www.jard.edu.pl http://dx.doi.org/10.17306/J.JARD.2024.01800

Journal of Agribusiness and Rural Development

pISSN 1899-5241
eISSN 1899-5772

1(71) 2024, 93–101
Accepted for print: 19.02.2024

DIGITILIZATION IN AGRICULTURAL COOPERATIVES: A PERSPECTIVE FROM MEMBERS IN RICE VALUE CHAIN OF ANAMBRA STATE, NIGERIA

Chijioke Uchechukwu Uneze[1]✉, Hikarofem Ise Egor[2], Njideka Justina Otaokpukpu[3]

[1]Federal College of Education, Nigeria
[2]Federal Cooperative College, Nigeria
[3]Federal Polytechnic, Nigeria

Abstract. Agriculture is a sector crucial to the growth of the Nigerian economy. In the past few years, its contribution to gross domestic product (gdp) has averaged at about 25 percent. Smallholders pool their resources in collective action to form agricultural cooperatives in order to increase farm productivity and income. These cooperatives account significantly for the development of the agriculture sector. Digitalization, on the other hand, has gained currency as a transformative strategy for agriculture. This study aimed to examine in broad terms the perspectives of digitalization in the rice value chain created by members of cooperative societies in Anambra State. A total of 180 members of cooperative societies across the four agricultural zones of the state who participate in the rice value chain were selected for the study using a multistage sampling technique. A structured and validated questionnaire was used to elicit information from the respondents. The data were consequently analyzed using descriptive statistics (frequency, percentage & ranking) and inferential statistics (chi-square & cramer's v). The study identified rudimentary digital tools and that technologies enabled members to use mobile phones for the purposes of financial services, input delivery, market access and weather prediction. However, technologies requiring high-level skills for their implementation were obviously lacking among these cooperators. Also, the ways in which individual, institutional and technological factors limit adoption of these technologies were empirically identified. However, members generally welcomed the use and application of digital tools to improve their value chain activities. There was the perception among members that though digitalization was necessary, its unguarded use in the processes of cooperatives could erode their participation in the governance of the cooperative, thereby compromising the principle of democratic member control. The study identified an urgent need for a strong digital infrastructure backbone, encouraging the formation of agricultural digital solution cooperatives, digital literacy programs support from companies providing special skill agricultural digitalization solutions, and instituting government grants to support the high cost of investments required for digitalization.

Keywords: digitalization, agricultural cooperatives, members, rice value chain, Anambra State

INTRODUCTION

Agriculture is pivotal to the growth of the Nigerian economy. In 2021 its contribution to gross domestic product (GDP) was approximately 24 percent (World Bank, 2021; NBS, 2021). This sector is dominated by smallholder farmers, who cultivate a farm size of less than 2 hectares per farmer (Metemilola and Elegbede, 2017). In the quest for these marginal farmers to improve market access for their produce, enhance the prices of their farm output and procure basic inputs at

✉Chijioke Uchechukwu Uneze, Department of Agricultural Education, Federal College of Education (Technical), Umunze, Anambra State, Nigeria, e-mail: cjuneze123@gmail.com, https://orcid.org/0009-0006-2640-7476

reduced prices, they pool resources and, consequently form cooperative societies (Royer, 1987; USDA, 2022).

Cooperative societies remain significant in helping farmers improve farm profitability. In Nigeria, there are currently over 300,000 cooperatives, which contribute about N1.2billion to GDP (Cooperative Rating and Award society of Nigeria RASON, Guardian 11 November, 2011). Also, in the United States of America (USA), cooperation in agriculture was reported to have generated $22.2 billion in 2020 (USDA, 2022).

Moreover, the digitalization of agriculture is considered paramount in any quest for improved farm efficiency, productivity and income. Palloni et al. (2018) defined digitalization of agriculture as the application of digital tools and systems to aid agricultural practices and processes. These technologies in agriculture are broadly divided into 3 groups: data/data collection tools, decision support software and input adjustment tools (OECD, 2022). Some of the contemporary applications of digital tools in big data analytics and Artificial Intelligence can help farmers improve output and productivity by measuring the quality parameters of crops and livestock in real time. Crucially, web-based platforms offer farmers data and analytics needed to prepare for shocks, thereby improving the resilience and sustainability of their farm enterprises. Several software programmes have been developed for Precision Agriculture, weather management and in vegetative status studies in the field. Digital agriculture has variedly been seen as simplifying complex agricultural activities through the available data that enable decision making, thus improving environmental concerns as well as enhancing transparency and traceability in the complex food system (Saunders et al., 2016; Shepherd et al., 2020). As important as these advantages remain, some scholars have also noted a cautious approach in the role of agri-tech (Hansen et al., 2020). Essentially, then, the application of agricultural technologies must consciously factor in farmers' concerns, equity and risks in advancing any recognized benefits (Wield et al., 2010; Wiseman et al., 2019).

