Economic Affairs, Vol. 68, No. 04, pp. 1937-1945, December 2023
DOI: 10.46852/0424-2513.4.2023.5

AESSRA

Research Paper

Capability Enhancement of Agricultural Extension Personnel through ICT Interventions and its Economic Impact in Bangladesh

Md Forhad Rabbi[1]*, Zafrin Ahmed Liza[2] and M. Shahidur Rahman[1]

[1]Department of Computer Science and Engineering, Shahjalal University of Science and Technology, Sylhet, Bangladesh
[2]Department of Anthropology, Shahjalal University of Science and Technology, Sylhet, Bangladesh

*Corresponding author: frabbi-cse@sust.edu (**ORCID ID:** 0000-0002-2468-7973)

Received: 15-09-2023 **Revised:** 02-11-2023 **Accepted:** 30-11-2023

ABSTRACT

In this paper, we evaluated the performance of various ICT interventions to empower agricultural extension personnel, especially the Sub Assistant Agriculture Officer (SAAO) and Upazila Agriculture Officer (UAO), the major stakeholders in Bangladesh's existing agricultural extension system. It is usually challenging for extension staff to keep track of their services and get up-to-date agricultural knowledge in developing nations due to the enormous geographical area and quantity of farmers and insufficient training and monitoring. Different ICT applications and tools, such as online and offline agricultural consultation services applications, a digital diary for recording the daily activities of the SAAOs, a monitoring system for the UAOs, and audiovisual materials have been developed to support the extension people. The evaluation was done after collecting data from Focus Group Discussions (FGD), Key Informant Interviews (KII), surveys, and server-side data processing. This study revealed that ICT applications have increased the knowledge base, efficiency, confidence level, and acceptance of the SAAOs and improved the financial aspects of the agriculture extension services. Thanks to ICT interventions, farmers receive timely and quality services from SAAO, leading to increased crop production and a better lifestyle for farmers.

HIGHLIGHTS

- Agriculture Extension officers try to reach each farmer in their area and provide advice and suggestions. However, it is hard to reach everyone in person due to the low number of officers and the large number of farmers in large areas.
- ICT interventions like mobile applications for various purposes and audio/visual materials can assist SAAO and UAO.
- Mobile apps help access modern knowledge of cultivation and reporting day-to-day activities.
- Farmers get the required support from agriculture extension officers for their farming, which makes them financially empowered.
- Rural female farmers can financially contribute to their families by getting adequate support from the SAAO for their garden farming.

Keywords: ICT Interventions, Agriculture Extension officer, Farmers, Mobile Applications,

Agriculture is the most important economic sector in Bangladesh. This sector alone contributes 19.6% to the national GDP and employs 63% of the total population (Encyclopedia, 2010). Moreover, the poverty reduction in rural Bangladesh solely depends on agriculture. From 2005 to 2010, 90% of

How to cite this article: Rabbi Md. F., Liza, Z.A. and Rahman, M.S. (2023). Capability Enhancement of Agricultural Extension Personnel through ICT Interventions and its Economic Impact in Bangladesh. *Econ. Aff.*, **68**(04): 1937-1945.

Source of Support: None; **Conflict of Interest:** None

the poverty reduction in Bangladesh happened due to agriculture (World Bank, 2016). However, the true potential of this sector is yet to be fully utilized. Lack of scientific knowledge and tools among the farmers and agricultural extension systems are obstructing the advancement of agriculture to a great extent. Most of the farmers in Bangladesh are illiterate or low literate. They mostly rely on traditional farming techniques. The agricultural extension system comprised of government and non-government officials does not have enough manpower to reach all the farmers, especially the marginal ones. These farmers then seek advice from nonexperts, which can be detrimental to the farmers' overall crop production and economic condition (Van Loon *et al.* 2020).

