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FACTORS INFLUENCING THE USE OF E-AGRICULTURE INFORMATION SOURCES AND THEIR EXTENT OF USAGE ON THE LIVELIHOOD STATUS OF CEREAL CROP FARMERS IN BORNO AND KEBBI STATES, NIGERIA

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ABSTRACT

The study examined the factors that influence the cereal crop farmers' usage of e-agriculture information sources and their extent of usage on their livelihood status in Borno and Kebbi state, Nigeria. The specific objectives of the study are; to investigate the sources of information of e- agriculture and their extent of usage by the cereal crop farmers, to examine the livelihood status of the cereal crop farmers in the usage of e-agriculture information sources and to determine the factors that influence the usage of e-agriculture by the cereal crop farmers in the study area. Three (3) stage sampling procedure were used for the sampling. Data were collected using structured questionnaires. Simple descriptive statistics along with Likert scale of measurement were used to summarize the data collected on objectives (i) and (ii), while logit regression model and Pearson product moment correlation (PPMC) were used to achieve objective (iii) and tested the hypothesis of this study respectively. The result of the simple descriptive statistics revealed that, about 90% of the cereal crop farmers were using e-agriculture information sources. The likert scale result on extent of usage revealed that, mobile phone which is ranked 1st in extent of usage with the mean score of 2.70 is highly in used by the cereal crop famers, along with radio which is ranked 2nd in extent of usage with mean score of 2.64. The marginal effect result of logit regression revealed an inverse relationship between age (-2.59***), household size (-2.75***) and labour usage (-1.82***) which are negative, but has significant influence on the cereal crop farmers usage of e-agriculture information sources. These variables are significant at 1%, and 10% levels of significance respectively. Result on education (4.10***), farm size (2.86***), extension contact (2.73***), membership of cooperative (3.73***), sources of e-agriculture (4.34***), e-agriculture information on marketing (3.45***) and e-agriculture information on training (3.21***) are positive and statistically significant at 1% levels of significance. The hypothesis that was tested using PPMC, revealed direct and inverse correlations between livelihood status and the extent of usage of e-agriculture information sources all at 0.05 levels of significance, it was weak correlations, but lead to the rejection of the null hypothesis of the study. Conclusively, the most used e-agriculture information sources are obviously mobile phone, radio and other farmers (friends). Therefore, cereal crop farmers are encouraged to explore the use of other sources of e-agriculture information; also extension contact with farmers in the study area should be increased as this will help them gain new knowledge that may help enhance their productivity.

Keynote: Factors influencing, Extent of Usage, E-agriculture information sources, Livelihood Status, Cereal Crop Farmers, Borno and Kebbi States, Nigeria

INTRODUCTION

E-Agriculture involves designing, developing and applying innovative ways to use Information and Communication Technologies (ICTs), including digital technologies in the rural domain with a primary focus on agriculture; these include fisheries, forestry and livestock. The aim is to boost agricultural and rural development by improving access to valuable information that can help people whose livelihoods depends on agriculture to

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make the best possible decisions and use the resources available in the most productive and sustainable manner (Abdulkareem, 2016). World Society Information Summit (WSIS, 2015) refers to E-agriculture as an area of application of information and communication technologies (ICTs) under Action line C7 (e-government). World Society Information Summit was attached with the responsibility of organizing activities related to the E-agriculture Action line. The E-agriculture community of practice was launched in 2007 together with the funding partners. According to Hassan (2009), the E-agriculture community is a global initiative to enhance sustainable agricultural development and food security by enhancing the use of ICT in the sector. The E-agriculture community of practice facilitated by FAO Acts as a catalyst for networking and knowledge sharing on the role of sustainable agriculture and rural development. It provides an international framework to facilitate the process of capturing, managing and disseminating the lesson learned as well as the result and the applications of multilateral process related to the use of E-agriculture and rural development. The overall aim of the community using e-agriculture is to enable farmers to exchange knowledge related to agriculture, and to ensure that the knowledge created is effectively shared and used worldwide (FAO, 2017).

E-Agriculture Information Sources

According to FAO (2007), the definition of E-agriculture, extends beyond the E-government aspect of agriculture, since it includes not only agricultural services provided by governments to citizens, for example, farmers, rural communities, via ICTs, but encompasses a whole range of product services and infrastructure provided by government, the private sector, public research and extension, NGOs and farmers, organizations. ICTs that can be harnessed for E-agriculture may include devices, networks, services and applications. These can range from cutting edge internet-based technologies and sensing tools to other technologies that have been around for much longer, such as radio, telephones, mobile phones, television and satellites (Lohento *et al.*, 2013). Fernado (2016) stressed that; public private partnerships should seek to maximize the use of E-agriculture as an instrument to improve production both in quantity and quality. Hand held personal computers are small, light, and robust and have been used for providing access to information, mobile mapping and other data gathering activities (Fernado, 2016). ICTs that can be harnessed for E-agriculture may include devices, networks, services and applications. These can range from cutting edge internet-based technologies and sensing tools to other technologies that have been around for much longer, such as radio, telephones, mobile phones, television and satellites (Lohento *et al.*, 2013).

