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Attitude, knowledge and constraints associated with the use of mobile phone applications by farmers in North West Nigeria

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ABSTRACT

The evolution of mobile phone applications has opened up a platform for easy and real time dissemination and exchange of agricultural information among agricultural extension officers, farmers, agricultural institutions and non-governmental institutions. This study examined attitude, knowledge and constraint associated with the use of mobile phone apps by farmers in North West region of Nigeria. A descriptive survey design was adopted; data collection tool was pre-tested and administered as interview schedule to randomly sampled farmers. Data were analyzed using descriptive statistics and correlation. The findings showed that farmers have positive attitude towards mobile phone applications, and knowledgeable of simple phone operation techniques. The constraints to the use of mobile phone applications are high cost of phones, poor network, poor power supply, high cost of airtime and complexity in operating phones. This study recommends training and re-retraining of farmers and extension agents on the use of mobile phone apps for effective information sharing among farmers in the region.

1. Introduction

The evolution of Information Communication Technology (ICT) and associated revolution have led to the development of many mobile phone applications. These include but not limited to voice call app, SMS/MMS app, WhatsApp, Facebook, IMO, voice recorder, email, search engines, social media, Instagram, opera mini, chrome, YouTube, farmerConnect, Farmer HelpLine, E-Wallet, NAQAS, mFishery, iCow, Rural eMarket, Esoko, Agribiz, AgroSIM, M-Shamba, and m4agriNEI. Some of these applications are applied in agriculture for crop selection, land selection, farming calendar design, access to credit and other inputs, market information & prices, weather information and for timely implementation of pre and post planting operations.

The increasing penetration rates of mobile phones have led to corresponding increase in application of mobile phone apps for rural livelihoods such that in India, farmers use digital mandi to get information on current prices of farm produce from different markets, prices and availability of seeds and pesticides. Similarly in Nigeria, e-wallet is a mobile phone-based app that is in use in Nigeria to distribute agro-input to core rural farmers and eliminate associated corruption with inputs distribution. These and many other mobile phones applications have proven the widespread awareness and adoption of mobile phone application among farmers (Nigerian Communication Commission, (NCC, 2016).

Rebekka and Saravanan [1] found that mobile phones are most widely used by farmers for social communications, reaching middlemen for marketing of farm produce and obtaining agricultural and health advisory services from professionals. Also, Isaac [2] established that mobile phones have significantly enhanced rural livelihoods, specifically in the context of market-oriented agriculture in linking farmers to markets.

Similarly, Williams and Opeyemi [3] ascertained that farmers significantly explore the benefits of mobile phones in marketing, management of animal health, connecting customers, and remote management of farms. In addition, Surabhi and Mamta [4] discovered that information delivery to farmers through mobile phone technologies contributed significantly in closing the gender digital-divide among farmers. Furthermore, Xiaolan and Shaheen [33] illustrated that the level, quality and timeliness of extension services access and delivery have significantly improved through the use of mobile phone apps.

The diffusion and adoption of any agricultural technology is influenced by the attitude of the farmers towards the technology, their knowledge of operation of the technology and constraints that they encounter within their socio-cultural milieu. The roles of knowledge,

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Table 1
Attitude of respondents towards mobile applications in the study area (n = 385).