Another notable problem is that the agricultural extension system severely lacks efficient decision-making strategies. The traditional data collection system is paper-based and takes much time and resources. As a result, it becomes harder to analyze real-time data and send instructions to the farmers (Fabregas *et al.* 2019). The Sub Assistant Agriculture Officer (SAAO) plays the most crucial part in Bangladesh's agricultural extension system. Bangladesh's" Upazila" (Sub District) is divided into several unions. For each Union, three SAOOs are assigned by the government. They collect information from the field and send it to the Upazila Agriculture Officer (UAO). They also provide consultation to the farmers regarding various farming issues. Unfortunately, due to the huge number of farmers in each union, it is nearly impossible for the SAAOs to provide services properly. Farmers complain constantly that the SAAOs are not available when the farmers need them the most. Moreover, the SAAOs struggle to stay updated about modern agricultural methods and equipment (Sennuga 2019).

Agricultural Extension Support Activity (AESA), a project funded by USAID, focuses on solving the above-mentioned problems using Information and Communication Technology (ICT) strategies. Mobile applications, websites, call centers, and multimedia content are developed to help the SAAOs and UAOs in better serve the farmers. The four ICT applications of AESA are as follows:

- Farmer Query System (FQS)
- Crop Diagnostic Application (CDA)
- SAAO Digital Diary and
- Audio/Visual Materials

FQS is a mobile application designed specifically for farmers. Using this application, farmers can send agricultural problems they face using detailed descriptions and pictures. A call center receives the queries, and in response of the queries, SAAOs provide solutions through SMS and phone calls. This application helps the SAAOs interact with the farmers effectively, saving time and resources.

CDA is a smartphone application that answers different agricultural queries based on its contents. SAAOs and farmers can search the apps for curative measures and pesticide information. There is information on ten plants: peanut, chili, mung bean, jute, eggplant, corn, ladyfinger, sunflower, rice, and lentil.

SAAO digital diary is a smartphone application developed for the SAAOs. This app replaces the previous paper-based system. Using this app, the SAAOs can store information about their daily field visits and the services provided to the farmers. Their supervisor, a UAO, can monitor their daily activities from a website that displays the stored contents of the SAAOs. This application helps in maintaining the accountability and transparency of the SAAOs who are in the front line of the agricultural extension system.

Lastly, the Audio-Visual materials are based on six videos demonstrating five key cultivation practices. These contents are created to share modern agricultural knowledge among the SAAOs and the farmers.

This paper evaluates the impacts of the above-mentioned ICT applications and tools on public extension agents (SAAO, UAO). The effectiveness of such applications in improving the agricultural knowledge base of the extension agents is thoroughly examined. The constraints and challenges of these applications in terms of design, navigation, and productivity are also analyzed.

This study employed qualitative and quantitative methods to determine the impacts of ICT interventions on extension agents. The quantitative method includes survey and server-side data. Qualitative methods such as focus group discussions

(FGD) and key informant interviews were conducted among the SAAOs to identify the impacts of FQS, SAAO digital diary, and other ICT applications. The duration of data collection through FGD and KIIs was from January 26 to January 30, 2018, and through the survey was from February 05 to February 16, 2018.

The key findings of this study show the significance and relevance of the implied ICT applications and tools for enhancing the overall excellence of the agricultural extension system in Bangladesh.

RELATED WORK

Designing ICT intervention for agricultural development is a challenging task. Such an endeavor requires extensive planning, analysis, and multi-dimensional efforts (Aker 2011). The scope of ICT is vast and versatile. Integrating ICT strategies for solving any social and economic issue offers an array of potential outcomes. With the introduction of advanced technology, researchers are trying to make scientific equipment, strategy, and logistic support available to modernize the agricultural knowledge base. Integrating ICT for agricultural development is extremely necessary. Information related to crop area, cultivation techniques, production forecasting, product marketing, and pest and disease control can be disseminated to the stakeholders by using scientific tools and strategies (Kashem *et al.* 2010). A central database for informing the farmers will positively and powerfully impact their lives (Kashem *et al.* 2010). Both governmental and non-governmental organizations have taken ICT initiatives to improve Bangladesh's agricultural sector. Many of those initiatives were based on mobile phone technology (Mittal, 2012).