E-agriculture offers strong potentials for driving economic growth, raising incomes and improving livelihoods among rural communities through increased efficiency of agricultural production and value chain development (Sheikh *et al.*, 2016). E-agriculture creates opportunities to address some of agriculture's most pressing challenges using ICT-driven solutions to tackle problems as varied as climate change, pests and diseases and poor market access. The cross-sectional nature of E-agriculture propels growth in other sectors (Fredrick *et al.*, 2016). A unique ICT-based platform can serve several

sectors such as agriculture, health and transportation by offering information to consumers on products and quality by ensuring timely transportation of products to market and by empowering farmers through stronger linkages through small-scale producers and markets (Thia *et al.*, 2016). FAO (2017) identified the sources of E-agriculture information to include;

1) Telephone; for interactive voice response,
2) Mobile phone; for advisory sales, banking and networking,
3) Computer and website; for agricultural information and markets,
4) Internet and broadband; for knowledge sharing, social media, E-community, banking, market platform, trading among others,
5) Broadcasting; for expertise sharing, advisory community,
6) Sensor networks; for real time information, better data quantity and quality, and decision making,
7) Satellite for weather universal accessibility remote sensing,
8) Data storage and analytics; for precision agriculture actionable knowledge,
9) Geographical Information System (GIS),
10) Handheld Personal Computer,
11) Global Positioning System (GPS),
12) Television,
13) News Papers,
14) Extension Agents,
15) Short Messages Service (SMS),
16) Interactive Voice Response (IVR) and
17) Smartphone apps with Integration with special media.

Food and Agricultural Organization and International Telecommunication Union (FAO and ITU, 2017) reported that, E-agriculture also plays the following role in agricultural production system. These roles include;

i. Regulatory frameworks: E-agriculture helps in assisting with implementing regulatory policies, frameworks and ways to monitor progress.
ii. Capacity development and empowerment: E-agriculture widens the reach of local communities, including women, youth and elders, and provides newer business opportunities and thereby enhancing livelihoods.
iii. Financial services and insurance: E-agriculture increases access to financial services for rural communities helping to secure savings, find affordable insurances and tools to better manage risks.
iv. Food safety and traceability: E-agriculture helps deliver more efficient and reliable data to comply with international traceability standards and food nutrition aspects.
v. Agricultural innovation systems: E-agriculture bridges the gap between agricultural researcher, academia, extension agents, various market players and farmers.
vi. Sustainable farming: E-agriculture offers improved access and knowledge to sustainable farming practices, plant protection and animal health or climate smart solutions.

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vii. Disaster risk management and early warning systems: E-agriculture provides actionable information to communities and government on disaster prevention, in real time, such as agro-metro information, while also providing advice on risk-mitigation.
Viii. Enhanced market access: E-agriculture facilitates market access for inputs and products as well as trade.

E-agriculture as an emerging field in the intersection of agricultural informatics, agricultural development and entrepreneurship, referring to agricultural services, technology dissemination and information delivered or enhanced through the internet and related technologies. The e-agriculture concept, however, moves even beyond technology to the combination of knowledge and culture, which is primarily focusing on the improvement of communication and the process of learning among the different stakeholders of agricultural sector who are engaging at the different levels (FAO and ITU, 2017).

The use of ICTs such as mobile phones and internet has increased significantly since the creation of the e-agriculture community. It is estimated that there are 608 billion mobile connections for a world population of a little over 7 billion (Alemu and Negash, 2015). According to Alemu and Negash (2015), the cellular phone has provided market links for farmers and entrepreneurs. Growth in mobile phones has been explosive and now reaches more than a third of the population. This has reduced transaction costs, broadened trade networks and facilitated searches for employment. Bertolini (2009) observed that, the telephone is the only e-agriculture used (if any) by the majority of farmers in Africa. Some of the respondents according to Bertolini in the study considered the cellular phone applications such as the SMS to be one of the most important e-agriculture applications. According to Mahanan, (2016), Radio is an important mechanism for disseminating knowledge and information in different languages and formats, especially to poor people. In Zambia, the Radio Farm Forum (RFF), a government initiative has shown that radio is important in addressing the common needs and problems of resource-deficient rural farmers by giving them an opportunity to listen to a radio discussion programme on agricultural problems and techniques. FAO (2014) stated that, internet, e-mail, websites and web-based applications are becoming increasingly important in sharing and in disseminating agricultural information and there are many ongoing web-based application initiatives worldwide. There is model flow of information from various sources, such as the farmers, the agricultural research institutes, meteorological stations and agricultural extension officers. The knowledge from these sources is brought together in the Knowledge Base (KB). This is then processed by the inference engine with some of the algorithms and the system can perform various actions. Small scale farmers can then interact with the system through Short-Message-Service (SMS) and the farmer can also obtain information through mass media (Lwande and Lawrence, 2008).

Concept of Cereal Crop

Africa with its vast land area covering 3 billion ha has 1.3 billion ha of agricultural land out of which only 252 million ha (19.36%) is for arable crops (FAO, 2011). Africa is the Centre of origin and also a major producer of several cereal like sorghum, pearl millet, finger

millet, teff and African rice. Another major cereal is maize, has over taken these traditional cereals, while wheat is widely cultivated in the northern Africa and in Sudan and Ethiopia. Agriculture is the engine for growth in Africa with subsistence agriculture practiced by the majority of the small holder farmers, yields gaps are high and poor soils, amongst other constraints add to the difficulties for sustainable farming and incomes. Cereals like Sorghum, Millets, Wheat, Maize and Rice are the major staple foods of the most populations. The cereals are grown over an acre of 98.6m ha producing 162m tons (FAOSTAT, 2012).

Concept of Livelihoods

According to Scoones (1998) in Anne (2009), livelihoods are 'the capabilities, assets (including both material and social resources) and activities required for making a living'. Rural Nigeria is characterized by agrarian livelihood as well as other primary production activities such as cereal crop farming, animal husbandry and fishery activities. Omonona (2010) in his study revealed that, agricultural-based livelihood in rural Nigeria has a higher level of poverty than other occupational groups. Rural agriculture is subjected to local variations in weather conditions, and thus expected variations in income levels and access to food. Livelihood systems are at the heart of poverty reduction and food security issues in different policy environments. According to Baro (2002), livelihood systems encompass means, relations, and processes of production, as well as household management strategies. The resources and values of specific physical and social environments determine the character of livelihood system components. Food security is not the only goal of rural populace; the need for a sustainable livelihood is more central since it reflects the ability to take hold of other issues like good nutrition and housing which guarantee an improved life (Ayantoye *et al.*, 2011).