Statement on Apps	Strongly* Agree	Agree	Undecided	Disagree	Strongly Disagree	Mean	Status
Apps have enhanced contact with extension workers.	99 (25.7)	64 (16.6)	54 (15)	161 (41.8)	3 (0.8)	3.23	Favourable
With App we have access to current information on improved farming activities	112 (29.1)	161 (41.8)	44 (11.5)	60 (15.6)	8 (2.1)	3.80	Favourable
With Apps, our farm produce is improving in quantity	110 (28.6)	149 (38.7)	58 (15.1)	56 (14.5)	12 (3.1)	3.75	Favourable
Apps have greatly help us improve the quality of our produce	104 (27)	137 (35.6)	68 (17.7)	65 (16.9)	11 (2.9)	3.66	Favourable
Availability of Apps has no impact on our production	25 (6.5)	48 (12.5)	90 (23.4)	178 (46.2)	44 (11.4)	2.54	Unfavourable
Apps help us to monitor market situations effectively	119 (30.9)	137 (35.6)	66 (17.2)	58 (15.1)	5 (1.3)	3.79	Favourable
Apps help in speedy spread of information amongst farmers	132 (34.3)	133 (34.5)	65 (16.9)	40 (10.4)	15 (3.9)	3.85	Favourable
Apps have helped to facilitate information transfer within farm families	130 (33.8)	148 (38.4)	57 (14.8)	38 (9.9)	12 (3.1)	3.89	Favourable
Apps aid significantly in input sourcing at good price.	94 (24.4)	162 (42.1)	60 (15.6)	49 (12.7)	20 (5.2)	3.66	Favourable
Apps help to monitor weather conditions	22 (5.7)	78 (30)	89 (23.2)	181 (47)	63 (16.4)	2.39	Unfavourable
Appropriate and timely weather forecast is aiding good response by farmers in terms of timely and appropriate decision making	37 (9.6)	148 (38.4)	77 (20)	75 (19.5)	48 (12.5)	3.13	Favourable
Apps help to get update on global trend on agric development	41 (10.6)	99 (25.7)	85 (22.1)	96 (24.9)	64 (16.6)	2.88	Unfavourable
With apps payments of bills are made easy	19 (4.9)	43 (11.2)	92 (23.9)	160 (41.6)	71 (18.4)	2.43	Unfavourable
Apps help to easily access government initiatives on agriculture	43 (11.2)	108 (28.1)	79 (20.5)	88 (22.9)	67 (17.4)	2.90	Unfavourable
Apps help to ensure togetherness of association members	50 (13)	130 (33.8)	77 (20)	98 (25.5)	30 (7.8)	3.18	Favourable
With apps members of the farmer group are effectively carried along	68 (17.7)	137 (35.6)	73 (19)	77 (20)	30 (7.8)	3.35	Favourable
International organizations can easily reach to farmers with the aid of apps	58 (15.1)	121 (31.4)	87 (22.6)	90 (23.4)	29 (7.5)	3.23	Favourable
Apps help to monitor trend of growth in the farm	63 (16.4)	97 (25.2)	96 (24.9)	99 (25.7)	30 (7.8)	3.17	Favourable
Apps help to timely detect production problem for prompt response	43 (12.2)	112 (29.1)	90 (23.4)	99 (25.7)	41 (10.6)	3.04	Favourable
With apps it is easy to access insurance cover for our farming process	23 (6)	33 (8.6)	83 (21.5)	185 (48.1)	61 (15.8)	2.39	Unfavourable
Apps aid timely delivery of farm inputs	65 (16.9)	105 (27.3)	86 (22.4)	98 (25.5)	31 (8.1)	3.19	Favourable
Apps not necessary in farming	25 (6.5)	39 (10.1)	45 (11.7)	205 (53.2)	71 (18.4)	2.32	Favourable
App are detrimental to our local ways of farming handed over to us	9 (2.3)	14 (3.6)	59 (15.4)	225 (58.4)	78 (20.3)	2.09	Favourable
Apps are causing complexity in farming operations generally	11 (2.9)	10 (2.6)	52 (13.5)	235 (61)	77 (20)	2.06	Favourable
I do not need apps to be able to enhance my production in quantity	32 (8.3)	36 (9.4)	47 (12.2)	206 (53.5)	64 (16.6)	2.35	Favourable
Apps not significant in improving quality of production	24 (6.2)	37 (9.6)	48 (12.5)	208 (54)	68 (17.7)	2.32	Favourable
Apps have greatly enhance extension activities in our area	40 (10.4)	86 (22.3)	56 (14.6)	159 (41.3)	44 (11.4)	2.78	Unfavourable
With apps, it is now easy to get information on any new problem in farming	58 (15.1)	150 (39)	63 (16.4)	93 (24.2)	21 (5.5)	3.33	Favourable
Apps have aided speedy transfer of fund for timely input delivery	30 (7.8)	54 (14)	184 (47.8)	87 (22.6)	30 (7.8)	2.89	Unfavourable
Apps have aided speedy disposal of farm produce at desirable price	49 (12.7)	89 (23.1)	140 (36.4)	84 (21.8)	22 (5.7)	3.14	Favourable

Source: Field Survey Data (2017). *Figures in parentheses are percentages.