In Bangladesh, mobile phones are used extensively in rural areas. This is considered an easy and convenient method of communication and information sharing. This technology also helps in organizing social and collective efforts for better management of agricultural resources (Liton *et al.* 2017). Pallitathya was a mobile phone-based helpline project undertaken by D.Net, a non-profit organization (Roy, 2009). It successfully created an information-sharing system for the rural farmers of Bangladesh. This project specifically emphasizes the technological inclusion of marginalized rural people (Coote *et al.* 2016).

Implementing ICT strategies in agriculture is also common in other developing countries. An Interactive Voice Response (IVR) system has been developed in Pakistan to examine the acceptance of digital information sources among the less tech-savvy farmers Riaz *et al.* (2017). Avaaj Otalo is a voice interaction-based social forum designed for farmers in Gujrat, India (Patel *et al.* 2010). This social forum gave the farmers a chance to create an online community where they can post their queries and learn from the responses of their fellow farmers. Lifelines is another social forum developed for the rural farmers of India where the farmers can ask questions related to different agricultural issues to a call center (Lifeline, 2019).

The answers collected from the experts are then sent back to the farmers. The Forum for Agricultural Research in Africa (FARA) created an inventory consisting of farming advice for agroconsultation among farmers with limited internet access (Gakuru *et al.* 2009). One of the major objectives of ICT intervention in agriculture is to provide services to the marginalized and overlooked farming community. In Uganda, the Women of Uganda Network (WOUGNET) took steps to train rural women who are heavily engaged in producing and marketing agro-products (Ugandanet, 2019). Their study showed that ICT-based projects should not rely on a single form of technology but on a collective form of innovative tools. In ICT-based agricultural implementations, service providers also face numerous challenges. This includes low literacy rate, unawareness of technology, weak mobile network coverage, unsuitable interface design, the complexity of shared information, and trust issues (Harris and Achora, 2018).

Another important element of the agriculture sector, the agricultural extension system requires rigorous ICT strategies for staying updated with modern agricultural knowledge. In a study (Islam *et al.* 2017), agricultural extension agents used the mobile phone heavily for communication. However, only 5.5% of respondents out of 110 used mobile phones to provide agro-consultations. Even after providing ICT tools to the extension agents, they sometimes remain reluctant to utilize them effectively (Thiga and Ndungu, 2015). Lack of training, illiteracy, and unwillingness to improve the knowledge base are the reasons for this reluctance among the extension

officers. Agroconsultation initiatives normally take farmers as the major stakeholders.

The agricultural extension agents (SAAO, UAO) received proper training and equipment for tackling modern-day agricultural challenges in this project. From the findings of the previous studies, implementing ICT intervention in agriculture certainly requires collaboration from different domains. Most importantly, the appropriateness of an ICT strategy depends mainly on various factors, including the demographic information of the stakeholders, the sustainability of the services, and the solution's effectiveness (Parveen *et al.* 2005).

METHODOLOGY

The main target audience of this study is the extension agents (SAAO, UAO). It was imperative to design a suitable data collection methodology that could provide valuable insights into the impacts of ICT among the SAAOs. Therefore, qualitative and quantitative research approaches were employed to understand the target audience better. The following methodological steps are followed in this study (Richardson, 2006):

- Focus Group Discussion (FGD)
- In-Depth Interview
- Survey Data Analysis
- Server-Side Data Analysis

1. Qualitative Approach

FGD and KII methods were used to collect qualitative data from the extension agents. These methods were time and resource-efficient and perfectly suitable for empirical data collection. Semi-structured interviews were prepared for FGD, and unstructured interviews were prepared for KII. Qualitative data were collected from six different areas of Jessore and Sathkhira districts. The collected data infers the adoption scenario of the ICT apps, the impacts and limitations of those apps, and the effectiveness of ICT-based solutions in improving agricultural aspects.

1.1 Focus Group Discussion

For the FGD, a mixed group of farmers and SAAOs were selected. Six FGDs were conducted among six different groups. These discussions focused on using FQS, CDA, and Audio/Visual materials. The questions asked in the FGD covered the following topics:

- Demographic information of the group.
- Usage history of the ICT apps.
- Effectiveness of the apps in mitigating their agricultural needs.
- Issues related to the navigation and usability of the apps.
- Future scope of the apps.
- Impact of these apps on their lives

In each group, there were 12-15 members. The FGDs were recorded and stored on mobile devices for further analysis.

