

Original Research Article

Adoption of Drones in Agriculture: Social, Economic and Personal Factors

ABSTRACT

Aims: The acceptance of drone technology is gradually rising up owing to its potential being understood by businesses. It is in this aspect that an outlook on the various factors that are responsible pertaining to the drone technology in the recent times has been carried out.

Study design: Ex-post Facto

Place and Duration of Study: Dindigul, Tiruppur, Erode and Namakkal districts of Tamil Nadu

Methodology: Simple Random Sampling was used to select the respondents and to find out the association between the different factors, chi-square test was used.

Results: There was a highly significant association between all the factors such as economic, social and personal with that of [the](#) utilization of drones in agriculture since the calculated ~~chi-square~~ [chi-square](#) values are more than the table values

Conclusion: The perceived factors which has been discussed in this article are a positive sign and can be used as an eye-opener to develop more ~~farmer-friendly~~ [farmer-friendly](#) drones ~~and~~ at a reasonable cost for owning them by the farmers

Keywords: Unmanned Aerial Vehicles, Agriculture, Factors, Chi – square test

1. INTRODUCTION

The sector of agriculture, although it contributes to 20.2 per cent of the Gross Domestic Product (GDP) of India (Press Information Bureau, 2021), it gambles with various constraints such as abnormal monsoons, production related issue, low productivity, ~~labour~~ [labor](#) shortage, price fluctuations, etc. Agriculture is the prime work source for man of the rural households. The FAO report on India at a Glance, 2022 in its report have insisted that 70 per cent of the rural households still depend on agriculture and about 82 per cent of the farm households are small and marginal. It is the dire need of all the stakeholders who are involved around agriculture to look into this situation seriously and find out path breaking ways to achieve sustainability for our younger generation. Automation in agriculture is an emerging subject across the world. In the current trend, the concept of Artificial Intelligence has found many applications in building solutions for agriculture related problems, which not only empower the farmers to continue farming amidst eradicating natural resources and also would improve the quality and ensure quick market penetration of various crops. Of all these, a pivotal role is being played by the technology of Unmanned Aerial Vehicles (UAVs), commonly referred to as Drones for agricultural purposes. Although it is in the latent stage and as a much longer road ahead, its presence can be felt in many patches of our country.

Drones, which are technically referred to as 'Unmanned Aerial Vehicles (UAVs)' are useful for carrying out tasks that are sometimes considered impossible for humans to do. These were originally developed for military purposes when the first types of drones were used in First World War. But now it has found its way into [the](#) mainstream because of the enhanced levels of safety and efficiency they bring. These vehicles do not need a pilot on board and it can either be controlled manually or by relying on a system of sensors (like LIDAR detectors) (Built In, 2022). Drones in general refer to multirotors. A multirotor is fixed with three or more propellers which are used for hovering or flying in any direction. However,

the most commonly used type of drone is the quadcopter having four propellers (GCF Global, 2022).

In the recent trend, drones have become essential for various tasks in different organizations and have also helped a lending hand in uplifting industries that were about to perish. From delivery services of food orders to [scan-scanning](#) an unreachable military base, drones are very smart enough than humans [acting-to act](#) in a more effective and in [an](#) efficient way. Moving the [work-relatedwork-related](#) graph upwards, decrease in work pressure and production costs, excellent accuracy, refining service and customer relations and solving security issues on a large scale are some of the areas where drones find a place.

2. MATERIAL AND METHODS

Based on the data obtained by [a](#) pilot survey of the units offering drones on a rental basis to the farmers for spraying chemicals to the crops in all the districts of Tamil Nadu, four districts that are having [the](#) highest number of drone users for agriculture viz., Dindigul, Tiruppur, Namakkal and Erode were selected as the study area. Respondents for the study was selected by following the method of Simple Random Sampling Technique wherein from each district, 25.00 [per-centpercent](#) of respondents comprising from all the blocks of a particular district was selected randomly owing to the minimal population of [drone usingdrone-using](#) farmers.

Table 1. Number of respondents chosen for the study from the selected districts

S.No.	District	Total number of farmers using drones	Selected-A selected number of respondents
1.	Dindigul	298	75
2.	Tiruppur	227	57
3.	Erode	228	57
4.	Namakkal	171	43

A [pre—testedpre-tested](#) and [well-structure-well-structured](#) interview [scheduled schedule](#) was used for the study and the factors were divided into three categories namely social, economic and personal factors. The response was recorded on a three – point continuum of greater extent, somewhat extent and not an [influence-influencing](#) factor assigning scores of 3, 2, and 1 respectively and the responses were obtained. The responses were subjected to percentage analysis and the results were tabulated and explained.

