

Application of Information and Communication Technology (ICT) for Agricultural Transformation in Nepal

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Abstract

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Information and communication technology (ICT) is often described as a key catalyst in empowering farmers towards achieving prosperity for rural area. Despite being fundamental source of livelihood for two-third of total population, Nepalese agriculture has suffered from multiple challenges, such as conventional practices, inappropriate technological adoption and fragmentation of productive land, all of which are impede its progress. This paper tries to emphasize the need of agricultural transformation through the integration of ICT that eventually contribute for rural development in Nepal. This is a review-based research paper consists of quantitative approach and employs a descriptive research design based on a rigorous review of scholarly publications, government plans and other documents along with online database related to the use of ICT in agriculture. The findings highlight the declining contribution of agriculture to the national GDP as a result of the prevalence of subsistence farming with ineffective technical accessibility and the potential of ICT to address these challenges. The study concludes with a discussion on the role of ICT in empowering farmers, improving productivity, and contributing to rural development through specific ICT initiatives such as mobile apps for agriculture-related information and advisory services. The study as a whole highlight the potential of information and communication technology (ICT) as a pivotal tool for driving transformation in the agricultural sector and fostering rural development in Nepal. The study suggests to integrate ICT in agriculture transformation to empower Nepalese farmers and boost agricultural productivity for rural development.

Introduction

Agriculture has always been a fundamental source of rural livelihood and occupies two third of total population in Nepal. It contributes about one fourth of national GDP (Gautam & Dhakal, 2022), whereas people consider agriculture as an ultimate source of survival in the sense that there is no alternative of edible commodities production. However, majority of the farmers in Nepal are still intend to apply the production mechanism and technologies that have been used from generations just for survival. Since, subsistence farming has been a rooted feature of Nepalese agriculture, people are unable to find the better opportunities because of the lack of scientific and commercial use of this sector in one hand and severs effect of land fragmentation and unplanned urbanization of cultivable land in the name of plotting has been realized as a serious issue even if there is the domination of sloppy topography in the country that further aggravates production and productivity indeed.

Pudasainee et al. (2020) asserted that Nepalese farmer are ignorant of soil nutrients and plant health due to the lack of professional consultants and agriculturalists to farmers by which the production mechanism in the country is more or

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less static and hard to transform. Additionally, farmers are far from the access of basic services as well as inputs because of the lack of road networks and market accessibilities in the needy period. As a result, farmers are compelled to practice whatever they know and learn despite considering soil and health hazards while applying pesticides and fertilizers. These are the main reason behind the backwardness of Nepalese agriculture. Poudel and Wagle (2019) identified that being one of the dominant sources of Nepalese economy, agriculture needs to be transformed not just by focusing on seeds, fertilizers, irrigation and rural roads but rather from the quality of governance, widespread commercialization and increased productivities. In this regard, the state authority should focus on heavy investment on public areas like; research and development, extension services and other physical infrastructure which favor agricultural transformation along with other allied sectors.

Piya (2012) identified that E-commerce has been playing a significant role in the global economy during last few decades, most of the developing countries like Nepal are also giving priority for establishing information technology (IT) friendly infrastructures in this sector. Furthermore, it is viewed that there are five key drivers for the growing trend of ICT in agriculture which are also preferred by World Bank in 2012. They are: (a) minimum cost and wide connectivity, (b) easily adaptable tools, (c) greater data storage and sharing, (d) innovative and collaborative, and (e) modern approach of information and sharing through social media. So many agricultures specific applications of ICT are emerging for smallholders. Better adaptation of such applications can be undertaken by performing two tasks: firstly, empower farmers to ICT related services and assets so that they can increase their farm output, income and secure livelihood; and secondly, use ICT effectively by the farmers so that they can compete with ever changing complex global market (World Bank, 2017).

ICT plays a crucial role in connecting people globally. IT professionals can assist marginalized communities in joining online platforms to exchange and acquire knowledge, new ideas, and technologies. Additionally, they can develop user-friendly applications that are accessible to everyone (Piya, 2012). The concept of digital agriculture is highly beneficial for understanding current agricultural advancements and aiding relevant departments in making informed agricultural development plans within a digital framework (Klerkx et al., 2019). When assessing the factors that impact the success of digital agricultural transformation, several key issues emerge like; establishing an institutional framework for digital agricultural growth, the necessity of developing information infrastructure, and the creation of digitally proficient human resources (Loi, 2022).

