

**ICTs in Smart Agriculture: Paths to Build SDGs of Bangladesh**

**Abstract:** This paper analyzes how the farmers of Bangladesh use ~~the~~ modern [information and communications technology \(ICT\)](#) ~~technology of information and communication~~ for gathering different agricultural data. Farmers of Bangladesh are being encouraged to use smart devices of information and technology such as ~~smart phones~~ [smartphones](#), android phones, laptops, desktops, [and](#) electronic television for getting updates on different agricultural products, harvesting, and competitive markets. Information and communication technology includes all the devices with inbuilt ~~it human to hu~~ [human-to-human](#) and ~~device to human~~ [device-to-human](#) interaction systems. Thus, information and technology have a direct and indirect impact on rising farmers' productivity and growth for sustainable development. This study shed light on the understanding of the effect of information and communication technology ~~in~~ [on](#) the agricultural growth of Bangladesh for sustainable development with the help of [a](#) conclusive research design and [a](#) secondary method of data collection ~~has~~ adopted in this research for understanding ~~of~~ the importance of using information and technology in smart agriculture.

**Keywords:** Bangladesh; ICT; ~~e~~ [e](#)-farming; ~~s~~ [s](#)Smart agriculture; ~~sustainable~~ [Sustainable](#) development.

**1. INTRODUCTION**

Modern technology based on [the](#) information and communications has helped in agricultural firm management and intensive decision-making for proper development and sustainability. The Social ~~and~~ economic well-being of present and future generations are major objectives of sustainable agricultural management through advanced [ICT](#). ~~information and communication technology~~. Information and communications have both direct and indirect contributions to firms' productivity. In the context of direct contribution "precision farming" is an accurate way of raising productivity and achieving food sufficiency in ~~the~~ [a](#) market of rising demand. Quality decision-making and farm management are indirect contributions of ~~information and technology~~ [ICT](#) in rising firms' productivity and adhering growth.

According to the current scenario of Bangladesh, the growing population creates pressure on farmers to involve in more production to meet the high demand and remain competitive in the [market](#).

Farmers of Bangladesh use the modern ~~technology of information and communication~~ [ICT](#) for gathering different data on marketing patterns, price, environmental conditions, and weather. Gathering large data is beneficial for farmers to avoid challenges and risks and involves [more](#) extraction of resources.

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~~Farmers of~~ Bangladeshi farmers are being encouraged to use smart devices of information and technology such as smartphones, desktops, and users. Artificial intelligence (AI) possesses the potentiality to supervise a firm and help in growth and development. Technological advancement and providing proper training to farmers can be beneficial in increasing productivity and using the resources for effective management. Cloud computational computing data management proves to be beneficial for farmers to be involved in storing agricultural information. "Artificial Intelligence" based drone auto flight systems are beneficial for farmers to gather information on environmental changes that have the potential to directly affect the process of farming and cramping patterns. Different crops require different types of favorable environments for proper harvesting. The advent of information and technology has helped in analyzing farming including different technological management rather than field works for growth and development.

Information and communication devices with advanced 0.4 technological systems are beneficial for farmers to be involved in effective farm management. Sustainability of social and economic factors can best adhere through the initiation of smart agricultural technology for effective growth and management. Artificial intelligence, drone software systems, GIS, and remote sensing are all major tools based on information and communication or data exchange management that helps in adhering to different aspects of the rising productivity of crops. Production growth is beneficial for meeting the needs of the Bangladeshi population. Meeting the needs of future generations and providing protection to the present generation from exploitation are two major objectives of sustainability. Farmers' ~~for~~ maintenance of agricultural products need to focus on effective field management through handling vast data related to the competitive market and environment.

