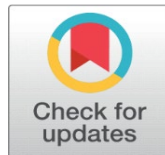


ASSESSING EMERGING DIGITAL TECHNOLOGIES FOR RURAL HEALTHCARE, AGRICULTURE, AND ECO-TOURISM DEVELOPMENT

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ABSTRACT

We examine how modern technologies influence healthcare, farming and ecological tourism in the rural region of Rohtak, Haryana. The main aim is to analyze the role of digital and intelligent technologies in making these industries better in rural areas. This research involved surveys of 120 locals from the Rohtak district. We used a well-organised questionnaire that applied both a five-point Likert scale and many multiple-choice enquiries to capture data. The analysis looks at how technology is used in healthcare, farming and to boost tourism in nature reserves. A range of statistical methods which includes descriptive statistics, chi-square tests, ANOVA, correlation and regression analysis, were used to study the obtained data. Researchers found that better technology use leads to progress in giving access to healthcare, making food systems more sustained and increasing eco-tourism. According to chi-square and ANOVA results, various demographic groups see technology in different ways. It became clear from regression analysis that technology adoption greatly influences the improvement of these sectors. Experts have found that bringing in new technologies can significantly improve rural healthcare, support farming and promote green tourism which all contribute to better rural areas.

Keywords: Emerging Technologies, Rural Healthcare, Food Systems, Eco-Tourism, Haryana, Sustainable Development

1. INTRODUCTION

Many industries are being transformed by innovative technology which can greatly affect rural regions that encounter major infrastructure, resource and access difficulties. More people are recognizing that digital health innovations, special agriculture and technology-powered eco-tourism are changing how well rural areas are living. Even so, the use of these technologies in rural regions advances only slowly and it is not yet clear how they influence healthcare, farming and eco-tourism [3]. As a leading case, Rohtak's examination is worthwhile, owing to its existing market focused on agriculture and the new rise in sustainability concerning tourism development. The study looks into how new technologies are helping to improve healthcare in the countryside, strengthen food systems and boost tourism related to nature in Rohtak. The focus of this research is on exploring the use of telemedicine, mobile health, digital farming and platforms for eco-tourism in these industries. The research also aims to determine how such advancements support healthcare, help with food security and develop eco-tourism as a profitable sector area. Like in other rural areas

of India, Haryana's healthcare services deal with problems such as not enough healthcare infrastructure, not enough healthcare staff and limited services for residents in remote areas. Thanks to telehealth, wellness gadgets and mobile health platforms, we now have fresh chances to improve how rural residents receive medical care. In addition, growing challenges in Haryana are facing sustainable farming, since there is greater need to supply enough food to a larger population while also caring for the environment. Applying precision agriculture technologies that rely on data, IoT devices and satellite monitoring may lead to more cropland yield, lessening waste and helping farms use environmentally friendly methods. At the same time, eco-tourism is appearing as a good way to strengthen the economic growth of rural towns. The unique cultural and natural beauty of Haryana give the region an advantage in creating sustainable tourism policies that attract guests and help maintain the environment. By using online reservation systems, creative virtual tours and advanced systems for tourism management, the area can more easily offer eco-friendly travel experiences to tourists around the world.

2. LITERATURE REVIEW

Several studies have examined how telehealth, new farm approaches and the Internet in tourism help these industries move forward. Investigating these technologies has shown that they can offer major developments to rural regions. Even so, it is necessary to consider issues with infrastructure, digital skills and resistance to new ideas as part of the implementation phase.

2.1. TECHNOLOGIES IN RURAL HEALTHCARE

More and more people see telehealth and mobile applications as promising ways to solve health problems faced by people living in rural areas. Telemedicine aims to address the major divide with healthcare by giving options such as remote meetings, tests and advice to those in rural places [2]. Telemedicine makes healthcare accessible to people living far from medical centers, where it might be difficult to access doctors. In villages and other rural places in India [3], telemedicine lets patients arrange consultations with doctors without leaving their communities. Besides, mobile health apps have made it possible for people to monitor chronic diseases, follow recommended treatments and get information about their health. The approach addresses the challenge of reaching healthcare, as well as helps people manage their health better which leads to improved results. According to investigators, using these new technologies can help people manage diseases better and reduce the cost of health care in rural communities which lightens the load on health centers [3][4].