perceptions and attitudes is cardinal to the decision-making process regarding adoption [5]. Farmers' knowledge on any agricultural technology in terms of its application and expected outcomes, environmental benefits, risks and costs form the basis of their perceptions and attitude. Farmers' perception about an innovation is closely linked to their awareness and knowledge of such technology based on their felt needs and prior experiences; which may not necessarily align with reality. The knowledge and perceptions farmers have on agricultural innovation jointly determined their attitude towards it. Several literatures on adoption of agricultural technologies have reported positive attitude, high level of knowledge and minimal constraints as effective factors promoting adoption of technologies. Chuang, Wang and Liou [6] reported that farmers' knowledge and attitude positively influenced adoption of smart agriculture technology in Taiwan. Li et al. [7] indicated that positive attitude toward technology also significantly influences technology adoption behaviours among Litchi farmers in China. Galadima, et al. [8] noted that knowledge and attitude, significantly affected the adoption of improved pearl millet by farmers in North-east, Nigeria. Despite all the aforementioned authors affirming the wide diffusion and adoption of mobile phone technology, Abdullahi et al. [9], reported poor use of mobile phone-based applications by farmers in the North Western Nigeria. Therefore, this study investigates the attitude, knowledge and constraints to the use of mobile phone applications among farmers.

2. Methodology

This study was carried out in the North-Western region of Nigeria.

The zone is located between latitude $9^0 10^1$ and $13^0 50^1$ to the North; and longitude $3^0 35^1$ and $9^0 00^1$, covering a land area of 168.719 km^2 and constitutes 18% of the Nigeria's land mass. The zone comprises seven states namely: Kano, Kaduna, Katsina, Sokoto, Zamfara, Jigawa and Kebbi States. A multi-stage sampling procedure technique was employed in the selection of farmers for data collection. The first stage involved a purposive selection of three states namely, Katsina, Kano and Kaduna States due to the high prevalence of poverty in there states (NBS, 2013, [10]. The population of farming households in the selected states was 6, 895,014; with 1,361,094 for Katsina State, 4,316,100 for Kano State and 1,217,821 for Kaduna State (NAERLS and FDAE, 2015; [9]. The second stage of the sampling procedure was the random selection of an agricultural zone in each of the selected states. The third stage of the sampling involved the random selection of three local government areas from each of the agricultural zone. The fourth stage of the sampling involved random selection of fifteen communities from the selected Local Government Areas. ROASOFT sample size calculator was used to select 385 farmers from the farming households across fifteen communities.

Data for the study were collected using a structured, pre-tested questionnaire with a reliability coefficient of 0.88 based on Kuder and Richardson rating. The questionnaire was administered with the assistance of trained enumerators from the Department of Agricultural Economics and Extension Federal University Dutsinma in Katsina State and National Agricultural Extension Research and Liaison Services (NAERLS) in Zaria and Kano. Attitude was operationalised on five –point Likert scale of Strongly Agree (5) Agree (4), undecided (3) disagree (2) and strongly disagree (1) and consist of 30 attitudinal statements. A mean score of <2.95 implies poor disposition toward apps, ≥ 2.95 and ≥ 3.05 implies favourable disposition toward the apps.

Knowledge was operationalised as the ability to use mobile apps, which was assessed based on knowledge test questions comprising of 34 knowledge test items rated on a 2-point scale of True (1) and False (0). Using an interval of 0.05, a mean value below 0.45 is considered low knowledge; $>0.045<0.55$ is considered moderate and ≥ 0.55 is considered high. Constraint was operationalised as challenges impeding farmers' ability to deploy apps in their day-to-day farming activities. From a list of the 32 constraints, farmers indicated the incidence of any constraints as yes (1) or no (0), and the extent of severity of the constraints on a 4 point Likert-type scale of very severe (3), severe (2), undecided (1) and not severe (0). Due to the rating scale used, a mean of ≤ 1.45 implies not severe constraint, >1.45 <1.55 implies severe constraint and >1.55 implies very severe constraint. Data collected were captured and analyzed with SPSS using frequency counts, percentages, mean and standard deviation. Correlation coefficient was used to establish relationship among attitude, knowledge and constraints.