According to IFAD reports, the government of Bangladesh has raised a fund of 2537.1 dollars for introducing information and communications technology for management and has initiated 35 agricultural development projects that have successfully impacted the lifestyle of 11,729,563 households. IFAD has extended its intervention to key areas of sustainable development through attaining food sufficiency by helping farmers to be involved in effective growth and management of different systems. Thus, ~~farmers of~~ Bangladeshi farmers are being encouraged to use smart devices ~~such as smartphones, electronic television, and desktops for getting updates on different environmental patterns, competitive markets, prices, and weather~~. Thus, information and technology have a direct and indirect impact on rising firms' productivity and growth for sustainable management. High populated developing countries tend to face scarcity of resources and modern technology based on information and technology is beneficial in attaining self-sufficiency. This research article mainly sheds light on the concept of information and communications technology. The benefits of ~~information and communication technology~~ ICT in agricultural management and production for sustainability in Bangladesh are described critically in this article. This article also sheds light on factors such as availability of resources, environmental data, and infrastructure affecting the utility of information and communications technology for effective management of growth and development.

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Challenges of using ~~information and communication technology~~ ICT such as lack of infrastructure, ~~and~~ farmers' knowledge ~~on~~ of effective management, and growth of agricultural products are ~~analyzing~~ analyzed critically in this article.

## 2. LITERATURE REVIEW

### 2.1 Concept of information and communications technology

Information and communications technology ~~includes~~ include all the devices with inbuilt ~~humanto~~ human human-to-human and ~~device to human~~ device-to-human interaction systems. Smartphone, laptops, desktops, television, ~~and~~ radios are major examples of ~~information and communication~~ ICT devices that help in farming, agriculture, manufacturing, and processing. As stated by Bai *et al.* (2020) both primary and secondary industrial systems adhere to the extensive benefit of ~~ICT~~ ~~information and communication technology~~ for acquiring data based on changing weather conditions for effective growth and development of different production processes. Transmission, storage, manipulation, and access to data and information become easy through ~~communication and~~ ~~information technology~~ ICT for effective growth and ~~management~~.

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As cited by Jancet *al.* (2019), ~~the~~ convergence of audiovisual media with telecommunication networking systems is referred to as information and communication technology effective for proper growth and management of different technology. In the current prospect "artificial intelligence, augmented and virtual reality, machine learning, cloud computing, and big data analytics are enabled in the smart devices of "Information Technology" for easing the task related to proper management and growth. ~~Information and communication technology~~ ICT has a 9.04% contribution to GDP and has helped in securing different primary and secondary business sectors. Sarkar *et al.* (2021) stated that ~~a~~ Agriculture and rural development programs are started by the government of Bangladesh and have focused on the utility of information and communication devices for easing the activities of communication and development.

Different agricultural expenses required for utilizing information and communications technology are "computer hardware, computer software, computer services, data processing services, communication services, and wired and unwired equipment" for effective management and agricultural ~~growth~~. ~~Information and communication technology~~ ICT has expanded from 6.5% in 2013 to 18.02% in the fiscal year 2017. In the words of Thornton *et al.* (2018), Bangladesh secured a rank of 147 out of 176 in information and communications growth and development. "Bangladesh Association of Software and Information Services" report highlights that 117.3 million people have internet subscriptions out of which 9.8 million people are involved in using broadband ~~services~~.

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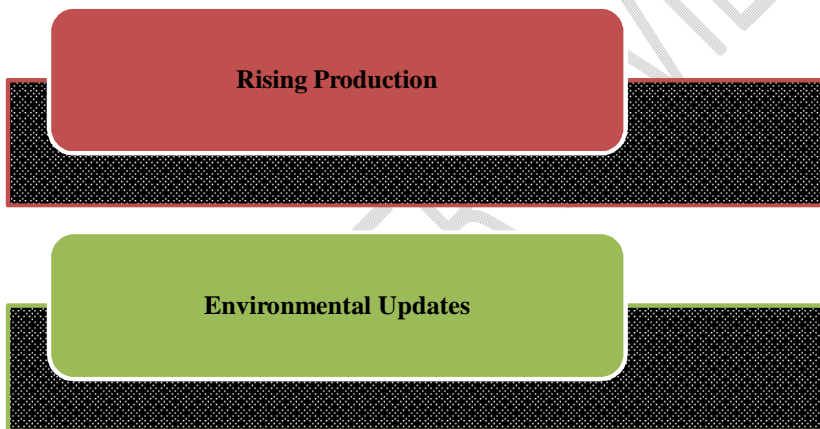
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According to ~~the~~ evaluation ~~in the above-mentioned report~~, 1500 software and IT-related corporations have extended their services in Bangladesh to initiate different agricultural development programs for growth and development. Thus, different aspects of growth and development are being observed in

information and technological improvement and have observed a rise in the government budget for software development and growth.

