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Adoption of Post-Harvest Handling Practices by Ginger Farmers in Palpa District, Nepal

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Abstract

Ginger has the potential for export and increased income for farmers in Nepal. Proper post-harvest handling practices has led to low market prices and significant post-harvest losses of ginger. The study was conducted in Palpa district to examine the post-harvest practices and technology adoption among ginger farmers. Data from 66 farmers in Bagnashkali, Purbakhola, Nisdi, and Rampur municipalities was collected through interviews, key informant interviews, and focus group discussions. Descriptive analysis was performed using MS Excel and SPSS. Results showed that 72.7% of farmers practiced storage, with Bhakari (60.41%) and Pit (39.59%) being the common storage types. Storage molds affected 72.2% of respondents, while 28.8% reported wrinkling during storage. Washing was practiced by only 7.6% of farmers. Manual grading was reported by all respondents, with no commercial grading observed. Black sutho production was carried out by 65.2% of farmers. Value addition activities such as sorting were practiced by 65% of respondents, while 25% engaged in transportation and packaging. Respondents' awareness of ginger post-harvest practices varied, with 75.76% having low awareness, 16.66% medium awareness, and 7.58% high awareness. Farmers' general precautions during harvesting, such as avoiding rhizome injury and minimal trimming and sorting, were not accompanied by specific precautionary practices, contributing to their challenges. The findings emphasize the importance of adopting modern post-harvest practices to increase production, improve product quality, and command higher market prices. Implementing these measures will enable ginger farmers in Palpa district to enhance their income and contribute to the growth of the ginger industry in Nepal.

Introduction

The rhizome of ginger (*Zingiber officinale, Rosc*), a member of the Zingiberaceae family, is a perennial herbaceous monocotyledon typically cultivated as an annual crop (Aleem et al., 2020). It can be successfully cultivated in areas with altitudes ranging from 300 to 1600 meters above sea level (Poudel et al., 2018). The fresh or dried rhizome is important as a spice, flavoring agent, and traditional herbal remedy as an anti-emetic, antioxidant, and anti-inflammatory agent against respiratory tract infections (Shahrajabian et al., 2019). Ginger is a common element in cuisine and medicine all around the world (Bag, 2018). Ginger is a stimulant, carminative, and pungent food that is frequently used to treat nausea, diarrhea, and stomach aches (Shivakumar et al., 2013). Ginger root can be used to make commodities either fresh, dried, or by steam distilling the root (Adamade et al., 2017). Products made from ginger rhizomes include ginger paste, fresh ginger, preserved ginger, dry ginger, ginger powder, ginger oil, and ginger oleoresin (Vasala, 2012). Ginger leathers and bars, ginger juice and scent, ginger appetizing flakes, crude fiber, and ginger starch are innovative goods made from spice (Kaushal et al., 2017).

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One of Nepal's high-value spice crops is ginger, which has great potential to be exported to other countries (Joshi et al., 2021). Nepal became the 4th largest country in the world in ginger production (FAOSTAT, 2020). The total area for ginger cultivation in Nepal is 23,500 hectares, with a total production of 2,98,945 metric tons (MoALD, 2020). The principal ginger-producing districts of Nepal are Illam, Salyan, Palpa, Tanahun, Sindhuli, Doti, Kaski, etc. Nepal contributes 9.21% of the world's production of ginger and has a strong export potential (Joshi et al., 2021). India is the major export destination for Nepalese ginger (Gc et al., 2019). About 99% of Nepal's ginger is exported to India, about three-fourths of which is fresh ginger, while the remaining is in dried form locally known as sutho (Acharya et al., 2019). About 862 hectares (ha) of land in Palpa is under ginger cultivation, with a production of 10,516 metric tons and a productivity of 11.05 metric tons per hectare (mt ha^{-1}) (MoALD, 2020). The Prime Minister Agriculture Modernization Project (PMAMP) designated this area as a "Ginger/Turmeric" zone in the years 2021–2022. The district has 6,140 farmers and 148 farmer groups (Aryal, 2022). Many farmers are unaware of good practices for better harvest and post-harvest management of their products, ensuring the optimum price available to them (FAO, 2016). Nepal's ginger is laced with soil. According to experts, this may be the result of storing the high-value spice in fields due to a lack of proper storage facilities (Menyangbo, 2018). Production decreased by 95 percent in the Palpa district. Production was only 10 percent of that because of market uncertainty (Aryal, 2022). Farmers have the superstition that washing decreases the shelf life of the ginger and decreases the weight of the fresh ginger after harvesting. Due to the dirt look, the ginger farmer gets a lower price. Farmers are unaware of the fact that adopting post-harvest handling practices can help them increase the value of ginger. Due to poor adoption of post-harvest handling practices like cleaning, grading, storage, and processing, farmers are forced to sell ginger rhizomes at low market prices after harvesting.