3. Results and discussions

The results and discussion section is organised into three main parts, each focussing on each key variable of the study. The findings on attitude towards the use of mobile phone apps by farmers in North-West Nigeria revealed that majority of the farmers across the study area have positive attitude towards mobile phone apps. The mean scores of 18 out of the 30 attitudinal statements on the use of the apps were above the mean value of 2.95. The most prominent statements were "Apps have helped to facilitate information transfer within farm families" ($\bar{x}$=3.89), "Apps help in speedy spread of information amongst farmers" ($\bar{x}$=3.85), "With Apps farmers have access to current information on improved farming activities" and "Apps help farmers to monitor market situations effectively" ($\bar{x}$=3.79) and "With Apps, farm produce is improving in quantity" ($\bar{x}$=3.75). The findings suggest that most of the farmers have positive attitude towards the use of mobile phone apps. Baumüller, [11]; Siwel and Malongo, [12]; Williams and Opeyemi [3], stated that mobile phone apps enhance farming activities through effective information disseminating. It also implies that farmers are

Table 2
Distribution of respondents according to knowledge of mobile apps (n = 385).

Knowledge statement	True (%)	False (%)	Mean (SD)
Internet is a source of information on all agricultural related issues	149 (38.7)	236 (61.3)	0.387 (0.488)
You can us your phone to access information from the internet	162 (42.1)	223 (57.9)	0.421 (0.494)
It is now easy to contact the extension agents via call	160 (41.6)	225 (58.4)	0.416 (0.494)
It is now easy to contact the extension agents via SMS	118 (30.6)	267 (69.4)	0.306 (0.462)
It is now easy to contact the extension agents via WhatsApp	65 (16.9)	320 (83.1)	0.169 (0.375)
It is now easy to contact the extension agents via email	26 (6.8)	359 (93.2)	0.068 (0.251)
I can open the e-mail page using my phone	41 (10.6)	344 (89.4)	0.106 (0.309)
I can write and attach materials to be e-mailed	48 (12.5)	337 (87.5)	0.125 (0.331)
I can store and retrieve numbers at any time using my phone	323 (83.9)	62 (16.1)	0.839 (0.368)
I can place and receive calls with my phone	362 (94)	23 (6)	0.940 (0.237)
I can use my phone to write and read text messages	288 (74.8)	97 (25.2)	0.748 (0.435)
I can form WhatsApp group to facilitate flow of information	96 (24.9)	289 (75.1)	0.249 (0.433)
I can access and read WhatsApp messages	108 (28.1)	277 (71.9)	0.280 (0.450)
With mobile phone, information easily transferred from one farmer to another and extension agents to farmers	229 (59.5)	156 (40.5)	0.595 (0.492)
Framers can use all Apps at their disposal to enhance their farming	153 (39.7)	232 (60.3)	0.397 (0.490)
Farmers can use their phone to access inputs and farm credit	218 (56.6)	167 (43.4)	0.566 (0.496)
With the mobile phone farmers can plan properly before and after cultivation of their farms	208 (54)	177 (46)	0.540 (0.499)
I understand when I am out of air time or data	327 (84.9)	58 (15.1)	0.849 (0.358)
I can load air time and data	312 (81)	73 (19)	0.810 (0.393)
I can download apps from Google stores	129 (33.5)	256 (66.5)	0.335 (0.473)
I can search and fix minor network issues	129 (33.5)	256 (66.5)	0.335 (0.473)
I can update apps when the need arises	267 (69.4)	118 (30.6)	0.694 (0.462)
I can use apps to transfer documents from desk/laptop to my phone and vice versa	48 (12.5)	337 (87.5)	0.124 (0.331)
I can use service providers' codes to load airtime and data	267 (69.4)	118 (30.6)	0.694 (0.462)
I can use codes to pay for bills	111 (28.8)	274 (71.2)	0.221 (0.415)
I can use apps to pay bills	40 (10.4)	345 (89.6)	0.104 (0.306)
I can use my phone to access insurance services	26 (6.8)	359 (93.2)	0.068 (0.251)
I can use apps to monitor weather conditions	92 (23.9)	293 (76.1)	0.239 (0.427)
I can use apps to measure growth trends in my yearly production process	115 (29.9)	270 (70.1)	0.299 (0.458)
I can use apps to follow trends of prices of produce in markets around me	209 (54.3)	176 (45.7)	0.543 (0.499)
I can update apps when the need arises	111 (28.8)	274 (71.2)	0.288 (0.354)
With apps I can monitor trends in prices at the international market	111 (28.8)	274 (71.2)	0.288 (0.354)
With apps I can source for good market, locally and internationally, for input purchase	222 (57.7)	163 (42.3)	0.577 (0.495)
Using apps, I can easily source for market for my produce, home and abroad	230 (59.7)	155 (40.3)	0.597 (0.491)
Mobile Apps have made it easy for farmers to get good price for their farm produce, home and abroad	213 (55.3)	172 (44.7)	0.553 (0.498)

Source: Field Survey Data (2017.

