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Case Study

SWOT Analysis on Drone in Agriculture-A Case study

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ABSTRACT

The study was conducted in 2023-24 in KVK operational area of Nandyal district with an objective of visualizing strengths, weakness, opportunities and threats in the use of drone technology in agriculture. The purpose of the study is to comprehend SWOT analysis and determine the best entry tactics for the sustainability of drone technology in agriculture by using TOWS matrix. Data was collected from 120 farmers those farms were covered under drone spraying more than twice under agriculture drone project, with pre-designed questionnaire. Opinions translated as coefficient and rating was given for the same by using Internal Factor Evaluation and External factor Evaluation matrices for evaluating the drone technology to reveal its strengths as well as weaknesses along with opportunities and threats. The internal and external factor (I-E) matrix tool is used to summarize the information gained from drone's external and internal environment analyses. The results found that the average for IFE and EFE score was 2.50 and 2.62, respectively, which reflects that opportunities and threats are more than strength and weakness of the drone technology in agriculture. It is more effective and easy in tall and dense crops i.e. Maize, Jowar, Red gram and Paddy. Less availability of spare parts, poor repair and maintenance services was founded as weaknesses of the technology.

HIGHLIGHTS

- I-E Matrix concluded that, technology was obtained in cell "V", suggesting that the hold and maintains strategy should be applied.
- It indicates that at present, drone spraying is profitable for both users and operators; there is still scope to improve operator service centers, enhance drone availability, and reduction of drone spraying operating costs, which results greater adoptability of the technology.
- Provided strategies with TOWS Matrix, which could improve efficiency to minimize threats and take advantage of opportunities in external environment of drone in agriculture.

Keywords: SWOT Analysis, I-E Matrix, TOWS Matrix and Drone technology

Agricultural sector has seen some innovative technologies that support farm management strategies in enhancing efficiency through the precision application of farm inputs in recent years. One of such innovations is the drone technology which has gained popularity (Kim *et al.* 2018) and has been widely used in precision agriculture (Zhang and Kovacs, 2012). A drone or an Unmanned Aerial Vehicle (UAV) according to the definition by

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International Civil Aviation Organization (ICAO, 2011) is an aircraft operated without a human pilot on-board. Drones use together with other Information Communication Technologies (ICTs) are opening a new phase in the agriculture domain where we have digital agriculture, smart agriculture, e-agriculture, and precision agriculture (El Bilali *et al.* 2019). They are rapidly evolving, replacing satellites and aircraft. They can capture high-quality images at cheap prices that satellites cannot do. They generally run on battery or fuel. They are being used in various fields including military, agriculture, film industry, humanitarian relief etc. Drones have initiated a technological revolution in the agriculture sector (Negash *et al.* 2019; Sharma, 2021). They can gather large volumes of spatial data. The usage of drones in the area of agriculture is raising especially crop production, early warning, forestry, fisheries etc. They are so efficient that they can gather whole soil data without even touching the soil (Arokiaraj *et al.* 2020; Ren *et al.* 2020; Reger *et al.* 2018).

These days drones are equipped with modern technologies like navigation, controls, imaging, sensing etc. Similarly, drones could be leveraged in several agricultural activities, including crop and growth monitoring, yield estimation, water stress assessment, and weeds, pest, and disease detection (Inoue, 2020; Panday, Pratihast, *et al.* 2020). They are also being used for predictive forecasts of pests and diseases, spraying fertilizers and pesticides (Barasa *et al.* 2021; David, 2020). However, with the advancement of technology, they are also being used in the whole production process from land preparation to harvesting (Muraru *et al.* 2019). Early insect identification can minimize output loss by up to 40%, based on crop species and growth stage (Ahirwar *et al.* 2019). As a result, farmers must devote their whole attention to crop monitoring (Srivastava, 2020). Rather than trekking around the field, farmers may now utilize technology such as drones to inspect their crops more quickly and correctly (Banumathi & Arokiaraj, 2011; Bhardwaj *et al.* 2021; Rejeb *et al.* 2022). In this regard, the majority of farmers accepted drone technology; yet, some farmers appear pessimistic toward technology due to a lack of knowledge about it. In this connection, in order to visualizing pros and cons of the technology we attempted a study with the objectives of displaying SWOT and eliciting strategies with TOWS matrix. SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis is one of the oldest and most widely adopted strategy tools in worldwide (R.F. Stewart 1965). SWOT was attempted with I-E Matrix tool.