Statement of the Research Problem

More than 70% of the working adult populations in Nigeria are employed in the agricultural sector directly or indirectly and over 90% of Nigeria agricultural outputs comes from peasant farmers who dwell in the rural areas where 60% of the population lives. The vast majority of these farmers have limited access to information, modern input, and other productive resources, such as access to pesticides, fertilizers, hybrid seeds and irrigation without some form of public sector intervention (Ogunwole *et al.*, 2014). The rate of growth of Nigeria's food production is 2.5% per annum in recent years, while food demand has been growing at the rate of 3.5% per annum due to high rate of population growth of 2.83% (Kolawale and Ojo, 2010). The accessibility to e-agricultural tools are still very low, especially among the rural poor of Nigeria as many are currently excluded from this new field of agriculture and opportunities. E-agriculture can bridge the digital gap that separates those with and without access to the internet. Having timely and accurate access to information that is tailored towards specific locations and conditions can be very helpful to farmers to make the most effective use of their resources in often changing circumstances. For example; shifting weather patterns, fluctuating pests and diseases epidemics and alterations in soil conditions. E-agriculture can enable them to tap in to reliable credit sources and profitable markets, and engage with other

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important services, such as input supply, and linkage to efficient value chain. Exploring the most effective sources for delivering information is an essential part of the e-agriculture approach. With the rapid growth of mobile phone ownership, together with mobile broadband provides an excellent opportunity for developing e-agriculture (Hassan, 2009).

In view of the above initiative, the research intends to evaluate the effects of e-agriculture by the cereal crop farmers in the study area. This is because e-agriculture can provide relevant information to cereal farmers that will help boost their productivity and increase their crop yields, thereby improving the farmers' livelihoods. Hence the research work intends to provide answers to the following research questions:

i. What are the sources of information of e- agriculture and their extent of usage by the cereal crop farmers in the study area?
ii. What are the livelihood statuses of the cereal crop farmers in e-agriculture usage in the study area? and
iii. What are the factors that influence the cereal crop farmers' usage of e-agriculture in the study area?

Aim and Objectives of the Study

The aim of this study is to evaluate the factors that influence the cereal crop farmers' usage of e-agriculture information sources and extent of usage on their livelihoods in Borno and Kebbi States, Nigeria.

The specific objectives of the study are to:

i. investigate the sources of information of e- agriculture and their extent of usage by the cereal crop farmers in the study,
ii. examine the livelihood status of the cereal crop farmers in the usage of e-agriculture in the study area; and
iii. Determine the factors that influence the usage of e-agriculture by the cereal crop farmers in the study area.

Hypothesis of the Study

Ho: There is no significant relationship between the extent of usage of E-agriculture and the livelihood status of the cereal crop farmers in the study area.

METHODOLOGY

Sampling Techniques and Sample Size

The study was carried out in Borno and Kebbi states, Nigeria. Three (3) stage sampling procedure were used for the sampling. The first stage involved the purposive selection of five (5) LGAs from Borno State and four (4) LGAs from Kebbi State giving a total number of nine (9) LGA selected from the two states. In a nutshell, the 9 LGAs that the study covered were predominantly engaged in cereal crop farming.The second stage of selection involved the proportionate ten per cent (10%) selection of the sample size of villages for this study, from the sample frame of villages for both states under study. Borno had the total sample size of twenty five (25) villages and Kebbi had the total sample size of nineteen (19) villages, this gave a total of forty four (44) villages both in Borno and

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Kebbi State.The third stage of the selection involved the selection of the sample size of farmers for the study using Yamane Formula. The sample frames were obtained through the farmers' group in the study area. The sample size was obtained using the Yamane Formula (1997):

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Where:

n = sample size

N = Population of Study (Sample frame total)

1 = Constant

e= Limit of tolerance error (0.07)

The total sample frame for Borno is 17,564 and the total sample frame for Kebbi is 5,637. The total sample size for farmers for Borno is 203, and the total sample size for kebbi is 197. These are shown on Tables 1 and 2 respectively.

Table 1: Sampling Distribution of the Study Areas in Borno and Sample Size

State	LGAs	Sample Frame of Villages (SFV 10%)	Sample Size of Villages (10% of SFV)	Sample frame of Farmers	Sample size of farmers
Borno	Biu	53 (5)	Gwaram	500	6
			Tabra	800	9
			Miringa	1000	12
			Ngrim	420	5
			Nassarawa	950	11
	Hawul	82(8)	Azare	1045	12
			Shaffa	1200	14
			Ngwa	500	6
			Yimirshika	900	10
			Sabon-gari	800	9
			Subwang	150	2
			Hyera	700	8
			Marama	1200	14
	Kwayakusar	50(5)	Gusi	1050	12
			Guwal	1000	12
			Kwayakusar	800	9
			Wandali	700	8
			Dayar	400	5
	Bayo	39(4)	Gaidam	800	9
			Maina Baba	700	8
			Tashanltashe	280	3
			Wuyo	150	2
	Shani	26(3)	Pela	334	4
			Walama	900	10

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			Kubo	285	3
Total	**5**	**250(25)**	**25**	**17564**	**203**

Figures in parenthesis are the sample size of villages
(10% of sample frame of villages)
Source: Pre- Survey Information (2018)