World Bank (2017) pointed out that since agriculture is facing several challenges itself, there is rising food demand, hiking prices, population growth and so forth along with greater responsibility to poverty reduction globally. Therefore, ICT in agriculture might be the best favorable option to tackle with the aforementioned challenges. The better ability of ICT to facilitate good momentum to agriculture to attract good investment in research and development from public as well as private sectors in ICT sector. Of course, ICT has greater potentialities that can be exploited by following two basic tasks. They are:

- (a) Empowering poor farmers through ICT by which the income and the productivities of them increased and will be able to protect food security and livelihood; and
- (b) Increase efficiency to compete with complex and challenging global market for effective ICT application.

It is well accepted that the massively growing accessibility of different means of information and communication like smartphones and internet access, new sign of hope has extended especially for transferring various agriculture related information and extension services. This became the way by which the rural smallholders and marginalized farmers can have easy access to agricultural information effectively and ICT become the backbone to agricultural transformation. Saidu et al. (2017) analytically presented the benefits and challenges to be handled regarding the application of ICT in agriculture sector. The major benefits are given below:

- improvement in market strength,
- easy exchange of relevant information,
- global networking along with the profit gain and
- opportunities of research and adoption of good strategy for economic growth to maintain self-reliant development are some remarkable.

Whereas, lack of adequate facilities, efficient technical manpower, insufficient infrastructure, language and knowledge barriers along with continued power supply as well as perception of the farmers toward ICT use are noticeable challenges and issues for successful implementation relating to ICT that to be solved sooner or later.

Ahmed et al. (2020) pointed that despite the country's inadequate infrastructure and other managerial shortcomings in its information and communication systems, there are significant opportunities to address the effects of natural disasters like extreme weather events, droughts, floods, and landslides on local communities. Moreover, the proper implementation of

ICT infrastructure and tools can foster rural development, boost productivity, reduce economic and digital divides, and support smallholders in developing small businesses in agriculture and related sectors. (World Bank, 2021).

Likewise, Bachkain and Karki (2022) also focused that there are numbers of intervening factors such as productive and practical education, high cost of technology, socio-economic circumstances of farmers influence the decision regarding whether or not ICT to be adopted. It has already been late to consider while formulating policies and plans to increase the adoption of ICT by the marginal segment of the farmers. Provision of subsidies and incentives in ICT facilities can be a few suitable ways to enhance ICT adoption in mass scale.

It is well accepted that development of agriculture sector sometimes used synonymously as the development of the country in Nepal because of the fact that still a large segment of the population depends upon in this sector. Application of suitable technology obviously help tracking on the defective and even in large cultivated farmland that eventually help to reduce the different kinds of risks such as, soil degradation, crop failure and postharvest losses, and increase the profit of the farmers. The primary emphasis of the farmers is to increase production and productivity in the agriculture through diversified and commercial practices which make them more competitive in local as well as external markets. Adoption of appropriate ICT and associated services can significantly contribute to enhance farming efficiency in Nepal (Pudasainee et al. 2020). Likewise, Shrestha and Khanal (2020) identified that a unique pattern of Precision agriculture (an IT based agriculture system that systematically organize farming that ensure diversification and enhanced productivity, profitability and sustainability with instant agro-treatment and quality support) would be the best possible way to adapt as a new concept of systematic cultivation. Authors further assorted that this type of agriculture is appropriate in Nepal in the sense that it is composed by the application of right means at a right place following the best suitable time which reduce the risk, minimize the cost of production and enhance profitability in farming by the help of three major elements namely; Data/information, technology and decision support system in agriculture.

Kadel (2023) assorted that ICT as a means of smart farming, which aims to address disease control challenges, optimize resource utilization, and promote sustainable agricultural practices in Nepal. Therefore, there is great potential to improve production and productivity of agriculture sector through the use of varieties of means of ICT in the country.