3. RESULTS AND DISCUSSION

3.1. Economic Factors

Any new agricultural technology comes into adoption mainly [due-to](#) because the farmers think that it may have economic [benefit-benefits](#) when compared with that of the presently undergoing technology. Economic benefits increase the adoption of a particular technology and create more diffusion [amongst-among the](#) other farmers. Hence the factors that were perceived to be the influential economic factors for adopting drones in agriculture and their results are presented below.

Table 2. Economic factors influencing the adoption of drones in agriculture (n=235)

S.No	Factors	Extent of Influence					
		Great extent		Somewhat extent		Not an influence factor	
		f	%	f	%	f	%
1.	To obtain more profit	209	88.94	26	11.06	-	-
2.	To increase savings	204	86.81	31	13.19	-	-
3.	High wages of labour	227	96.60	8	3.40	-	-
4.	Large scaled farm	195	82.98	39	16.60	01	04.26
5.	To get subsidy	149	63.40	86	36.60	-	-
6.	Demand driven	96	40.85	139	59.15	-	-
7.	Marketing	87	37.02	148	62.98	-	-
8.	Involvement in other economic activity	160	68.09	75	31.91	-	-

From Table 2, it can be seen that the top most prioritized factor which was responsible to take up drones in agriculture economically was due to high wages of labour that was felt to a great extent by nearly 97.00 per cent of the respondents and the rest felt that it was extent-extended upto a level. This may be due to the reason that the labour force in agriculture is in much grave situation that the availability of labours for performing various agricultural tasks is challenging amidst the growing scenario of the technology sector. The other factors which made up the farmers to adopt drones in their fields owing to economic reasons were for obtaining more profit was given by about 89.00 per cent as to a great extent and to increase savings as a factor to a greater extent to use drones in agriculture by nearly 87.00 per cent of the respondents. This shows that the farmers may be more oriented towards economic benefits and to cater to this need, drones are used as a helping hand.

The economic factors that were given the least importance were demand driving and marketing aspects that were influential only to some extent by 40.85 and 37.02 per cent respectively. This would have arrived due to the reason that farmers may have felt that demand and marketing area continuous activity in agricultural scenario and the involvement of drones in such activity might not show any major difference between conventional farming and precision farming.

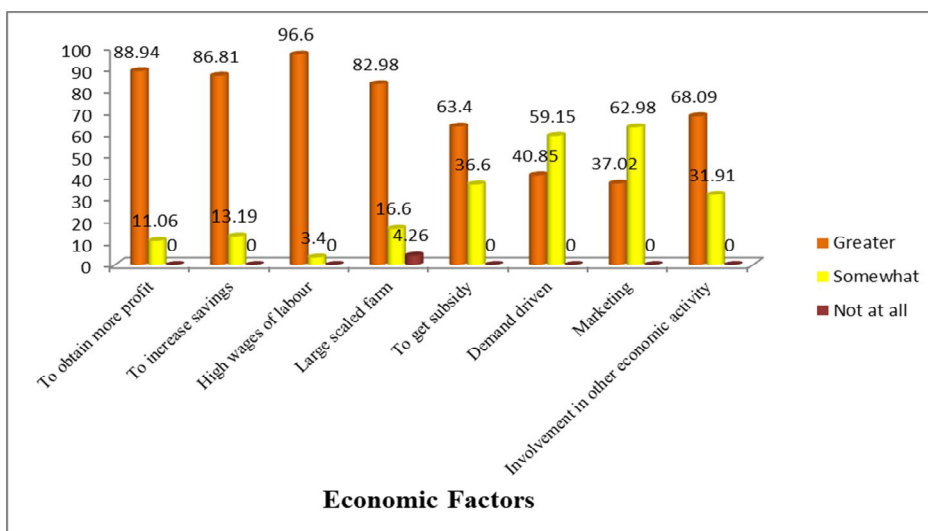


Figure 1. Economic factors influencing adoption of drones in agriculture

3.2. Social Factors

Social factors are the factors that have a direct influence on the society and its culture. India being a diverse country is fond of various societal backgrounds and hence it has a lot of dimensions to be taken into consideration while developing any new technology. It was therefore out of many factors, the most important shortlisted social factors were perceived and after conducting the survey, the below results were obtained.