Post-harvest loss refers to the reduction in crop quantity or quality that takes place after the separation of the crop from the production site and continues until the crop is prepared for consumption. The main issues with ginger exporting to foreign markets are the lack of post-harvest management methods such as cleaning, grading, packing, shipping, storage (Chhetri et al. 2023), and manufacturing of new, diverse goods like dry ginger, ginger oil, ginger pickle, and ginger squash. In recent years, the global production of ginger has decreased due to several factors, including diseases and fluctuations in global prices. Farmers in the current era of global and liberal agriculture have a strong desire to increase their income per unit. To achieve this, it is crucial for them to embrace modern post-harvest practices. These practices play a vital role in boosting production and improving the quality of agricultural produce, specifically ginger, thereby enabling farmers to command higher prices. Given its proximity to the national capital, Haryana state enjoys advantageous marketing opportunities for value-added products derived from ginger. To meet both domestic and export demands for ginger, it becomes imperative to seamlessly integrate diverse technologies throughout the entire production-to-post-harvest process. Adoption of proper post-harvest processing techniques can help compensate for the decreased production by reducing post-harvest losses and adding value. The objectives of this study are to examine and discuss the status of the adoption of post-harvest practices and technology in the Palpa district of Nepal

Methods

The study was carried out in the Bagnashkali, Purbakhola, Nisdi rural municipalities, and Rampur municipalities, which lie in the mid-hill region of Lumbini province, Nepal (Figure 1). The latitude, longitude, and altitude coordinates of this study site are 27°49′ 36.48″ N and 83°38′ 16.44″ E, at 152 to 1936 meters above mean sea level. The research regions were chosen on purpose as locations for ginger cultivation. All of Palpa's ginger producers made up the

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sampling population for the study. Simple random sampling was followed during the study. Different procedures and methods were employed, such as interviews, key informant interviews (KII), and focal group discussion (FGD), to collect the data and primary information for this survey, as described by Ghimire et al. (2023a), and Ghimire et al. (2023b). Furthermore, various relevant pieces of literature were reviewed for secondary information. Three rural communities collectively sent 66 ginger farmers as samples.

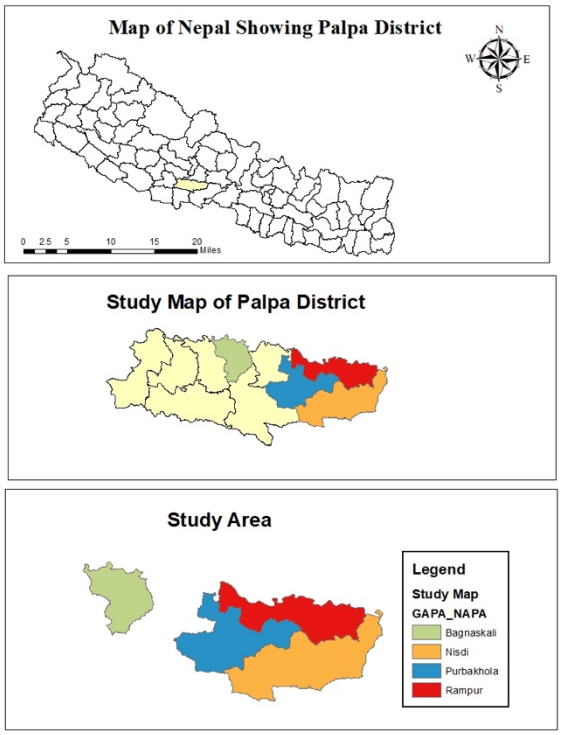

Figure 1. Map of Nepal showing the study site

Statistical analysis

The gathered data and information were input, coded, and analyzed using different statistical programs, including MS Excel 2010 (Version: 4.0.4734.1000, Washington, US) and SPSS (Version: IBM SPSS Statistics 28, New York, USA). The data for the variables gender, age, religion, family size, educational attainment, principal occupation, and adoption of post-harvest management procedures were all subjected to descriptive analysis using mean and percentage statistics.