Table 2: Sampling Distribution of the Study Areas in Kebbi and Sample Size

State	LGAs	Sample Frame of Villages (SFV 10%)	Sample Size of Villages (10% SFV)	Sample frame of farmers	Sample size of farmers
Kebbi	Zuru	92(9)	Bedi	1250	44
			Dongo	150	5
			Amanawa	63	2
			Dongo	324	11
			Manga	265	10
			Dabai	350	12
			Senchi	435	15
			Rikoto	260	9
			Isgogo	174	6
	Fakai	28(3)	Mahuta	293	10
			Matseri	250	9
			Janhawa	125	4
	Danko-Wasagu	30(3)	Gwazawa	420	15
			Ranfin-Zuru	370	13
			Yarbuga	270	9
			Dirin Daji	183	7
	Sakaba	40(4)			
			Sakaba	246	9
			DankanKambari	120	4
			DirinGari	89	3
Total	**4**	**190(19)**	**(19)**	**5637**	**197**

Figures in parenthesis are the sample size of villages
(10% of sample frame of villages)
Source: Pre- Survey Information (2018)

Method of Data Collection

The data for this study were collected from primary sources, (structured questionnaires) that contain both open and close ended questions and interview schedule was used for farmers who cannot read nor write with the help of well-trained enumerators.

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Analytical technique

The analytical technique that was used in this study is simple descriptive statistics (frequency Tables and percentages) which also involved the use of likert scale to present the results on objectives i and ii to describe the perceived effects and extent of usage of e-agriculture information sources.

Logit Regression Model

Objective (iii), was achieved using Logit regression model. This was used to estimate the factors that influence the use of E-agriculture by the cereal crop farmers in the study area. It was as well used in estimating the influence of independent variables in order to establish the best variables that serve as the determinant of the factor that influence the use of E-agriculture by the cereal crop farmers in the study area (Owoeye and Toluwase, 2018) and (Adesiyan, 2015). The Logit regression in this study is specified explicitly as follows:

$$Y = \beta_0 + \beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6\ldots\ldots\ldots+\beta_{18}X_{18}+e_i \quad (2)$$

Where;

Y = Use of E-agriculture (1 usage, 0 otherwise)
$X_1 - X_{18}$ = Independent Variables
X_1 = Age (years)
X_2 = Gender (1 male, 0 otherwise)
X_3 = Marital status (1 married, 0 otherwise)
X_4 = Educational (years)
X_5 = Household Size (number)
X_6 = Farming experience (years)
X_7 = Farm Size (hectare)
X_8 = Extension Contact (number)
X_9 = Cooperatives Membership (years)
X_{10} = Access to Credit (naira)
X_{11} = Labour usage (man-day)
X_{12} = Income (₦)
X_{13} = Sources of E-agriculture Information (number)
X_{14} = E-agriculture information on marketing (1 yes, 0 otherwise)
X_{15} = E-agriculture information on training (number)
X_{16} = E- agriculture information on weather (1 yes, 0 otherwise)
X_{17} = E-agriculture information on farming system (1 yes, 0 otherwise)
X_{18} = E-agriculture information on post-harvest technology (1 yes, 0 otherwise)
β_0 = Intercept to be estimated
$\beta_1 - \beta_{18}$ is parameters to be estimated e = error term

Pearson Product Moment Correlation (PPMC)

The Pearson product moment correlation shows the degree of association between any two given variables (Olowu, 2004). This is usually represented by symbol "r" and can only be applied if the two sets of scores are at interval level, that is, if both sets of scores are

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continuous. The Pearson "r" in this study will be calculated using the Rho score method as specified below:

The Rho score method is calculated using the formula:

$$"r" = \frac{N\sum XY - \sum X\sum Y}{\sqrt{[NX^2 - (\sum X)^2][NY^2 - (\sum X)^2]}} \quad (3)$$

(11)

Where:
N = Number of observations
∑ = Summation
X = Independent variables
Y = Dependent variables
Therefore, the null hypothesis (Ho) was tested using the above PPMC model.

RESULTS AND DISCUSSION

Sources of e-agriculture and their extent of usage by the cereal crop farmers

Objective (i) investigated the sources of e-agriculture and their extent of usage by the cereal crop farmers in the study area. Items discussed here include response on the cereal crop farmers' usage of e-agriculture, sources of e-agriculture information and extent of usage of e-agriculture information sources.

Table 3: Distribution of the cereal crop farmers' responses on the use of e-agriculture

Responses	frequency	percentages
Yes	358	89.5
No	42	10.5
Total	400	100

The above Table 3 presents the cereal crop farmers response on the use of e-agriculture information sources. This revealed that, about 90% of the farmers do use e-agriculture information sources and about 11 percent of them do not use the e-agriculture information sources. This finding implies that, majority (about 90%) of the cereal crop farmers' uses e-agriculture information sources in their cereal crop farming in the study area.

Table 4: Distribution of the cereal crop farmers sources of e-agriculture information used

Sources of e-agriculture	frequency	percentages
Telephone	30	7.5
Mobile phone	368	92.0
Computer website	38	9.5
Internet broadband	34	8.5
Radio	354	88.5
Palmtop PC	19	4.8

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Television	255	63.8
Newspapers	133	33.3
Extension agents	154	38.5
Short message service (SMS)	127	31.8
Social media	116	29.0
Satellite	80	20.0
Other farmers (friends)	196	49.0

Table 4 present the cereal crop farmers sources of e-agriculture information used in their cereal crop farming in the study area. The study revealed that, mobile phone was high in use by the farmers with 92% of them using it, this is followed by about 89% of them who were using radio as their source of e-agriculture for their cereal crop farming. While only about 5% of the cereal crop farmers were using palmtop PC, while about 8% of the cereal crop farmers were using telephone, about 64% of the cereal crop farmers were using television, about 39% were using extension agents, 33% were using newspapers, about 32% were using short messages services, while 49% of the cereal crop farmers were contacting other farmers who might be their friends about their farming activities. Twenty percent (20%) of them were using satellite as their sources of e-agriculture, about 10% and about 9% of the cereal crop farmers were using computer website and internet broadband respectively. And 29% of the cereal crop farmers were using smartphone/social media as their source of the e-agriculture in their cereal crop farming.

