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Role of AI and DT in Agriculture Intelligence in Karnataka State India

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Abstract

Agriculture is the biggest sector in the world. This was a naturally available resource to the human being, beyond any doubt; it is India's main source of income and livelihood, and most of the rural population depends on agriculture for their better survival. Globally and in India, agricultural land acreage is limited, and agricultural land fragmentation is rising while demand for food is growing due to population expansion. It is a critical mission to boost productivity on limited land to fulfill the increased demand caused by population expansion and higher wealth. To overcome these barriers digital technology has the potential to alter rural India's agricultural operations by updating and coordinating them. Artificial Intelligence (AI), Drone Technology (DT), the Internet, Big Data Analytics, and Block Chain Technologies are examples of such technologies**.** The main purpose of this paper, first is to reveal the advantages of AI and DT to farmers to enrich their Agriculture Intelligence, and the second is to know the awareness and usage of AI and DT among small and marginal farmers in north Karnataka, particularly where the survey was conducted, and finally to find out the most significant factor of the problem which influencing the farmers while adopting the AI and DT in Agriculture using Henry Garrett's Ranking model.

Keywords

Artificial Intelligence (AI), Drone Technology (DT), Agriculture Intelligence (AI), Rural Agriculture, Agribusiness, Henry Garrett's Ranking model

1. Introduction

On the map of the world, India has the second highest land source. India has all of the world's 15 major climates, with 20 agri-climatic areas. The country has 46 types of soils out of 60 types of soils which are existed in the world. India is the world's leading producer of spices, pulses, milk, tea, cashews, and jute, as well as wheat, rice, fruits and vegetables, sugarcane, cotton, and oil seeds. India is also the world's second-biggest supplier of fruits and vegetables, and the world's largest grower of mango and banana. Food grain output hit a new high of 296.65 million tons in the 2019-20 crop years (IBEF, 2022). An increase in the population, as well as the high-income level of the households which leads to high demand for food articles and other agricultural products sometimes, creates a vulnerable situation in the country.

Then the problem of inflation, non-availability of commodities, competition at the market level, variation in supply, price increase, etc. system has to face all these. On the other hand, the productivity and quality of agricultural produce are decreasing due to many reasons. Land pollution, increased reliance on artificial fertilizers, decreased soil fertility, decreased ground water table, and insect resistance, among other issues, are strong indicators of India's unsustainable agricultural methods. Dependence on unsustainable agricultural techniques will only heighten the possibility of food scarcity as climate change becomes more evident and unpredictable. Similarly, water use in agriculture is excessive and inefficient **(Abdullah. et al., 2015)**. Hence the developments in the field of information and technology are not only restricted to the service and knowledge industry as a part of the solution and for smart work. These innovations are also possible to use in the field of agriculture as remedies for many problems and to develop the smart agriculture scenario in the country and as well as in the world. The emerging models of the digital era are in debate namely Artificial Intelligence (AI) and Drone Technology (DT). AI and DT are assisting several agricultural sectors in increasing output and sustainability. In every industry, AI and DT technologies are aiding in overcoming conventional problems. AI intervention in agriculture is assisting peasants in increasing their agricultural efficiency while reducing harmful ecological consequences. Agribusiness has embraced AI with open arms to improve overall results **(Kumar and Pillai, 2021).**

2. Importance of Artificial Intelligence (AI) and Drone Technology in Agriculture

Artificial intelligence (AI) is an area of computer science that is frequently referred to as machine intelligence. It is the knowledge expressed by computers as opposed to genuine intellectual ability exhibited by people and animals. It is focused on the development of intelligent machines competent in doing activities that would normally need cognitive abilities. John McCarthy, an American computer scientist, coined the phrase "Artificial Intelligence" in 1956 at The Dartmouth Conference. Drone technology is also a part of AI. Any unpiloted aircraft is commonly referred to as a "drone." These devices, sometimes known as "Unmanned Aerial Vehicles" (UAVs), are capable of a wide range of functions, from military activities to product deliveries. Drones may be as big as planes or as little as your palm. Abraham Kareem (born 1937) is an unmanned vehicle designer with fixed and rotating wings. He is considered the inventor of UAV (drone) technology Sectors like transportation, healthcare, finance, manufacturing, advertising, the automobile, and many sectors are applying and using these technologies in their day-to-day business, in recent years the agriculture sector was also influenced by these innovations, the concept of smart agriculture is emerging and debatable one. In every sector AI and DT are used for two purposes, first one is to add additional value to existing infrastructure and for the workstation to improve the working condition. The second one is to solve the problems. In the agriculture sector also it was used to improve the farmer's intelligence to focus on the new innovative ideas for better and quality output which is called "Agriculture Intelligence". On the other hand agriculture, itself is a natural phenomenon for this reason it has to face many natural and climatic problems. Soil erosion, increased reliance on artificial fertilizers, decreased soil richness, decreased groundwater resources, and insect susceptibility, as climate change becomes more foreseeable and sensible, reliance on unsustainable agricultural techniques will only raise the probability of food scarcity and other related issues. To overcome the natural and unnatural coercion problems, AI and DT are solutions. Artificial Intelligence and Drone advancements facilitate in production of healthier crops, providing information on current climate scenarios such as temperature, rain, weed speed, weed path, and solar radiation, controlling pests, monitoring soil and growing conditions, organizing data for farmers, reducing workload, and improving the food supply chain.

