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A REVIEW ON THE FACTORS INFLUENCING THE ADOPTION OF NEW AGRICULTURAL TECHNOLOGIES

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Abstract

Adoption of improved agricultural technologies is a tool for increasing the agricultural sector's output and productivity, reducing poverty, and guaranteeing food security in underdeveloped nations. The majority of developing nations have many influencing factors, which contribute to the low rate and intensity of adoption of new agricultural technologies. This study focuses on a few potential factors that may influence farmers in developing nations from implementing and adopting improved agricultural technologies. Numerous reviews of the literature revealed that the primary determinants of technology adoption and diffusion are institutional, socio-cultural, technological, economic, and demographic factors. Policy makers should concentrate on developing irrigation systems, bolstering the research-extension-farmers (R-E-F) linkage, improving the accessibility of credit services, providing development agents with various workshops and training, enabling the educational sector to concentrate on adult education, advising farmers to raise their educational levels, and ensuring that farmers have timely access to information. Lastly, technology developers should take into account the needs and perspectives of farmers during the design and development of their products, as this will facilitate the adoption of the technology more readily.

Key words : Underdeveloped nations, farmers, adoption, technology, agricultural, nations, developing, improved, factors, educational, concentrate

1. Introduction

Since the dawn of human civilization, agriculture has entered the realm of sustenance and employment. Since then, there have been numerous opportunities for someone to start their own business. Agriculture was viewed as an unprofitable endeavor in the past, as the world was heading towards industrialization. But things remain the same even now. However, agriculture continues to be a vital source of income for a large number of people worldwide. New technologies for the advancement of agriculture are being introduced daily. To help farmers and other stakeholders improve their practices, those are presented to them.

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However, the rate at which those new technologies are being adopted is low. Investigating the matter thoroughly reveals that a variety of factors influence the adoption process. The adoption process has been explained by a number of theories and models. These elements influencing technology adoption are compiled in this review along with an analysis of various studies that have been done on the subject. A review of the literature on technology adoption was done in order to achieve this.

The literature was gathered from a variety of sources, including academic journals, technical reports, government websites, and textbooks, and it covered very recent one. Future researchers will benefit from this compilation of literature and knowledge for the efficient management of their research and technology dissemination process.

2. Agricultural technology adoption

Ensuring food security and mitigating poverty in developing nations can be achieved through the implementation of advanced agricultural technologies.

A number of factors, including a slow adoption rate and a lack of understanding regarding many aspects of adoption, make it difficult for farmers to accept agriculturally improved technology. The nature of the technology, awareness of the technologies, risk aversion, institutional constraints, lack of human and financial capital, and lack of infrastructure are just a few of the barriers to adoption that are covered in many academic publications.

The application of adoption and diffusion theory has been prevalent in identifying the determining factors that impact an innovation's decision to be adopted or rejected by the user. Innovation is any concept, method, or item that a person perceives as novel . The innovation diffusion theory (IDT) consists of five steps that one must take in order to decide on a specific innovation. The initial phase involves educating the person about the innovation, its purpose, and the necessity of a new technology. The person enters the second stage based on how they feel about the new technology. According to many scholars, there are five characteristics that influence a person's decision and make them more likely to enjoy new technologies.

The person enters the second stage based on how they feel about the new technology. There are five characteristics that influence a person's decision and make them more likely to enjoy new technologies. Answers to the question "Is the new technology better than existing technology?" indicate **relative advantage**. The degree to which an innovation is viewed as congruent with adopters' preexisting experiences, needs, and beliefs is known as **compatibility**; **Complexity**: the extent to which an

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innovation is challenging to comprehend and apply; **Trialability:** the extent to which the invention can be applied sparingly; **Observability**: the extent to which an innovation's effects are apparent to other people.

Individuals' decisions to embrace or reject the technology constitute the third stage. The application of this new technology is the fourth stage, and the individual's decision is confirmed in the final stage. The process of incorporating a new technology into an established practice is called adoption, and it typically involves some degree of adaptation and a period of "trying." Adoption is defined by some as the cognitive process that a person goes through from the moment they learn about an innovation until they finally use it. The adoption intensity and rate of adoption are its two categories. Time is one of the foundations of the former, which measures how quickly farmers adopt innovations. On the other hand, adoption intensity describes how much a technology is used over any given period of time. Adopting new technology can be challenging because the process varies depending on the technology. Consequently, the first thing to take into account when characterizing farmers' adoption of agricultural technology is whether or not adoption is a discrete state with binary response variables.