Table 5: Distribution of the cereal crop farmers' extent of usage of e-agriculture information sources in their cereal crop farming in the study area

E-agriculture information sources	Extent of Usage					
	Highly used (HU 3)	Fairly used (FU 2)	Not in used (NU 1)	WS	WM	Rank
Telephone	78	14	367	459	1.15	11th
Mobile phone	951	94	36	1081	2.70	1st
Computer website	45	62	354	461	1.15	11th
Internet/broadband	57	50	356	463	1.16	10th
Radio	921	84	51	1056	2.64	2nd
Palmtop PC	27	24	379	430	1.08	12th
Television	465	172	159	796	1.99	4th
Newspapers	138	168	270	576	1.44	7th
Extension agents	285	110	250	645	1.61	5th
Short message services (SMS)	123	182	268	573	1.43	8th
Smartphone /social media	219	118	268	605	1.51	6th
Satellite	147	62	320	529	1.32	9th
Other farmers (friends)	657	22	170	849	2.12	3rd

Table 5 presents the cereal crop farmers' extent of usage of e-agriculture information sources in the study area. Likert scale was used to ascertain the extent of usage of e-

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agriculture by the cereal crop farmers. Scores were assigned as highly used 3, fairly used 2, and not in use 1. The result presented shows that, mobile phone is ranked 1st in usage by the cereal crop farmers in the study area and it has the mean value of 2.70. This signifies that mobile phone is highly in used because it is easily accessed by the farmers in the study area as compared to other e-agriculture information sources. Radio is ranked 2nd in extent of usage by the cereal crop farmers with the mean score of 2.64. This implies that, radio is also highly in used by the cereal crop farmers and has the capacity of reaching large number of farmers in different location as news travel fast through radio. Also, information about farming are delivered to farmers about new farming practices in diverse languages that suit the understanding of the farmers. Information giving to farmers by other farmers or their friends about new farming practice has help the cereal crop farmers in boosting their productivity, this is evident in this study as it is ranked 3rd and carriers the mean score of 2.12, which also signifies that it is highly in used by the cereal crop farmers in the study area. This is considered e-agriculture because; e-agriculture has gone beyond technology to the combination of different culture, knowledge and skills of stakeholders from across the globes. This finding has confirmed that fact, because other farmers can stand as transmission agents' delivery new innovation to other farmers who are less privilege to have the first class information. Television is ranked 4th with the mean score of 1.99. This implies that, the extent of usage of television is also high among the farmers. This might be as a result that it combined both audio and visual aspects which the farmers can easily see and understand any demonstration made on new innovation for farmers to learn and adopt the use.

The extent of usage of extension agents ranked 5th with the mean score of 1.61, this signifies that the cereal crop farmers still have access to extension agents as their extent of usage is also on the high side. Also the result shows the extent of use of smartphone integrated with social media to rank 6th with the mean score of 1.51. This implies that, social media usage is also on the high side in use by the cereal crop farmers in the study area; this could be as the result of it helping farmers to interact with other people/farmers from other parts of the world to gain access to information on their cereal crop farming. In a similar vein, reported in this study that, newspaper is ranked 7th in the extent of usage of e-agriculture information sources with the mean score of 1.44. This implies that, newspapers were also fairly in use when it comes to disseminating information to farmers about their farming activities. The implication is that, it can only be successfully used by the farmers who are literate, because understanding the content of written words can only be by those who can read and write. Therefore the farmers who cannot read nor write are at the disadvantage of using newspapers. Going by this same finding, the cereal crop farmers has reported that, short message services (SMS) is fairly used by them in their cereal crop farming which is ranked 8th with the mean score of 1.43. This is closely related to the use of newspaper since they both demand reading and understanding the content of the message. This finding is in agreement with that of Lwande and Lawrence, (2008), who in their findings revealed that, small scale farmers can interact with the system through short message service (SMS) and the farmer can also obtain information through mass media. Satellite is also indicated to be fairly in used by the cereal crop farmers in the study

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area, this is ranked 9th with the mean score of 1.32. The usage of satellite is essential, as it help the farmers to gain access to knowledge about farming that comes from other part of the world that might not be possibly accessed without the use of this satellite. Computer/website and telephones are ranked 11th in the extent of usage by the cereal crop farmers and they both have the mean score of 1.15. This signifies that, the cereal crop farmers were fairly using this medium for information on their cereal crop farming, as it clearly indicated that majority of this farmers were not using computer/website. Similarly, internet/broadband is ranked 10th with the mean score of 1.16, this implies that, this e-agriculture information sources was fairly in used by very few of the cereal crop farmers in the study area, while majority of them were not using it. Palmtop PC is ranked 12th with the mean score value of 1.08 is fairly used by few of the cereal crop farmers, while majority of them were not using it. This finding commensurate that of FAO (2014), who stated that, internet, e-mail, computer/websites and web-based applications are becoming increasingly important in sharing and in disseminating agricultural information and worldwide.

Livelihood Status of the Cereal Crop Farmers in the Study Area

Objective (ii) presents the livelihood status of the cereal crop farmers in the study area.