Applications of Artificial Intelligence (AI) and Drone Technology in Agriculture

Here's how AI and DT are altering the agricultural sector, from automated insect and plant ailment diagnosis to smart spraying and produce sorting. Crop production, quality, and labor conditions are all unquestionably better because of the application of technologies in agriculture. Observing crops and soil, Detection of insects and plant diseases, Smart Irrigation, Keeping an eye on livestock's health, spraying with intelligence, Aerial photography, and survey, sorting and grading the produces, and Precision farming is the areas of agriculture where AI and DT are applied.

Advantages of AI and DT in the Agriculture sector

In farming, AI and DT aid producers in comprehending data insights such as weather, rainfall, wind path, and sunlight. Data assessment of historical results allows for a more accurate evaluation of planned results. The greatest aspect of deploying AI in agriculture is that it won't take away human farmers' employment; instead, it will help them better their operations.

1. AI allows for more effective production, harvesting, and marketing of major crops.
2. AI approaches can alleviate problems that farmers confront, such as climate change, pest infestations, and weed infestations that diminish yields.
3. Artificial intelligence may help many tech companies engage in algorithms that are emerging and effective in farming by improving crop management practices.
4. Artificial intelligence is being applied in sectors like automatic machine modifications for forecasting the weather and infection or pest diagnosis.
5. The advancement of Artificial Intelligence technologies has helped agricultural firms function more effectively.
6. The goal of AI deployment is to detect damaged crops and increase the potential for healthy agricultural output.

3. Objectives of the Study

The main objective of this paper is to study how Artificial Intelligence (AI) and Drone Technology (DT) enhanced intelligence in the Agriculture industry. The main objective is fulfilled by the following three objectives those are as follows.

1. To know the advantages of AI and DT to farmers to enrich their Agriculture Intelligence.
2. To examine the awareness, usage, and adoption level of AI and DT among small and marginal farmers in north Karnataka.
3. To find out the most significant factor of the problem which is influencing the farmers while adopting the AI and DT in Agriculture using Henry Garrett’s ranking model.

4. Research Design

The study is empirical research based on the survey method. The study was confined to the farmers in north Karnataka and the usage of AI and DT in their profession. To know the awareness and usage of AI and DT from small and marginal farmers in the rural agriculture region, North Karnataka was intensively chosen. This includes 13 districts namely, Bagalkot, Ballary, Belagavi, Bidar, Dharawad, Gadag, Haveri, Kalaburgi, Koppal, Raichur, Vijayanagara, Vijaypura, and Yadagiri. This area naturally had great fertile agricultural land and the main occupation of this region was agriculture it is a suitable area of study to achieve the pre-determined objective of this study. To extract the information from small and marginal farmers has been collected through personal interviews of farmers with a set of structured questionnaires. In North Karnataka, there are more than 27 lakh farmers (Census of India, 2011) involved in farming

activity. Due to the non-availability 2021 census report, there is no exact population of the farmers. As per the projected population, the farmer's population will also increase with the increase in population. Assume that there are 30 lakh farmers. And to derive the sample size from this huge population, the sample size formula of "Solvin's formula" was employed." The nominal sample size for gathering data, according to Solvin's algorithm, is 400 respondents. The calculation is as follows.