Table 3. Social factors influencing adoption of drone applications in agriculture

(n=235)

S.No	Factors	Extent of Influence					
		Great extent		Somewhat extent		Not an influence factor	
		f	%	f	%	f	%
1.	Family background	148	62.98	87	37.02	-	-
2.	Compulsion from family members	163	69.36	72	30.64	-	-
3.	Encouragement from friends	178	75.74	57	24.26	-	-
4.	After looking at the peers	197	83.83	38	16.17	-	-
5.	Influence from the society	193	82.13	42	17.87	-	-
6.	Labour scarcity	198	84.26	37	15.74	-	-

From the above table 3, it can be observed that the most influential social factor influencing farmers to adopt drones in agriculture was labour scarcity that which was a greater extent for nearly 84.00 per cent and to some extent were the rest 16.00 per cent of respondents. This would have been because the farmers may still face the problem of labour-labor shortage in the agriculture sector due to the still prevailing societal differences among the people and which would have affected the normal productivity of crops in the field. The introduction of drones wherein the efficiency when compared with that

of humans is more might have combated this problem and so the first priority was given to this factor. The other two top factors contributing to the adoption of drones include ~~after~~ looking at peers and influence from ~~the~~ society by 83.83 ~~per cent~~percent and 82.13 ~~per cent~~percent of respondents respectively up to a great extent for which the reason may be as determined by Rogers and Shoemaker (1971) the different categories of adopters in a society. The farmer who is more innovative and always ~~have~~~~has~~ a search ~~in~~~~for~~ new technology might have first used the technology and this might have influenced others also to do the same in their fields.

The least prioritized social factors include family background (62.98%) and compulsion from family members (69.36%) since ~~the~~ adoption of ~~a~~ new technology involves a major contribution of taking the decision to whether to do or not by an individual at the final and hence these factors may have a less effect on the decision to adopt drones in the field.

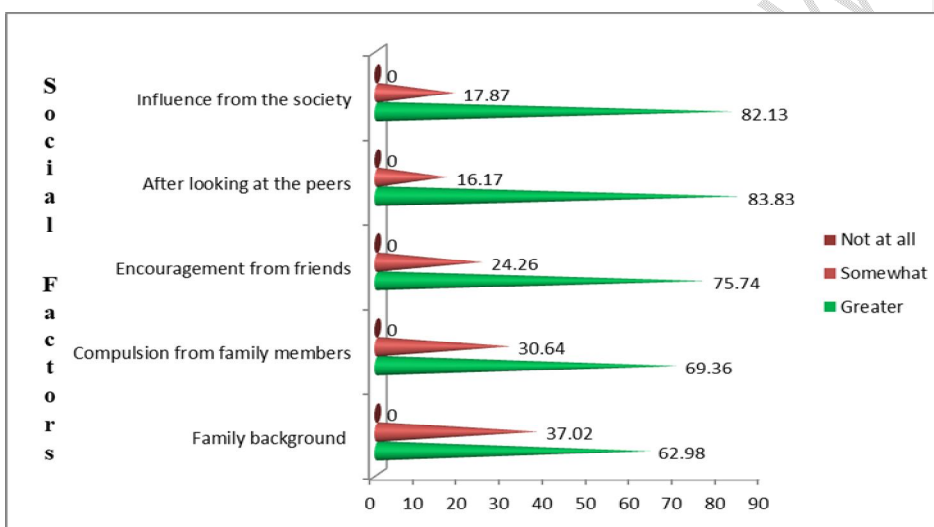


Figure 2. Social factors influencing adoption of drone applications in agriculture

3.3. Personal factors

Factors that are dependent on the attempt of an individual to adopt a particular technology in his / her own field are considered in the personal factors. In this context, the various personal factors that would influence an individual to take up drone technology in the field was perceived after a knowledge gained from the initial pilot survey of the farmers using drones and the results obtained after the original survey is tabulated below.

Table 4. Personal factors influencing the adoption of drones in agriculture (n=235)

S.No	Factors	Extent of Influence				Not an influence factor	
		Great extent		Somewhat extent		f	%
		f	%	f	%		
1.	Self –reliance or independence	84	35.74	151	64.26	-	-
2.	To avoid migration	96	40.85	138	58.72	1	04.26
3.	Saves energy	181	77.02	54	22.98	-	-

4.	Educational status	123	52.34	111	47.23	1	04.26
5.	Scientific orientation	217	92.34	18	7.66	-	-
6.	Risk orientation	201	85.53	33	14.04	1	04.26
7.	Reduces time consumption	225	95.74	10	4.26	-	-