Problems in the adoption of post-harvest practices and technology

Using MS Excel 2010 (Version: 4.0.4734.1000, Washington, US), the indexing/scaling technique was used to create an index for prioritizing the issues based on farmers' perceptions. The index for the intensity of problems faced by respondents in the adoption of post-harvest practices and technology was computed by using the formula.

$$\text{Iprob} = \Sigma \text{SiFi/N} \qquad (1)$$

Where, Iprob = index value for intensity, Σ = summation, Si = scale value of ith intensity, Fi = frequency of i^{th} response, N = total number of respondents

Results and Discussion

Socio-demographic characteristics of respondents

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Socio-economic factors such as age, level of education, years of experience, and farm size are utilized as variables to elucidate the choices made by farmers when adopting technology or implementing specific practices (Walisinghe et al., 2017). The study showed that the majority of respondents were female. Among the 66 ginger-growing farmers as respondents, 42 were female farmers, whereas the remaining were male farmers, where the percentages of females and males were 63.3% and 36.4%, respectively, which reveals a prevailing trend where females have predominantly occupied and controlled post-harvest activities. Age is a significant demographic factor that influences the efficient allocation of resources since it reveals a person's aptitude for work, productivity, desire for advancement, and attitude toward many social and economic facets of life. According to the field survey data, in the research region, 59.1% of respondents were between the ages of 16 and 59, and 40.9% were over 60. According to the aforementioned statistics, agriculture employs a larger portion of the younger population.

People of the Janajati, Brahmin/Chhetri, and other ethnic groups predominate in the research region. According to the study, the Janajati (51.5%) community was the dominant ethnic group in the study region, followed by others (39.4%), Brahmin/Chhetri (7.6%), and Dalit (1.5%). The Hindu faith completely dominated local society. Hinduism was practiced in every one of the tested families. None of the research area's ginger farms included households that practiced Buddhism, Christianity, or Islam.

As stated in Table 1, all households were divided into three categories. According to the results of the field survey, the majority of homes (86.4%) have families with three to eight people, while just 4.5% of households have families with fewer than three members. One of the key elements in the socioeconomic growth of a community or a country is education (Sodirjonov, 2020; Abdurakhmonova et al., 2021). Three categories were created in this study to classify the education levels. Those who are illiterate are incapable of reading or writing. The primary level was defined as having completed formal education up to class five, and the secondary level as finishing with the School Leaving Certificate (SLC) or above. According to the survey, 45.5% of the respondents had finished their elementary schooling, while 24.2% had finished their secondary schooling. The study also indicated that 30.3% of the respondents were illiterate. Individuals with a higher level of education are expected to exhibit a more favorable attitude toward accepting and utilizing technology (Ye et al., 2020). A large primary source of income for households was determined by the survey to be agriculture (60%) with non-farm sources (23%) coming in second. Remittance (15%) and government service (2% each) made less of an impact on the main occupation. Table 1 provides further information on families' major occupations. According to the survey, the average amount of land owned by a household ranged from 0.05 to 1.53 hectares and was determined to be 0.58 hectares (Table 1). The average landholding of a household was higher than the district's average landholding (0.50 hectares). Additionally, it was determined that the household's average area under ginger cultivation, which ranged from 0.05 to 0.61 hectares, was 0.15 hectares. Landholdings and education level are widely acknowledged as crucial factors that significantly influence the decision-making process and adoption of technology in agriculture (Walisinghe et al., 2017).

