

Journal of Agriculture



ISSN Online: 2616-8456



Effect of Agricultural Extension Services and Development on Productivity among Small Scale Farmers in India

**Vikram R. Rushdie, Prof. Chetan M. Singh & Amrita Desai
Divakaruni (PhD)**

ISSN: 2616-8456

Effect of Agricultural Extension Services and Development on Productivity among Small Scale Farmers in India

*¹Vikram R. Rushdie, ² Prof. Chetan M. Singh & ³Amrita Desai Divakaruni (PhD)

¹Indian Institute of Technology Madras-India

²Indian Institute of Technology Madras-India

³Jadavpur University, West Bengal, India

*E-mail of corresponding author: rushdievikramr@gmail.com

How to cite this article: Rushdie, V. R., Singh, C. M. & Divakaruni, A. D. (2022). Effect of Agricultural Extension Services and Development on Productivity among Small Scale Farmers in India, *Journal of Agriculture*, 6(2), 11-20. <https://doi.org/10.53819/81018102t4109>

Abstract

Since the history of mankind, agriculture evolved round the basic food needs of man and developed principles and practices in crop production including field management. With changing situation, technological development have shifted the traditional agriculture from mere crop production to mixed farming involving allied activities like animal husbandry, sericulture, pisciculture etc. Need for technological development in agriculture. Extension services have become the gold standard for agricultural development programs to spur farm productivity and enhance farmers' livelihood. Scholars from distinct strands of research have contested the virtues of these programs as systematic reviews failed to disentangle the different causal paths. Despite a wide range of reform initiatives in agricultural extension in India in the past decades, the coverage of, access to, and quality of information provided to marginalized and poor farmers is uneven. While the call for demand-driven agricultural extension has existed in India for several decades now, new modes of reaching out to farmers could have significant impact in India, as they might better reflect the local information needs of farmers. This study therefore sought to find out through literature review the effect of agricultural extension services and development on productivity among small scale farmers in India. Using information provision and access as the basis for analysis, the paper reviewed some of the major agricultural extension programs in India by considering their ability to provide information and facilitate information sharing and use in small scale farming communities in India. The study established that access to information from any source increased with larger farm size in India. Most farmers sought information on seed for cultivation, followed by veterinary care in animal husbandry, and then management and marketing in fisheries.

Keywords: *Extension services, agricultural development, productivity, small scale farmers*

<https://doi.org/10.53819/81018102t4109>

1.0 Background to the Study

Agriculture, which has been around since the beginning of human history, developed on the basis of man's fundamental requirements for sustenance and established various principles and techniques in crop production, including management of fields (Ogundari, 2022). Because of the changing circumstances, advances in technology have caused traditional farming to transition from a focus on crop production to one that emphasizes mixed farming, which includes allied activities such as animal husbandry, sericulture, and pisciculture. As a result, there is a pressing need for technological advancement in agriculture (Netter, Luedeling & Whitney, 2022). Extension services have established themselves as the benchmark for agricultural development initiatives, with the dual goals of boosting farm productivity and improving farmers' standard of living. The value of these programs has been called into question by researchers working in a variety of subfields due to the inability of systematic reviews to differentiate between the various chains of causation. It cannot be denied that agriculture plays an indispensable role in both the growth of the economy and the well-being of its inhabitants. The carrying capacity of farm productivity is under stress as a result of rising food costs, the depletion of natural resources, and the negative consequences of climate change. This has far-reaching repercussions for the livelihoods of farmers (Jarial, 2022). The expansion of land area, an increase in cropping frequency achieved by increased water irrigation, and an increase in yields are the primary contributors to the rise of plant output. Given that the potential for land expansion and the availability of water supply appear to be reaching their limits from a global perspective, a more effective use of natural resources through innovative methods of farming will continue to play a substantial role in the future. This is because global food production is expected to increase substantially over the next few decades (FAO, 2020).