1.2 In-Depth Interview

Four in dept interviews were conducted among four SAAOs. Like the FGD, the impacts and effectiveness of the ICT apps and the Audio-Visual materials were studied in these interviews. The major difference with FGD is that these interviews were completely unstructured. The participant got the chance to express their opinions in more detail. All the interviews were recorded on mobile devices for further analysis.

2. Quantitative Approach

Quantitative data was collected from Surveys and server-side data. Extension personnel from three different regions of Bangladesh were selected for this purpose.

2.1 Survey Data

A survey was conducted among 151 extension agents using a structured questionnaire. The questionnaire covered the (i) demographic information of the respondent, (ii) Usage scenario of ICT apps, (iii) Impact of ICT strategies on agriculture, (iv) Degree of satisfaction, (v) Knowledgebase of these apps, and (vi) Implications and challenges in navigating the apps. Answers were recorded using a set of predetermined possible answers and rating scales. Later, the surveys were transferred into Google Forms for better analysis.

2.2 Server-Side Data

This is the largest source of quantitative data in this study. 79,984 user data of FQS, 49,736 user data of CDA, and 38,361 user data of SAAO Digital diary have been analyzed to find the impacts of the ICT apps on the target users. The data obtained from FQS and CDA contain the queries posted by the users alongside other relevant information. The SAAOs recorded their field visit-related data on the digital diary, which was further analyzed to find significant insights.

3. Ethical Consideration

While conducting FGD, KII, and surveys, the ethical code of research was consciously followed. The participants were not harmed, and their full consent was asked before collaboration. They were aware of the objective of the study. The participation was voluntary without any monetary support or other rewards.

DESIGN AND DEVELOPMENT OF THE ICT APPLICATIONS

MPower Social Enterprises Ltd. develops FQS, CDA, and SAAO digital diaries and Audio-Visual materials. Before developing the apps, rigorous studies were conducted to identify the farmers and the SAAO's needs and expectations from ICT-based agro-consultation systems. Agricultural contexts technical and socio-economic conditions of the target users were considered while doing surveys. Based on the findings of these surveys, three ICT-based solutions were developed to improve the agricultural extension system. A mid-level project evaluation has been conducted by the Institute for Computing in the Humanities, Arts, and Social Sciences at the University of Illinois Urbana-Champaign.

1. Evaluation of the Development Process of ICT apps

Developing software for less tech-savvy users is always a challenging task. In this AESA project, the target audiences are unaware of their needs. The SAAOs had no idea about integrating technology to solve their problems. Moreover, it was difficult for them to express their requirements, which a software-based solution can implement. It was also difficult for the development team to gather the functional and non-functional requirements from the target users. It took nearly nine months to plan and conduct requirement elicitation and specification. The SAOOs and UAOs participated in FGD and KII to help the developers in the requirement specification process.

The development team used several prototypes and took feedback from the SAAOs and UAOs. This gave the target audience a chance to collaborate with the development process. It also helped the developers modify the applications based on the users' opinions.

FINDINGS ON THE USAGE OF ICT APPS

FQS, CDA, SAAO digital diary and the Audio-Visual Materials were well received by the SAAOs and UAOs. From the beginning of the project, they were enthusiastic about the possibilities of the project. Throughout the project they remain cooperative and optimistic about the impacts of the ICT applications on their works.