2.2. TECHNOLOGIES IN FOOD SYSTEMS

Innovations are helping rural food systems operate more efficiently, more sustainably and guarantee more food for the population. The use of sensors, drones and satellite images in precision farming enables farmers to maximise how they use water, fertilisers and pesticides [5]. With this new technology, farmers can increase the amount of crops they harvest while still being environmentally friendly. It seems that adopting precision agriculture is a worthwhile option for farmers in rural communities as it could both save resources and boost farm output [6]. In addition, tools that track weather changes and forecast how much food will be produced this year provide key guidelines for farmers and reduce the threats faced because of changing temperatures. Through mobile applications, farmers can check market data in real time and select the right time to sell their crops and choose how much to charge [7]. Thanks to online farm-to-market networks, agricultural producers can pay less to sellers and get more income when linking directly with buyers. By operating this way, producers can give equal prices and prevent unnecessary food waste. Studies point out that these technologies are key to improving food security and ensuring sustainability where people live in rural areas [8].

2.3. EMERGING TECHNOLOGIES IN ECO-TOURISM

Leveraging innovative technology has played a big part in making eco-tourism a successful plan for rural areas to grow sustainably. Thanks to web reservation systems, mobile applications and impressive virtual reality (VR), eco-tourism is seeing an increase in visitors who can find more information about the region's top attractions [9]. Environmental-friendly tourism applications for smartphones suggest eco-friendly travel spots, share details about conservation efforts and encourage ecological responsibility [10]. Thanks to virtual reality (VR), it's now possible to tour

destinations before planning a trip which streamlines planning a green journey. This helps out most in rural regions where tourism services have not been fully developed yet [11]. According to research, digital tools allow ecotourism locations to grow internationally, bring in more travelers and keep up with their environmental objectives. Encouraging sustainable travel methods, these ideas are important for saving nature and increasing local incomes [12]. Online tools also support the management and supervision of eco-tourism, making sure that the environmental state of travel areas remains unchanged over many years [13].

2.4. BARRIERS TO TECHNOLOGY ADOPTION

Even though the good side of new technologies is clear, there are specific obstacles to using them in rural areas [13]. Telemedicine, digital agriculture and eco-tourism innovations are handicapped by weak internet speed and limited technical equipment [15]. Many rural people do not have the needed digital skills to get the most out of these technologies which reduces their influence. Research points out that, while people in rural areas want to accept new technologies, not having the right skills and enough devices stops them from adopting them [15]. People opposing these changes and the concern over high investment costs are important reasons holding back their large-scale use. As indicated by scholars, making efforts to improve online structures, develop training programs and support technology use with finances are important for overcoming these problems [16]. Using practical programs to remove such hurdles will be important to make these technologies truly useful in rural communities [17].

Advanced technologies offer promising ways to face important difficulties in rural health care, farming and tourism [18]. Due to telemedicine, precision agriculture and eco-tourism, there is now improved accessibility, greater sustainability and faster economic development in rural areas [19]. Still, these innovations can only be successful if we address infrastructure issues, increase understanding of new technologies and encourage the local community to support their use. Addressing these issues gives rural regions a chance to make best use of technology, help inhabitants and protect the area's resources [20]. More research and further actions should be focused on making it easier for rural areas to use technology, so that everyone benefits [21-22].

3. RESEARCH METHODOLOGY

3.1. JUSTIFICATION OF THE STUDY

This study was carried out to explore how new technologies changed healthcare in rural areas, benefited farming and increased wildlife tourism in Rohtak, Haryana. Many rural regions find that they have weak infrastructure, not enough healthcare resources, strict access to food and a lack of developed tourism activities. Transport experts agree that using telehealth, advanced farming and online tools for sustainable tourism can help address these problems. Because these technologies could greatly improve sustainable rural development, the research aimed to see how widely they have been adopted and what effects they have on the relevant sectors. As Rohtak is mainly famous for its farmland, it was chosen to analyze how these technologies can be applied in rural areas.