The journey of modern ICT has started with the inception of Telecommunications act and its regulation on 1997. Likewise, the Information Technology Policy has come to exist on 2000 as a milestone policy on information technology which made the provision of private sector participation for the development of information technology in Nepal. Furthermore, as a result of growing demand to revise the entire policy featuring the information communication technology, the government of Nepal put forwarded the Information Communication Policy 2015 to regulate all the activities within the umbrella of information and communication in Nepal. Since, Nepal has already prepared the Digital Nepal Framework in 2019, there is great potential to harness the potential of information technology to accelerate economic growth by preparing the roadmap of development in the country through following key initiatives:

- Drive economic growth,
- Discover innovative solutions to significant challenges more efficiently with fewer resources,
- Uncover opportunities for Nepal to engage in the global economy (MoCIT, 2019).

National Information and Communication Technology Policy (2015) has put forwarded the following ICT related policies in agriculture sector:

- Programs will be created and executed to enhance productivity and competitiveness in the agricultural sector by utilizing ICTs in planning, implementation, monitoring, market expansion, and information delivery.
- Private sector investments in developing and providing ICT services, including infrastructure in agriculture-intensive rural areas, will be incentivized with public resources.
- Measures will be implemented to deploy, utilize, and integrate ICTs and other technologies across all operations and activities in the sector, from production to processing, packaging, marketing, and distribution. (MoIC, 2015).

Similarly, E-Governance Master Plan phase-two (eGMP-2) also highlighted that agriculture has taken as one of the four priority stream which is specified as mostly demanded for e-services from the government. Likewise, the second version of eGMP stressed that Agriculture, Health, Education, Local Government, Roads, Tourism etc. are taken as the priority areas (MoCIT, 2019).

The existing literature relating to agricultural transformation predominantly highlights the strength of technological adoption among the farmers, demonstrating the increased productivity and income of the farmers but does not specify the adaptability of rural and smallholder farmers. The researchers also recommend different measures to technical reforms and adoption of new technology. However, there is a notable gap in highlighting the strength

and prospects of ICT related innovation and application in the existing context of widespread access to its means and services in Nepalese rural agriculture. Therefore, this research aims to fulfill the gap by exploring the prospects of ICT contributing to reformulate the existing conventional farm practices to progressive and competitive one that specifically focus on progressive outcome by minimizing the resource gap to the rural farmers.

In this way the importance of ICT has been realized as an innovative approach to harness human potential regardless of its implication. To some extent, it is viewed that there is no any sectors which are separate or not aligned with rapid growth of ICT globally. In this connection, this paper aims to find out the prospects of information and communication technologies (ICT) in agricultural transformation in Nepal. More specifically, it intends to focus on the importance of ICT in transforming the rural scene through agricultural reform in Nepal.

Materials and Methods

This research paper has employing the descriptive research design based on quantitative approach and the secondary sources of data. The data sources consist of varieties of scholarly articles related to ICT in agricultural system, governmental policy documents and reports, authentic and academic publications of national as well as international levels. The rigorous studies are made to confine and prioritize the relevant sources within the research topic horizon so as to prioritize the relevant and up to date materials that ensures the validity and objectivity of the study. Additionally, different online databases such as; nepjol, JSTOR, ResearchGate, Google scholar, Science direct and others along with concerned governmental websites of Nepal and the data from authentic international communities such as World Bank, ILO, FAO, UNDP are also implied to produce the desirable findings.

Results and Discussion

Results

Growing importance of ICT in agriculture might have some variation in different part of the world. However, there are five important trends considered to be the common key sources of ICT application in agriculture sector for developing communities. They are: 1. Affordable and wider connectivity; 2. Flexible and cost-effective tools; 3. Improvements in data storage and sharing; 4. New business models and collaborations; and 5. The democratic application of information, through open access initiatives and social media (World Bank, 2017).