In the 20th century, an innovation known as agricultural extension was developed with the goals of fostering agricultural development and creating incentives for farmers to adopt new modern technology through the decrease of expenses associated with the acquisition of information (Alexandratos, 1995, Anderson and Feder, 2004). Extension programs have been implemented on a global scale with the intention of enhancing human capital through disseminating information to farmers regarding production techniques, efficient input utilization, and management practices (Alene & Hassan, 2020; Dinar et al., 2017). The majority of the approximately one million extension workers that provide daily advice to farmers around the world are concentrated in low- and middle-income nations, with the majority of these agents being based in Asia (70%) in particular (Bahal, 2021). Despite the fact that many achievements have been recorded, skeptics believe that there are flaws in the performance of extension systems. These flaws could be the result of low staff morale, financial stress, poor interaction with agricultural research, misuse of extension officials for political purpose, or the inability to ensure farmers' interest in training over the long term (Agitew *et al.*, 2018).

Numerous aspects that could potentially have an impact on the estimated technical efficiency have been the subject of discussion among academics. These aspects include econometric methods, the selection of a functional form, the type of data, mathematical programming techniques, and the number of observations (Bravo-Ureta et al., 2019; Thiam et al., 2021). Nevertheless, the effect of extension measures on technical efficiency is a critical variable that has been largely disregarded by prior study that utilized meta-analysis. Extension services can be provided by governments to provide help for farmers. These services comprise a wide variety of communication and learning activities that are conducted by educators specifically for farmers. Farmers can receive education

<https://doi.org/10.53819/81018102t4109>

from extension agents in a variety of topics, including harvesting and conservation methods, the application of new technologies, fertilizers, and pesticides, as well as technical instruction on plant production or agricultural marketing. Extension services are associated with a robust social character, and their work has grown more diverse as a result of the provision of socio-demographic counseling. This is done in order to sustain not only the income levels of farmers, but also to protect rural livelihoods (Swanson, 2020). Agricultural extension is part of a larger knowledge system that includes research and agricultural education. Its primary goal is to improve farm productivity by leveraging agriculturally relevant technology, information, and knowledge (Rivera, 2021).

Application of the approach framework provided by the Agriculture Innovation System (AIS) is required for multi-stakeholder interactions. According to the World Bank (2019), the Agricultural Information System (AIS) is defined as the entirety of organizations, enterprises, and individuals that both demand and supply agriculture-related knowledge and technology, as well as the rules and mechanisms by which these various agents interact. In addition to this, the innovation system method necessitates the collaboration of stakeholders from both the demand and supply sectors in the form of joint learning encounters in order to produce knowledge that is both locally relevant and applicable on a broad scale (World Bank, 2022). According to Ayele et al. (2022), the framework was successfully used to the invention of fodder in the countries of Ethiopia, Syria, and Vietnam. Interactions between numerous players, collective education on farms, and network linkages to businesses with a focus on the market all contributed to the inception and spread of the idea. Through the sharing of knowledge, this innovation process contributed to the creation of value among social actors. As a result, the examination of non-technological elements such as fodder markets systems, social networks, and institutional changes required in the system along with the promotion of novel feeding technologies in dairy farms can be incorporated into the innovation systems framework study.

According to the authors Van den Ban and Hawkins (2019), the term "extension" refers to the deliberate use of transmission of information in order to assist individuals in the formulation of reasonable viewpoints and the selection of appropriate actions. Moris (2021) characterized extension as the process by which information and new technologies are transferred to farmers. The World Bank provides a definition of extension services that is more all-encompassing by stating that it is "the process that helps farmers become aware of improved technologies and use them in order to improve their efficiency, income, and welfare" (Awulachew et al, 2021). The empirical literature that was compiled from a variety of studies on the effects of agricultural extension services on production does not provide a definitive answer. For instance, Betz (2019) pointed out that prior research on the effects of agricultural extension on production had produced conflicting findings. Because of the way in which the methodological challenges of endogeneity, heterogeneity, and measurement of productivity variable are approached, the findings addressing the impact of agricultural extension on productivity have been shown to be inconsistent. The literature on agricultural productivity and extension exposes a variety of methodological issues, which makes it difficult to make broad generalizations regarding the influence agricultural extension services have on the productivity of agricultural production.