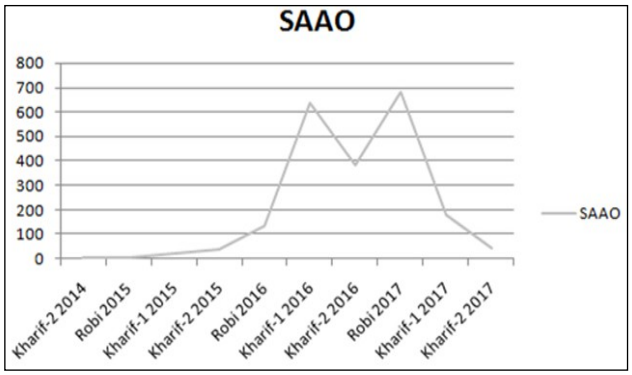

Fig. 1: Pattern of SAAOs' usage of FQS over time

1. Information Choice on FQS

The SAAOs have reported significant improvement regarding consultation and communication with the farmers through FQS. According to the server-side data, more than 50% of farmers use FQS to contact the SAAO and other agriculture experts for disease or insect-related information. It is also seen that queries regarding particular crops were much higher than the others.

Before ICT intervention, it was much more difficult for the SAAO to reach out to the landless and marginal farmers. With the FQS, they can provide

services to such farmers without investing much time and resources.

Another notable finding on FQS is the female farmers' interaction with the extension agent. From their queries, it can be said that they are mostly interested in home home-garden crops.

2. Digital Diary as a Useful Tool

The SAAO digital diary is specifically designed for the SAAOs. They are the most critical part of Bangladesh's agricultural extension system. This digital diary became very popular among the SAAOs within a very short period. SAAOs of all ages used the app. In the end, it became an integral part of their daily work. The monthly usage scenario of this app based on the ages of SAAOs is depicted in Fig. 2.

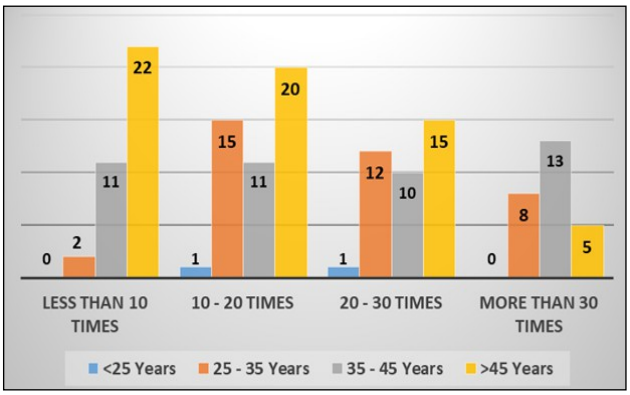

Fig. 2: Monthly Usage of SAAO Digital Diary based on age (146 Responses)

Almost all the SAAOs have used the digital diary more than ten times per month. Moreover, 18.1% of SAAOs have used this diary more than 30 times per month. This is a very significant finding of this study. Fig. 3 depicts the monthly usage of the SAAO diary based on monthly usage.

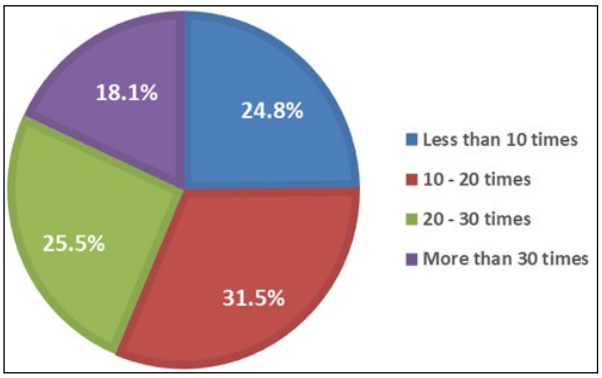

Fig. 3: Monthly Usage of SAAO Digital Diary (149 Responses)