Gautam (2018) in his study asserted that more than 37 per cent of the farmers use to receive the information regarding agriculture in Nepal whereas, just greater than one fifth (21.3 per cent) of them have used internet facilities. Only 2 per cent of the farmers are using smart phone for agro-based information in Nepalese case. Wagle (2023) asserted that as digitalization has been at the forefront of all kinds of development around the globe in the last 50 years, least developed countries like Nepal should open all possibilities to attract and address digitalization in our society as good as possible so that the country can harness its maximum possible potentials to strengthen our national outcome. It is further added that if the country take time to digitalized the economy, we would have to face exponential loss in the days to come. So, it is high time to take the action by the government to take necessary steps for digitalization.

Land use status according used category

The distribution of land use by its use in Nepal shows that even there are diversity in use, the majority of the land fall under the agricultural category either cultivated or uncultivated in nature. The current status of land use category except used for settlement are given in table below:

Table 1
Land Distribution by the Use Category in Nepal

Use Category	Area (in thousand Hector)	Percentage
Agricultural land cultivated	3,091	21.00
Agricultural land uncultivated	1,030	7.00
Forest	4,268	29.00
Shrubland	1,560	10.60
Grassland and pasture	1,766	12.00
Water	383	2.60
Others	2,620	17.60
Total	14,718	100.00

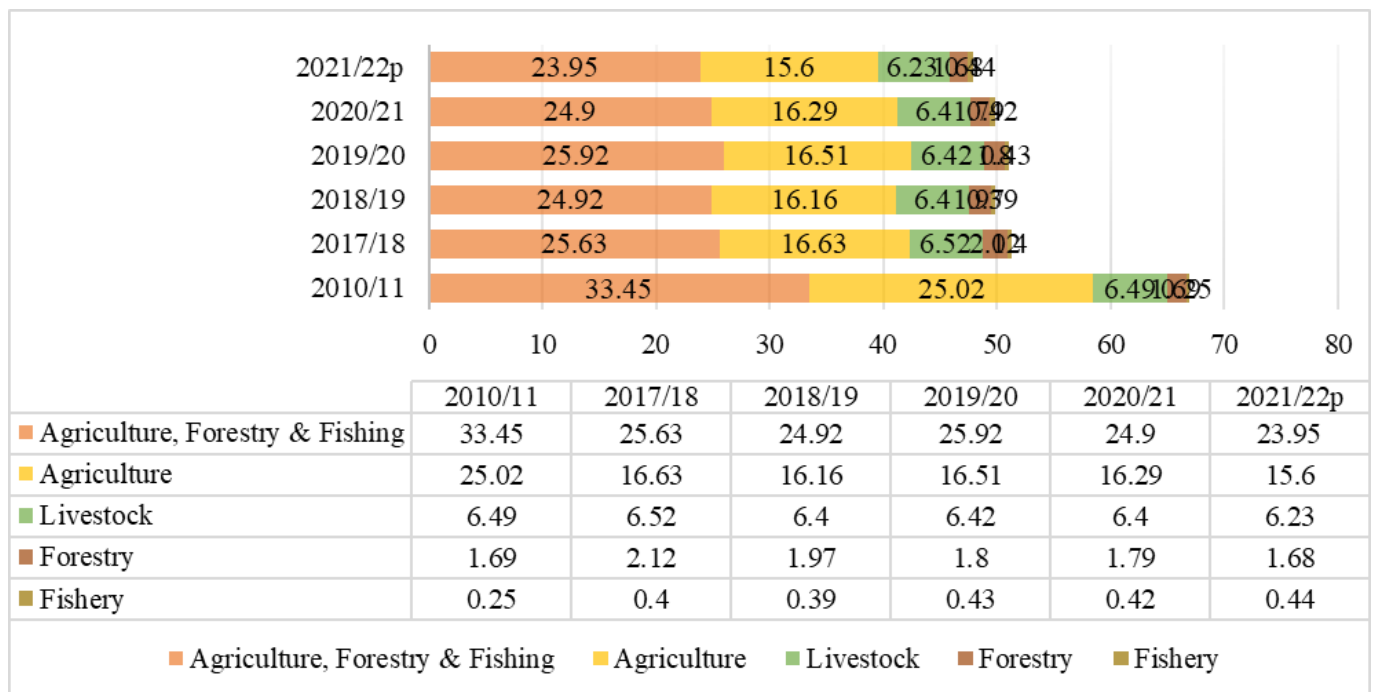
The table 1 depicts the overall distribution of land according to use category in Nepal. The data shows majority part of the land are applied in agriculture sector. All together it occupies 28 per cent of total usable land within which 7 per cent are still uncultivated. That means, there is a huge potential of ICT application so that there would be desirable growth in agricultural production and productivity.