## 2.2 Benefits of information and technology in smart agriculture in Bangladesh

Bangladesh is an agro-based country with more than 47% of the entire population directly depending on the primary sector. The GDP contribution of the agricultural sector is 16% in Bangladesh's economic growth providing economic security to the rural residents. Silva de Amorim *et al.* (2019) cited that the availability of different agricultural products and resources is high in developing countries such as Bangladesh and this has helped in focusing on agricultural sectors for effective living. Estimation highlights that the population size of Bangladesh is expected to grow up to 230 to 250 million by the fiscal year 2050 executing pressure on primary workers for rising production and meeting the growing needs.



**Figure 1: Benefits of using ICT in agriculture for sustainability**

(Source: Self Developed)

Sustainability thus has a major role to play in effective development and growth and therefore plays an important role in effective management. Information and communication devices are effective for agricultural workers to be involved in effective farm management through adhering to data based on the environment and diverse species that affect agricultural products. "Artificial Intelligence" AI inbuilt in drone aircraft are connected to ground level teams backed up by machine learning (ML) and "Internet of Things IoT". These information and communication devices are used for updates concerning environmental change and development. Drone software systems of ICT are effective in the proper management of farms and effective weather forecasts and are beneficial for the production of rabi crops such as rice, wheat, maize, corn, and barley. The rise in the production of food crops is effective for Bangladesh to attain food sufficiency and deal with issues related to hunger and poverty. The government of Bangladesh has been involved in hybrid and high-yielding varieties of plants and has been involved in the rising growth of rice import to 200,000 tons in the fiscal year

2021). As opined by Smith *et al.* (2021), agricultural growth and development can be adhered to ~~through by~~ using "artificial intelligence" for crop protection against pests and animals. Instead of traditional mechanisms of crop protection information and communications technology is effective in initiating crop protection through robotics and machine learning.

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"Internet of Things" is a networking system that connects two different devices and equipment and helps in proper communication and management. ~~Information and communication technology ICT~~ is effective in the proper growth and management of agriculture and helps firms to adhere to different information related to the management of farms. ~~Information and communication technology ICT~~ is beneficial for effective management and growth of different sectors of the economy such as primary, secondary, and tertiary. Sadaf Khan *et al.* (2021) agricultural management and growth ~~has have~~ a major impact on sustainable structure and management. ~~The~~A department of Bangladesh Agriculture program highlights that wheat production has increased by 6.4 million tons in Bangladesh after initiating information and communications technology for sustainability and management.

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Thus, ~~information and communication technology ICT~~ helps farmers in adhering to smart development through effective management of weather, environment, and domestic market for focusing on production. ~~Thus farmers of Bangladesh are being encouraged to use smart devices such as smart phones, electronic television, and desktops for getting updates on different environmental patterns, competitive markets, prices, and weather.~~

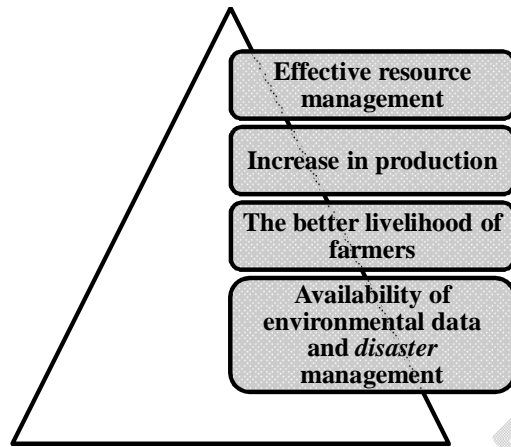
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### 2.3 Factors affecting the use of ICT in smart agricultural development for sustainability

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#### ~~1. FACTORS AFFECTING THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN SMART AGRICULTURAL DEVELOPMENT FOR SUSTAINABILITY~~