This suggests that the definition is contingent upon the farmer's use of the technologies, the assignment of values ranging from zero to one, and whether or not the response is continuous. Agricultural new technologies include the development and use of hybrids, greenhouse technology, genetically modified food, chemical fertilizers, insecticides, tractors, and the application of other scientific knowledge. The five stages of technology adoption are inventors (2.5%), early adopters (13.5%), early majority (34%), late majority (34%), and laggards (16%), to put it succinctly. New agricultural technologies are factors of production that have been altered in some way from their original form in order to improve their efficiency.

3. Determining factors of Agricultural technology Adoption

The research **(Ahmed & Ahmed, 2023)**explores factors influencing modern agricultural technology adoption in developing economies, focusing on obstacles faced by smallholder farmers. It highlights the importance of understanding resource availability, farmer perception, and technology-specific factors, and the need for effective technology-related programs to address food production challenges.

A meta-analysis of 367 regression models **(Ruzzante & Bilton, 2021)** found that the adoption of agricultural technologies, promoted by governments and development organizations to boost farm

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productivity and reduce poverty, is low, with factors like farmer education, household size, land size, credit access, and organization membership positively influencing adoption.

The meta-analysis of 12 Ethiopian studies **(Feyisa, 2020)**found significant determinants of agricultural technology adoption, including household head age, education, farm size, livestock holding, access to extension services, cooperative membership, and market distance.

(*Takahashi - 2020*) evaluates case studies on technology adoption and its impact on productivity in low-income nations, particularly sub-Saharan Africa, to identify inadequacies and unresolved concerns. It also discusses the growing body of research on social networks and farmer-to-farmer technology extension, focusing on effective strategies.

Global poverty and hunger have increased, threatening Sustainable Development Goals. Sub-Saharan Africa (SSA) has experienced the most regression, despite numerous farm management methods. Despite numerous theories, most farmers have not adopted new agricultural technologies. A meta-econometric analysis **(Arslan et al., 2022)** reveals that 53% of factors affecting technology adoption are not supported by empirical data. Adoption is influenced by 18 characteristics, including affluence, land tenure, group membership, social capital, and information access. Wealth remains a significant factor in fertilizer use.

Digital agriculture, the digitalization and automation of farming operations, could help address issues like labor costs, production costs, and climate change. The USDA's Agricultural Resource Management Survey (ARMS) shows a surge in automated guidance, applied on over 50% of US farmland. Factors influencing farmers' adoption include cost, soil variability, USDA programs, labor-saving advantages, productivity gains, and advisory services accessibility **(McFadden et al 2023)**.

The study by **(Fiocco et al., 2023)** surveyed 5,500 farmers in Asia, Europe, North America, and South America to understand regional variations in agricultural technology usage and obstacles to wider acceptance. The majority of farmers in North America and Europe anticipate adopting agricultural technology in the next two years, with unclear ROI and high costs being major obstacles. South America (50%) farmers are most cautious about internet platforms, and the adoption rate is lowest in Asia (9%).

The research found the following new five trends in relation to the agricultural technology adoption,

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1. Despite the slow adoption rate of agricultural technology, farmers remain receptive to new ideas.
2. Precision agriculture is a major enabler of the shift toward less resource-intensive, more sustainable food systems.

3. It is probable that regulations will become more crucial in propelling the expansion of specific agricultural technology submarkets.
4. Business models are still developing in the direction of integrated solutions.
5. There is a chance to strengthen data sharing trust and enhance product customization.

The research **(*Agtech in Latin America_ A Promising Landscape (2023, Q4),* n.d.)** on Latin America's agriculture technology industry highlights its potential for growth. However, challenges such as infrastructure, connectivity, and road access in rural areas hinder adoption. Insufficient electricity availability and regulatory frameworks also hinder technology adoption. Despite funding options from impact investors, venture capital firms, and cooperatives, market risk perception and information asymmetry can hinder financing for innovative agriculture technology startups.