The adoption of post-harvest management procedures depends heavily on training. Results indicated that only 28.8% of respondents had access to PMAMP training. The remaining 71.2% of respondents didn't receive any ginger training. As a result, these farmers did not implement post-harvest management procedures. The adoption of excellent agricultural techniques is significantly influenced by agricultural subsidies. According to the survey, the majority of respondents (83.3%) did not get any type of subsidy program, and just 16.7% did. As a result, these farmers did not implement adequate post-harvest management methods. The findings suggest that a limited number of households' heads have received subsidies, primarily due to

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the scarcity of extension agents and a lack of knowledge. Additionally, the majority of farmers are unable to access subsidies due to the remote locations where they reside.

Table 1. Summary statistics of socio-demographic variables of respondents

Variable	Frequency	Respondent percentage (%)
Gender		
Female	42	63.3
Female	24	36.4
Age		
Between 16-59 years	39	59.1
Above 60 years	27	40.9
Ethnicity		
Janajati	34	51.5
Brahmin/Chhetri	5	7.6
Dalit	1	1.5
Others	26	39.4
Religion		
Hinduism	66	100
Family size		
Greater than 8 members	6	9.1
Between 3-8 members	57	86.4
Less than 3 members	3	4.5
Education level		
Illiterate	20	30.3
Primary	30	45.5
Secondary	16	24.2
Primary occupation		
Agriculture	39	59.1
Government-service	1	1.5
Off-farm	16	24.2
Remittance	10	15.2
Training obtained by the respondents		
Training received	19	28.8
Training not received	47	71.2
Subsidy obtained by the respondents		
Not received	55	83.3
Received	11	16.7

Landholding	Minimum (ropani)	Maximum (ropani)	Mean (ropani)
Landholding	1	30	11.44
Ginger cultivation area	1	12	2.88

Harvesting of Ginger

Based on the responses received, it was found that all farmers engage in the manual harvesting of ginger using traditional methods. The harvesting of ginger takes place nine months after plantation, typically in November, when the ginger rhizome reaches full maturity. Farmers carry out two harvests per year, one in June and one in July, primarily for selling seed rhizomes in the market when ginger prices are higher compared to the main harvesting season in November.

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Precaution to Protect Ginger Quality

Farmers take certain precautions to safeguard the quality of ginger during the harvesting process. They make conscious efforts to avoid injuring the rhizomes while harvesting. Additionally, they undertake activities such as trimming, curing, and sorting before supplying the ginger to traders, but very rarely. However, apart from these measures, there are no other specific precautionary practices implemented by farmers to protect the quality of ginger. It is worth noting that farmers preserve the larger-sized rhizomes as seeds for obtaining good-quality ginger the following year.

Adoption of post-harvest handling practices

Means of transportation and transportation materials

From the study, it was concluded that the majority of households (89.4%) manually transport ginger from the field to the home or collection center after harvesting (Table 2). Only a few households (10.6%) used tractors as means of transportation. The main forms of conveyance are doko (a traditional tool made of bamboo is commonly used for carrying goods) and gunny bags. According to the survey, 10.61% of the homes used gunny bags for transportation, while 89.39% of the households utilized doko (without packaging).

Table 2. Transportation and packaging materials used by ginger farmers in Palpa district, Nepal

Description	Frequency	Respondent percentage (%)
Means of transportation		
Manually	59	89.4
Tractors	7	10.6
Transportation materials used		
Doko (without packaging)	59	89.39
Gunny bags (packaging)	7	10.61

Storage

Storage facilities are essential for extending raw ginger's shelf life after harvest and contributing to its value. The investigation showed there was no ginger storage facility with a temperature, relative humidity, and ventilation management system. In the research region, ginger is often preserved for domestic use, before being marketed, as well as for seed purposes. According to the survey, the majority of homes (72.7%) have accepted the habit of storing ginger, while 27.3% of them have not**.**

Types of ginger storage

In the study area, it was found that ginger was stored in traditional ways, i.e., in pits and bhakari (Table 3). From the study, it was found that 60.41% of households store ginger in Bhakari, which was followed by pit storage (39.59%).

Problem during Storage

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Due to the study's use of conventional techniques for ginger preservation, several issues, including storage molds and wrinkling, were common. Storage molds made up the bulk of issues (72.2%), while wrinkling came in second (28.8%).

Washing Practice

The washing practice gives ginger an appealing look and is easily accepted in the local market. In the study, it was found that the majority of households (92.4%) did not adopt washing practices. While 7.6% of households adopted the washing practice, they also reported that washed ginger gets a higher price and higher preference from retailers and consumers in comparison to unwashed ginger.