Table 6. Distribution of the cereal crop farmers' livelihood status

Livelihood status	Frequency (f)	Percentages (%)
Low	25	6.25
Moderate	341	85.25
High	34	8.50
Total	400	100

Table 6 above unveiled the cereal crop farmers' livelihood status in the study area. The result above revealed that, 85% of the cereal crop farmers were in the second class of social status which is moderate livelihood status, while about 9% of them were in the first class of social status which is high livelihood status and 6% of the cereal crop farmers were in third class of social status which is low livelihood status. This finding implies that, the cereal crop farmers were not totally on the lower livelihood status nor totally on the high livelihood status, but moderate livelihood status which is comfortable for them. Going by this research work, the cereal crop farmers were not totally poor as depicted by these findings, since their cereal crop farming helps them get additional income that helps them care for their households' needs and wants.

Factors that Influence the Use of E-Agriculture by the Cereal Crop Farmers

Objective (iii) examined the factors that influence the use of e-agriculture in cereal crop farming by the cereal crop farmers in the study area. The items discussed here are the logits regression analysis of the factors influencing the use of e-agriculture and the marginal effects of the result on the factors influencing the use of e-agriculture by the cereal crop farmers in the study area.

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Table 7. Logit Regression Estimates of the Factors Influencing the use of E-agriculture on the Cereal Crop Farmers Livelihood Status

Variable	Coef.	Std.Err	Z.value	P>/Z/
Age	-.1026799	.0405557	-2.53**	0.011
Gender	1.580904	.8082108	1.96*	0.050
Marital status	.0935608	.6777614	0.14	0.890
Educational level	.190862	.0498786	3.83***	0.000
Household	-.4409141	.1647599	-2.68***	0.007
Farming experience	-.0186835	.0277503	-0.67	0.501
Farm size	.1615857	.0588286	2.75***	0.006
Extension contact	1.198695	.4598528	2.61***	0.009
Membership of cooperative	1.856573	.5176582	3.59***	0.000
Access to credit	1.031829	.5087573	2.03**	0.043
Labour usage	-.9227073	.5154561	-1.79*	0.073
Income level	2.28e-07	6.16e-07	0.37	0.711
Sources of e-agriculture	.5582567	.1373973	4.06***	0.000
E-agriculture info on marketing	3.545899	1.081414	3.28***	0.001
E-agriculture info on training	2.058129	.6646296	3.10***	0.002
E-agriculture info on weather	.4890241	.4710159	1.04	0.299
E-agric. info on farming system	1.689208	.814939	2.07**	0.038
E-agric. info on post-harvest tech.	2.862208	1.235574	2.32**	0.021
Constant	-2.14511	1.238683	-1.73*	0.083

Key note: *: significant at 10%
**: significant at 5%
***: significant at 1%

Table 7 present the result of the logit regression estimates on the factors that influence the use of e-agriculture on the cereal crop farmers' livelihood status in the study area. The result of this finding revealed that, age (-2.53**), household (-2.68***) and labour usage (-1.79*) are negatively significant at 5%, 1% and 10% levels respectively. This signifies that, these variables are negative but significantly influencing the use of e-agriculture information sources by the cereal crop farmers. This implies that, increase in these variables will decrease the use of e-agriculture information sources by the cereal crop farmers. Gender (1.96*) has positive influence on the use of e-agriculture information sources at 10% level of significance. This implies that gender plays an important role in the use of e-agriculture information sources. Therefore, having more males in cereal crop farming will increase the usage of e-agriculture as compared to females. In a similar vein, the result on educational level (3.83***), farm size (2.75***), extension contact (2.61***), membership of cooperative (3.59***), sources of e-agriculture usage (4.06***), e-agriculture information on marketing (3.28***) and e-agriculture information on training (3.10***) are positively significant at 1% levels. This implies that increase in livelihood status of the cereal crop farmers will in turn increase the usage of e-agriculture information sources,

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thereby granting more access to the use of these variables by the farmers. Result on access to credit (2.03**), e-agriculture information on farming system (2.07**) and e-agriculture information on post-harvest technology (2.32**) are having significant and positive influence on the cereal crop farmers usage of e-agriculture information sources at 5% levels of significance.

Table 8. Logit Regression Analysis of the Marginal Effects of the Factors Influencing the use of E-agriculture on the Cereal Crop Farmers Livelihood Status

Variables	Dy/Dx	Std.Err	Z. value	P>/Z/
Age	-.0059775	.002308	-2.59***	0.010
Gender	.0920326	.0463174	1.99*	0.047
Educational level	.0111111	.0027083	4.10***	0.000
Household size	-.0256679	.0093381	-2.75***	0.006
Farm size	.0094067	.0032926	2.86***	0.004
Extension contact	.0697822	.0255552	2.73***	0.006
Membership of cooperative	.1080807	.0289576	3.73***	0.000
Access to credit	.0600681	.0293457	2.05**	0.041
Labour usage	-.0537156	.0295599	-1.82*	0..069
Sources of e-agriculture	.032499	.0074903	4.34***	0.000
E-agric. info on marketing	.2064252	.0598331	3.45***	0.001
E-agric. info on training	.1198144	.0373155	3.21***	0.001
E-agric. info on farming syst.	.0983375	.0469178	2.10**	0.036
E-agric. info on post-harv tech.	.166624	.0710783	2.34**	0.019