A study by **(Echeverría, 2021)** reveals challenges in Latin America and the Caribbean's rural societies and agri-food systems, including enhancing food productivity, promoting sustainability, adapting to climate change, and promoting economic inclusion. Barriers to technology adoption include information and training, policy/institutional issues, economic issues, social/cultural issues, and environmental issues. To overcome these, strengthening producers' social networks is crucial for exchanging projects, best practices, and innovations.

A study by **(Brief, 2021)** analyzed factors influencing smallholder farmers' adoption of agricultural technologies. Surveys were conducted in nine countries, including Asia, Latin America, and Africa. The study also evaluated maize seed adoption in Benin and Farmers Field School (FFS) programs in 25 countries. The Benin study used improved maize seed and agricultural extension assistance. A meta-analysis of 168 researches in 23 African nations identified positive factors influencing agricultural technology adoption.

The result of the finding was that farmers in areas with certain policy tools in place had higher adoption rates of new agricultural technologies. These tools guaranteed that farmers could invest in newer technologies, had access to credit, could understand new technologies and make informed decisions, had secure land tenure, which allowed them to continue benefiting from new technologies with upfront costs, and participated in organized farmer groups where they could learn from one another about new farming techniques.

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(Aryal et al., 2020) investigates the impact of women's participation in adopting agricultural technology on climate-smart agriculture (CSA) adoption in Indian farm households. Results show that women in Haryana have a higher likelihood of adopting CSA than in Bihar. Wealth, training, and access to extension and market positively influence CSA adoption. Women farmers prioritize family food security over farm income, making CSA adoption more likely in Haryana.

Brazil's digital agriculture has significantly increased, with 34% of farmers buying agricultural products online, compared to 26% in the US. A McKinsey poll **(*Brazilian Farmers' Approach to Digital: Embracing Digital | McKinsey*, 2020)**found that 85% of farmers use WhatsApp daily for work-related matters and 70% regularly use internet channels for non-farming purposes. However, inadequate internet access at the farm level, poor website user experience, and cybersecurity concerns are impeding the broader adoption of digital technologies in agriculture.

(Martinez et al., 2021) studied Bolivian rice growers' adoption of complementary agricultural technology. They found that farmer organization membership, access to agricultural extension, and proximity to San Juan de Yapacaní which is Bolivia's main rice-related technological dissemination area are crucial factors for adopting improved technologies. Farms located in areas like Santa Cruz, where labor is abundant and markets are larger, are more likely to influence the adoption of these technologies.

(Marshall et al., 2022) study explores the adoption of digital agricultural technology by Australian farmers. They found that many farmers are not using technology due to the digital divide between rural and urban areas. The study uses a "communitive ecology" framework to investigate the technological, discursive, and social aspects of digital farming adoption on a cotton farm in South-East Queensland, Australia.

A study **(B. Singh & Sharma, 2019)** in Rajasthan's Dantiwara village, Jodhpur district, examined the factors influencing the adoption of organic farming practices. Eighty farmers were selected, with 55% falling into the medium adoption category. The study found that education, caste, occupation, social engagement, herd size, information source, exposure to media, attitude, knowledge, and training were positively and significantly connected with organic farming adoption.

(Workineh et al., 2020) study examined Ethiopian households' welfare influenced by adopting improved wheat varieties. Factors like credit availability, extension visits, soil fertility, plot size, off-

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farm employment, age, distance from input market, and farm experience influenced adoption. The study concluded that adopting better wheat varieties significantly improves farm households' welfare.

(Barua, 2016) study found a positive correlation between land cultivation and technology adoption among Tanzanian smallholder maize farmers. Fair payment motivates technology use, but price volatility hinders adoption. Altitude also positively influences technology adoption. High and medium land farmers are more likely to adopt technology compared to low land farmers. However, female heads of family may lack decision-making authority and may not be aware of new technologies.

The adoption rate of sustainable innovations in agriculture is below the 2030 Sustainable Development Goals, despite their benefits. A systematic literature review**(Rizzo et al., 2024)** reveals individual psychological and socio-demographic traits, along with specific innovation characteristics, contribute to this phenomenon. Environmental values influence sustainable technology adoption, with organic farmers prioritizing environmental concerns over financial rewards. Obstacles include complexity, aversion, and low perceived control. Future research could explore farmers' adoption dynamics of sustainable technology.