MATERIALS AND METHODS

KVK conducted 1500 ac of drone spraying under Agriculture Drone Project (ADP) in different field and horticultural crops, in this wise plan to conduct study on them to know the SWOT of the technology at farmers level. The present study was conducted in 2023-24 through 120 respondents were selected purposively those who utilized drone for spraying in their farm at least three times in a season under agriculture drone project by using pre designed questionnaire. Translated opinions of the respondents in to a coefficient and given the rating for the same by using matrices called EFE and IFE. Conclusion drawn by using I-E Matrix. EFE, IFE and I-E tools was explained below.

IFE Matrix: The ratings in the internal matrix refer to how strong or weak each factor is in a technology. The numbers range from 4 to 1, where 4 means a major strength, 3 – minor strength, 2 – minor weakness and 1 – major weakness. Strengths can only receive ratings 3 & 4, weaknesses – 2 & 1. Internal Factor Evaluation (IFE) Matrix is a strategy tool used to evaluate technology's internal environment and to reveal its strengths as well as weaknesses.

EFE Matrix: External Factor Evaluation Matrix is a strategy tool used to examine technology's external environment and to identify the available opportunities and threats. The ratings in the external matrix refer to major opportunities and major threats in a technology. The numbers range from 4 to 1, where 4 means a major opportunity, 3- minor opportunity, 2 indicates minor weakness and 1- major weakness. Ratings, as well as weights, are assigned based on frequency of each statements.

Weighted Scores & Total Weighted Score: Each key factor was assigned a weight ranging from 0.0 (low importance) to 1.0 (high importance). The sum of all the weights must equal 1.0. The score is the result of weight multiplied by the rating. Each key factor must receive a score. Total weighted score is simply the sum of all individual weighted scores. The technology can receive the same total score from 1 to 4 in both matrixes. A total score 2.5 is an average, 1 is indicates poor, 4 indicates strong/high. In external evaluation, a low total score indicates that the drone technology isn't designed well to meet the opportunities and defend against threats. In internal evaluation a low score indicates that the drone technology is weak against its competitors.

Internal-External (IE) Matrix: The internal and external factor evaluation matrixes were introduced by Fred R. David (2007) in his book 'Strategic Management' was used to evaluate technology's internal and external environment analyses. The IE matrix is a continuation of the IFE, EFE Matrix models.

The IE matrix belongs to the group of strategic portfolio management tools. The IE matrix positions an organization/technology into a nine cell matrix.

The IE matrix is based on the following two criteria:

- ❖ Score from the **EFE matrix** -- this score is plotted on the y-axis
- ❖ Score from the **IFE matrix** -- plotted on the x-axis

The IE matrix works in a way that you plot the *total weighted score* from the EFE matrix on the y axis and draw a horizontal line across the plane. Then you take the score calculated in the IFE matrix, plot it on the x axis, and draw a vertical line across the plane. The point where your horizontal line meets your vertical line is the determinant of your strategy. This point shows the strategy that you should follow.

On the x axis of the IE Matrix, an IFE total weighted score of 1.0 to 1.99 represents a weak internal position. A score of 2.0 to 2.99 is considered average. A score of 3.0 to 4.0 is strong.

On the y axis, an EFE total weighted score of 1.0 to 1.99 is considered low. A score of 2.0 to 2.99 is medium. A score of 3.0 to 4.0 is high.