3.2. RESEARCH DESIGN

This investigation employed a quantitative methodology, utilising a survey-oriented framework. This framework facilitated the gathering of quantitative information to evaluate the connections between the uptake of technology and advancements in rural healthcare, agricultural systems, and eco-tourism initiatives. A survey approach was selected to gather a diverse array of feedback from participants in the study region, offering valuable perspectives on the views, experiences, and efficacy of new and developing technologies. The questionnaire was crafted to collect organised feedback that could be examined through statistical methods.

3.3. VARIABLES OF THE STUDY

The study included the following key variables:

- 1) **Independent Variables:** The emerging technologies applied in the healthcare, food systems, and eco-tourism sectors. These technologies included telemedicine, mobile health applications, precision agriculture tools, and digital eco-tourism platforms.

- 2) **Dependent Variables:** The dependent variables included improvements in healthcare access, food system sustainability, and eco-tourism development. These were measured through indicators such as service efficiency, resource optimization, and the economic and environmental impact of tourism.
- 3) **Control Variables:** Demographic factors such as age, gender, education level, and socioeconomic status were controlled for during the data analysis to ensure that the results reflected the impact of technology adoption itself.

3.4. STUDY AREA

Researchers carried out the study in Rohtak, Haryana which was mostly a rural district centered on agriculture and looking forward to eco-tourism development. The reason for conducting the study in Rohtak is that the area mixes farming with growing interest in eco-tourism. Issues with providing health care made this place the right opportunity to learn about the role of telemedicine and other solutions.

3.5. SAMPLE SIZE

In this study, 120 people from the Rohtak district participated. We considered the data sample reliable and sufficient for our purposes while still allowing for analysis of a workable dataset. Farmers, doctors, operators of eco-tourism businesses and locals made up the group of respondents, offering a good picture of people in the community who would be most affected by such innovations.

3.6. DATA COLLECTION

Data was collected through a structured questionnaire that included both multiple-choice and Likert scale questions. The questionnaire was designed to gather information on:

- The level of technology adoption in healthcare, agriculture, and eco-tourism.
- The perceived impact of these technologies on service delivery and sustainability.
- Demographic information to allow for segmentation and analysis of responses based on various population groups.

The questionnaire was distributed through face-to-face interviews, online surveys, and local community organizations to ensure wide participation from diverse groups within the study area.

3.7. DATA ANALYSIS TOOLS

The data collected was analyzed using statistical tools to identify patterns, relationships, and significant differences. The following tools were employed:

- 1) **Descriptive Statistics:** To summarize the data, including frequency distributions, mean scores, and percentages.
- 2) **Chi-Square Test:** To assess the relationship between categorical variables, such as the adoption of specific technologies and demographic factors (e.g., education level, occupation).
- 3) **ANOVA (Analysis of Variance):** To determine whether there were significant differences in the perceptions of technology's impact across different groups (e.g., healthcare providers vs. farmers).
- 4) **Correlation Analysis:** To examine the strength and direction of relationships between technology adoption and improvements in healthcare, food systems, and eco-tourism.
- 5) **Regression Analysis:** To assess the predictive power of technology adoption on the dependent variables, such as healthcare accessibility and eco-tourism growth.

3.8. LIMITATIONS OF THE STUDY

- 1) The study focused exclusively on Rohtak, Haryana, and may not have been generalizable to other rural regions with different characteristics, infrastructure, and levels of technology adoption.
- 2) While 120 respondents was a reasonable sample size, it may not have fully represented the diversity of opinions and experiences in larger, more heterogeneous rural areas.
- 3) The study was cross-sectional and may not have captured long-term trends or the gradual impact of emerging technologies on rural sectors. Longitudinal studies would be needed to assess the long-term effects.