The purpose of agricultural extension is to improve farmers' knowledge and abilities in order to increase yield (Mitala, 2022). From a global viewpoint, agricultural extension programs are highly diverse. The majority are run as public sector organizations and are often housed under the ministry of agriculture, however some are in other departments like rural development or education. Nongovernmental groups oversee many (NGOs). Numerous private businesses and organizations

run extension programs. The degree of decentralization of management of extension services varies greatly, even within the most common organizational structure, where extension is a part of the government's ministry of agriculture (Rivera, 2022). Extension is decentralized in certain nations, such as India, where it is a governmental concern. However, government services are typically highly centralized in emerging nations, with many regional and subregional divisions created to serve local areas. The amount of expertise and agricultural knowledge of field employees also varies greatly. Some systems offer limited formal technical training in the agricultural sciences for the field personnel. This is mandated in certain situations by a village worker's mindset and in others by requirements of the local tongue. However, in the majority of situations, it is merely a consequence of the decisions made in the 1950s and 1960s to rapidly develop agricultural extension programs at a time when there were few highly qualified agriculturalists available (Bindlish & Evenson, 2021; Bindlish, Gbetibouo, & Evenson, 2018 for African studies; and Swanson & Claar, 2018 for a general history).

The range of talents, management practices, and goals has also evolved over time in different nations. The training and visit (T&V) system was developed in the 1970s by Benor, Harrison, and Baxter (2019) and put into place in many nations with the help of World Bank lending. It is possible that this system is to blame for the significant changes in the management and design of agricultural extension systems over the past forty years. Because of this variability, it is impossible to make generalizations regarding the economic value of agricultural extension to the development of agriculture. The efficiency of extension programs is affected by numerous situation-specific elements. The fact that many extension programs have undergone extensive modification and redesign shows that some of them were thought to be less than totally effective by their sponsors.

According to Kamal, Sheikh, Azhar, Munir, Baig, and Reed (2022), extension can refer to a wide range of activities and strategies rather than one single, universal form. Agricultural extension is the most common type of extension seen in rural regions because agriculture is the foundation of a rural economy, as was already mentioned. However, the knowledge and fresh perspectives that farmers and their families need are not only related to agriculture (Kamal et al., 2022). There are other facets of family life that could benefit from improved understanding and methods. Any endeavor that works with farmers and their families to enhance their economic and social circumstances and foster their capacity to take charge of their own future development is known as extension. There are probably more extension agents active in agricultural activities than in any other element of rural life, but this extension can take many different forms, therefore it would be instructive to cover the two most common ones (Fabregas, Kremer & Schilbach, 2019). This emphasis on agricultural extension is appropriate given the significance of agriculture and the necessity to generate food for both the farm family and the country as a whole. A single crop serves as the foundation for certain agricultural extension services, while others take a "whole farm" approach. The local agricultural system and the requirements for the country's crops have a significant impact on the decision. The single crop extension strategy is more prevalent in areas where cash crops like cotton, cocoa, or sugar are grown.

Extension tries to improve farm operations and farmer families' lives overall on the farmer's own initiative and aims to alter the outlook and attitude of the agricultural community as a whole (Zabel, Delzeit, Schneider, Seppelt, Mauser & Václavk, 2019). The majority of farmers are small-scale and subsistence farmers, thus they don't have direct access to new agricultural technologies. This set of farmers needs to be educated over time in order to stay up with the continuously evolving agricultural technology. To prevent uneven development, the philosophy of extension is primarily

<https://doi.org/10.53819/81018102t4109>

built on the growth of the individual farmer and interaction among the many segments of the rural society (Zabel et al., 2019). The farm family is the first training group that comes to mind while considering this procedure because the individual farmer is king. Second, extension services are provided to help plan, carry out, and assess the technological advancements made by farmers. Thirdly, rather than pressuring the farming community to adopt the newest advancement, extension attempts to educate and inspire them to do so through an organic response. Naturally, specific methods and equipment are needed to empower the populace and make sure the extension agency serves as a catalyst or change agent.