Contribution of Agriculture in national GDP

Despite being one of the principal sectors contributing for national income and employment, the contribution of agriculture sector has been gradually declining over the years. The growing food demand always challenges the existing production mechanism in agriculture. As a result, the mass dependence on abroad for agriculture production exponentially reverse foreign trade deficit in the country. When we compare the status of agriculture sector for GDP contribution, it has been declined by 10 per cent overall during the period of 10 to 12 years. Current status of GDP contribution by different sub-sectors of agriculture are depicted in the following figure 1.

Figure 1

Sector wise Agricultural Contribution in Nepalese GDP



Source: MoALD (2022); Khatri & Timsina (2023)

*p: Preliminary

Figure 1 shows the different sub-sectors within agriculture sector in GDP contribution in Nepal. Data show that there is continual decline in agricultural GDP and stood near to one fifth of total contribution which used to be near to one third during 2010/11. More specifically, the agriculture exactly instead of livestock, forestry or fishery, has remained remarkable decline during the period of last 12 years. The very reason behind the decline in agricultural production is due to the lack of mechanization and application of more productive technology ended. In this scenario, wide application on ICT would the best suitable option by which the Nepalese agriculture may be revive with new signal of prospect.

Agricultural census of Nepal shows that there are about 41.30 lakh agricultural household around the country, among which some insignificant per cent of them are producing for commercial purpose. The reason behind the low involvement of farmers in commercial agriculture obviously remain backward in table commercial farming practice even with the less access of modern technology and ICT. The status of Nepalese agricultural families related to commercial practices below:

Tabel 2*Use of Agricultural Products for Consumption versus Commercial Purpose*

Status of Agricultural product use	Number of families (in Thousand)	Percentage
All for domestic use	2843.2	66.8
Major domestic use and limited selling	1021.4	24.7
Major selling and a few domestic use	221.8	5.4
All for selling	44.3	1.1
Total	4130.8	100.0

Source: National Agricultural Census 2078, (2023)

Table 2 shows the status of agricultural product use by Nepalese producer. The data shows that more than two third of producer use their product just for household use and next one forth partially involve to selling whereas only one per cent people completely sell their product outside. That means, there is a great importance of ICT in Nepalese agriculture to make it more competitive and productive so that it can have greater contribution to employment and GDP growth.

ICT can contribute to strengthen agricultural productivity and the up-to-date information opportunities to the farmers by which they can handle immediate as well as distance problems in the sector. The remarkable contribution of modern means of ICT helps farmers to weather forecast, measuring soil contents, strength of seeds and fertilizer using mechanism, means to control different diseases as well as better aware upon marketing and pricing. Even they are able to exchange the ideas on climate change and potential impact over their production mechanism. The Government of Nepal has also paid the good attention to improve agriculture sector through mechanization and information technology development with the close consultation of NGOs, INGOs and related researchers. Therefore, ICT can be one of the fundamental tool to transform Nepalese agriculture. Realizing this fact, some of the ICT initiatives which are trying to solve the agricultural challenges are as follows:

GeoKRISHI: a mobile app designed to exchange integrated information even integrating satellite data applied for finding agriculture related information by the farmers firstly introduced in March 2017 by Rajan Bajracharya.

Krishi Guru: a mobile application designed to provide information to the farmers regarding crops, weather forecast, agro-news, diseases and their remedial measures from experts developed by SMILE in collaboration with US Embassy, Kathmandu, a award winning application.

Smart Krishi: a mobile application developed to facilitate agricultural information regarding high value crops, soil type, improved seeds and fertilizers, weather forecast and some other ways to adapt modern farming system, developed by Anil Regmi in 2014. These applications are considered as highly suitable tool to expand agricultural knowledge and means to control over outmigration of youth and stabilize the agricultural productivity (Rai, 2018).