~~Information and communication technology ICT~~ has a major role to play in the effective management and growth of the agricultural farming sector for sustainable development and management. "Artificial intelligence, big data analytics, machine learning, and Internet of Things" are major advanced equipment that affected the utility of ~~information and communication technology ICT~~ in the agricultural and management field. Different factors affecting the use of ~~ICT information and communication technology~~ in the agricultural sector for sustainability are as follows:



**Figure 2: Factors affecting utility of ICT in agricultural sector**

(Source: Self developed)

### **2.3.1 Effective resource management**

Resource management is an important contribution of technology in the effective growth and management of the agricultural sector. Klerkx *et al.* (2019) cited that agricultural development tends to involve huge management of resources for growing production. Smart devices, tools, and equipment have helped the farmers to use resources efficiently and involve in the growth of production. Resource management and growth has been effective in proper sustainable development for meeting the need and requirements of both primary and secondary data. Thus effective resource management is a major contribution of effective primary resources management.

### **2.3.2 Increase in production**

Information and communications technology is beneficial ineffective management and growth of production. ICT is beneficial for farmers to include effective farm management to increase the production of different crops. In the words of Roy *et al.* (2019) increased production and growth are the major benefits of ~~information and communication technology ICT~~ in rising agricultural production. Databases on weather and environmental changes can be effective in increasing the production of rabi and Kharif crops through analysis of different seasonal changes. Production and management ~~is are~~ the major factors that affects the government of Bangladesh to promote information and technology development.

### **2.3.3 The better livelihood of farmers**

Technological development and utilization of many types of equipment are beneficial for farmers to be involved in effective management and development of basic livelihood. ~~ICT Information and communication technology~~ has extended its facility of gathering critical data based on weather forecasts and environmental changes that affect the entire process of production directly (Deebak *et*

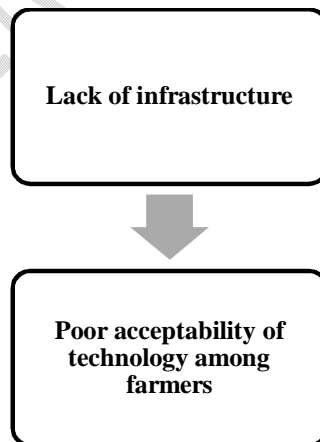
al.,2020). Artificial drones, GIS remote sensing, and satellite imaging ~~has~~ have helped in broadcasting information ~~of~~ about weather ~~change~~ changes that helps farmers to protect crops from bad weather conditions. Different marketing aspects such as the price of the product, competitiveness, and demand range can be accessed by farmers to raise income through agricultural products.

#### **2.3.4 Availability of environmental data and disaster management**

Information and communication technology is beneficial in raising environmental awareness through the broadcasting of data-related weather changes. Different GIS software with enabled artificial intelligence has made the process of human-to-device and device-to-device interaction easy with help of the "internet of things". The utility of modern technology is beneficial for farmers to harvest different crops according to environmental conditions (Lioutaset *al.* 2021). Access to environmental data and resources is beneficial for effective management and growth of primary resources. Thus, the agriculture sector has adhered to different benefits, growth, and management of agricultural products for adhering to effective management and production.

### **2.1 CHALLENGES OF INFORMATION AND COMMUNICATION TECHNOLOGY IN SMART AGRICULTURAL SYSTEM AND SUSTAINABLE DEVELOPMENT**

Information and communication technology has a major impact on the effective growth and management of agricultural production. The advent of information and communication technology in the agricultural field has established an acute necessity for infrastructural development. Dhaka Chamber of Commerce and Economy Reports highlight that the government of Bangladesh needs to include a budget of 25 billion dollars for effective management and development of resources. Thus major challenges of using information and communication technology are as follows:



**Figure 3: Challenges of using ICT in farming and sustainable development**

(Source: Self developed)

#### 4.1 Lack of infrastructure

Lack of infrastructure is a major challenge of using information and communication technology. Remote regions of rural Bangladesh fail to adhere to electricity facilities and advanced equipment for supporting information access for development and growth. Bangladesh report highlights that only 39% of rural households have access to electricity. Thus, the availability of electricity and infrastructure restricts the utilization of smart devices for rising production and growth and agricultural residue (Peña Zarzuelo *et al.* 2020). Poor infrastructure weekend the networking system of the area leading to poor machine learning system for effective management and growth.