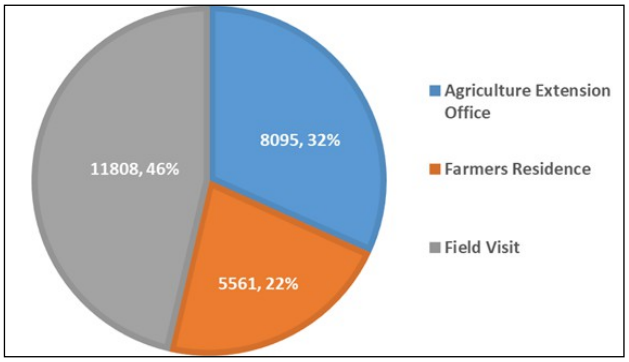

Fig. 4: Places of providing agricultural support by the SAAOs

IMPACTS OF ICT ON AGRICULTURAL EXTENSION SYSTEM

1. Level of Involvement

From the FGD, KII, and surveys, ICT apps have been well adopted in the daily lives of the extension agents. The SAAOs utilized the user-friendliness and effectiveness of the apps. According to the SAAOs, the apps, especially the digital diary, helped them maintain their daily activities and field visits. This app largely reduced their paperwork. 145 SAAOs out of 151 said the digital diary reduced t h e works of the traditional system. They also used the FQS and CDA extensively to provide services to the farmers of their assigned area. According to the survey data, 148 SAAOs out of 149 used the digital diary and other ICT apps regularly. They became so habituated with these apps that they were willing to pay for using the apps when the project ended. The respondent SAAOs did not mention any major difficulties in terms of usability and navigation of the apps.

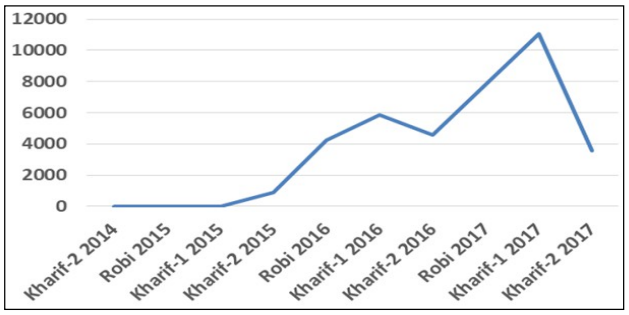

Fig. 5: Pattern of SAAOs' usage of Digital Diary over time

Fig. 5 shows that the usage of the digital diary has increased gradually during ten seasons from 2014 to 2017.

2. Enhanced Capacity of SAAO

Before the AESA project, the SAAOs struggled severely to keep them updated with modern agricultural knowledge. Moreover, it is difficult for the government to arrange training sessions and workshops for such a large working force. As a result, the farmers and the agricultural extension system suffer extensively from the ineptitude of the SAAOs.

The major objective of this project was to equip the SAAOs with modern technology and knowledge to prepare them for agro-consultation. Therefore, using ICT interventions proved to be the most pragmatic solution. From the queries posted by the farmers in FQS, the SAAOs learned about the unknown and advanced solutions to different agricultural issues. 82.3% of SAAOs have reported that the ICT apps have made them more confident in providing solutions. Also, they said that their improved knowledge makes them more respected among the farmers. 72.1% of SAAOs have confirmed that the solutions of the ICT apps were very effective in helping the farmers. Fig. 6 depicts the usefulness of FQS among the farmers according to the opinions of SAAOs.

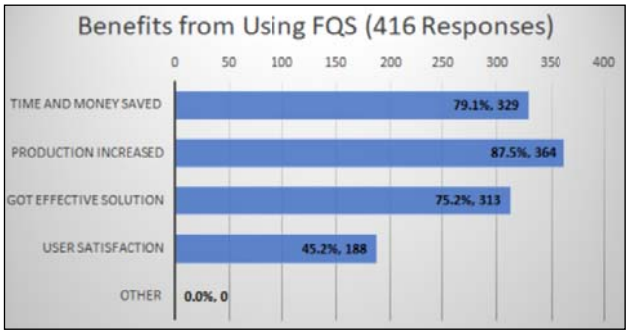

Fig. 6: How farmers get benefit from ICT apps according to SAAOs

FQS and CDA allowed the SAAOs to review their knowledge with the information provided by those apps. It is seen that 90% of SAAOs cross-checked the solutions received from the ICT apps. Fig. 1 shows the usage pattern of FQS among the SAAOs from 2014-2017 in 10 seasons. *Kharif*-1, *Kharif*-2, and *Rabi* are the names of the agricultural seasons.

3. Increase Accountability and Management of Extension Activities of SAAOs

During the field visits, the SAAOs take notes on their activities, problems faced by the farmers, and the prescribed solutions. The detailed description of these field visits was recorded in the SAAO digital diary. The recorded contents of their daily activities were uploaded on a website monitored by UAO.