$$\textbf{Sample size (n) } = N \div (1+Ne^2)$$

$$\textbf{Sample size (n) } = 30,00,000 \div (1+30,00,000 \times 0.5^2) = 399.99 \text{ or } 400.$$

n= Sample size, N= Population, e= Error of Significance

To select the respondents the probability sampling method was introduced. In the probability sampling method, the multi-cluster sampling method was used. Among 13 districts, 110 taluks are there and 309 hobbies are included in 110 taluks. Per estimated population of farmers is 30 lakh, which includes all the segments of farmers. From each mobile two respondents are selected based on the two-parameter first one is Famers who are cultivating a minimum of 2.5 acres to a maximum of 5 acres of land and the second one is Farmers who are growing/cultivating commercial crops. The total sample size is 618. And to perform the final objective of the paper i.e. to find out the most significant factor of the problem which is influencing the farmers while adopting AI and DT in Agriculture. The same questionnaire asked to rank the problems faced by the farmers on their experiences. To analyze the ranking and to find out the most significant factor of the problem Garrett's ranking technique was applied.

Table 1: Profile of the Small and Marginal Farmers

Age of Respondent (in Years)	Frequency	Percentage
Up to 25	96	15.5
26-30	159	25.7
31-40	342	55.3
41-50	21	3.4
51-60	0	0.0
60 Above	0	0.0
Total	**618**	**100.0**
Gender		
Male	599	96.9
Female	19	3.1
Third gender	0	0.0
Total	**618**	**100.0**
Educational qualification.		
Below SSLC	439	71.0
SSLC	143	23.1
PUC / Equivalent	33	5.3
under Graduation	3	0.5
Graduation	0	0.0
Professional Degree	0	0.0
Total	**618**	**100.0**
Type of Agriculture Land		
Irrigated	177	28.6
Non-Irrigated	441	71.4

Total	**618**	**100.0**

Source: Primary Data

Table 1 presents the profile of the respondents particularly age, gender, education, and type of land owned by the farmers. More than 80 percent of the respondents have an age gap of 25 to 40 years. More than 95 percent are male respondents. More than 70 percent of them are studied up to high school education and the same percentage of the farmers are possessed non-irrigated land. Inference from table 1 is the positive sign as per age, education level of the farmers and negative side as per land and female respondents.

5. Results and Discussion

Awareness and Usage of AI and DT among the Respondents

Agriculturally very sound sector in India as stated in the introduction. Karnataka state is also prominent in agriculture because of the vast cultivation of land. The question is though having all-natural resources is not able to reach the targeted outcome and not able to compete with agriculturally advanced countries with having minimum land source in terms of production, quality, and other aspects. The major reason is not aware of innovations related to agriculture and the usage of such innovations. The present study was carried out to know how the farmers are very aware and using the AI and DT innovations in their Agri practices the following information will reveal the results.

Table 2: Method of agriculture

Method of agriculture	Traditional method	In percent	Modern method	percentage	**Total**
No of Respondents	558	90.29	60	9.70	**618**

Source: Primary Data

In table 2, we come to that the farmers in rural areas still follow the old practice of farming. In this survey out of 618 farmers, 558 farmers are involved in agriculture with the conventional method. It implies that 90 percent of the North Karnataka farmers are in old-age methods of farming. The remaining 9.7 percent of farmers adopt modern agricultural technologies in cultivation.

Table 3: Farmer's Awareness, usage, and adoption level of AI and DT in agriculture activities

Levels	**No of farmers**	**Percentage of farmers**
Fully aware	20	3.2
Partially aware	40	6.4
Interested	50	8.09
Evaluating the concepts	5	0.8
In trial stage	10	1.6
Adoption	30	4.8
Discontinued	20	3.2
Not aware	300	48.5
Not interested	143	23.13
Total	**618**	**100**

Source: Primary Data

The above table 3 was framed to determine the level of awareness, usage, and adoption of AI and DT in the agriculture system. Nine main points are used, and full awareness is that the farmers are very knowledgeable and ready to use the concepts. Partially aware of is dilemma in understanding the innovation. When a person wants to learn more about a new technology to see if it may benefit him, which is considered interest. The assessment step entails the individual's mental review of the information obtained to evaluate if it will have a significant influence on his job that is evaluation. The individual tries the invention at the trial stage to determine if it meets his expectations. When a person reaches the adoption stage, he has decided that he loves innovation and wants to adopt and apply it in his job. Some of them failed to manage and maintain the technology then they discontinued its usage. Not aware and not interested are both fully opposite the aware of the innovation where they never come across the existence of such new technology. The majority of the farmers in North Karnataka are not aware of AI and DT about 48.5 percent of farmers and not interested portion also a little bit more about 23.13 percent the reason may be that they are very sticking to the traditional method of farming. Other than these two remaining are not in big numbers, the percentage analysis was shown in table-3.