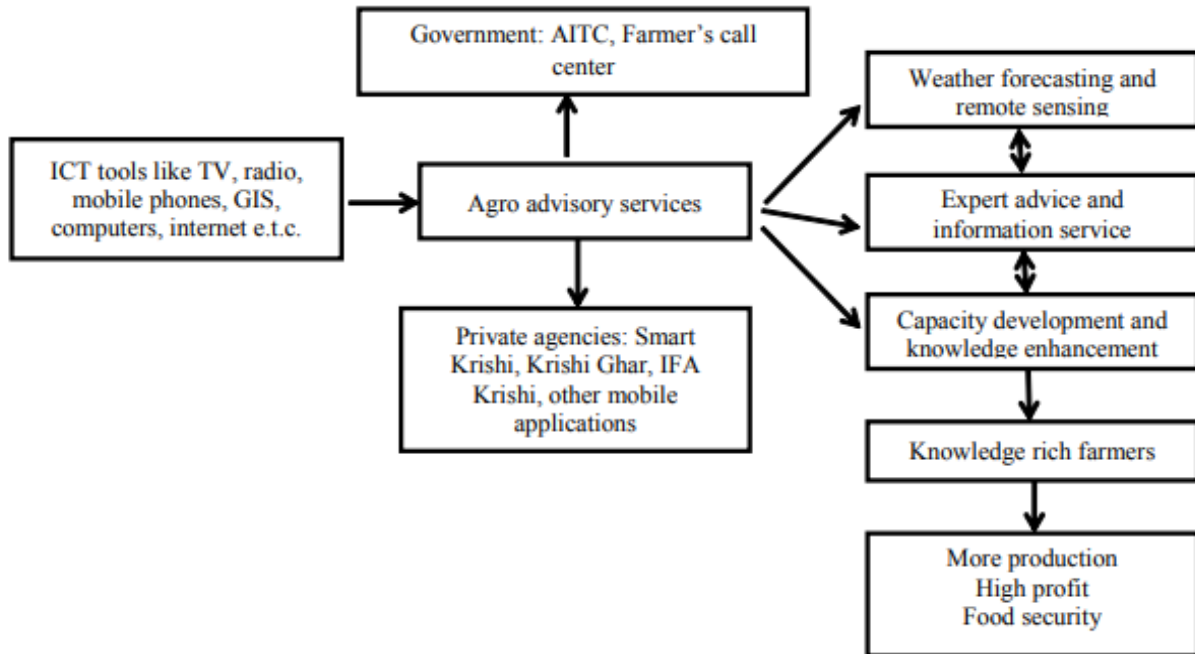
Discussion

Agriculture in Nepal has great potential to develop by the application of modern scientific technologies including ICT even it has declining output trend. The conventional extension services of agriculture are not enough in one hand and not providing good expertise to fulfill farmers need at suitable time. Due to this, there is growing trend of youth migration for the sake of good opportunities and income. The situation can be recorrected if there is appropriate mechanism to advance agriculture sector. Poudel et al. (2018) truly asserted that the barriers behind Nepalese agriculture can be handled by the help of ICT based agro-advisory services. The mechanism how the agro-advisory services can handle the agriculture related problems basically inherent to the rural and small farmers are shown in the following figure.

Figure 2 represents the ICT based Agro-advisory service framework through which the issues associated to the agriculture production and productivity can easily be handled. The various tools of ICT such as Mobile phone, radio, television, computer and so many others are the means through which either government or private agencies can provide such advisory services so that the farmers can have better ideas, information, skill, knowledge and knowhow to increase production, secure profit and better food security.