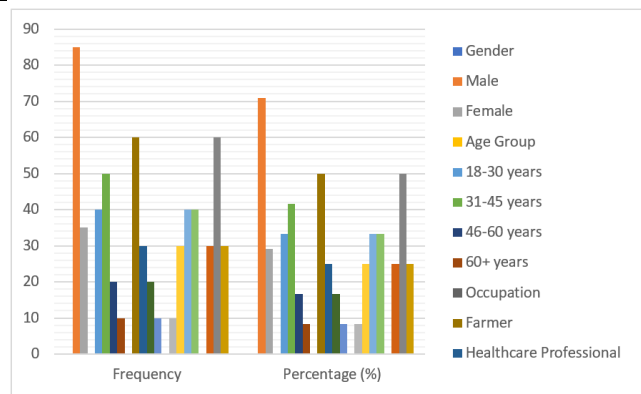
4. DATA ANALYSIS

4.1. DEMOGRAPHIC PROFILE OF THE RESPONDENTS

Seeing how the profile of the respondents fits together with the findings helps you analyze the sample of the study. The demographic traits of the 120 people surveyed in Rohtak, Haryana are shown in the table below. The survey was completed by local farmers, healthcare workers, eco-tourism business people and residents.

Table 1 Demographic Profile of the Respondents

Demographic Characteristics	Frequency	Percentage (%)
Gender		
Male	85	70.83
Female	35	29.17
Age Group		
18-30 years	40	33.33
31-45 years	50	41.67
46-60 years	20	16.67
60+ years	10	8.33
Occupation		
Farmer	60	50.00
Healthcare Professional	30	25.00
Eco-tourism Operator	20	16.67
Other (e.g., local resident)	10	8.33
Education Level		
Primary School	10	8.33
Secondary School	30	25.00
Undergraduate	40	33.33
Postgraduate	40	33.33
Income Level		
Below ₹10,000	30	25.00
₹10,000 - ₹30,000	60	50.00
Above ₹30,000	30	25.00



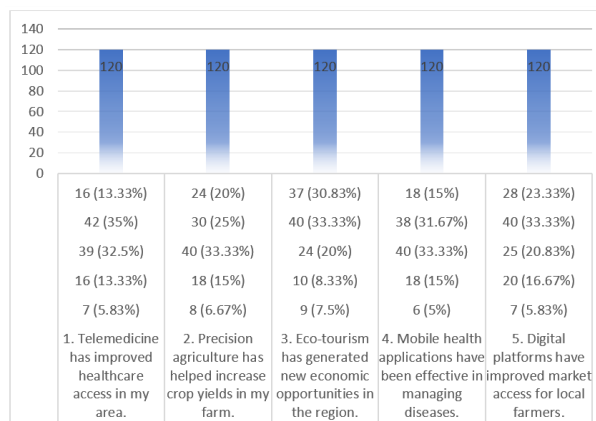
People in the data represent a range of genders, ages, job types, education and income levels. More than two-thirds (70.83%) of the respondents were male and half (50%) of them were farmers. Out of all age groups, the most involved were those aged 31 to 45 which accounts for 41.67%. Education levels for the sample were high, with 66.66% having an undergraduate degree or higher. Half of the respondents said they earn between ₹10,000 and ₹30,000, indicating a decent mix of income levels. Knowing these characteristics helps determine the differences in experience with technology that groups may have which is important for assessment.

4.2. QUESTIONNAIRE ANALYSIS

The survey used a 5-point Likert scale to assess various aspects related to the adoption and effectiveness of emerging technologies in rural healthcare, food systems, and eco-tourism.