There are three main regions of the IE matrix which are as follow:

- ❖ Grow & Build Region which covers the I, II, or IV cells
- ❖ Hold & Maintain Region which covers the III, V, or VII cells
- ❖ Harvest or Divest Regions which cover VI, VIII, or IX cells

TOWS matrix: According to Weihrich (1982) TOWS analysis is an extension of the SWOT analysis framework that identifies your Strengths, Weaknesses, Opportunities and Threats but then goes further in looking to match up the Strengths with Opportunities and the Threats with Weaknesses. It's a great next step after completing SWOT and allows to take action from the analysis. Translated SWOT data in to SO Strategy, ST Strategy, WO Strategy, WT Strategy to minimize threats and take advantage of opportunities in external environment.

RESULTS AND DISCUSSION

1. Internal Factor Evaluation

Strength and weakness of drone technology (IFE analysis): From the data presented in Table 1, inferred that under strengths received highest score of '0.48' for S5 '*It more effective and easy in tall and dense crops i.e. Maize, Jowar, Red gram and Paddy*' and S8 '*It can operate at undulated areas*', followed by 0.28 score for S1 '*Uniform application of chemical spraying*' and 0.20 score of S2 '*Usage of agriculture drone is time effective (10 min. /ac)*'.

The possible reason for S5 and S8 receiving highest score might be that superior field efficiency of drone in agro chemical spraying in maize, jowar, red gram and paddy crops. 'It can operate at undulated areas' received highest weightage due to analyzing the area and establishing a boundary, analyses of the area, and then finally, uploading the technical GPS information into the drone's navigation system. Followed by S2 is due to application of drone-mounted sprayers in the field has enhanced the coverage ability, increased the chemical effectiveness, made the spraying job easier

Table 1: Strength and weakness of the drone technology

Sl. No.	Strength	Response		
		Coefficient	**Rating**	**Score**
S1	Uniform application of chemical spraying	0.07	4	0.28
S2	Usage of agriculture drone is time effective (10 min./ac)	0.05	4	0.20
S3	Useful in reducing the impact of pesticides on environment	0.02	3	0.06
S4	Reduce the cost on chemicals	0.03	3	0.09
S5	It more effective and easy in tall and dense crops i.e. Maize, Jowar, Redgram and Paddy	0.12	4	0.48
S6	Best alternative to overcome labor scarcity	0.06	3	0.18
S7	Drone utilization helps to reduce drudgery	0.04	4	0.16
S8	It can operate at undulated areas	0.12	4	0.48
	Weakness			
W1	High initial investment	0.04	1	0.04
W2	Low payload (10 lit.)	0.06	1	0.06
W3	Operation of drone require technical skill	0.05	2	0.10
W4	Battery longevity very low	0.10	1	0.10
W5	Need charging point for spraying larger area	0.05	1	0.05
W6	Availability of Spare parts is very low	0.07	1	0.07
W7	Repair and Maintenance services was poor	0.07	1	0.07
W8	If applied during the crop's flowering and fruiting stages, it could result in yield losses	0.03	2	0.06
W9	Poor maintenance leads to increase the drone maintenance cost	0.02	1	0.02
	Total IFE Score	1	—	2.50

4- Major strength, 3-Minor strength, 2-Minor weakness, 1- Major weakness.

and faster. Spraying is done in pre-mapped routes to spray crops according to the requirements. Drones are showing great potential in covering the fields precisely in short period of time in pre-mapped routes. S1 received next best score due to advantage is release of relatively uniform droplets as opposed to the wide range of droplet sizes produced by conventional flat-fan nozzles calibrating the droplet size and flow rate to account for changes in operational parameters such as spray pressure and flying speed.

Table 1 is indicates under weakness both W4 *'low battery longevity'*, and W3 '*required technical skill received'* 0.10 score, as a major weakness in drone in agriculture spraying. This results are similar with results of Zhang. C & Kovacs, (2012), Laksham, (2019). '*Low availability of spare parts'* W6, '*Poor repair and maintenance services'* W7, also found as major weakness with score of 0.07.

2. External Factor Evaluation

Opportunities and threats of drone technology (EFE Analysis): table 2 indicating that under opportunities O2 *'Promotion of drone may create jobs for unemployed rural youth'* received top score 0.48, Followed by O1 *'Drone helps in crop health management decision'* and O6 *'Pest and diseases forecasting can possibly with drone data base'* received highest score (0.40) as drone helps in crop with their ability to capture high-resolution images and employ spectral analysis, drones provide unparalleled insights into crop health. This information aids farmers in making precise decisions about nutrient application and pest and disease management. These results suited with the Reinecke and Prinsloo, 2017; Trivelli *et al.* 2019.