(Yokamo, 2020) literature survey analyzed the adoption of improved agricultural technologies in developing countries, revealing factors influencing adoption include technological, socio-cultural, demographic, economic, and institutional aspects. Farmers' perception of technology features, trialability, observability, compatibility, and complexity determine adoption. The review reveals that technology adoption varies based on factors like technology type, price, education, and access points. Experts have conflicting views on age's role in adoption, with some suggesting older farmers are less risk-averse. Policy makers and agricultural technology developers must understand factors influencing adoption to increase production, productivity, food self-sufficiency, and ensure food security in developing nations.

The study by **(Cui and Wang, 2023)** reveals that despite China's recent promotional campaigns, the adoption rate of digital technology in agriculture remains low, with various factors influencing farmers' decisions. Five factors predict adoption decisions for digital technologies: institutional, technological, agro ecological, psychological, and socioeconomic. Collaboration between individuals, governments, technology providers, and extension agents is crucial for rural adoption.

(Dissanayake et al., 2022) conducted a literature review on technology adoption, analyzing factors from over 50 years of research and dividing them into three groups. The adoption of a new farming

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method is influenced by various user-related (size, income, gender, age, experience, trialability, and observability of the farm), technology-related (compatibility, affordability, availability, trialability, and observability), and institutional factors (availability of credit facilities, markets, inputs, and extension services), which interact and work together.

(Das & Das, 2017) The research explores the use of technology in farming, its partners, how farmers learn about it, and the limits of its application, using data from the 70th round of the National Sample Survey. A study found that only 4.41 percent of Indian agricultural households have formal training in agriculture, and only 38% use modern techniques. Only 44.26 percent of households reported machinery expenditure, with crop category significantly influencing machine usage. Factors influencing machinery use in agriculture include irrigation, marketable surplus, leased-in areas, crop insurance, and information sources. SC and ST households have less access, but OBC farm households use more machinery.

The Rwandan government has increased irrigation development investments to address erratic rainfall patterns and droughts. A study analyzing the adoption of small-scale irrigation technologies (SSITs) among 360 farmers **(NGANGO & HONG, 2021)**found that adoption decisions are influenced by factors like education, farm size, gender, and access to credit. SSITs positively impact land productivity, emphasizing the need for policy promotion to improve agricultural productivity and food security

The study **(Adams & Jumpah, 2021a)**analyzed the impact of technology adoption on smallholder farmers' welfare, focusing on regional location, educational level, age, and Farmer Base Organization membership. Results showed that technology adoption had a positive but statistically insignificant impact on welfare, with consumption and clothing expenditure increasing with adoption but not healthcare. To improve technology adoption, emphasis should be placed on business supporting, agricultural extension outreach, and finance/input support.

The study **(Apicella & Tarabella, 2024)** aims to identify the awareness rate and adoption drivers of precision agriculture (PA) among Italian farmers. Based on an online survey of 755 farmers, the results show that 48.48% of informed farmers lack the necessary information for PA techniques, with a diffusion rate of around 20%. The research suggests training development paths for farmers to adopt technologies with sustainability orientation. This research serves as a starting point for future studies.

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The study **(Chuchird et al., 2017)**examines the factors influencing the adoption of water wheel (WW), water pump (WP), and weir (WR) irrigation technologies among 207 rice-growers in Chaiyaphum province, Thailand. Results show land holding size, farm income, and water use association (WUA) membership positively influence WW adoption, while age, farm income, skills training, and WUA membership negatively affect WP adoption.

The study **(Kebebe, 2015)** aimed to understand the factors affecting the adoption of improved livestock technologies in the Ethiopian highlands, focusing on dairy production. The findings suggest that the returns to investment for these technologies may be too low to justify widespread adoption. Interventions at production, storage, transportation, processing, and marketing chains and macroeconomic institutions and policies are needed for successful dairy development programs.

This systematic review of 21 Ethiopian studies on farmers' adoption decisions of improved crop varieties **(Abdurehman & Abdi, 2021)** found that access to credit, social organization participation, hired labor, field day participation, farm income, farm size, extension contact, training, oxen, fertilizer, and input market access are the best determinants.

(Dessart et al., 2019) conducted over the past 20 years on the behavioral factors influencing farmers' decisions to adopt ecologically friendly methods. According to the analysis, a greater adoption of sustainable techniques is linked to extraversion, risk-taking, moral and environmental concern, openness to new experiences, lifestyle farming goals, willing to rise in social standing, accept the advice of social referents & their neighboring farmers and when they possess the necessary knowledge and expertise in these areas.