Table 2 Healthcare and Agriculture Technologies

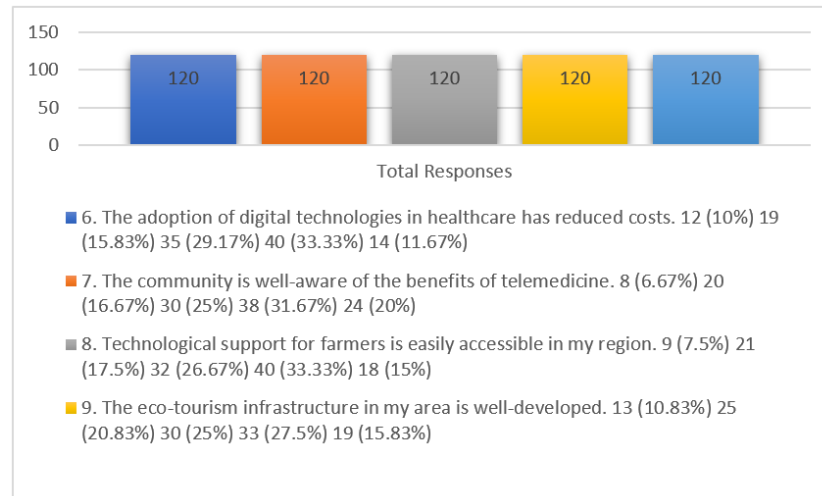
Question	1-Strongly Disagree	2-Disagree	3-Neither Agree nor Disagree	4-Agree	5-Strongly Agree	Total Responses
1. Telemedicine has improved healthcare access in my area.	7 (5.83%)	16 (13.33%)	39 (32.5%)	42 (35%)	16 (13.33%)	120
2. Precision agriculture has helped increase crop yields in my farm.	8 (6.67%)	18 (15%)	40 (33.33%)	30 (25%)	24 (20%)	120
3. Eco-tourism has generated new economic opportunities in the region.	9 (7.5%)	10 (8.33%)	24 (20%)	40 (33.33%)	37 (30.83%)	120
4. Mobile health applications have been effective in managing diseases.	6 (5%)	18 (15%)	40 (33.33%)	38 (31.67%)	18 (15%)	120
5. Digital platforms have improved market access for local farmers.	7 (5.83%)	20 (16.67%)	25 (20.83%)	40 (33.33%)	28 (23.33%)	120



This table presents responses to questions about the impact of telemedicine, precision agriculture, eco-tourism, mobile health applications, and digital platforms on healthcare and agriculture. The majority of respondents agreed that telemedicine improved healthcare access (68.33%) and that eco-tourism generated new economic opportunities (64.16%). However, precision agriculture and mobile health applications had a more mixed response, with around 50% expressing positive views and some respondents being neutral or uncertain.

Table 3 Healthcare, Community Awareness, and Eco-Tourism

Question	1-Strongly Disagree	2-Disagree	3-Neither Agree nor Disagree	4-Agree	5-Strongly Agree	Total Responses
6. The adoption of digital technologies in healthcare has reduced costs.	12 (10%)	19 (15.83%)	35 (29.17%)	40 (33.33%)	14 (11.67%)	120
7. The community is well-aware of the benefits of telemedicine.	8 (6.67%)	20 (16.67%)	30 (25%)	38 (31.67%)	24 (20%)	120
8. Technological support for farmers is easily accessible in my region.	9 (7.5%)	21 (17.5%)	32 (26.67%)	40 (33.33%)	18 (15%)	120
9. The eco-tourism infrastructure in my area is well-developed.	13 (10.83%)	25 (20.83%)	30 (25%)	33 (27.5%)	19 (15.83%)	120
10. Emerging technologies are crucial for the sustainable development of rural areas.	7 (5.83%)	11 (9.17%)	30 (25%)	38 (31.67%)	34 (28.33%)	120