The role of agricultural cooperatives as platforms that help farmers improve their individual farm profitability without the cooperative in itself pursuing the objective of profit is a major reason for the formation of cooperative societies. This understanding is aptly extended to the agency theory of cooperatives. In the Economic Theory of Cooperation (1942), Emelianoff established cooperative organizations as representing the aggregates of economic units. Agency theory is generally applied to the relationship between agents and their principals and the tendency towards optimizing behavior by the agents towards the principal. Philips (1953) argued that the cooperative simply represented a jointly owned plant operated by independent firms. In this manner, cooperatives were interpreted to be a form of vertical or horizontal integration of its members. This study will draw from this paradigm to highlight the perspectives of members as principals in relation to the digitalization of their practices in agriculture value chain. Cooperatives remain people-centered and value-based enterprises that help millions of people around the world to take control of their own livelihoods and expand their economic opportunities (OCDC, 2022). The available literature is dominated by studies on the depth and value of digitalization in the agriculture sector (Lio and Liu, 2006; Cardona et al., 2013; Lu et al., 2016), and very few insights and a low adoption of digitalization have been provided on cooperatives and their member-patrons (Cristobal-Fransi et al., 2020; Jorge-Vazquez et al., 2021), even on their formidable roles in rural community development (Majee and Hoyt, 2011; Bharadwaj, 2012; Hussain, 2014). The following important questions become pertinent for research to address: What forms of digital technologies are available and adopted by members of cooperatives in agriculture? What factors limit the uptake and adoption of digitalization by members of agricultural cooperative societies? In an attempt to close this gap, this study aims to understand the degree of implementation of new digital technologies by member-patrons of cooperatives and, particularly, to identify those individual, institutional and technological factors that have constrained their application. Consequently, the broad objective of this work is therefore to examine the digitalization of agricultural cooperatives from the perspectives of members in the rice value chain of Anambra State. Specific objectives will be:

i. To ascertain those digital tools and technologies that are used by members of cooperative societies operating in the rice value chain
ii. To identify how patrons' individual factors are associated with uptake of digitalization in their rice value chain activities
iii. To determine the institutional and technological influences that have hindered cooperators' digitalization in the rice value chain

The findings of the work will be essential to national and sub-national governments in Nigeria to align their policies in order to effectively capture how valuable digital tools and technologies can be leveraged through cooperatives to increase agricultural productivity, income and reduce poverty.

METHODOLOGY

Study Area

The study was conducted in Anambra State. The state lies within the tropical rainforest zone of south-eastern Nigeria. Anambra State is situated between the latitudes 5°32' and 6°45' N and longitude 6°43' and 7°22' E. It has an estimated land area of 4,865 sq. km with a population of 4,177,828 people (NPC, 2006). The state is comprised of 21 local government areas that are subdivided into four Agricultural Zones – Onitsha Zone, Aguata Zone, Awka Zone and Anambra Zone. The state has many rice production clusters with the majority of those engaged in the sector being smallholders. The notable large-scale entities include Coscharis Rice Farm and Milling company at Igbariam, Oyi LGA; JOSAN Rice Farm and Mill at Ufuma in Orumba North & Omor, as well as the FGN/IFAD/VCDP Rice Milling at Achalla, Awka North LGA.

Sampling Technique and Data Collection

A multi-stage sampling technique was used for the study. First, three Agricultural Zones were randomly selected from the four agricultural zones of the state. Further, one local government area considered as the rice belt was purposely selected from each of these three agricultural zones. These local governments were Ayamelum LGA (Anambra Agricultural Zone), Orumba North LGA (Aguata Agricultural Zone) and Awka North (Awka Agricultural Zone). Thereafter, purposive sampling was used to select two towns with a high rice production rate from each of the three previously selected local government areas. Finally, a simple random technique was adopted to select 30 entities in the rice value chain across each of the six towns in three local governments areas chosen from the three sampled agricultural zones of this state. These selected value chain entities were screened to ensure that they were members of registered and active cooperative societies in the state. The eventual sample size of the study was 180 entities in rice value chain. The distribution of this sample size is shown in Table 1.