Table 3
Incidence and Severity of constraints to the use of apps by respondents (n = 385).

Constraints	Frequency (%) Yes	Frequency (%) No	Very severe	Severe	Undecided	Not severe	Mean (SD)	Remark
Poor network	298 (77.4)	87 (22.4)	61 (15.8)	196 (50.9	87 (22.6)	41 (10.7)	1.6 (1.00)	Very serious
Poor power supply	226 (69.1)	159 (30.1)	115 (29.9)	103 (26.8)	159 (41.3)	3 (0.8)	1.7 (1.20)	Very serious
No power supply	21 (5.5)	364 (94.5)	6 (1.6)	11 (2.9)	364 (94.6)	4 (1)	0.2 (0.63)	Not serious
High cost of charging battery	132 (34.3)	253 (65.7)	23 (6)	51 (13.3)	253 (65.7)	58 (15.1)	0.5 (0.94)	Not serious
Apps are too complex	237 (61.6)	148 (38.4)	38 (9.9)	175 (45.5)	148 (38.4)	0 (0)	1.3 (1.08)	Not serious
Inability to operate apps	216 (56.1)	169 (43.9)	21 (5.5)	195 (50.7)	169 (43.9)	24 (6.2)	1.2 (1.06)	Not serious
No access to apps	126 (32.7)	259 (67.3)	15 (3.9)	90 (23.4)	259 (67.3)	21 (5.5)	0.7 (0.97)	Not serious
Lack of access to credit	230 (60)	155 (40)	56 (14.6)	155 (40.3)	155 (40.3)	19 (4.9)	1.3 (1.14)	Not serious
Lack of access to education	249 (65)	136 (35)	52 (13.5)	180 (46.8)	136 (35.3)	17 (4.4)	1.4 (1.11)	Not serious
Lack of access to extension	194 (50.4)	191 (49.6)	60 (15.6)	127 (33)	191 (49.6)	7 (1.8)	1.2 (1.19)	Not serious
Lack of access to network	40 (10.4)	345 (89.6)	1 (0.3)	16 (4.2)	345 (89.6)	23 (6)	0.1 (0.43)	Not serious
Lack of access to functional apps	190 (49.4)	195 (50.6)	34 (8.8)	81 (21)	195 (50.7)	75 (19.5)	0.7 (1.07)	Not serious
Lack of time to practice app use	171 (44.4)	214 (55.6)	45 (11.7)	107 (27.8)	214 (55.6)	19 (4.9)	0.9 (1.13)	Not serious
Lack of technical knowhow	280 (73)	105 (27)	56 (14.6)	205 (53.2)	105 (27.3)	19 (4.9)	1.6 (1.04)	Not serious
Lack of information from radio	174 (45)	211 (55)	23 (6)	72 (18.7)	211 (54.8)	79 (20.5)	0.6 (0.98)	Not serious
Lack of awareness of apps	299 (77.7)	86 (22.3)	42 (10.9)	228 (59.2)	86 (22.3)	29 (7.5)	1.6 (0.95)	Very serious
Cost of training is high	169 (43.9)	216 (56.1)	25 (6.5)	53 (13.8)	216 (56.1)	91 (23.6)	0.7 (0.88)	Not serious
Cost of airtime is high	261 (68)	124 (32)	68 (17.7)	188 (48.8)	124 (32.2)	5 (1.3)	0.5 (1.11)	Serious
Lack of social interaction	215 (55.8)	170 (44.2)	29 (7.5)	102 (26.5)	170 (44.2)	84 (21.8)	1.2 (1.09)	Not serious
Lack of willingness to learn	170 (44)	215 (56)	21 (5.5)	100 (26)	215 (55.8)	49 (12.7)	0.8 (1.02)	Not serious
Lack of demonstration of app use	244 (63.4)	141 (36.6)	44 (11.4)	178 (46.2)	141 (36.6)	22 (5.7)	1.3 (1.09)	Not serious
Lack of app update technology	111 (28.8)	274 (71.2)	13 (3.4)	53 (13.8)	274 (71.2)	45 (11.7)	0.5 (0.81)	Not serious
Lack of encouragement	300 (77.9)	85 (22.1)	0 (0)	275 (71.4)	85 (22.1)	25 (6.5)	1.5 (0.82)	Serious
Problem of updating apps	96 (24.9)	289 (75.1)	14 (3.6)	43 (11.2)	289 (75.1)	39 (10.1)	0.5 (0.84)	Not serious
High cost of apps	185 (48.1)	200 (51.9)	27 (7)	57 (14.8)	200 (52)	101 (26.2)	0.7 (0.84)	Not serious
High cost of phones	300 (77.9)	85 (22.1)	84 (21.8)	204 (53)	85 (22.1)	12 (3.1)	1.8 (1.03)	Very serious
Complexity in operating phones	279 (72.5)	106 (27.5)	60 (15.6)	192 (49.9)	106 (27.5)	27 (7)	1.5 (1.06)	Serious
Socio-religious values	171 (44.4)	214 (55.6)	14 (3.6)	29 (7.5)	214 (55.6)	128 (33.2)	0.5 (0.70)	Not serious
Customary values	184 (47.8)	201 (52.2)	18 (4.7)	25 (6.5)	201 (52.2)	141 (36.6)	0.6 (0.68)	Not serious
Political influence	174 (45.2)	211 (54.8)	8 (2.1)	29 (7.5)	211 (54.8)	137 (35.6)	0.4 (0.71)	Not serious
Actions of association/grp	57 (14.8)	328 (85.2)	2 (0.5)	20 (5.2)	328 (85.2)	35 (9.1)	0.2 (0.53)	Not serious
Problem of acceptance by local leadership	224 (58.2)	161 (41.8)	12 (3.1)	128 (33.2)	161 (41.8)	84 (21.8)	0.6 (0.83)	Not serious