1.1 Statement of the Problem

Despite a wide range of reform initiatives in agricultural extension in India in the past decades, the coverage of, access to, and quality of information provided to marginalized and poor farmers is uneven (Agriculture and farmers welfare India, 2021). Although the need for demand-driven agricultural extension has been voiced in India for a number of years, new ways of connecting with farmers could have a big impact there since they may better capture their local information needs. Agroclimatic areas and socioeconomic conditions in rural populations are widely varied in the Indian subcontinent, necessitating agricultural extension strategies that are situation- and context-specific.

Indian small-scale farmers must contend with a plethora of new obstacles. These include declining access to land and water, which is made worse by resource depletion; climatic changes; shifts in demand and consumption patterns toward high-value agriculture; rising population pressure; and trade liberalization (Lele *et al.* 2020). High levels of inflation and recent increases in food prices worldwide have given farmers the chance to become more profitable. However, in order for farmers to benefit from better prices, they must have access to a larger range of information, including knowledge on post-harvest procedures, access to profitable marketplaces, price information, and business growth (Sulaiman & van den Ban 2019). Agricultural extension and development projects in India have received renewed interest and funding, but their reach is still insufficient. The reach of government extension programs, national agricultural research system extension services, cooperatives, and voluntary extension programs is relatively constrained (NSSO, 2022). Therefore, the purpose of this study was to determine through a review of the literature how agricultural extension services and development affected small-scale farmers' production in India.

2.0 Empirical Review

Alvi, Barooah, and Gupta Saini (2021) evaluated women's access to agricultural extension during COVID-19 and found the following: The rural sector, notably women farmers, has been significantly impacted by COVID-19-induced lockdowns, according to findings from Gujarat, India, and Dang, Nepal. The study intended to determine how the lockdowns and their effects on agricultural productivity affected women's access to agricultural extension by using panel phone survey data from India and Nepal. The results showed that women's already limited access to official extension was further restricted, causing them to depend more heavily on informal social networks. Nearly 50% of farmers in both nations reported decreased output as a result of information being inaccessible during the lockdown. The study found that access to formal extension in India was influenced by crop type, region, and caste identification. The study presented recommendations for improving the inclusiveness and crisis-resilience of the extension systems in India and Nepal, including adapting group- and community-based strategies to post-

pandemic best practices.

In 2019, Abdullah *et al.* evaluated the issues Pakistani rice farmers faced and how they reacted to government measures. The primary goal of the study was to investigate the challenges faced by rice farmers during the production, crop protection, and marketing phases of rice cultivation. Due to the considerable rice cultivation in these locations, two of the four tehsils of the district of Sialkot were specifically chosen. Ten villages were randomly chosen from each tehsil, and six farmers were randomly chosen from each village. The research revealed that farmers believed that the biggest issues during the rice crop's production stage were the high price of fertilizer, a lack of canal water, high prices for agricultural inputs, high rent costs for agricultural machinery, a lack of consulting services, and a lack of credit or financing. The farmers listed expensive pesticides, weedicides, and inefficient fungicides as challenges connected to rice crop protection, whereas issues with rice crop marketing included low pricing offered for the food, poor transportation, storage problems, and a lack of market awareness.