UAO supervises the SAAOs in the agricultural extension system. Due to the digital diary, UAOs could check the work of the SAAOs without having any direct interaction. This saved a lot of time on both ends. Most importantly, this app increased the accountability of the SAAOs. 127 SAAOs out 151 mentioned that this improved monitoring system made them more confident and responsible. Fig. 4 shows the places and the number of agro-consultations provided by the SAAOs in those places.

SOCIO-ECONOMIC IMPACT OF THE INTERVENTIONS

The ICT interventions had a significant socio-economic impact on farmers and SAAO, both directly and indirectly. 71.5% of farmers stated that they have been recognized as informative farmers in society, and 62.6% of farmers reported that they can now solve their agricultural problems independently.

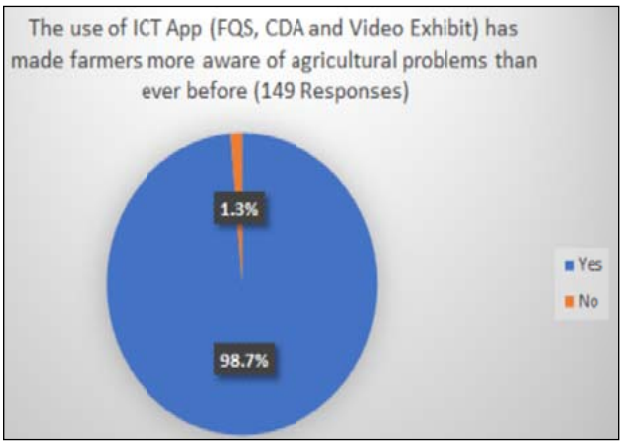

Fig. 7: Response of the farmer on agro knowledge

Effective techniques and proper inputs have increased production and reduced production costs. Group intervention has improved bargaining capacity. 100% of farmers prioritize natural solutions, while 78.9% follow modern agricultural processes instead of traditional ones. Additionally, 92% of input sellers confirm an increase in the use of bio-pesticides. "Using this method provides greater benefits compared to traditional approaches."

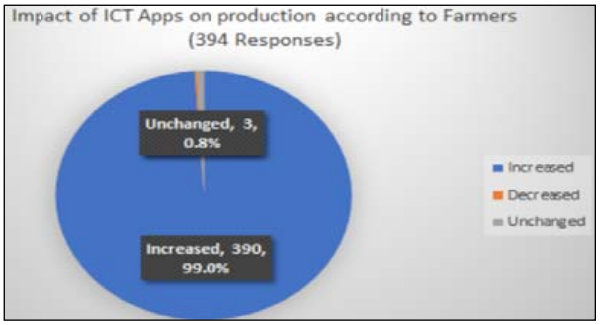

Fig. 8: Increase of production according to farmers

The lifestyle of farmers has improved: 59.4% report saving extra money, while 32.6% mention being able to afford better clothes and food thanks to agricultural apps.

CONCLUSION

In this study, it is seen that due to the ICT interventions in the agricultural extension system, there were significant changes in the social and economic aspects of the target users. During the interview with the SAAOs, it was repeatedly mentioned that ICT apps enabled solving any agricultural issue within a day. It made the SAAOs more confident and reliable. The gap between the farmers and the SAAOs decreased greatly after the inclusion of ICT strategies. Survey data shows that 79% of app users brought changes in their traditional farming knowledge. 390 farmers out of 393 in the survey reported that their production increased due to efficient consultation with the SAAOs. Moreover, 233(59%) farmers said that their production costs decreased due to the timely solutions provided by the SAAOs.

Government support is very much needed to continue and upgrade the services provided in this project. According to the survey, 85% of farmers want to pay for the agricultural services they get from the ICT apps. However, 147 out of 149 SAAOs think that the farmers' support will not be sufficient in the long run. Instead, government support should be sought for the sustainable development of the agricultural extension system (Singh and Burman, 2019).