Figure 2

Framework of ICT Based Agro-Advisory Services in Nepal



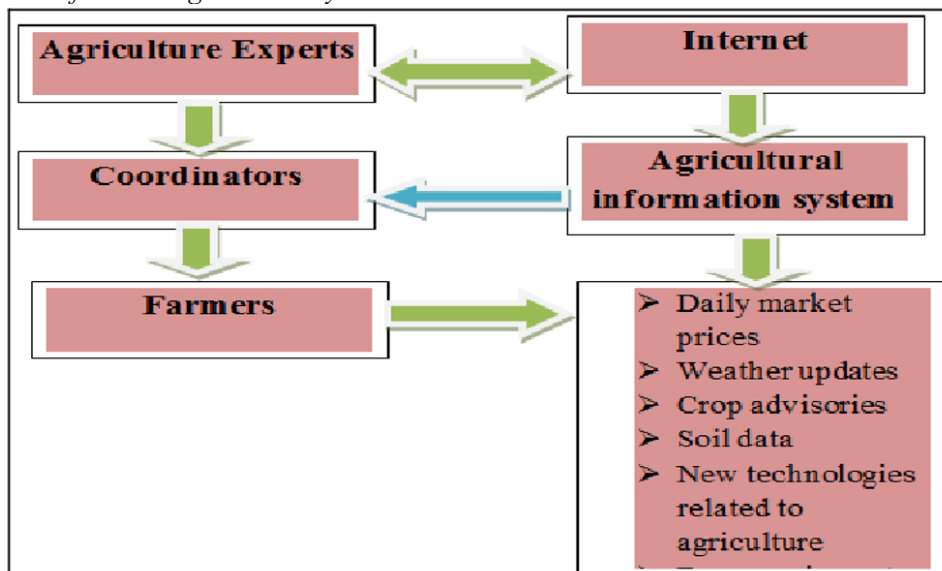
Source: Adopted from Paudel et al. (2018)

Functional Networks of ICT in Agriculture

It is obvious that ICT can play creative and constructive role to promote agricultural production and productivity through which the real farmers can harness desired benefits for social and economic progress. Similarly, majority of the farmers are rural dwellers and the socio-economic progress of the rural farmers eventually contributes the development of rural areas through the enhanced productivity, efficiency and better access to information. There are various means of ICT through which rural farmers can take productive benefits and transform themselves from subsistence farming to commercial agriculture. Following figure shows how the ICT related mechanism contributes for agricultural development in Nepal.

Figure 3

Functional Network of ICT in Agriculture System



Source: Google picture (2024)

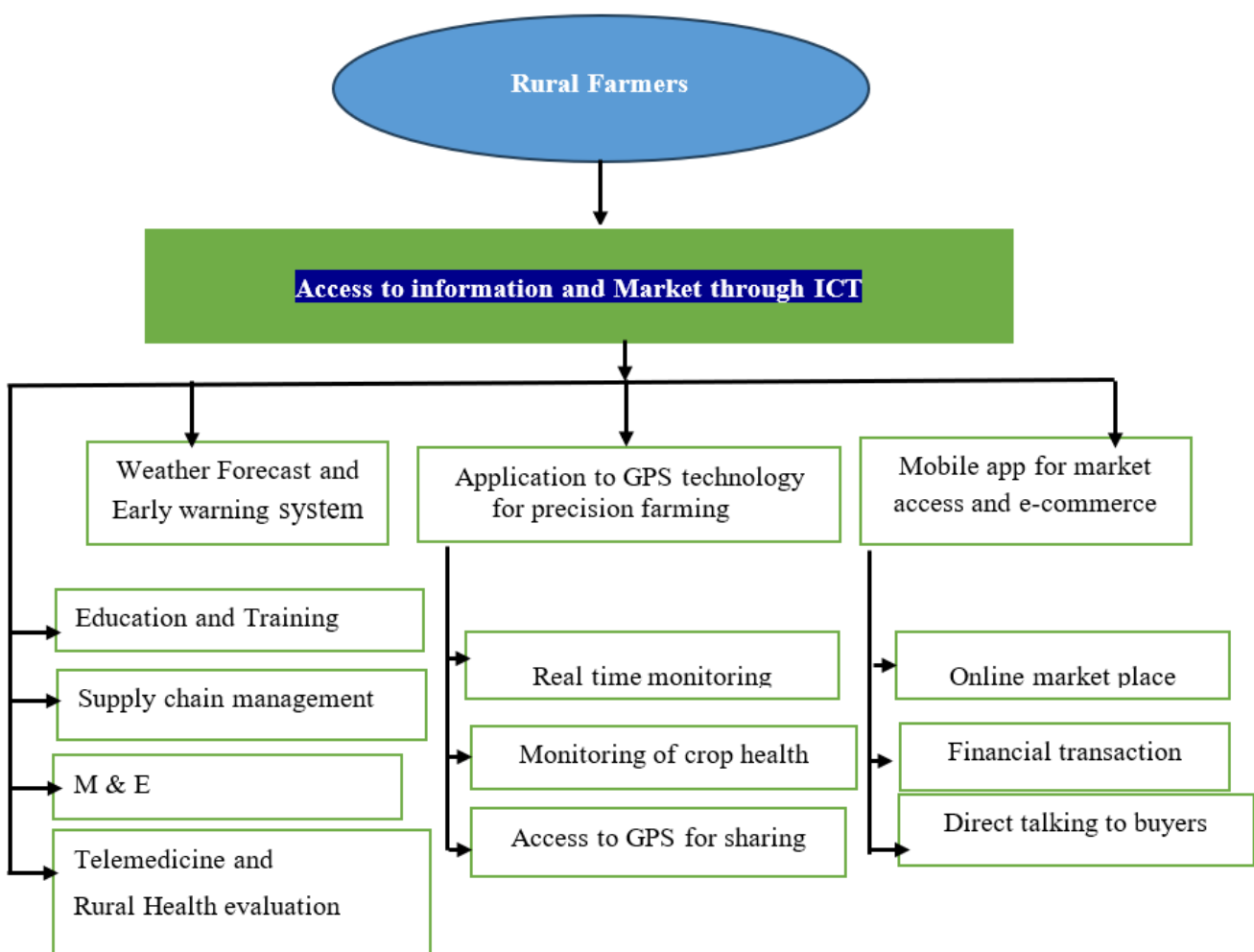
Figure 3 demonstrate the functional networks of ICT in agriculture. As a result of easy access to ICT, farmers can obtain necessary suggestion and information regarding prices, products, technology and markets. With the wider access of internet serves, they enjoy all the information either from experts or through agricultural information system themselves. Sometimes, experts provide information and technical supports through ICT related tools such as GeoKRISHI, Krishi Guru and so on.