The Ministry of Agriculture and Farmer's Welfare at the central level; State Agricultural Universities and the State Department of Agriculture, Cooperation, and Farmer's Welfare at the state level; and the District Department of Agriculture, Animal Husbandry, Horticulture, Fisheries, Krishi Vigyan Kendras, and Agriculture Technology Management Agency (ATM) and other public sector organizations, according to Rivera (2022). Particularly in distant locations without institutional extension networks, private input companies and smaller fertilizer dealers serve as a vital informational resource for farmers. Furthermore, according to Nikam, Ashok, and Pal (2022), a large number of grassroots and civil society organizations are engaged in agriculture extension initiatives across the nation. Agriculture extension has changed dramatically over the past three decades, moving from the old, top-down "training and visit" strategy to one that is more decentralized, participatory, and demand-driven. To make it easier for women farmers to be mainstreamed, special provisions have been provided in a number of national programs. The ATMA program dedicates 30% of the total budget to women beneficiaries across all active programs and initiatives.

In Cole's analysis from 2022, rice production limitations and "new" obstacles for South Asian smallholders were also examined, along with an understanding of de facto research objectives. The research found that although accounting for more than 22% of rice yield losses in the South Asian farming systems evaluated, socio-economic production constraints have gotten very little attention from the scientific community. Furthermore, despite the fact that research papers have a tendency to focus on the most significant barriers to rice production and link those barriers to problems identified by environmental disciplines, there are numerous medium- and small-scale production barriers that have received little research attention. This is true even though the combination of these less severe limitations accounts for the largest share of lost rice yields. The study came to the conclusion that while national and international research bodies are aware of the difficulties faced by smallholders, there appears to be a lack of coordination in the determination of research priorities because many fields, particularly those in the social sciences, are not receiving the attention they deserve when compared to the opportunities that improvements in this field could offer, as this study has shown.

Arida (2019) identified issues with rice growing from the viewpoint of Filipino farmers. The goal of the study was to find patterns in the typical issues that farmers face. It also sought to identify which of these issues has the greatest impact on rice output. In this investigation, straightforward

statistical tools and a production function were employed. The findings showed that high input costs, low palay prices, a lack of capital, a labor shortage, a lack of post-harvest facilities, pest and disease problems, and irrigation system deficiencies were the most frequent issues faced by rice producers. The findings also indicated that productivity is strongly impacted by financial constraints, pests, and diseases during the wet season, while irrigation systems have a significant role in both seasons. This suggests that a rise in these variables would significantly lower the production.

3.0 Methodology

This study aimed to identify the factors that prevent the majority of small-scale farmers in India from obtaining agricultural extension services, information, and knowledge gaps, as well as the effects of extension services and development on productivity. The report assessed some of the major agricultural extension programs in India by taking into account their capacity to give information and allow information exchange and usage in small scale farming communities in India, using information provision and access as the basis for analysis. The review provided a synthesis of current arguments and the views of numerous authors, with a general focus on extension services and development projects in India.

4.0 Findings and Discussion

The vast majority of studies that have been conducted on the effects of agricultural extension on output and other outcomes make the assumption that extension services are provided solely by extension workers. Therefore, dummy variables have been employed as variables to capture extension contact, such as whether a farmer has been visited by an extension worker or not, or the number of visits by an extension worker. The usage of an extension contact variable implies the presumption that only extension workers can provide information about agricultural extension. This suggests that information exchange between farmers and other sources of agriculture information, such as radio, farmer-to-farmer, television, telephone, internet, newspapers, magazines/bulletins, and agriculture shows/exhibitions, among others, is not taken into account by the available evidence on the impact of extension. The calculated coefficient on the extension variable, as a result, is skewed lower according to several research. It is true that most farmers benefit from extension without speaking to extension staff members directly.

The results showed that in India, larger farms were associated with greater access to information from all sources. The majority of farmers looked for information on seeds for planting, then on veterinary care for animals, and finally on management and marketing for fisheries. Other farmers served as the primary information source, followed by input dealers, radio, TV, and newspapers. Only 12% of the population used information from the public sector. Smallholder farmers generally relied on other progressive farmers, input dealers, and radio for information, whilst medium- and large-scale farmers utilized radio, TV, and newspapers equally. This is in contrast to the 40% of farmers who had access to information. Medium- and large-scale farmers had nearly twice as much contact with extension agents than smallholder farmers did.