Source: Field Survey Data (2017).

favorably disposed to the use of mobile phone apps and explore e-extension platforms for information sharing. The findings agree with Tyabo et al. [13] and Williams and Opeyemi [3] who reported that farmers have favourable attitude towards the use of mobile phone apps in Niger and Oyo states of Nigeria respectively. Conversely, farmers indicated that mobile phone apps have not been used for dissemination of weather information ($\bar{x}$=2.39). This corroborated the findings of Osadebamwen and Ideba [14]; Sulaiman et al. [15]; Obiora and Emordi [16] who reported low use of mobile phone apps for sharing climate and weather information (see Table 1).

The results on knowledge of mobile phone apps in North-West Nigeria showed that farmers were highly knowledgeable on knowledge statements such as "I can place and receive calls with my phone" (94%; $\bar{x}$ = 0.940, SD = 0.237), "I understand when I am out of airtime and data" (84.9%; $\bar{x}$ = 0.849, SD = 0.358), "I can store and retrieve numbers anytime using my phone" (83.9%; $\bar{x}$ = 0.839, SD = 0.368) and "I can load airtime and data" (81%; $\bar{x}$ = 0.810, SD = 0.393). The findings suggest that farmers are conversant with common phone operations. In line with these findings, Daniel (2015) reported that farmers under an SMS-based information sharing system affirmed their skills in utilising several features of their mobile phones.

The results further revealed that the farmers indicated low knowledge on statements such as "use of apps to pay bills" and "ability to use phone to access insurance services" (93.2%; $\bar{x}$ = 0.104, SD = 0.306), "ability to contact extension agents via e-mail" (93.2%; $\bar{x}$ = 0.068, SD = 0.251); "ability to open the e-mail page using phones" (89.4%; $\bar{x}$ = 0.106, SD = 0.309); "ability to transfer documents from desk/laptop to phone and vice versa" (87.5%; $\bar{x}$ = 0.221. SD = 0.415) and "ability to attach document to e-mail" (87.5%; $\bar{x}$ = 0.125, SD = 0.331). These findings may be attributed to the fact that many farmers own and operate non smart phones (see Table 2).