Table 1. Distribution of the sample size

Agricultural zone	LGA	Town	Number of respondents
Aguata	Orumba North	Omogho	30
Aguata	Orumba North	Ufuma	30
Anambra	Ayamelum	Omor	30
Anambra	Ayamelum	Ifite-Ogwari	30
Awka	Awka North	Achalla	30
Awka	Awka North	Ebenebe	30
Total			180

Source: own elaboration.

The data were collected using a structured questionnaire designed to elicit information from the actor-patrons of cooperative societies in the rice value chain. The information was sought on the socio-economic characteristics, digital tools and technologies used and facilitated by the cooperative, individual factors association with use of digitalization, as well as institutional and technological factors hampering the uptake of these technologies on their operations.

Method of Data Analysis

Both descriptive and inferential statistics were used to analyze data from the study. The descriptive analytical tools including frequency, percentages and rank were used to analyze data on the socio-economic characteristics of these entities as well as their responses on various digital tools and technologies used by rice value chain entities. Additionally, for these responses, a ranking was utilized to show the level of priority given to these tools deployed in digitalization of agriculture. The inferential statistics used were Chi-square and Cramer's V. Chi-square was used to measure the statistical significance of the association of individual factors of members to their use of digitalization and also how institutional and technological factors influence their use. Cramer's V was specifically used to measure the strength of the association between those patron's individual factors and uptake of digitalization in value chain. The Chi-square test statistic x^2 was mathematically determined as:

$$x^2 = \Sigma[(O_i - E_i)^2/E_i]$$

Where O_i – observed frequency
E_i – expected frequency

Degree of freedom = (r – 1) (c – 1) for independence test and (no of categories –1) degree of freedom for goodness of fit test, while r is the number of rows and c is the number of columns.

Cramer's V was mathematically determined as:

$$V = \sqrt{x^2/n.(c-1)}$$

Where n – sample size and c – min (m, n) is the minimum of the number of rows m and column in the contingency table. The following approach was used to interpret the Cramer's V, $V \in [0.1, 0.3]$: weak association $V \in [0.4, 0.5]$: medium association, V > 0.5: strong association.

RESULTS AND DISCUSSION

Socio-economic characteristics of cooperators in the rice value chain

The summary of selected socio-economic characteristics of cooperators in the rice value chain of Anambra state is shown in Table 2. This summary showed that 80 percent is the sum of the actors who were aged between 21–60 years, while 20 percent were aged between 61–80 years. The result signifies that an energetic population is engaged in this value chain.

This is further explained by the enormity and demanding nature of activities involved at both on-farm and off-farm of rice production. The rice value chain in Anambra state is predominantly female, as it was found that 63.88 percent were females, while 36.11 percent were males. The study also showed that these cooperators were heavily involved in production only and in the production & processing nodes of the rice value chain: a total of 63.33 percent are engaged in these two sections of the chain, and only 36.88 percent was the aggregate percentage of those involved in input supply, aggregation/storage/offtake and logistics/distribution/marketing. These cooperators were very experienced entities of the value chain. Only 21.11 percent of these cooperating entities had experience ranging between 1–5 years, while 78.88 percent have experience that ranged from 6–20 years. Again, members of cooperatives in the value chain were very literate. The total percentage for all those that had an education up to primary school was 93.32 percent. This indicates that they have the capacity to read and understand basic directions on the use of farm inputs and technologies, as may be required in their operations, as well as the ability to undertake accurate record-keeping and documentation regarding their business operations.

Table 2. Selected socio-economic characteristics of respondents

Socio-economic variable	Frequency (N = 180)	Percentage
Age (years)		
21–40	66	36.66
41–60	78	43.33
61–80	36	20.00
Gender		
Male	65	36.11
Female	115	63.88
Value chain node		
Production only	53	29.44
Production& Processing	61	33.88
Input supply	12	6.66
Aggregation/Storage/Offtake	36	20.00
Logistic /Distr./Marketing	18	10.00
Experience(years)		
1–5	38	21.11
6–10	62	34.44
11–15	47	26.11
16–20	33	18.33
Educational level		
No formal education	12	6.66
Primary education	56	31.11
Secondary education	88	48.88
Tertiary education	24	13.33

Source: field survey data, 2023.