REFERENCES

Aker, J.C. 2011. Dial "A" for agriculture: a review of information and communication technologies for agricultural extension in developing countries. *Agricultural economics,* **42**(6): 631-647.

Coote, C. and Rahman, Z. 2016. Scoping Studies for the Capacity Development of Agricultural Innovation Systems (CDAIS): Bangladesh Country Report.

Encyclopedia, T. 2010. "Bangladesh Agriculture" [https://www.nationsencyclopedia.com/economies/Asia-and-the-Pacific/Bangladesh-AGRICULTURE.html].

Fabregas, R., Kremer, M. and Schilbach, F. 2019. Realizing the potential of digital development: The case of agricultural advice. *Science,* **366**(6471): eaay3038.

Gakuru, M., Winters, K. and Stepman, F. 2009. Innovative farmer advisory services using ICT. *Africa Perspective on the Role of Mobile Technologies in Fostering Social Development.*

Harris, C. and Achora, J. 2018. Designing ICT for agriculture (ICT4a) innovations for smallholder farmers: The case of Uganda, pp. 1–9. https://doi.org/10.1145/3233824.3233830

Islam, M., Haque, M., Afrad, M.S.I., Abdullah, H.M. and Hoque, M. 2017. Utilization of ICTs in agricultural extension services of Bangladesh. *Asian Journal of Agricultural Extension, Economics and Sociology,* **16**: 1–11.

Kashem, M., Faroque, M.A.A., Ahmed, G. and Bilkis, S. 2010. The complementary roles of information and communication technology in Bangladesh agriculture. *Bangladesh Science Foundation,* **8**(12): 161–169.

Lifeline. 2019. "life lines India- knowledge services over your phone" [https://lifelinesindia.net/].

Liton, A., Azad, D. and K, M. (2017). The ICT in agricultural development of Bangladesh. *Int. J. of Engineering and Applied Sciences (IJEAS),* **4**: 56–59.

Mittal, S. 2012. *Modern ICT for agricultural development and risk management in smallholder agriculture in India.* CIMMYT.

Parveen, S. and Leonhäuser, I. 2005. *Empowerment of rural women in Bangladesh: A household level analysis* (Vol. 72). Berlin: MARGRAF.

Patel, N., Chittamuru, D., Jain, A., Dave, P. and Parikh, T. 2010. Avaaj otalo - a field study of an interactive voice forum for small farmers in rural India. *Conference on Human Factors in Computing Systems - Proceedings,* **2**: 733–742.

Riaz, W., Durrani, H., Shahid, S. and Raza, A. 2017. ICT intervention for agriculture development: Designing an IVR system for farmers in Pakistan, pp. 1–5.

Richardson, D. 2006. ICTs–transforming agricultural extension? report of the 6th consultative expert meeting of CTA's observatory on ICTs. *CTA Working document.*

Roy, R. 2009. Trends of ict usage in agriculture and extension. *Bangladesh Research Publications J.,* **2**: 307–318.

Sennuga, S.O. 2019. *Use of ICT among smallholder farmers and extension workers and its relevance to sustainable agricultural practices in Nigeria* (Doctoral dissertation, Coventry University).

Singh, A. and Burman, R.R. 2019. Agricultural extension reforms and institutional innovations for inclusive outreach in India. In *Agricultural extension reforms in South Asia* (pp. 289–315). Elsevier.

Thiga, M. & Ndungu, S. 2015. Utilization of ICT for agriculture: A case study of Kakamega county, Kenya, pp. 1–9. https://doi.org/10.1109/ISTAFRICA.2015.7190569

Ugandanet, W. 2019. *"women of Uganda network"* [http://wougnet.org/].

Van Loon, J., Woltering, L., Krupnik, T.J., Baudron, F., Boa, M. and Govaerts, B. 2020. Scaling agricultural mechanization services in smallholder farming systems: Case studies from Subsaharan Africa, South Asia, and Latin America. *Agricultural systems,* **180**: 102792.

World Bank. 2016. "Bangladesh: Growing the economy through advances in agriculture" [https://www.worldbank.org/en/results/2016/10/07/bangladesh-growing-economy-throughadvances-in-agriculture].