#### 4.2 Poor acceptability of technology among farmers

Farmers and rural residents often tend to lack proper knowledge on the utilization of advanced technology for effective growth and management of resources. The Government of Bangladesh has been involved in raising the consciousness of using modern technology among farmers for decreasing the challenges of poor consciousness among farmers of Bangladesh. Khan (2019) cited those modern tools and technology are beneficial in proper growth and management of modern equipment and tools for rising production, managing farms, and reducing workloads. Poor acceptability of technology can lead to poor production and the inability to feed the needs of millions of people. Information and communication technology is effective in the proper management and growth of agriculture for sustainable development. Concern about the present generation and protecting the needs of the upcoming population is the major concept of agricultural sustainability. Lack of technological awareness among farmers can restrict the overproduction of goods and leads to ineffective allocation and distribution of resources among consumers.

### 3.2 STRATEGIES TO MITIGATE CHALLENGES

Allocation of proper budget for agriculture production is an effective way of meeting different requirements for rising business outcomes. The Government of Bangladesh has been involved in allocating a fixed budget for farmers to promote the production of primary products and meet the rising demand of the population. Rather than budget allocation, providing farmers training using technology can be effective in introducing "artificial intelligence-based devices" for effective management and growth of information and communication technology (Heeks, 2017).

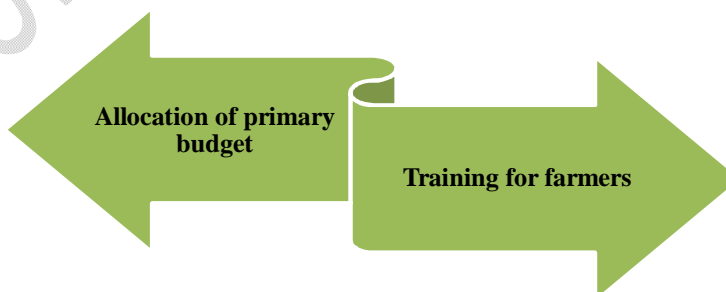


Figure 4: Strategies to mitigate challenges of using ICT in farming and sustainable development

(Source: Self developed)

Farmers of Bangladesh can access different environmental and marketing information and data for manipulating the production of different crops. Installation of proper training is effective for farmers to use modern and smart agricultural management systems using digital tools and equipment. Providing a proper infrastructural development system and management is an effective way of mitigating the issue of lack of infrastructural development in rural areas of Bangladesh (Bakker *et al.* 2018). The Government of Bangladesh should focus on improving different aspects of providing electricity and transportation facilities in rural Bangladesh for effective management and growth of technology. The Government of Bangladesh has started conducting rural development programs for rising production for food sufficiency and including different aspects of rising production. Providing training and education for rural residence is beneficial ineffective management and growth of agricultural production for rising growth and management. Thus, the initiation of different Government programs on social development is being effective for the farmers of Bangladesh to include effective management and growth of different technological equipment.

#### **4.3.METHODS**

The present study is a qualitative method of in nature. More specifically, it can be said that the study has conducted through conclusive method. It is a type of research that describes a situation, or phenomenon is used to obtain information that can be used to reach conclusions or make decisions, (Nargundkar, 2008:39). It depends on each secondary data, significantly existing databases that are reanalyzed to shed light on a special downside than the first one that they were established, and first analysis, or data specifically gathered for the study. For this study ICTs smart agriculture of Bangladesh, has used the secondary data sets and previous government data for the development of the study. The data sources were authentic and have reliability on that topic. All books and journals have taken followed by application of title and abstract screening method (Nourani, M., et al., 2020:1-8). Secondary method of data collection is being adopted in this research for understanding of the importance of using information and technology. Qualitative data analysis is being adopted in this research for understanding the effect of information and communication technology in agricultural growth of Bangladesh for sustainable development.