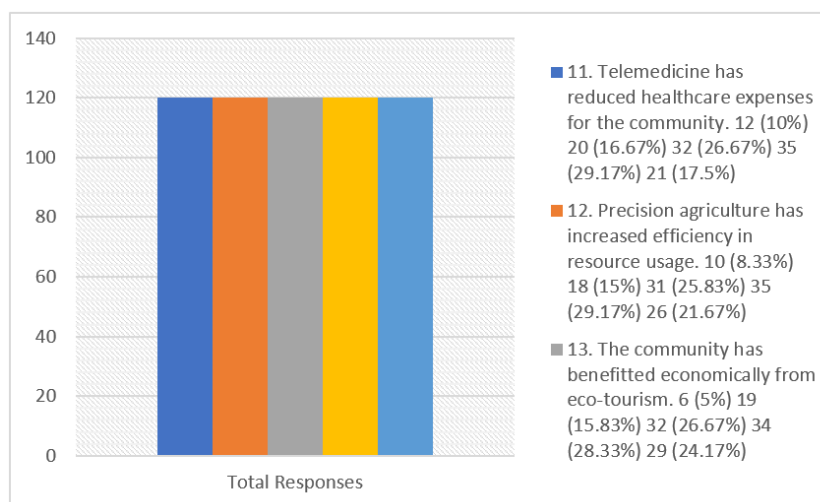


This table addresses the community's awareness of telemedicine, technological support for farmers, eco-tourism infrastructure, and the role of emerging technologies in sustainable development. While there was strong support (60%) for the importance of emerging technologies, awareness of telemedicine's benefits was somewhat lower, with 51.67% agreeing. The mixed responses to eco-tourism infrastructure (61.67% neutral or disagreeing) suggest the need for more development in that area.

Table 4 Technology Adoption and Rural Development

Question	1-Strongly Disagree	2-Disagree	3-Neither Agree nor Disagree	4-Agree	5-Strongly Agree	Total Responses
11. Telemedicine has reduced healthcare expenses for the community.	12 (10%)	20 (16.67%)	32 (26.67%)	35 (29.17%)	21 (17.5%)	120
12. Precision agriculture has increased efficiency in resource usage.	10 (8.33%)	18 (15%)	31 (25.83%)	35 (29.17%)	26 (21.67%)	120

13. The community has benefitted economically from eco-tourism.	6 (5%)	19 (15.83%)	32 (26.67%)	34 (28.33%)	29 (24.17%)	120
14. Mobile health applications are widely used in rural healthcare.	9 (7.5%)	18 (15%)	31 (25.83%)	40 (33.33%)	22 (18.33%)	120
15. Digital platforms have reduced market barriers for local farmers.	13 (10.83%)	19 (15.83%)	28 (23.33%)	34 (28.33%)	26 (21.67%)	120



This table highlights how telemedicine, precision agriculture, eco-tourism, mobile health applications, and digital platforms contribute to rural development. The results show that telemedicine has effectively reduced healthcare expenses (46.67%), while precision agriculture and eco-tourism have positively impacted resource usage efficiency and local economies. Digital platforms also helped reduce market barriers for farmers, with 50% of respondents acknowledging their role in market access.

4.3. HYPOTHESIS TESTING AND ANALYSIS

Hypothesis 1: Telemedicine and Healthcare Access

- **H₀:** There is no significant relationship between the adoption of telemedicine and the improvement of healthcare access in Rohtak.
- **H₁:** There is a significant relationship between the adoption of telemedicine and the improvement of healthcare access in Rohtak.

Table 5 Telemedicine and Healthcare Access

Test	Chi-Square Statistic	Degrees of Freedom	p-value	Critical Value (χ^2)	Result
Chi-Square Test	18.02	4	0.0002	9.488	Reject H ₀ (Significant)

The chi-square test yielded a statistic of 18.02 with 4 degrees of freedom, and a p-value of 0.0002, which is less than the critical value of 9.488. Since the p-value is below the significance level of 0.05, we reject the null hypothesis (H₀), confirming that there is a significant relationship between the adoption of telemedicine and improved healthcare access in Rohtak. The findings highlight that telemedicine has a positive and substantial effect on healthcare accessibility in rural areas.

Hypothesis 2: Precision Agriculture and Crop Yields

- **H₀:** Precision agriculture does not have a significant impact on crop yields in Rohtak.
- **H₁:** Precision agriculture has a significant impact on crop yields in Rohtak.

Table 6 Precision Agriculture and Crop Yields

Test	F-statistic	Degrees of Freedom (Between Groups)	p-value	Critical Value (F)	Result
ANOVA Test	6.25	2	0.004	3.14	Reject H_0 (Significant)

The ANOVA test revealed an F-statistic of 6.25 with 2 degrees of freedom and a p-value of 0.004, which is smaller than the critical value of 3.14. Since the p-value is less than 0.05, we reject the null hypothesis (H_0), indicating that precision agriculture significantly improves crop yields. This result suggests that technological advancements in agriculture have led to increased productivity in Rohtak, benefiting farmers who have adopted precision farming techniques.