Contribution of ICT in agriculture and Rural Development

On the basis of above information, it is come to know that ICT can have a creative and constructive role in transforming agricultural system in rural areas through which rural development is possible. The current land distribution is obviously uneven in rural areas. However, those farmers who are willing to involve in agriculture are not facing the scarcity of cultivable land. The problem is the lack of knowhow and productivity so that they can commercially use the available where the ownership of land seems to be insignificant issue. The overall strength of ICT of rural agricultural transformation can summed up in following figure:

Figure 4

Framework if ICT Contribution to Rural Farmers in Nepal



Source: Developed by authors, 2024

Figure 4 clearly demonstrate that how the ICT based services relating to agricultural system in rural areas connects farmers to outside because ICT provides the gateway to the access of information and entire market through different channels is shown in the figure. Therefore, ICT contributes rural farmers by accessing various means of technologies, ideas and information to be more advanced and productive. In a nutshell, ICT can contribute for agricultural transformation and Rural Development in case of Nepal.

Conclusion

The current study focuses on the crucial role of ICT in transforming the existing agriculture and promoting rural development in Nepal. Despite having numbers of challenges, Nepalese agriculture still stood as a dominant source of

livelihood for majority rural people. This research paper emphasizes the urgency of technological shift for agricultural modernization through the integration of ICT. Leveraging the ICT obviously can assure the benefit from the practice of precision farming, improved access to market, and enhanced skill, training and education. More specifically, the potential use of mobile applications, data analysis and e-commerce along with access to updated information and resources amalgamate better impact in empowering rural farmers through which, development of rural area seems obvious in the country.

Therefore, the prospects of ICT in agriculture rely on the ability to empower real farmers, enhance productivity and develop the connectivity to global market. In this regard some specific initiatives like GeoKrishi, Smart Krishi and Krishi Guru can exemplify the strength of technology to bridge the information as well as resource gap and step forward to sustainable agriculture. In a nutshell, this research highlights the needs of broad based approach through combining technology with information, policy measures along with public engagement to unlock the full potential of ICT in deriving desired outcome in agriculture and rural development in Nepal.

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