#### **5.4. RESULTS AND DISCUSSIONS**

Growth of using ICT in different parts of Bangladesh is regarded as quite promising as it benefits more than 14 million farming households by using agricultural-based information. It is essential for Bangladesh government for designing ICT based solutions that are both user friendly and cost-effective. Future of using ICT for accelerating agricultural sector includes telecom operators, agricultural-based content providers, and software developers along with market actors. Tools provided by ICT possess ability to record text, drawings, video, producing an exact form of duplicates of same information at a lower cost. Other tools include using transfer information, developing standardized algorithms along achieving a greater level of interactivity in sharing valuable sources of information. Economy of Bangladesh is mainly based on agricultural sector and using “Nuclear Agriculture” was estimated to bring dynamic changes within specified sectors in Bangladesh. Installation of Nuclear agriculture has been brought by farmers by making usages of modern and innovative technology developed by varied research organizations.

A new era of installing smart processes of agriculture in Bangladesh was initiated on 20<sup>th</sup> January. MoU signed on E village project among CRI, BSMRAU and iSOFT stone. This initiation was undertaken with aim of utilizing using ICT to provide agricultural sector with a boost. In addition, an E-village based project was being launched with a major purpose of bringing down cost of farming along with increasing production by multiple times. In terms of addressing event Nasrul Hamid trustee of CRI proposed that using innovative technology will usher into a new era with aim of transforming agricultural sector. According to initiator using real-time information can aim at reducing cost of input by 15% to 20% and tend on increasing output level by 15-20% in agricultural production. Thus, it can be summarized that farmers in Bangladesh will tend to receive 30-40% benefits by using innovative technologies.

#### **6.5. CONCLUSION**

Hence based on above discussion it can be summarized that information is regarded as a key component that aid in improving smallholder based agricultural production and linkage to remunerative market, this in turn aid in improving rural livelihood, maintaining food security and national economies. Agriculture is regarded as largest employment sector in Bangladesh as it employs 475 f total labour force and it comprises 16% of total GDP of a country as of 2016. It is required to use ICT in agriculture as E agriculture aid in dissemination of gathered sources of information to different farmers that live in rural areas for using it in their routine work.

Digitalization is effective for achieving varied sustainable development goals and it is regarded as an essential step towards attaining a smarter Green planet. Using sustainable development aid in promoting digitalization, using IoT is regarded as an essential tool that will be used for promoting sustainable production of food and planet health. In addition, using artificial intelligence [AI] can aim at optimizing energy-based production along with managing water treatment. It can further be

summarized that using smart technology including IoT and AI can aim at providing equity access to different services along with increasing well-being of an individual. Using digitalization can be used for guiding actions to face changes in climatic condition that in turn assists in protecting biodiversity. It can further be concluded that one major advantage of using smart technology and digital era is that it possess ability to check both price and demand of market. Rice farmers in Bangladesh were facing major issues due to sudden outbreak of Covid-19 pandemic scenario. Due to pandemic farmers of Bangladesh faced high impact in scheduling sowing of seeds, process of harvesting, maintaining transportations and marketing. A recommendation can further be provided to promote crop diversification process by replacing rice with different short duration based crops. Replacing rice is primarily done in monsoon season with an aim at alleviating a potential shortage of agricultural forms of labor during a pandemic scenario. In addition, using crop diversification is also important for addressing issue of a declining rate of groundwater table. In this digitalized era evolution of Machine Learning [ML] and IOT aim at providing support to farmers of Bangladesh to implement automation. On other hand, it can further be suggested that using sensor technology within agricultural domain aim at providing effective support along with offers to farmers in order to map their land easily. GPS can also be used by government of Bangladesh in promoting agricultural sector as it is used to measure distance to precisely located GPS form of satellite along with finding a position on Earth. Using GPS technology is highly recommended due to its inexpensive nature and it also aids in parallel tracking devices. Within last decades, IoT sensors are being installed in a crop that in turn aims at providing support to different farmers for allocation of pesticides and different fertilizers in right way. Thus, making usage of GPS controlled based steering can aid in improving rate of accuracy in operation, fuel-based cost reduction along minimizing erosion by tracking vehicle path.

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