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Assessment of knowledge of drone pilots on standard operating procedures (SOPs) for drone operations in paddy

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Abstract

The present study was conducted to assess the knowledge level of drone pilots on Standard Operating Procedures (SOPs) in drone operations for paddy crop management and to analyse the relationship of selected profile characteristics with their knowledge level. The study was conducted among 120 drone pilots engaged in agricultural drone operations in Telangana State. An ex-post facto research design was adopted for the study. The results revealed that majority of the respondents (42.50%) had medium level of knowledge regarding Standard Operating Procedures, followed by high (31.67%) and low (25.83%) levels of knowledge. Correlation analysis revealed that digital literacy, extension contact, innovativeness, economic motivation and years engaged in drone operations had a positive and highly significant relationship with knowledge level. There is a positive and significant relationship between risk orientation, number of drone operations conducted per season and training exposure with the knowledge level. Age, education and annual income were not significant with knowledge level. Multiple regression analysis revealed that innovativeness and experience as a drone pilot significantly contributed to variation in knowledge level. The coefficient of determination indicated that the selected profile characteristics together explained 31.00 per cent of the variation in knowledge level. The results suggest that there is a need for continuous capacity building, practical training and increased field exposure to enhance the technical knowledge of drone pilots regarding Standard Operating Procedures in agricultural drone operations.

Keywords: Agricultural drones, drone pilots, profile characteristics, knowledge level, standard operating procedures, paddy crop management

Introduction

Agriculture is undergoing rapid technological transformation with the increasing adoption of digital and precision farming technologies. Unmanned Aerial Vehicles (UAVs), commonly known as drones, have emerged as promising tools for crop monitoring, pesticide spraying, nutrient application and other precision agricultural operations. Their use can improve operational efficiency, facilitate timely farm operations and reduce dependence on manual labour (Hafeez *et al.*, 2023) ^[1]. In recent years, the use of agricultural drones for precision farming, efficiency and sustainability has also been emphasized.

Paddy is one of the important crops in which drone-based spraying has considerable potential, particularly for crop protection operations. Traditional pesticide application techniques in paddy fields are limited by labour shortages, are impractical in standing crops and delay in taking timely actions for plant protection. Drone spraying can overcome some of these limitations by enabling rapid application without requiring operators to physically enter the crop field. However, studies on UAV application in paddy have shown that spray performance is influenced by factors such as nozzle

type, flight velocity, atomization and other operational parameters (Wongsuk *et al.*, 2024) ^[2].

The effective and safe utilization of agricultural drones largely depends upon the technical competency of drone pilots. Operators require adequate knowledge regarding pre-flight inspection, flight planning, calibration, battery management, payload handling, spray parameters, weather conditions, safety precautions, emergency procedures and post-flight maintenance. Recognizing the importance of standardized operations, the Ministry of Agriculture and Farmers Welfare, Government of India, issued Standard Operating Procedures (SOPs) for the use of drones in pesticide application for crop protection and spraying of soil and crop nutrients (Ministry of Agriculture & Farmers Welfare, 2021) ^[3].

The knowledge level of drone pilots may vary according to their socio-personal, psychological, communication and professional characteristics. Factors such as digital literacy, extension contact, innovativeness, risk orientation, economic motivation, training exposure and practical experience may influence their ability to acquire and apply technical knowledge. Lack of training and skill development has also

been identified as an important challenge affecting wider adoption of agricultural drone technology in India.

Keeping this in view, the present study was undertaken to assess the knowledge level of drone pilots on Standard Operating Procedures in drone operations for paddy crop management and to analyse the relationship and contribution of selected profile characteristics towards their knowledge level.

Methodology

The present study was conducted among drone pilots who are involved in agricultural drone operations in Telangana State. The research design adopted was Ex- post facto where the characteristics of the respondents and their knowledge level were examined without manipulation.

A total of 120 drone pilots were selected as respondents for the study. The knowledge level of drone pilots regarding Standard Operating Procedures in drone operations for paddy crop management was assessed using a structured knowledge test. The knowledge test covered various aspects of drone operations and Standard Operating Procedures related to paddy crop management.

Based on the knowledge scores obtained, the respondents were categorized into low, medium and high knowledge categories. The profile characteristics selected for the study included age, education, digital literacy, extension contact, innovativeness, risk orientation, annual income, economic motivation, experience as a drone pilot and training exposure. The collected data was analysed to identify the relationship and contribution of the selected profile characteristics to the knowledge level of drone pilots by frequency, percentage, correlation coefficient and multiple regression analysis.