Application of the Henry Garrett's Ranking Technique

The final objective of this paper is to find out the most significant factor of the problem which is influencing the farmers while adopting AI and DT in Agriculture. The identified problems of the farmers are ranked by using Garrett's ranking technique. The model is used to rank the different factors of problems by the respondents. Through this ranking model the most highly influencing factor of a problem for adopting the AI and DT in agriculture. This model converts the rankings given by the respondents into score value and rank. The following is the formula for converting the rankings into score values.

Percent Position = $\frac{100(Rij-0.5)}{Nj}$

Where,

Rij = Rank given for the i^{th} variable by j^{th} Respondents

Nj = Number of Variables ranked by j^{th} Respondents

The percent position calculated is converted into scores using Garrett's table by referring to the table provided by Garrett and Woodworth (1969). The following is Garrett's ranking conversion table.

Table 4: Garrett's ranking scores

Percent	Score	Percent	Score	Percent	Score
0.09	99	22.32	65	83.31	31
0.20	98	23.88	64	84.56	30
0.32	97	25.48	63	85.75	29
0.45	96	27.15	62	86.89	28
0.61	95	28.86	61	87.96	27
0.78	94	30.61	60	88.97	26
0.97	93	32.42	59	89.94	25
1.18	92	24.25	58	90.83	24
1.42	91	36.15	57	91.67	23
1.68	90	38.06	56	92.45	22
1.96	89	40.01	55	93.19	21
2.28	88	41.97	54	93.86	20
2.69	87	43.97	53	94.49	19

3.01	86	45.97	52	95.08	18
3.43	85	47.98	51	95.62	17
3.89	84	50.00	50	96.11	16
4.38	83	52.02	49	96.57	15
4.92	82	54.03	48	96.99	14
5.51	81	56.03	47	97.37	13
6.14	80	58.03	46	97.72	12
6.81	79	59.99	45	98.04	11
7.55	78	61.94	44	98.32	10
8.33	77	63.85	43	98.58	9
9.17	76	65.75	42	98.82	8
10.06	75	67.48	41	99.03	7
11.03	74	96.39	40	99.22	6
12.04	73	71.14	39	99.39	5
13.11	72	72.85	38	99.55	4
14.25	71	74.52	37	99.68	3
15.44	70	76.12	36	99.80	2
16.69	69	77.68	35	99.91	1
18.01	68	79.17	34	100.00	0
19.39	67	80.61	33		
20.93	66	81.99	32		

Source: Henry Garrett's Ranking Technique

After converting the scores into the Garrett value, the ranking given by the respondents to each variable will multiply with the Garrett value to derive the value of the score and the mean value of the score. The variable having the highest mean value is considered the most influencing factor of the problem. The following table depicts the problems faced by the farmers while adopting AI and DT in Agriculture.

Table 5: Problems faced by the farmers while adopting the AI and DT in Agriculture

Problems Faced by the Farmers	**Ranks are given by the Respondents**				
	1st Rank	**2nd Rank**	**3rd Rank**	**4th Rank**	**5th Rank**
High hardware cost	190	260	98	70	0
Privacy and security issues	20	0	140	170	288
Deficiency of Awareness	260	200	96	42	20
Nonexistence of institutional Training and Support	58	58	190	100	212
Absence of digital Skill	90	100	94	236	98

Source: Primary Data

Table 5 shows the rankings given by the 618 respondents that these farmers faced the problems of Adopting AI and DT in agriculture. Among 618 respondents, the of problem Deficiency of awareness of AI and DT is ranked first by 260 respondents, second-ranked by 200, and 20 respondents ranked fifth. Similarly, all the other remaining variables are ranked.

Percent Position and Garrett Value

The Garrett value is calculated by using the Garrett ranking formula which is stated in the above paragraph. The following table 6 shows the calculation of the value.

Table 6: Percent position and Score

Sl.No	100(Rij-0.5)/Nj	Percent Position	Score Value
01	100(1-0.5)/5	10	75
02	100(2-0.5)/5	30	60
03	100(3-0.5)/5	50	50
04	100(4-0.5)/5	70	40
05	100(5-0.5)/5	90	24

Calculation of Garrett Value and Ranking

The following table 7 shows the results of the Garrett value and ranking of the problems faced by the farmers while adopting AI and DT in Agriculture.

