15 |
| 2 | | Lack of framework and codified laws in line with agricultural drones (generality of drone laws) | 14 |
| 3 | | Government strictures in terms of required permits | 14 |
| 4 | | Absence of a course unit or subject in the field of drones in agricultural universities and technical and vocational schools | 12 |
| 5 | | Not integrating agricultural knowledge and ecology with drone technology (lack of coordination of relevant organizations) | 10 |
| | | **Total frequency of phrases** | **65** |
| 6 | Unfavorable access | Inadequate knowledge and expertise in data analysis and interpretation by the user | 15 |
| 7 | | Farmers not being aware of the existence of technology (unfavorable information) | 15 |
| 8 | | Lack of sufficient access to drones (lack of agricultural drones) | 13 |
| 9 | | Lack of training centers on how to interpret data | 12 |
| 10 | | Lack of trained local experts (people familiar with agriculture) | 12 |
| 11 | | Lack of proper access to air infrastructure (lack of air highways) | 7 |
| | | **Total frequency of phrases** | **74** |
| 12 | Ethical-social concerns | Security and privacy | 15 |
| 13 | | Misuse of data for specific purposes (agricultural terrorism) | 15 |
| 14 | | Fear and worry about the optimal performance of technology as a new phenomenon in the farm | 15 |
| 15 | | Trust and responsibility of the user (pilot) | 14 |
| 16 | | Data ownership | 13 |
| | | **Total frequency of phrases** | **72** |
| 17 | Safety issues | Environmental obstacles such as trees, birds, buildings, irregular geometric shapes of the farm, etc. | 15 |
| 18 | | Remote control system malfunction (communication link failure) and loss of control during flight | 15 |
| 19 | | Sensitivity to weather conditions (rain, wind, fire, etc.) and being affected by the results | 13 |
| 20 | | Damage to property and people | 12 |
| | | **Total frequency of phrases** | **55** |
| 21 | Hardware and software limitations | Low battery capacity | 15 |
| 22 | | Persistence of low flight of the bird (limitation of flight time) in the field of spraying drones | 15 |
| 23 | | Lack of standards in the construction of tools and software for agricultural drones (including in the case of spraying drones) | 15 |
| 24 | | Legal height limit | 14 |
| 25 | | Limited load capacity (poison and fertilizer) | 13 |
| 26 | | Limitation in the type of sensors used (lack of sufficient access) | 12 |
| | | **Total frequency of phrases** | **84** |
| 27 | Complexity and time-consuming | Difficulty analyzing and interpreting data | 15 |
| 28 | | The entry of few companies in the field of agricultural drone technology | 15 |
| 29 | | Difficulty in providing and repairing defective parts | 15 |
| 30 | | High cost | 14 |
| 31 | | Lack of effective counseling services | 12 |
| 32 | | Spending relatively much time to introduce to farmers (awareness) | 12 |
| 33 | | Long return on investment for investors | 11 |
| 34 | | The long process of training local users | 11 |
| | | **Total frequency of phrases** | **105** |

In general, the most important challenges of using drones in paddy fields included "complexity and time-consuming", "hardware and software limitations", "unfavorable access", "ethical-social concerns", "lack of macro and integrated approach", and "safety issues", respectively (Fig 1).

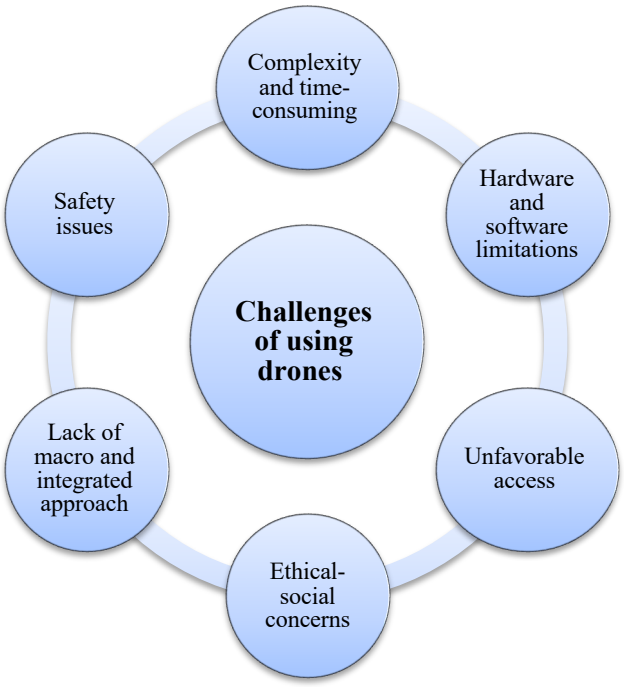


**Fig 1. The challenges of using drones in paddy fields.**

## Conclusion or Summary

Based on the available evidence, the weak political will of authorities to expand and develop the use of technology (Bosompem, 2021) related to the category of "lack of macro and integrated approach"; inadequate knowledge and expertise in data analysis and interpretation by the user (Ammann et al., 2022; Chakreeves et al., 2014; Subeesh & Mehta, 2021; Ofori & El-Gayar, 2021; Bosompem, 2021; Reddy Maddikunta et al., 2021; Tey & Brindal, 2022) and unfavorable information (Chakreeves et al., 2014) related to the category of "unfavorable access"; security and privacy (Alwateer et al., 2019; Ayamga et al., 2021; Chamuah & Singh, 2020; Scott & Scott, 2017; Aydin, 2019; Barbedo & Koenigkan, 2018), misuse of data for specific purposes (agricultural terrorism) (Sparrow & Howard, 2021; Siva balan, 2016; Kraus et al., 2020; Reddy Maddikunta et al., 2021; Kraus et al., 2020; Rao et al., 2016; Sandbrook, 2015; Bodkhe et al., 2020), fear and worry about the optimal performance of technology as a new phenomenon in the farm (Duffy et al., 2018; Kraus et al., 2020; Reddy Maddikunta et al., 2021) related to the category of "ethical-social concerns"; environmental obstacles such as trees, birds, buildings, irregular geometric shapes of the farm, etc. (Chamuah & Singh, 2020; Barbedo & Koenigkan, 2018; van der Merwe et al., 2020; Yang et al., 2018; Duffy et al., 2018), remote control system malfunction (communication link failure) and loss of control during flight (Sah et al., 2021) related to the category of "safety issues"; low battery capacity (Kraus et al., 2020; Galkin et al., 2019; Hirling & Holzapfel, 2018; Chakreeves et al., 2014; Cummings et al., 2017), persistence of low flight of the bird (limitation of flight time) in the field of spraying drones (Aswini et al., 2018), lack of standards in the construction of tools and software for agricultural drones (including in the case of spraying drones) (Sah et al., 2021; Kraus et al., 2020) related to the category of "hardware and software limitations"; and difficulty analyzing and interpreting data (Bosompem, 2021), the entry of few companies in the field of agricultural drone technology (del Cerro et al., 2021), difficulty in providing and repairing defective parts related to the category of "complexity and time-consuming" are as the most important challenges of using agricultural drones in paddy fields, which were emphasized by all the experts. Based on the results obtained, the following suggestions are provided:

- Strong political will to develop the application of agricultural drone technology
- Providing short-term and long-term training courses regarding data analysis and interpretation for users
- Informing farmers about the existence of drone technologies
- Identification of drone users
- Technical upgrade of drones in order to increase efficiency in the paddy fields
- Encouraging farmers to consolidate land in order to create agricultural plots with a regular geometric shape in paddy fields.
- Encouraging knowledge-based companies to operate in the field of agricultural drone technologies by providing banking and tax facilities.

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