Results and Discussion

Knowledge level of drone pilots regarding Standard Operating Procedures

The data presented in Table 1 revealed that the majority of the respondents (42.50%) had medium level of knowledge regarding Standard Operating Procedures in drone operations, followed by high (31.67%) and low (25.83%) levels of knowledge.

The results presented above indicate that the majority of the drone pilots had medium level of knowledge regarding Standard Operating Procedures in drone operations. The probable reason for this might be that agricultural drone technology is a relatively new field and requires continuous updating of technical knowledge regarding operational procedures, safety measures and emerging technological developments.

The considerable proportion of respondents with high knowledge level might be due to their practical experience in drone operations, exposure to technical information and repeated involvement in field-level drone spraying activities. Continuous engagement in drone operations would provide opportunities for experiential learning and enable pilots to understand different technical and operational aspects more effectively.

However, 25.83 per cent of the respondents had low level of knowledge, indicating the need for improving their technical competency. Hence, to bring the knowledge level of drone pilots to higher categories, capacity building through regular training programmes, practical demonstrations and hands-on

technical sessions is required.

Table 1: Distribution of drone pilots according to their overall knowledge level

S. No.	Knowledge category	Frequency	Percentage
1	Low	31	25.83
2	Medium	51	42.50
3	High	38	31.67
	Total	120	100.00

Relationship between profile characteristics and knowledge level of drone pilots

In order to study the relationship between the knowledge level of drone pilots and their profile characteristics, correlation coefficient (r) values were computed.

It is revealed from Table 2 that there was a positive and highly significant relationship between knowledge level of drone pilots and variables viz. digital literacy ($r = 0.325$), extension contact ($r = 0.291$), innovativeness ($r = 0.389$), economic motivation ($r = 0.317$) and years engaged in drone operations ($r = 0.343$).

Further, risk orientation ($r = 0.225$), number of drone operations conducted per season ($r = 0.212$) and training exposure ($r = 0.183$) had a positive and significant relationship with the knowledge level of drone pilots. Age ($r = 0.112$), education ($r = 0.105$) and annual income ($r = 0.143$) showed a positive but non-significant relationship with knowledge level.

The positive and highly significant relationship between digital literacy and knowledge level indicates that drone pilots possessing better digital skills would be able to understand and utilize drone software, GPS systems, mobile applications and other digital platforms more effectively. More the digital literacy, greater would be the ability of drone pilots to access and acquire technical knowledge related to drone operations.

Extension contact had a positive and highly significant relationship with knowledge level. More the extension contact, the greater the opportunities for drone pilots to interact with agricultural experts, technical personnel and other information sources. Such interactions would help them acquire updated knowledge regarding drone technology, operational procedures and safety requirements.

Innovativeness had a positive and highly significant relationship with knowledge level. Innovative individuals generally show greater interest in new technologies and improved practices. More the innovativeness, greater would be the tendency of drone pilots to seek new information, experiment with emerging technologies and update their technical knowledge.

Risk orientation had a positive and significant relationship with knowledge level. Drone operation involves the use of new technologies and requires the ability to handle technical and operational uncertainties. Respondents with greater risk orientation might be more willing to explore new technologies and operational practices, thereby acquiring greater knowledge.

Economic motivation had a positive and highly significant relationship with knowledge level. More the economic motivation, greater would be the interest of drone pilots in acquiring technical knowledge to improve their service quality and operational efficiency. Better knowledge would

enable them to perform operations more effectively and improve their income-generating opportunities.

Experience as a drone pilot had a positive relationship with knowledge level. Both years engaged in drone operations and number of drone operations conducted per season showed positive and significant relationships with knowledge. More experience and repeated involvement in drone operations would provide greater practical exposure and opportunities for learning. Continuous field-level experience would enable drone pilots to understand operational problems and appropriate procedures more effectively.

Training exposure had a positive and significant relationship with knowledge level. More exposure to training programmes would provide opportunities for drone pilots to acquire information regarding drone technology, Standard Operating Procedures, safety precautions and technical advancements. Hence, increased participation in training programmes would help improve their knowledge level.