Based on most of the empirical studies, given the increased attention devoted to agricultural extension, or agricultural advisory services, by governments and donors worldwide, there is a growing body of literature examining and reviewing agricultural extension. However, within the existing literature, no common analytical framework that can be used to compare and review agricultural extension programs is defined, though there are a number of common themes and

issues that are tackled similarly in different reviews.

The scale and complexity of agricultural production, reliance on the broader policy environment, weak links between the extension and research systems, difficulty attributing impact, lack of accountability, lack of political commitment and support, public duties other than knowledge transfer, and challenges with fiscal sustainability are also shown to contribute to small farmers' poor extension performance in India. A holistic strategy to agricultural extension and development today goes beyond technology transfer for important crop and livestock production systems, as is also clear from the data. Along with social capital development objectives, such as forming producer groups, it also includes human capital development objectives aimed at improving farm households' management and technical skills in relation to the production and post-harvest handling of high-value crops, livestock, and fisheries, sustainable natural resource management, family health and nutrition, and leadership and organizational skills.

5.0 Conclusions

The study comes to the conclusion that information flow occurs linearly throughout the Indian public sector, with content concentrated on the transfer of technology to boost crop output. Agriculture extension has not been given a more inclusive definition that goes beyond increasing crop productivity. Farmers view the quality of the information provided by the public extension personnel as a significant deficiency because the information flow is supply-driven rather than needs-based or region-specific. This is because the organization continues to use a top-down hierarchical structure and is rigid and static in nature. Due to the poor degree of outreach by public extension agencies, access to extension is also a problem. This is largely because public employees are overworked implementing centralized and state-level policies, which are also difficult to adapt to local conditions and requirements.

The effectiveness of private extension in India clearly varies, despite the fact that few empirical studies have been conducted. It tends to concentrate its services in regions with ample resources and is restricted to a few crops and regions where profits can be guaranteed. This idea has already been put out in the discussion of the e-Choupal project, which provides services to bigger villages and particular types of crops. Additionally, while the private sector works with individual farmers to advance corporate interests, social capital is not created. Furthermore, farmers must be ready and able to pay for private extension to function effectively. One idea put out by several of the studies is that the public sector might work in distant areas, which are currently underserved, while the private sector may cater to the requirements of medium-sized and commercial farms. Such a system would call for public-private partnerships, which are now nonexistent in India.

Furthermore, despite the pluralistic extension system in India with the public sector, private sector, and third sector all playing some roles this review concludes that the sectors tend to work in isolation from each other. The difficulties of working with the public sector mean that the private sector has few partnerships with public-sector extension. The scale and complexity of Indian agriculture, with many small scale farmers, remote regions, poor and subsistence farmers, and varied farming systems, means that a pluralistic extension system, as encouraged by the policy framework on agricultural extension, will reach farmers more effectively than a will focus on one method of funding and delivery. Finally, a number of empirical studies have shown that Indian agriculture faces serious challenges because of ever-increasing population, limited land and water availability and degradation of natural resources. The national average yields of most commodities are low. In many areas there are limits to achievable increase in productivity, unless appropriate

institutions that can help farmers to access information, inputs and services are strengthened, and joint action for natural resources management, marketing and processing are promoted. New opportunities and threats for trade in international markets have also added a new challenge for Indian small scale farmers. Agricultural extension services therefore need to play a much larger role in assisting farmers in meeting the above challenges.

6.0 Recommendation

Based on the findings from the reviewed literature, if extension services and development programs in India is to remain relevant, particularly for marginal and smallholder farmers in rainfed regions, it needs to evolve to provide a diverse set of services that support agricultural livelihoods, offering relevant technologies that are integrated with appropriate services. Additionally, agricultural extension should support and address relevant areas beyond the farm, such as storage, processing, market access and trade, agribusiness management and entrepreneurship, natural resource management, and issues related to women. Within the paradigm of innovation systems, extension agencies can act as innovation intermediaries or innovation brokers, working with many partners to strengthen linkages and provide support for innovations.