Key note: *: significant at 10%
**: significant at 5%
***: significant at 1%

Table 8 above shows the result of the marginal effects of the factors influencing the use of e-agriculture by the cereal crop farmers in the study area. The marginal effect result revealed the same result as in Table 8 above. It revealed an inverse relationship between, age (-2.59***), household size (-2.75***) and labour usage (-1.82***) to be negative but has significant influence on the cereal crop farmers usage of e-agriculture information sources. These variables are significant at 1%, and 10% levels of significance respectively. Gender (1.99*) shows positive and significant at 10% level of significance. Similarly, education (4.10***), farm size (2.86***), extension contact (2.73***), membership of cooperative (3.73***), sources of e-agriculture (4.34***), e-agriculture information on marketing (3.45***) and e-agriculture information on training (3.21***) are positive and statistically significant at 1% levels of significance. Access to credit (2.05**), E-agriculture information on farming system (2.10%) and e-agriculture information on post-harvest technology (2.34**) are positive and statistically significant at 5% levels of significance. This result implies that, an increase in age of the cereal crop farmers will cause reduction in the usage

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of e-agriculture by -0.59%, similarly, it is disclosed in this finding on the result of gender that, an increase in males cereal crop farmers will cause an increase in the usage of e-agriculture information sources by 9.2%. Result on educational levels indicates positive significance in influencing the cereal crop farmers' usage of e-agriculture information sources, this also signifies that, an increase in education will cause increase in the usage of e-agriculture information sources by 1.1%. The result on household size revealed negative but significant in influencing the use of e-agriculture information sources, this implies that, a percent increase in the number of house hold size of the cereal crop farmers will cause a decrease in the usage of e-agriculture information sources by -2.56%. In a similar vein, a percent increase in farm size of the cereal crop farmers will cause an increase in the usage of e-agriculture information sources by 0.94%. Increase in extension contact, will cause increase in the usage of e-agriculture information sources by 6.98% by the cereal crop farmers in the study area. Still on the result of the marginal effects of the facts influencing the cereal crop farmers' usage of e-agriculture information sources revealed that, a percent increase in cooperative membership by the cereal crop farmers will cause 10.8% increase in the usage of e-agriculture information sources. Access to credit revealed positive significance and a percent increase in credit accessed by the cereal crop farmers, there will be 60% increase in the usage of e-agriculture information sources. The result on labour usage unfolds negative but significant relationship with the usage of e-agriculture information sources, this implies that, a percent increase in labour usage, will cause -5.37% decreases in the use of e-agriculture information sources by the cereal crop farmers in the study area.

Result on access to sources of e-agriculture shows positive significant influence on the use of e-agriculture information sources which implies that, a percent increase in access to this variable, will bring about 3.2% increase in the usage of e-agriculture information sources by the cereal crop farmers in the study area. The result on access to e-agriculture information on marketing unveiled positive significance influence on the cereal crop farmers usage of e-agriculture information sources, this signifies that, a percent increase in access to this marketing information using e-agriculture, will in turn bring about 20.64% increase in the usage of e-agriculture information sources. Access to training using e-agriculture information sources revealed that, if there is a percentage increase in access to e-agriculture training, there will be increase in the usage of e-agriculture information sources by 11.98% by the cereal crop farmers in the study area. While, access to farming system through the use of e-agriculture information sources will increase the usage of e-agriculture information sources by 98.3% if there is a percent increase to information on farming system through the use of e-agriculture, and a percent increase in access to e-agriculture information on post-harvest technology will cause an increase in the usage of e-agriculture information sources by 17% by the cereal crop farmers in the study area.

Result of Hypothesis Testing

Table 9. Correlation analysis showing the relationship between the extents of usage of e-agriculture on livelihood status of the cereal crop farmers in the study area

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	Livelihood status (Y)	Tel(X_1)	MP(X_2)	CW(X_3)	IB(X_4)	R(X_5)	PPC(X_6)	TV(X_7)	NP(X_8)	EA(X_9)	SMS(X_{10})	SSM(X_{11})	SAT(X_{12})	FF(X_{13})
Livelihood status (Y)	1.0000													
Tel.(x_1)	0.0216	1.0000												
MP.(X_2)	0.0803	-0.0511	1.0000											
CW(X_3)	0.1389*	0.1532*	0.1077*	1.0000										
IB(X_4)	0.0490	0.0073	0.1154*	0.3755*	1.0000									
R(X_5)	0.0865	-0.0976	0.4152*	0.0235	-0.0099	1.0000								
PPC(X_6)	0.0255	0.0951	-0.0009	0.3668*	0.2521*	-0.0127	1.000							
TV(X_7)	0.0595	-0.1139*	0.2344*	0.1349*	0.0865	0.3020*	0.0275	1.0000						
NP(X_8)	0.0476	-0.1215*	0.2112*	0.1856*	0.3058*	0.1422*	0.0835	0.2280*	1.0000					
EA(X_9)	0.1428*	0.1163*	0.1277*	0.1484*	0.0771	0.1071*	0.0755	-0.0052	0.2369*	1.0000				
SMS(X_{10})	0.0302	0.0993*	0.1820*	0.2359*	0.1386*	0.1298	0.0884	0.2637*	0.1559	0.1326*	1.0000			
SSM(X_{11})	0.0614	0.1372*	0.2300*	0.3721*	0.3589*	0.1730*	0.1190*	0.2593*	0.3224*	0.1716*	0.3484*	1.0000		
SAT(X_{12})	0.1542*	-0.0728	0.1200*	0.1408*	0.1592*	0.1763*	0.0144	0.3701*	0.3631*	0.1566*	0.2255*	0.3507*	1.0000	
OFF(X_{13})	-0.1206*	-0.1173*	0.2318*	-0.0762	0.0122	0.1454*	0.0478	0.3215*	0.1127*	-0.1484*	0.1477*	0.1300*	0.1734*	1.0000

Key note: * Correlation is significant at 0.05 levels (2-tailed)