Grading Practice

In the study, it was found that grading practices were done manually in traditional ways. It was found that no commercial grading practice was adopted in the study area.

Packaging Practice

There is no advanced packaging practice adopted in the study area. Most gunny bags are used as packaging materials (10.61%).

Ginger Products

From the study, it was concluded that the majority of households (65.2%) had made black sutho, while 34.8% of households had not made black sutho. It was found that none of the households adopted post-harvest handling practices to make ginger products like dry ginger, ginger powder, ginger candy, ginger pickle, ginger squash, and ginger oil extraction.

Value addition

Approximately 65% of the farmers engage in sorting as a means of adding value to their products. Additionally, some farmers practice grading to enhance the value of their produce, while 25% of farmers focus on activities such as transportation and packaging to increase the value of their goods.

Distribution of respondents based on their awareness about post-harvest handling practices

The distribution of respondents in Table 3, based on their level of awareness of post-harvest management practices, reveals that a significant majority (75.75%) falls under the 'low' category, followed by 16.66% in the 'medium' category, and 7.57% in the 'high' category of adoption of post-harvest management practices. This suggests that a considerable number of vegetable growers may not have been adequately exposed to post-harvest management practices.

Table 3. Different post-harvest adoption practices adopted by ginger farmers in Palpa district, Nepal

Description	Frequency	Respondent percentage (%)
Storage		
Practiced	48	72.7
Not practiced	18	27.3
Types of ginger storage		
Bhakari	40	60.41
Pit	26	39.59

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Problems during storage		
Storage molds	48	72.2
Wrinkling	18	28.8
Washing practice		
Practiced	5	7.6
Not practiced	61	92.4
Grading practice		
Manually	66	100
Commercial grading	0	0
Ginger products		
Black sutho	43	65.2
Not black sutho	23	34.8
Value addition		
Sorting	43	65
Transportation and packaging	23	25
Respondents awareness on ginger post-harvest practices		
Low	50	75.76
Medium	11	16.66
High	4	7.58

Study on major problems in the adoption of post-harvest handling practices

Responses regarding various constraints in the adoption of post-harvest handling practices were recorded and analyzed during the field study. The respondents were asked to rank the constraints they had been facing in the adoption of post-harvest practices and technology. Table 4 reveals that lack of knowledge ranks in the first position with an index value of 0.763. Similarly, lack of extension services ranks in 2nd place with an index value of 0.754, followed by lack of modern technology and equipment, disease and pests, and lack of labor.

Table 4. Major problems in the adoption of post-harvest practices and technology

Problems in the adoption of post-harvest practices and technology	Index value	Rank
Lack of knowledge	0.763	1st
Lack of extension services	0.754	2nd
Lack of modern technology and equipment	0.536	3rd
Disease and pest problem	0.451	4th
Lack of labor	0.442	5th

Factor Affecting Adoption of Post-Harvest Handling Practices

The adoption level of post-harvest practices is relatively low, with an acceptance rate of 70%, as shown in Table 5. This suggests that respondents have not fully embraced post-harvest adoption practices. It can be inferred that farmers with limited knowledge and awareness regarding technology and practices are more inclined to refrain from adopting post-harvest practices (Elemasho et al., 2018). According to the findings of this study, performance expectancy demonstrates a high frequency (42), indicating that it can be considered the most influential factor in determining a user's behavioral intention to adopt post-harvest practices. The effort expectation stands out with the highest frequency (47). It is known that effort expectancy plays a significant role in influencing users' intentions to adopt and accept new technologies (Sun et al., 2013). Additionally, having knowledge and understanding of new

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technologies or practices is an important contributing factor that influences the willingness to adopt such practices. This study, supported by a majority of respondents (60.62%), has confirmed that social influence plays a significant role in the adoption of post-harvest practices. Farmers in the study have acknowledged that various entities, such as the government, extension agents, friends, and family, have actively encouraged them to adopt post-harvest practices. In this study, factors such as financial support, necessary knowledge, resources, training, and facilities were identified as components of facilitating conditions that have the potential to influence the adoption of new technologies or practices. The findings indicate that ginger farmers in Palpa district agree that facilitating conditions have played a significant role in motivating them to adopt post-harvest practices. Attitude can play a significant role in contributing to post-harvest losses of fruits and vegetables (Rose et al., 2016). In line with this, the current study's findings also indicate a high frequency (42) of positive attitudes among farmers towards ginger post-harvest management practices.