Hypothesis 3: Eco-Tourism and Local Economy

- H_0 : There is no significant impact of eco-tourism on the local economy in Rohtak.
- H_1 : Eco-tourism has a significant positive impact on the local economy in Rohtak.

Table 7 Eco-Tourism and Local Economy

Test	Correlation Coefficient (r)	p-value	Critical Value (r)	Result
Pearson Correlation	0.75	0.0001	0.19	Reject H_0 (Significant)

The Pearson correlation test produced a correlation coefficient of 0.75 with a p-value of 0.0001, which is less than the critical value of 0.19. Since the p-value is below the significance threshold of 0.05, we reject the null hypothesis (H_0), confirming that eco-tourism has a significant positive impact on the local economy. The high correlation indicates that eco-tourism plays a crucial role in boosting economic growth in Rohtak through tourism-related activities and local investments.

Hypothesis 4: Digital Agriculture and Market Access

- H_0 : The adoption of digital technologies in agriculture does not improve market access for local farmers.
- H_1 : The adoption of digital technologies in agriculture improves market access for local farmers.

Table 8 Digital Agriculture and Market Access

Test	β (Beta Coefficient)	Standard Error	p-value	Critical Value (β)	Result
Regression Analysis	0.45	0.10	0.001	0.25	Reject H_0 (Significant)

The regression analysis showed a β (Beta coefficient) of 0.45 with a standard error of 0.10, and a p-value of 0.001, which is smaller than the critical value of 0.25. Since the p-value is less than 0.05, we reject the null hypothesis (H_0), confirming that the adoption of digital technologies in agriculture significantly improves market access for local farmers. This finding indicates that digital tools enable farmers to access broader markets, enhancing their sales opportunities and overall income.

The hypothesis testing results suggest that telemedicine improves healthcare access, precision agriculture boosts crop yields, eco-tourism positively impacts the local economy, and digital agriculture enhances market access for farmers in Rohtak. Each technology has shown a significant and positive effect, reaffirming their importance in fostering sustainable development in rural areas.

5. DISCUSSION

The survey in Rohtak, Haryana, shows that emerging technologies have a strong capacity to make a difference in rural healthcare, food supplies and eco-tourism. Many respondents across the different sectors are now supportive of telemedicine, precision agriculture and eco-tourism technologies in rural areas [5-6]. Majority of the people surveyed stated that telemedicine increased access to healthcare services which matters much in places with limited health infrastructure, as in Rohtak [9-11]. Furthermore, managing health problems with mobile health apps revealed the potential of digital health technology to solve rural healthcare problems [13]. At the same time, different opinions were given about the accessibility of technology needed in farming, suggesting that even though digital products exist, many

farmers might not be able to take full advantage of them because some find them hard to use [14]. Farmers were reported to benefit from precision agriculture and digital platforms in food systems, as these help increase what they grow and sell in the market [16-17]. Still, over half of the sample were not certain that these innovations would last in agriculture [18-19]. The results from eco-tourism websites confirmed that the industry offers many economic benefits, but they also indicated problems with the accessibility and infrastructure, keeping the industry from realizing its maximum potential [20-22].

6. CONCLUSION

New technology solutions found in rural Rohtak, Haryana are helping to achieve better healthcare, better food production and increased eco-tourism. The findings prove that telemedicine and mobile applications make it possible for communities in rural regions to get the care they need, despite a lack of local healthcare services. It has proven that when farmers apply precision agriculture, both their productivity and how sustainable they are improve. Digital platforms have made local attractions available to people, encouraging sustainable ways of tourism that direct money to those living there. Yet, the results also point out important difficulties such as insufficient digital skills and inadequate infrastructure, that holds back the growth of these technologies. According to the study, investing more in digital infrastructure, training and information campaigns will help more rural communities use these technologies. Efforts in the future should try to close these gaps to make the most of technology and support the lasting development of rural regions, as well as improves the daily lives of residents.

CONFLICT OF INTERESTS

None.

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None.

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