- = 0.01 - 0.49 = weak correlation relationship

The result of the correlation analysis on Table 9 above shows the relationship between the extent of usage of e-agriculture and the livelihood status of the cereal crop farmers in the study area. The result revealed a direct and positive relationship between livelihood status and computer websites (CW) (0.1389*) at 0.05 level of significance. This implies that, as the cereal crop farmers' livelihood status increases, it will in turn increase their extent of usage of e-agriculture information sources. Also result on extension agents (EA) (0.1389*) and livelihood status on the extent of use of e-agriculture information sources, shows significant correlation with increase in livelihood status of the cereal crop farmers at 0.05 level of significance. Notably, this implies that, increase in extension contact by the extension agents with the farmers, will invariably increase their chances of using e-agriculture information sources and in turn improve their livelihood status. Similarly, extent of use of satellite (SAT) (0.1542*) and livelihood status, is statistically significant at 0.05 level of significance. This also implies that, increase in livelihood status of the cereal crop farmers will lead to increase in the usage of this e-agriculture information sources by the farmers. While other farmers or friends (OFF) (-0.1206*) showed an inverse (negative) correlation between the extent of use of e-agriculture information sources and the livelihood status of the cereal crop farmers in the study area at 0.05 level of significance. This implies that, increase in the cereal crop farmers' livelihood status will lead to decrease in the usage of OFF. Therefore, this may mean that, when the livelihood

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status of the cereal crop farmers increases, their taste changes, thereby leading them to use other e-agriculture information sources that are more professionally based, than using other farmers and friends to solve their cereal crop are farming problems. Computer websites (CW) has a direct positive correlation with telephone (Tel) (0.1532*) and mobile phone (MP) (0.1077*) at 0.05 levels of significance. Internet broad band (IB) has a direct positive correlation with MP (0.1154*) and CW (0.3755*) at 0.05 levels of significance. Radio ® has a direct positive correlation with MP (0.4152*) at 0.05 level of significance. Palmtop PC (PPC) has a direct positive correlation with CW (0.3668*) and IB (0.2521*) at 0.05 levels of significance. Television (TV) has an inverse (negative) correlation with Tel. (-0.1139*) but also have a direct positive correlation with MP (0.2344*), CW (0.1349*), and R (0.3020*) at 0.05 levels of significance. Newspaper (NP) has an inverse correlation with Tel (-0.1215*) but has a positive direct correlation with MP (0.2112*), CW (0.1856*), IB (0.3058*), R (0.1422*) AND TV (0.2280*) at 0.05 levels of significance. Extension agents (EA) has a direct positive correlation with Tel (0.1163*), MP (0.1277*), CW (0.1484*), R (0.1071*) and NP (0.2369*) at 0.05 levels of significances respectively. Short messages services (SMS) has direct positive correlation with Tel (0.0993*), MP (0.1820*), CW (0.2359*), IB (0.1386*), R (0.1298*), TV (0.2637*), CW (0.2359*), IB (0.1386*), R (0.1298*), TV (0.2637*), NP (0.1559) and EA (0.1326*) at 0.05 levels of significance respectively. Meanwhile, smartphone integrated with social media (SSM) has direct positive correlation with Tel (0.1372*), MP (0.2300*), CW (0.3721*), IB (0.3589*), R (0.1730*), PPC (0.1190*), TV (0.2593*), NP (0.3224*), EA (0.1716*) and SMS (0.3484*) at 0.05 levels of significance. Similarly, satellite (SAT) has direct positive correlation with MP (0.1200*), CW (0.1408*), IB (0.1592*), R (0.1763), TV (0.3701*), NP (0.3631*), EA (0.1566*), SMS (0.2255*) and SSM (0.3507*) at 0.05 levels of significance respectively. Finally, other farmers and friends (OFF) has an inverse correlation with Tel (-0.1173*) and EA (-0.1484*) but has a direct positive correlation with MP (0.2318*), R (0.1454*), TV (0.3215*), NP (0.1127*), SMS (0.1477*), SSM (0.1300*) and SAT (0.1734*) at 0.05 levels of significance. Since most of the variables tested between livelihood status and the extent of usage of e-agriculture information sources showed direct and inverse correlation at 0.05 levels of significance (though with weak correlations), the null hypothesis which stated that, there is no significant relationship between the extent of usage of E-agriculture and the livelihood status of the cereal crop farmers in the study area is therefore, rejected, and alternative hypothesis is accepted.

CONCLUSION

Base on the result of this findings, the study conclude that, the cereal crop farmers were engaged in the use of e-agriculture in their cereal crop farming with majority (about 90%) of the farmers using it. Notably, mobile phone, radio and other farmers (friends) were the most preferred and most used e-agriculture by the cereal crop farmers. This could attribute to the fact that, the cereal crop farmers gets more information about their cereal crop farming through these medium. It can be seen on both the result of likert scale of measurement that, other friends (friends) were ranked 3rd in the usage by the cereal crop farmers. Since e-agriculture has gone beyond technology to the combination of different knowledge of stakeholders in agriculture and cultures, it is important to note that, other

farmers or friends can be sources of e-agriculture to other farmers who are less privileged to get such information through social media or through other means of communication. Other sources as seen on Tables 4 and 5 were also used by the farmers, but with less dedication since most of the cereal crop farmers were not having formal education and were financially handicaps to afford or access more expensive e-agriculture tools to use. Farmers in the study area are therefore encouraged to intensify their contact with the extension agents, also to get themselves involved in more agricultural related activities that will help enhance their knowledge and make them acquire skills related to the use of e-agriculture tools, also they should try to explore the use of other sources of e-agriculture information, as this will help them gain more new knowledge that may help to enhance their productivity.

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