Table 2: Opportunities and threats of drone technology

Sl. No.	Opportunities	Response		
		Coefficient	Rating	Score
O1	Drone helps in crop health management decision	0.10	4	0.40
O2	Promotion of drone may create jobs for unemployed rural youth	0.12	4	0.48
O3	Agril. drone enable precise and targeted crop monitoring & treatment	0.08	3	0.24
O4	Drones could be highly effective in assessment of crop losses	0.07	3	0.21
O5	Broadcasting of Seed and fertilizer can also possible with drone	0.08	3	0.24
O6	Pest and diseases forecasting can possibly with drone data base	0.10	4	0.40
	Threats			
T1	Possibility of spray drift to the nearby crop fields	0.06	2	0.12
T2	> 12 kmph wind speed affect the drone spraying	0.15	1	0.15
T3	Adverse weather conditions limit the effective use of drone	0.10	1	0.10
T4	It will be dangerous for the birds and pollinators	0.05	2	0.10
T5	Cannot operate nearby electricity lines (3 phase), Railway tracks and gas stations	0.05	2	0.10
T6	Increasing of competition for similar services	0.04	2	0.08
	Total EFE Score	1	—	2.62

4-Major opportunities, 3-Minor opportunities, 2-Minor threats, 1-Major threats.

The possible reason for 'O2' receiving highest score was given the technical nature of the job, training farmers as 'Kisan Drone pilots' just like combined harvester operators, Kisan Drone pilots will have demand seasonally and they will be attached to the Custom Hire Centers (CHCs) under SHGs/FPOs to which drones are given. The drone operator is likely to earn fixed amount per day. This way not only more jobs are created, but the farmers will get a ready-made solution for their farmhands' problem. These results are lined with the Sylvester, 2018.

Under threats 'T2' *'>12 kmph wind speed affect the drone spraying'* received highest score '0.15', because wind speed affect the drone spraying in various ways. Wind can alter your drone's flight path, rain can damage electronic components, and cold temperatures can drain battery life faster. Followed by T1 *'Possibility of spray drift to the nearby crop fields'* next best score '0.12' when compared with ground-based spraying equipment, plant protection drones spray at a higher altitude from the crop canopy and fly faster, which is bound to cause more serious droplet drift and environmental safety problems.

3. I-E Matrix for SWOT of Drone Technology in Agriculture:

The data presented in table 1, Total weighted score of IFE Matrix received 2.50 which points the technology at average internal strengths. Whereas table 2 indicated that EFE Score received 2.62 which suggest above average to respond the external factors of the technology.

The values of IFE score and EFE score plotted in the IE matrix as mentioned in Fig. 1.

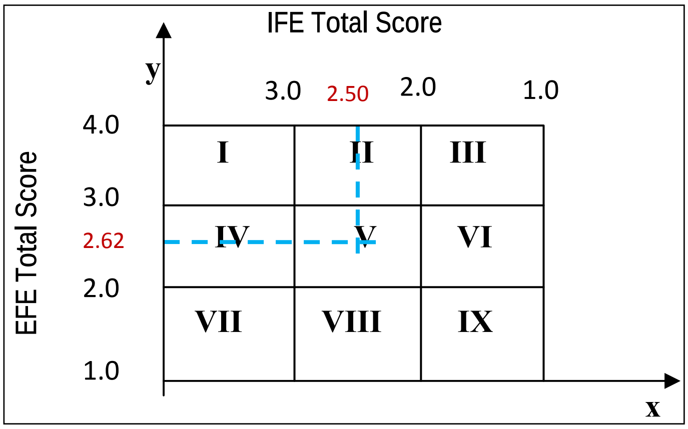

Fig. 1: I-E Matrix for Drone technology in agriculture

The results of I-E Matrix indicated that, the strategy for drone technology in agriculture should be "hold and maintained". It shows that the crossing point of the EFE and IFE total weighted score observed at cell 'V'. This indicates that drone spraying is profitable for both users and operators. But there is still lot of scope to improve drone operator service centers, drone availability and reduction in operating costs, which results in increase in adoptability of drone technology.