Table 5. Factors influencing ginger post-harvest handling practices.

Factors	Frequency	Respondent percentage (%)
Post-harvest practices adoption		
Low	46	70
Medium	20	30
High	0	0
Performance expectancy		
Low	10	15.15
Medium	14	21.21
High	42	63.64
Effort expectancy		
Low	5	7.58
Medium	14	21.21
High	47	71.21
Social influence		
Low	5	7.58
Medium	21	31.82
High	40	60.60
Facilitating conditions		
Low	11	16.67
Medium	20	30.30
High	35	53.03
Attitude		
Low	4	6.06
Medium	20	30.30
High	42	63.64

SWOT analysis of ginger sub sector

Strength, weakness, opportunities and threats (SWOT) analysis of ginger in Palpa district, Nepal is presented in Table 6.

Table 6. SWOT analysis of ginger in Palpa district, Nepal

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Strength	Weakness
• Low labor costs. • Local traders make selling easy. • Smooth supply chain. • Ginger with high oil content. • Strong market demand. • More profitable than other crops. • Ideal soil and climate for ginger. • Consumers love Palpa district ginger.	• Lack of appropriate ginger varieties. • Insufficient physical facilities for washing and cold storage. • Inadequate irrigation facilities for timely watering. • Limited technical knowledge among chain actors regarding production and quality management. • Infrequent availability of services from service providers. • Lack of organization among growers, resulting in individual actions. • Shortage of skilled labor for ginger harvesting. • Non-functioning collection centers.
Opportunities	**Threats**
• Geographic and climatic suitability for ginger cultivation. • Strong market demand in the international market. • Potential for expanding the production area. • Possibility of product diversification, such as jam and jelly, for added value. • Increased employment opportunities. • Government policies supporting the development of value chains for high-value crops. • Export potential for ginger.	• Variable weather conditions, including the possibility of high rainfall and drought during production. • Incidence of diseases and pests affecting ginger crops. • Illegal charges for custom clearance and SPS (Sanitary and Phytosanitary) certification at the Indian border. • Competition in the international market. • Lack of clear government policy for the development of physical infrastructure. • Unstable market prices for ginger. • Farmers generally have limited control over determining the price of their ginger produce.

Conclusion

From this study, the majority of ginger farmers were not familiar with post-harvest methods and technology. The research found that the majority of families moved ginger manually from the field to their residences or gathering locations. Similarly, no storage facility in the study area had a system for controlling temperature and humidity. Given that diverse goods such as dried ginger, ginger powder, candies, and oils were not processed in the research location, extension services highlighting the value of these diversified products had to be made available on the global market. The study found that the main obstacle to the adoption of post-harvest handling procedures was lack of knowledge; as a result, knowledge about these practices should be spread via radio, television, newspapers, and social media. There is an immense need for strategic plans to be formulated by the concerned authority to address the major constraints in the adoption of post-harvest practices and technology faced by farmers and come up with measures to solve the prevailing constraints. However, it is important to acknowledge certain limitations that should be addressed to enhance the understanding of future research. Firstly, conducting future studies on ginger could involve exploring different states or even countries

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to obtain a broader perspective. Additionally, it is crucial for future research to encompass various stages and types of post-harvest practices adopted by ginger farmers. This would enable a more comprehensive analysis of the adoption levels and provide a deeper understanding of the subject matter.

Author Contributions

BPC and SKC conceived the study, curated the data, and contributed to methodology; SKC and BPC obtained funding; SKC, BPC, and SG conducted the investigation; SG provided resources and software; SG and BPC supervised the project; SG validated the findings; BPC visualized the data; SG and BPC drafted the original manuscript and conducted the review and editing process.

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Conflicts of Interest

The authors declare no conflict of interest.

Institutional/Ethical Approval

The authors do not involve any approval as the work does not contain human or animal participants or experiments.

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