Table 3 presents the results on constraints to use of mobile apps by farmers in North-West Nigeria The table also revealed the severity of the constraints as perceived by the farmers. The most common constraints identified were: "high cost of phone" (77.9%; $\bar{x}$ = 1.8, SD = 1.03), "lack of encouragement" (77.9%; $\bar{x}$ = 1.5, SD = 0.82), "lack of awareness" (77.7%; $\bar{x}$ = 1.6, SD = 0.93) and "poor network" (77.4%; $\bar{x}$ = 1.6, SD = 0.95). Others include poor power supply (69.1%; $\bar{x}$ = 1.7, SD = 1.20), high cost of airtime (68%; $\bar{x}$ = 1.5, SD = 1.11) and complexity in operating mobile phones (72.5%; $\bar{x}$ = 1.5, SD = 1.02). The least considered constraints by farmers include: no power supply (94.5%; $\bar{x}$ = 0.2, SD = 0.63), lack of access to network (89.6%; $\bar{x}$ = 0.1, SD = 0.43), action of association/farmer groups (85.2%; $\bar{x}$ = 0.2, SD = 0.53) and problem of updating apps (75.1%; $\bar{x}$ = 0.5, SD = 0.84). These findings are supported by Munyua (2008), Daniel (2012), Osadebamwan and Ideba [14]; Okeke, Hycinth and Uzuegbunam [17]; who identified high cost of technologies, inadequate infrastructure, poor and expensive internet connectivity as constraints to the application of mobile phone apps by farmers in Sub-Saharan countries.

Table 4
Result of correlation matrix of the relationship between Attitude, Knowledge and Constraints.

		Constraint	Knowledge	Attitude
Constraint	Pearson Correlation	1	−.187**	−.203**
	Sig. (2-tailed)		.000	.000
	N	385	385	385
Knowledge	Pearson Correlation		1	.545**
	Sig. (2-tailed)			.000
	N		385	385
Attitude	Pearson Correlation			1
	Sig. (2-tailed)			
	N			385

**. Correlation is significant at P < 0.01 level (2-tailed).

Table 4 shows results of correlation coefficients between attitude, knowledge and constraints. The findings revealed significant correlation

between the variables; while there are positive correlation between attitude and knowledge ($r = 0.55$, $p = 0.00$, $n = 385$); attitude is negatively correlated with constraints ($r = -0.20$, $p = 0.00$, $n = 385$). The correlation coefficients range from −1 to +1 on a continuum, where 0 indicates that there is no linear association, and the relationship gets stronger and ultimately approaches an absolute value of 1. The positive and negative correlation coefficients are usually interpreted as direct and inverse relationship respectively. In these results, the more knowledgeable farmers are on mobile phone applications, the more favorably disposed they are to the apps. Conversely, an inverse relationship between attitude and constraints implies that farmers with negative attitude to mobile phone apps will indicate more constraints to the use of the apps. Furthermore, if the correlation coefficient is interpreted as a causal factor, 55% of farmers' attitude to the use of mobile phone apps is determined by knowledge of the apps; while 20% of the constraints experience by farmers on the use of apps is influenced by attitude. These findings corroborate that of Chuang, Wang and Liou [6] who reported positive relationship between attitude and knowledge in the adoption of smart agricultural technologies among farmers in Taiwan. Furthermore, Alan and Peter [18] opined that "the ease of use of a technology can have a direct effect on the attitude towards adoption"; Serebrennikov, Thorne, Kallas and McCarthy [19] posited that "the lower the perceived difficulty, the lower is the level of perceived risk and the higher the probability of a successful technology transfer leading to adoption by end-users". It is therefore inferred that the higher the knowledge of mobile phone apps, and the lower the constraints to the use of the mobile phone apps by farmers, the greater the use of the mobile phone apps for information access and transfer.

4. Conclusion and recommendation

The study showed that the farmers were generally disposed positively to mobile phone apps. Similarly farmers indicated low level of constraints and the severity of such constraints. In exploring and maximizing the potentials of mobile apps therefore, there is need to improve the competence of farmers through tailored training on the use of mobile applications. Farmers will then be able to harness the full benefits of the mobile phone application and ICT related features to improve their livelihoods of agricultural enterprises. The study recommends training to improve the versatility of farmers on the use of mobile apps.

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