4. TOWS Matrix

Appropriate strategies were generated by translating the data of SWOT in to TOWS matrix. In this connection exemplary suggestions were devised to increase the effectiveness of drones in agriculture with the aid of SWOT data (Tables 1 and 2). Strategies listed in Table 3, *Reduction of cost on chemicals with location specific spraying of drone* was developed as Maxi-Maxi strategy (SO) with S3, O4 from SWOT. *Impart technical skill to rural youth for drone operation* and *Improving repair and maintenance services* may maximize the drone adoption generated as Mini-Maxi (WO) strategy. *Plan to spray on morning times will improve drone efficiency*, and *Plan to spray at a low wind speed to prevent spray drift in adjacent crops* provided as Maxi-Mini (ST) strategy. *Minimize poor maintenance of drone and avoid operation of drone in adverse weather conditions* provided as WT Strategy. These are possibilities rather than solutions, however if applied properly, they might turn into such.

CONCLUSION

Agricultural drone technology have several strengths, weaknesses, opportunities and threats. Understanding these factors is crucial for any organization or business or enterprise looking to venture into this. The strengths of agricultural drone technology lie in their ability in effective and easy spraying in tall and dense crops i.e. Maize, Jowar, Red gram and Paddy followed by its operation in undulated areas, uniform spraying of chemical, reduced costs, assess crop health, detect pest and diseases enabling farmers to make informed decisions about their crops resulting in improved productivity.

However, weaknesses of drones are, if applied during the crop's flowering and fruiting stages, it could result in yield losses, non-availability of spare parts and poor repair and maintenance services, high initial investment and technological limitations can deter some farmers from adopting this technology. Drone technology cannot be operated by family labor; but manual spraying can be deployed to complete this task which helps in reducing

Table 3: TOWS matrix of drone technology in agriculture

TOWS	Strength (S)	Weakness (W)
Opportunities (O)	**SO Strategy** **Maxi-Maxi strategy** **SO-1:** Improving the Location specific chemical spraying may help to reduce the cost on pesticides **(S3, O4)** **SO-2:** Broadcasting of seed and fertilizer may overcome labour scarcity at peak season **(S6, O5)**	**WO Strategy** **Mini-Maxi Strategy** **WO-1:** Impart technical skill to rural youth for drone operation **(W3, O2)** **WO-2:** Improving repair and maintenance services may maximize the drone adoption **(W7, O2)**
Threats (T)	**ST Strategy** **Maxi-Mini Strategy** **ST-1:** Plan to spray on morning times will improve drone efficiency **(T3, S1)** **ST-2:** Plan to spray at a low wind speed to prevent spray drift in adjacent crops. **(T1, S1)**	**WT Strategy** **Mini-Mini Strategy** **WT-1:** Maintain extra batteries to cover larger areas **(W4, T2)** **WT-2:** Minimize poor maintenance of drone and avoid operation of drone in adverse weather conditions **(W9, T3)**

the operating cost of hiring labour charges for small and marginal farmers.

Despite these challenges, there are significant opportunities in the agriculture drones i.e., create jobs for rural unemployed youth, easy pest and disease management and enable precise and targeted crop monitoring & treatment. As the global population continues to grow, the demand for sustainable and efficient agricultural practice will increase. Drones can play a pivotal role in addressing these needs by providing accurate and real time data, enabling precision agriculture to maximize yields and minimize resource wastage.

Lastly, agricultural drone technology also faces threats that need to be considered. Dangerous for the birds and pollinators, adverse weather conditions limit the effective use of drone and increased competition in market can impact its profitability.

The agricultural drone technology present a range of strengths, weaknesses, opportunities and threats. By understanding and addressing these factors drone entrepreneurs and farmers can position themselves for success in farming.

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