Table 7: Calculation of the Garrett value and Ranking

Problems Faced by the Farmers	Ranks are given by the Respondents after being multiplied with the Garrett score value					Total	Percentage	Rank
	1st Rank	2nd Rank	3rd Rank	4th Rank	5th Rank			
High hardware cost	14250	15600	4900	2800	0	37550	24.40	II
Privacy and security issues	1500	0	7000	6800	6912	22212	14.43	V
Deficiency of Awareness	19500	12000	4800	1680	480	38460	24.99	I
Nonexistence of institutional Training and Support	4350	3480	9500	4000	5088	26418	17.16	IV
Absence of digital Skill	6750	6000	4700	9440	2352	29242	19.00	III

Figure 1: Problems faced by the farmers while adopting the AI and DT in Agriculture using Garrett's ranking technique

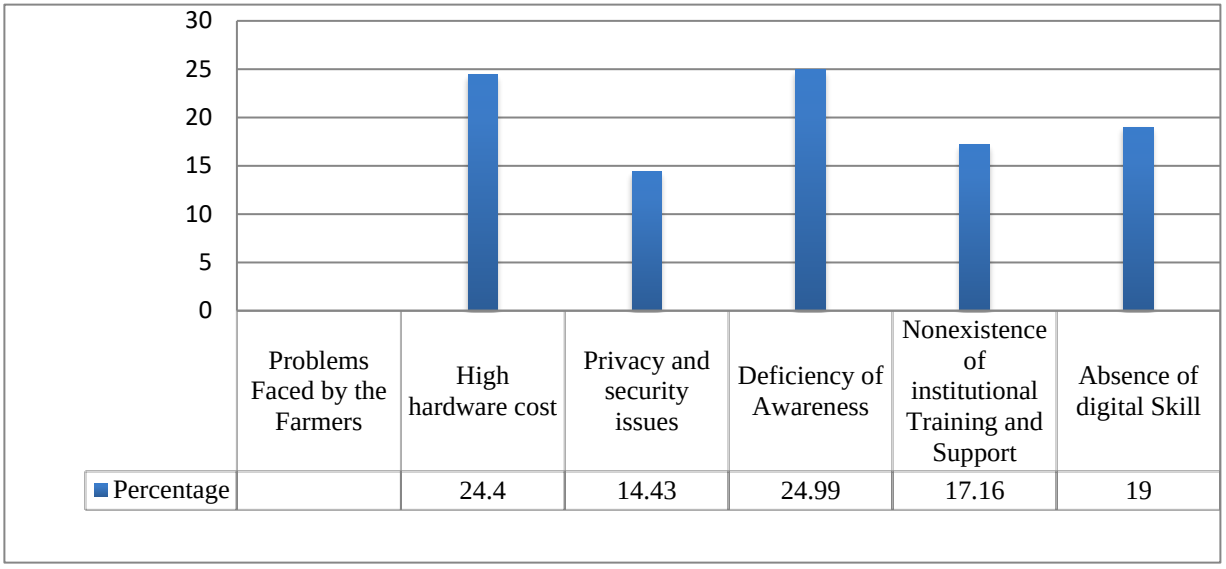

Table 7 and figure 1 show that the ranks given to the farmers for every problem of adopting AI and DT in agriculture are analyzed. According to Garrett's ranking technique, the Deficiency of awareness got the first rank in the analysis. It means no awareness about the use of AI and DT in Agriculture is the main and significant problem for the farmers as per this result. High hardware cost is the second highest factor problem for the farmers. Similarly, the absence of digital skills, the nonexistence of institutional training and support, and privacy and security issues are ranked 3rd, 4th, and 5th respectively.

6. Conclusion

In agriculture, artificial intelligence (AI) and Drone Technology (DT) are assisting farmers in increasing efficiency while minimizing unfavorable climate implications. The agriculture business has enthusiastically adopted AI and DT to improve overall results. Adapting AI and DT technology aid in the control and management of any unwelcome natural occurrence. AI-enabled techniques might identify illnesses or climatic changes faster and respond intelligently. Agriculture firms are using these technologies to process agricultural data to prevent undesirable results. As a result, AI and DT are emerging new technology that has the potential to revolutionize agriculture in India. And the AI and DT should reach the farmers with low-cost technology, easily portable hardware, and policies towards enabling digital agriculture. From these measures, technology in agriculture shall be used by poor, marginal, and small farmers as a result agriculture production increases, and farmers will improve financially and economically empowered.

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