The study **(Dai et al., 2015)**analyzed factors influencing farmers' adoption of water-saving practices in Heilongjiang Province, China. Factors such as water source reliability, government promotion, household adulthood, risks, education, soil texture, oil price, electric power, labor access, technical complexity, investment, water source, soil texture, oil price, and lack of electric power impacted adoption.

Rice is the world's most important food crop, with over 90% grown in Asia and Africa. A study **(Achukwu et al., 2023)**on small-scale rice farmers Nigeria found few agricultural innovations being used. The main innovations were herbicide spraying, fertilizer application, pesticide use, and improved seeds. Barriers to innovation adoption included high costs, lack of adoption training, inability to acquire financing, and inadequate extension services. Demographic factors like gender, education

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level, and farm size also impacted adoption. The study recommends government and organizations encourage farmer education and regular visits by extension agents to promote new ideas.

Climate-smart agriculture (CSA) practices are proposed to mitigate climate risks and reduce greenhouse gas emissions. However, resource-poor farmers face financial and knowledge barriers. A study in Odisha by **(Tanti et al., 2022)** found that 95% of farmers have adopted CSA practices, with factors like government extension service, farmer school participation, subsidies, energy access, and climate shock perception being major determinants. Improved institutional support is crucial for CSA adoption.

(Hooks et al., 2022)'s study using a random effects panel model found that countries with high competitiveness, enhanced cybersecurity, ease of doing business, and low political violence/terrorism adopt new technologies more readily.

(Begho et al., 2022) paper reviews adoption literature of sustainable agricultural technologies in South Asia and finds that over the last four decades, empirical data has demonstrated that a variety of factors, including financial, attitudinal, psychological, social, agronomic, and regulatory ones, can impede the adoption of innovative methods. The research found that education, extension and training, soil quality, irrigation, income, and credit are significant drivers of adoption decisions. The findings could help shape research and policies to promote sustainable nitrogen management technologies in South Asia.

The study **(S. Barman et al., 2019)** in Central Brahmaputra Valley and Upper Brahmaputra Valley Zone of Assam, India, examined factors affecting farm mechanization adoption. Data from 240 sample farms was collected using personal interviews and Logit Regression Analysis. Factors affecting mechanization adoption included age, education level, and land holding size, access to irrigation, extension agents, high yielding varieties, and institutional credit. Younger farmers preferred mechanization more than older ones. The study concluded that linkage between extension functionaries and grassroots level is crucial for successful farm mechanization.

(Bagal et al., 2020) investigated the factors influencing adoption of farm mechanization in Jammu district of Jammu and Kashmir. Farm mechanization reduces human and animal work, increasing crop production and productivity. However, farmers are not fully using equipment due to lack of awareness, higher prices, and less operational land holding. To enhance knowledge, state agriculture departments should introduce schemes, agro industries corporations, private machine owners, and co-operative societies for payment-based machine usage.

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According to **(Chi, 2008)** while studying factors affecting technology adoption among rice farmers in the mekong delta region, reported that perceptions and educational levels of farmers, the expertise of extension workers, the structure and administration of extension programs, and the physical attributes of the region all had an impact on the adoption of new technology. The main obstacles to the adoption of new technologies were the low educational attainment of farmers, their poor impression of the technologies, and the extension staff's poor teaching abilities. Remote areas were not reached by the extension effort. It is possible that some of the technical knowledge that skilled farmers orally impart to unskilled farmers would be lost. Farmers found the IPM and its three reductions and three gains to be complex techniques. The adoption of these technological solutions required a significant amount of time, labor, and capital. To buy certified seeds and row seeding gear, farmers require funds. Due to its high cost and the tiny areas of land with a network of irrigation canals and river branches, mechanization was not common in the harvesting and post-harvest processes.

Dryland ecosystem smallholders continue to live in poverty and face severe social and economic hardships as their landholding shrinks. Due to inefficiency with resources and ignorance, the majority of dryland farmers use traditional disintegrating agricultural methods. In order to solve the problems with dryland farming today, **(Kandasamy et al., 2022)** looks into the viability of an Integrated Farming System (IFS) and explores the elements that could influence the agricultural community's adoption of it. The purpose of this research is to evaluate the main factors influencing the adoption of the IFS in rural southern India by applying and contrasting supervised learning approaches. According to the study, the main variables influencing dryland farmers' adoption of IFS are their age, their level of involvement in extension activities, and their output of organic fertilizer. The study demonstrates that there is a good chance for small and marginal farmers to experience the greater benefits of IFS.