Additionally, the results of this study imply that there should be innovations in extension delivery that embrace many approaches and provide adaptable solutions to meet the demands of users in various states, regions, and communities. Extension must be able to address new agricultural challenges. All participants in the food and agricultural value chain must collaborate, contribute knowledge, and share that knowledge with users for the content to be a part of an integrated knowledge system. The Indian government should adapt by working with both for-profit and nonprofit players to close the various gaps that still exist. This ought to open the door for later commercial agriservice supply to unserved regions of the nation. The Indian government should also carefully examine each state and crop. Funding may become a problem, but other challenges are more likely to arise due to a greater political commitment to agriculture, institutional problems, implementation problems, management problems, and organizational problems. In India's agriculture and rural development, implementation issues are frequently highlighted as a barrier, raising the question of how the government can provide the necessary skills, desire, and sense of purpose.

References

- Alvi, M., Barooah, P., Gupta, S., & Saini, S. (2021). Women's access to agriculture extension amidst COVID-19: Insights from Gujarat, India and Dang, Nepal. *Agricultural Systems*, 188, 103035.
- Cole, R. (2022). Prospects and limitations of 'Responsible Agricultural Investment' for governing transboundary agri-food systems in Mekong Southeast Asia: Implications for upland maize in the Lao-Vietnamese borderlands. *Environmental Policy and Governance*, 32(4), 362-373.
- Fabregas, R., Kremer, M., & Schilbach, F. (2019). Realizing the potential of digital development: The case of agricultural advice. *Science*, 366(6471), eaay3038.
- Farid, M., Fayyaz, A., Ahmed, E., Arooj, M., Ali, S., Sarfraz, W., ... & Rasheed, Z. (2022). Increase in Food Scarcity, Agricultural Challenges, and Their Management: Pakistan

- Perspectives. In *Managing Plant Production Under Changing Environment* (pp. 437-458). Springer, Singapore.
- Fathonah, F. I., & Mashilal, M. (2021). Rice Production Analysis in Reflecting Rice Self-sufficiency in Indonesia. In *E3S Web of Conferences* (Vol. 316, p. 02041). EDP Sciences.
- Jarial, S. (2022). Internet of Things application in Indian agriculture, challenges and effect on the extension advisory services—a review. *Journal of Agribusiness in Developing and Emerging Economies*.
- Kamal, A. B., Sheikh, M. K., Azhar, B., Munir, M., Baig, M. B., & Reed, M. R. (2022). Role of Agriculture Extension in Ensuring Food Security in the Context of Climate Change: State of the Art and Prospects for Reforms in Pakistan. *Food Security and Climate-Smart Food Systems*, 189-218.
- Mitala, Y. (2022). *The role of mobile phone short message service (SMS) in the provision of agricultural extension services: the case of Momulimisa in Lira district* (Doctoral dissertation, Makerere University).
- Netter, L., Luedeling, E., & Whitney, C. (2022). Agroforestry and reforestation with the Gold Standard-Decision Analysis of a voluntary carbon offset label. *Mitigation and Adaptation Strategies for Global Change*, 27(2), 1-26.
- Nikam, V., Ashok, A., & Pal, S. (2022). Farmers' information needs, access and its impact: Evidence from different cotton producing regions in the Maharashtra state of India. *Agricultural Systems*, 196, 103317.
- Ogundari, K. (2022). A meta-analysis of the impact of agricultural extension services. *China Agricultural Economic Review*.
- Rivera, W. M. (2022). India's Agricultural Extension Development and the Move Toward Top-Level Management Training. In *Agricultural Extension Worldwide* (pp. 225-250). Routledge.
- Zabel, F., Delzeit, R., Schneider, J. M., Seppelt, R., Mauser, W., & Václavík, T. (2019). Global impacts of future cropland expansion and intensification on agricultural markets and biodiversity. *Nature communications*, 10(1), 1-10.