Table 4 shows that more than 95.00 per cent of the respondents expressed the amount of time consumed for agricultural activities was reduced to a greater extent when drones were applied in the field. Conventional farming used to have time constraints for conducting agricultural activities in the field owing to the dependency on various aspects such as ~~labour-labor~~ availability, implement availability, pesticide availability, climate ~~dependency, etc.dependency, etc.~~ which ultimately results in loss of time concentrated on agriculture. But when drones are employed for ~~activitiesactivities~~, such as spraying and their efficiency is high, it definitely saves time for the farmers to focus on other farm activities which may be the reason for such a result. The other two personal factors that contribute to ~~the~~ adoption of drones include scientific orientation by more than 92.00 ~~per-centpercent of~~ farmers and risk orientation by 85.53 ~~per-centpercent of~~ farmers to a greater extent because the farmers who were under the study area may be innovative in their ideas and hence their personal interest in utilizing the drone facilities in their fields may have influenced the farmers to adopt drones.

The least influential factors to adopt drones by personal factors include self – reliance and ~~to-avoidavoiding~~ migration which ~~is-are~~ 64.26 and 58.72 ~~per-centpercent~~ respectively to some extent since the farmers are mostly ~~self-reliantself-reliant~~ even when they use conventional farming and the migration aspect nowadays is not influential among farmers because the government is ~~foecussingfocusing~~ equally on all the villages by allocating different schemes and concentrating more on agriculture which might have caused such a result to occur.

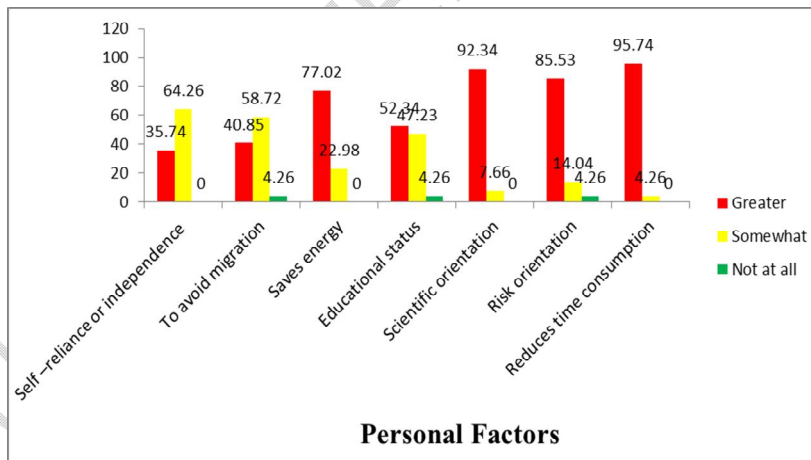


Figure 3. Personal factors influencing the adoption of drones in agriculture

3.4. Association of different factors responsible for using drone applications in agriculture

To find out the association of the factors such as social, economic and personal factors with that of the utilization of the drones in agriculture, chi – square was used.

$$\chi^2_c = \frac{\sum(O_i - E_i)^2}{E_i}$$

where,

- c - Degrees of freedom
- O - Observed value
- E - Expected value

Table 5. Association of different factors responsible for using drone applications in agriculture

S.No.	Factors	χ^2 value
1.	Economic factors	34.55**
2.	Social factors	30.74**
3.	Personal factors	29.24**

Data presented in Table 5 point out that there was a highly significant association between all the factors such as economic, social, and personal with ~~that-the~~ utilization of drones in agriculture since the calculated ~~chi-square~~ ~~chi-square~~ values are more than the table values. This indicates that the usage of drones is dependent on all the ~~above mentioned~~ ~~above-mentioned~~ factors and hence these factors play a significant role in determining the adoption of drones in agriculture.

The candidate manuscript does not have a robust scientific discussion, I suggest the authors incorporate the suggested paragraphs, in this way it would improve the scientific quality of the manuscript:

The findings highlight the urgent need to address the social, economic, and personal factors influencing the adoption of drones in tropical rural agricultural territories. Policymakers, agricultural extension services, and technology providers should collaborate to overcome the challenges identified, by offering financial incentives, tailored training programs, and simplified regulatory frameworks. Moreover, the preservation and integration of traditional farming practices within the context of drone technology should be emphasized to ensure the cultural sustainability of these territories.