Table 2: Relationship between profile characteristics and knowledge level of drone pilots

V. No.	Profile characteristics	"r" Value
X ₁	Age	0.112
X ₂	Education	0.105
X ₃	Digital Literacy	0.325**
X ₄	Extension contact	0.291**
X ₅	Innovativeness	0.389**
X ₆	Risk Orientation	0.225*
X ₇	Annual Income	0.143
X ₈	Economic Motivation	0.317**
X ₉	Experience as a drone pilot	
	a) Years Engaged in drone operations	0.343**
	b) Number of operations conducted per season	0.212*
X ₁₀	Training Exposure (Number of Trainings attended)	0.183*

Significant at 0.05 level of probability

** Significant at 0.01 level of probability

NS – Non-significant

Contribution of profile characteristics towards knowledge level of drone pilots

The contribution of selected profile characteristics towards the knowledge level of drone pilots was analysed using multiple regression analysis. The results presented in Table 3 revealed that innovativeness and experience as a drone pilot significantly contributed towards explaining the variation in knowledge level.

Innovativeness had a significant regression coefficient ($b = 0.122$) at the five per cent level of probability. The result indicates that respondents possessing greater innovativeness were more likely to acquire higher levels of knowledge regarding drone operations and Standard Operating Procedures. Innovative individuals generally show greater interest in adopting and experimenting with new technologies and continuously seek updated information.

Experience as a drone pilot also significantly contributed towards knowledge level. Years engaged in drone operations had a regression coefficient of 1.689 and was significant at the one per cent level of probability. Similarly, the number of drone operations conducted per season significantly contributed towards knowledge level.

The significant contribution of experience indicates that continuous involvement in drone operations provides

opportunities for practical learning. More years of engagement and repeated field-level operations would enable drone pilots to understand technical problems, operational requirements and Standard Operating Procedures more effectively.

The remaining profile characteristics did not show significant independent contribution towards knowledge level after controlling for other variables in the regression model. This indicates that although some variables were positively associated with knowledge, their independent contribution became less pronounced when all the selected characteristics were considered simultaneously.

The coefficient of determination ($R^2 = 0.310$) indicated that the selected profile characteristics together explained 31.00 per cent of the variation in knowledge level. The adjusted R^2 value was 0.240 and the overall regression model was statistically significant with an F value of 4.421.

The findings indicate that behavioural characteristics, particularly innovativeness, and practical operational experience play an important role in determining the knowledge level of drone pilots.

Table 3: Contribution of profile characteristics towards knowledge level of drone pilots

S. No.	Independent variables	'b' value	SEb	't' value	Significance
X ₁	Age	0.105	0.102	1.030	0.305
X ₂	Education	0.377	0.441	0.855	0.395
X ₃	Digital literacy	0.051	0.050	1.019	0.311
X ₄	Extension contact	0.012	0.073	0.163	0.871
X ₅	Innovativeness	0.122	0.052	2.342	0.021*
X ₆	Risk orientation	0.019	0.082	0.999	0.320
X ₇	Annual income	0.006	0.000	0.999	0.320
X ₈	Economic motivation	0.053	0.061	0.868	0.387
X _{9a}	Years engaged in drone operations	1.689	0.482	3.503	0.001**
X _{9b}	Number of drone operations conducted per season	0.139	0.454	3.503	0.001**
X ₁₀	Training exposure	0.220	0.417	0.526	0.600

*Significant at 0.05 level **Significant at 0.01 level

Conclusion

The study revealed that majority of the drone pilots had medium level of knowledge regarding Standard Operating Procedures in drone operations for paddy crop management, followed by high and low levels of knowledge. The findings indicate that although a considerable proportion of drone pilots possessed adequate knowledge, there is still scope for improving their technical competency.

Digital literacy, extension contact, innovativeness, economic motivation and years engaged in drone operations had a positive and highly significant relationship with knowledge level. Risk orientation, number of drone operations conducted per season and training exposure had a positive and significant relationship. Age, education and annual income had a non-significant relationship with knowledge level.

The regression analysis revealed that innovativeness and practical experience as a drone pilot significantly contributed towards variation in knowledge level. The selected profile characteristics together explained 31.00 per cent of the variation in knowledge level.

The probable reason for the predominance of medium

knowledge level might be that agricultural drone technology is continuously evolving and requires regular updating of technical knowledge and operational skills. Hence, to bring the knowledge level of drone pilots to higher categories, continuous capacity building through refresher training programmes, hands-on demonstrations and increased field-level exposure is required. Special emphasis may be given to strengthening digital competency, encouraging innovativeness and providing opportunities for practical learning to ensure safe and efficient implementation of Standard Operating Procedures in agricultural drone operations.

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