(Ullah et al., 2020) explores factors affecting farmers' access to agricultural credit and adoption of improved agricultural technologies in Khyber Pakhtunkhwa, Pakistan. Results show a moderate positive association between credit access and technology adoption. Farmers with large farms, high income, better access to information, and physical assets have better credit access. However, farming experience negatively affects credit access. The study emphasizes the importance of effective information provision for different farmers.

In order to investigate how adoption models are currently reliant on farm/farmer attributes in relation to technology attributes and disseminating institutions, **(Jones-Garcia & Krishna, 2021)** reviewed the studies published between 2007 and 2018 on the adoption of sustainable intensification

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technologies in maize systems of the Global South. The key conclusion emerged from an analysis of 137 adoption studies is that the primary barriers to farmers adopting new technology were limited information availability and technologies unfit for small landholdings.

The study **(Liu et al., 2018)**reviews best management practices (BMPs) for reducing agricultural pollution, highlighting the lack of adoption by farmers. It explores factors influencing BMP adoption in developed and developing countries to improve water quality. The result shows that access to credible information, government subsidies, environmental consciousness, and profitability are positive. Other factors like farm size, land tenure, experience, and education are unclear or debatable. Further research is needed to understand the roles of social norms, peer pressure, and macro factors like geographic regions, policies, markets, and business.

There was research by **(Odame et al., 2011)** to find out the reason why agricultural technology is low in eastern and central Africa. The result showed that the success of adoption is attributed to a complex institutional framework, technical innovation, and participatory approach to adaptive research and technology transfer, focusing on demand-driven training and education for farmers. Collaboration among researchers, extensionists, private sector, and farmers has led to the adoption, incorporating crop and livestock farming, and developing rotational grazing patterns for cover crops. This approach also addresses environmental concerns and watershed degradation. The strategy involved aggressive dissemination of technical, economic, and environmental information through media, written documents, and farmer-to-farmer exchange. Private-public partnerships and an agro-input company supported demonstration projects. Targeted subsidies significantly supported small farmer adoption of no-till practices.

With strong market and regulatory pressure to adopt more environmentally sustainable methods while improving production, European agriculture faces an increasingly difficult future. Technologies that are powered by data are essential for tackling these issues. Given the abundance of farming data available today, it is crucial to understand the factors affecting the adoption of data-driven technology in this sector. In Ireland, **(*Factors Impacting Farmers' Adoption of Digital Agriculture - Demeter,* n.d.)** discovered that adoption was primarily motivated by the hope of improving productivity and performance through, among other things, time savings, less bureaucracy, improved yields and outputs, and more efficient use of agricultural inputs. The largest obstacles are the perceived high cost of acquiring and maintaining data-driven technology, as well as the overall absence of high-quality broadband and internet connectivity.

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(John et al., 2023) assessed the various factors that affect precision agriculture adoption in Europe's small-scale farming industry. The most important component is clearly the social dynamics, which are influenced by cultural norms that are deeply ingrained, awareness levels, and knowledge distribution channels. The most complex layer influencing adoption attitudes is formed by these social factors, which frequently converge with deeply embedded traditional practices and beliefs. Social reasons take precedence over economic factors, such as large initial investments and the return on investment calculation. The problems of digital literacy, infrastructure preparation, and technological interoperability define the technological landscape. Finally, resource scarcity, climate change resilience, and ecosystem services highlight environmental imperatives, which present both difficulties and opportunities.

Farmers in Nepal have a unique opportunity to sell their enormous cardamom on the international market thanks to the ecological surroundings in the Himalayan hills. Nevertheless, the nation does not put much effort into implementing profitable large-cardamom post-harvest upgrading techniques. The implementation of significant post-harvest methods for huge cardamom in the Eastern Himalayan region and the Nepali corridor is examined and discussed by **(Kattel et al., 2020)**. The adoption of main post-harvest practices of large cardamom was positively influenced by a number of factors, including experience, household income from large cardamom, commercial size of production, risk aversion, access to credit, and availability of technical services, according to adoption model results.