Economic Factors:

a. Cost-effectiveness: Economic considerations play a crucial role in the adoption of drones in agriculture. Farmers in tropical rural and indigenous agricultural territories of Latin America assess the cost-effectiveness of drone technologies compared to traditional farming practices (López-Beltrán et al. 2019; López and Olivares, 2019). Factors such as the initial investment cost, operational expenses, and potential return on investment influence their decision-making process.

b. Farm size and productivity: The size of agricultural landholdings and the productivity levels of farms impact the adoption of drone technologies. Large-scale farms in these territories may find drones more economically viable due to the potential for increased efficiency and productivity gains (Zingaretti et al. 2016; Montenegro et al. 2021a; 2021b). Conversely, smaller farms may face financial constraints that hinder their ability to invest in drone technology.

c. Access to capital and financial resources: Limited access to capital and financial resources can be a significant barrier to the adoption of drones in agriculture. In rural and indigenous agricultural territories, where traditional banking services may be limited, alternative financing mechanisms, such as microcredit and cooperative schemes, can facilitate the acquisition of drones and enabling technologies (Olivares, 2022; Pitti et al. 2021).

Cultural Factors:

a. Traditional agricultural practices: In many tropical rural and indigenous agricultural territories, traditional farming practices are deeply ingrained in local culture and heritage (Olivares, 2014b; Rodriguez et al. 2015). The adoption of drones may be met with resistance due to concerns about disrupting long-standing practices, cultural values, and a preference for manual labor. Cultural sensitivity and education programs can help bridge the gap between traditional knowledge and the benefits of drone technology (Olivares, 2016; Camacho et al. 2018).

b. Knowledge and skills transfer: Successful adoption of drones in agriculture requires a certain level of technical knowledge and skills. In rural and indigenous communities, the availability of training programs and capacity-building initiatives becomes crucial (Olivares, 2014a). Empowering local farmers with the necessary skills and knowledge to operate and maintain drone technologies fosters a sense of ownership and encourages adoption.

c. Perception of technology: Attitudes and perceptions towards technology vary across cultures. Some communities may embrace technological advancements, while others may exhibit skepticism or fear. Overcoming cultural barriers involves engaging local communities, addressing misconceptions, and highlighting the potential benefits of drones in agriculture, such as increased efficiency, reduced labor, and improved crop yields (Hernandez et al. 2018; 2020).

Social Factors:

a. Farmer networks and knowledge sharing: Social networks and community structures play a vital role in the adoption of new agricultural practices. In tropical rural and indigenous agricultural territories, close-knit communities and farmer networks can influence the spread of information and knowledge regarding drone technology (Hernandez and Olivares, 2020; Cortez et al. 2016a). Establishing platforms for knowledge sharing, demonstrations, and peer-to-peer learning can accelerate adoption rates.

b. Institutional support and policy framework: Strong institutional support and a favorable policy framework are essential for the widespread adoption of drones in agriculture. Governments and relevant organizations should develop policies that promote the use of drone technology while considering the specific needs and circumstances of tropical rural and indigenous agricultural territories (Olivares et al. 2017a; 2017b). This includes addressing regulatory barriers, ensuring privacy and data protection, and fostering collaborations between research institutions, industry stakeholders, and local communities.

c. Environmental and social impact considerations: Tropical rural and indigenous agricultural territories are often characterized by fragile ecosystems and cultural landscapes

[\(Cortez et al. 2016b; Orlando et al. 2018\)](#). The adoption of drones should be accompanied by careful consideration of their potential environmental and social impacts [\(Guevara et al. 2012a; Orlando and Franco, 2015\)](#).- Integrating sustainable agricultural practices, respecting land rights, and involving local communities in decision-making processes can ensure responsible and inclusive adoption [\(Guevara et al. 2012b; Olivares and Hernandez, 2019\)](#).

Conclusion:

The adoption of drones in agriculture and enabling technologies in tropical rural and indigenous agricultural territories of Latin America and India is influenced by a complex interplay of economic, cultural, and social factors. Understanding and addressing these factors are critical for successful integration and maximizing the benefits of drone technology. A comprehensive approach that combines economic incentives, cultural sensitivity, community engagement, and supportive policies can pave the way for sustainable and inclusive agricultural practices in these regions.

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4. CONCLUSION

Drone technology is definitely a game changer in the field of agriculture. Many Indian start-ups are investing more in ~~low-cost~~ low-cost drones that can help farmers and create simultaneously employment opportunities for the rural youth and enhance the knowledge of farmers too. However, the drone industry needs more ~~path-breaking~~ path-breaking reforms by taking into account the rapid increase in population, dire needs of the farmers, operational policies, and shrinking farm fields which is a matter to be worried.

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