In many parts of the world, the adoption of unsustainable farming practices, such as excessive soil tillage without soil coverings, has resulted in accelerated erosion, decreased soil fertility, and degradation of arable land. Food insecurity and lower yields are the outcomes of this. Determining the socioeconomic, biophysical, and institutional elements influencing farmers' decisions to implement conservation agriculture methods in Mozambique was studied by **(Chichongue et al., 2020)**. The findings show that the adoption of CA techniques is influenced by both biophysical factors (perception of falling soil fertility) and socioeconomic factors (household size, animal ownership, communication assets, farmer associations, and gender of the household head).

Using climate-smart agriculture (CSA) techniques is a long-term way to improve food security and agricultural sustainability in the face of climate change. Still, there is a low global adoption rate for CSA procedures. Increasing the spread of CSA practices requires an understanding of the primary drivers behind their adoption. This research **(Li et al., 2024)** offers a comprehensive analysis of the literature, encompassing 190 papers that were published between 2013 and 2023. The study shows that

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the majority of the variables covered in the literature—such as age, gender, education, perception and preference of risk, loan availability, farm size, production circumstances, off-farm income, and labor allocation—have a twofold effect on the adoption of CSA practices, which can be either favorable or negative. The adoption of CSA practices is consistently and favorably impacted by factors like labor endowment, land tenure security, access to agricultural training, access to extension services, membership in farmers' organizations, support from non-governmental organizations (NGOs), climate conditions, and information availability.

Modern agriculture is now mostly driven by labor-saving mechanized technology, yet adoption of these technologies is still low in many developing nations, most notably Ghana. The findings **(Guo & Akudugu, 2023)**indicated that a lack of access to commercial lands, gender prejudices, a lack of financial availability, and a lack of knowledge about the advantages of these technologies are the main causes of the low adoption of agricultural mechanization.

Floods cause devastation for farmers, particularly Assamese rice growers who cultivate sali rice during a flood-prone season. An investigation into the factors influencing the adoption of flood-tolerant cultivars was carried out in the Jorhat area of Assam by(**U. Barman et al., 2023)** , which is regarded as the rice bowl of the state. The findings showed that socioeconomic factors like education, age, occupation, family size, holding size, and interactions with extension agents had an impact on respondents' likelihood of adopting flood-tolerant rice varieties. Nonetheless, it was discovered that the adoption decision was positively and effectively influenced by education and the quantity of interactions with the extension agent.

4. Discussion

The reviewer concludes that a variety of personal factors are influencing the adoption process after taking into account all of these variables and studies written by numerous authors. While some of these writers have combined some factors, the majority of them have taken each one and listed it separately. However, a thorough search for the factors reveals that the majority of them are related to one another. For instance, the degree of education, experience, and age. Farmers who are older have greater farming experience. Throughout their lives, they must have been exposed to a lot of new technologies. Hence, compared to younger and less seasoned farmers, they may have a tendency to adopt the technology much more readily. In contrast, it's possible that the younger farmer has received more education than the more experienced ones. As a result, they might use the technology far more quickly than the more

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experienced farmers. The ability to take risks may vary depending on factors like age, education, and work experience.

Another illustration is that, when it comes to gender issues, the majority of these studies are carried out in African nations where the husband or another male family member leads the home. Women have less decision-making authority in those nations due to social norms and beliefs. However, some authors discovered that there is no connection between gender and adoption even in these nations.

Adoption is impossible because the features of the technology do not meet the expectations of the farmers. As a result, there needs to be a lot of attention paid to this. However, in some circumstances, social influence and the social network may have an impact on the adoption of even these technologies. Additionally, even in cases where the technology is excellent, the user's access to additional information and the information disclosed about it may have an impact on the adoption process.

The availability of the required capital resources and infrastructure is another noteworthy factor. Adoption will be hampered even if the technology is suitable and the end user is willing to adopt, provided that the necessary funding is available.

In conclusion, a variety of factors influence the adoption of technology in the agricultural industry. They are either user- or technology-related factors, or they are institutional factors. However, when considering the majority of the individual characters, they become more connected and related. To ascertain the adoption process of a particular technological advancement, these factors must be examined separately as well as in relation to other factors. Consequently, more research and analysis of these factors' effects is advised in order to determine how they affect the adoption of technology in the agricultural sector both individually and collectively.

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