Digital tools and technologies used by cooperators in the rice value chain

The various tools and digital technologies used by cooperators are shown in Table 3. The use of mobile phones (90.55 percent), software for weather prediction (80.55 percent), an e-wallet for input purchases and delivery (73.88 percent), digital financial services and solutions (70.55 percent), price /advisory on good agricultural

Table 3. Digital tools and technologies used by cooperative societies' members in the rice value chain

Digital tool and technologies	Responses	Percentage	Ranking of use
Use of Mobile Phones	163	90.55*	1st
Computers and Tablets	95	55.00*	6th
Digital Financial Service & Solutions	127	70.55*	4th
Market Access and Information Solutions	95	52.77*	7th
E-wallet for Inputs purchase and delivery	133	73.88*	3rd
Data Capture Tools and Analytics	86	47.77	
Farm Management Software	51	28.33	
Software for weather prediction	145	80.55*	2nd
Price /Advisory on GAP	123	68.33*	5th
Drones for Farm scouting	35	19.44	
GIS, Precision Agriculture and Remote Sensing	59	32.77	
Variable Rate Applicator/ Machinery Sensor	21	11.66	

* Responses over 50 percent.
Source: field survey, 2023 (multiple responses).

practice GAP (68.33 percent), computers and tablets (55.00 percent) and market access & information software solutions (52.77 percent) were tools and areas where these respondents made major use of digitalization in their operations.

The dominance of the use of mobile phones by farmers as a mode for agricultural digitalization is in agreement with previous research (Abdulai et al., 2023). Sadly, several other important aspects, such as use of drone technology for farm scouting (19.44 percent), variable rate application/machine sensors (11.66 percent), and GIS/precision agriculture/remote sensing, have not gained prominence as schemes for cooperators to digitalize the rice value chain in Anambra state. This situation is explained by the high level and special skills required to deploy these technologies. More so, the cost of their initial acquisition and even their routine maintenance and repairs may not be within the resources available to these cooperators. In this scenario, there is a need for cooperative societies to fill these gaps and assume responsibility that would leverage their members' use of digital technologies, although cooperatives have generally been observed in Nigeria to have small sizes, as is often reflected in their turnover.

How Individual Factors of the Cooperators are Associated with their Use of Digitalization in the Rice Value Chain

The summary of how selected individual factors of the cooperators are associated with their use of digitalization technologies following a chi-square test of independence is shown in Table 4. The Chi-Square statistics on age, income, gender, experience, perception of ICT and knowledge and competence were significant at the 0.05 percent level of significance. These indicate those individual factors of cooperators which are associated with their abilities to adopt digitalization in their operations.

A cursory look at the Cramer's V showed that income and experience had the stronger levels of association as given by their values of 0.440 and 0.3606, respectively. Although these numbers reflect medium and near-medium associations, they nonetheless show how important factors of capital earnings and business experience leverage the ability to acquire and use digital tools and technologies. Moreover, other factors that were significant maintained a very weak association, given their Cramer's values, which ranged between 0.1536-0.2590. Muslem et al. (2018), Ajena (2018), Okeke et al. (2019)

Table 4. Chi-square test of individual factors that are associated with digitalization in the rice value chain

Factor	X^2	Probability (p)	Cramer's V
Age	4.85	0.0277*	0.1641
Educational level	2.45	0.1180	0.1536
Income	35.50	0.0000*	0.4440
Previous ICT experience	12.10	0.0005*	0.2590
Gender	8.72	0.0031*	0.2200
Experience	23.43	0.0000*	0.3606
Perception of ICT	8.72	0.0031*	0.2200
Knowledge and competence	9.67	0.0018*	0.2320

Level of significance at 0.05 test.
*$p < 0.05$.

and Albaom et al. (2022) had variously agreed that individual factors are determinants to use digitalization in agriculture. Surprisingly, educational level was not significantly associated with the adoption of digitalization. This could result form the fact that the majority of cooperators were all literate, as such a factor did not bring much variation in the data pool of the study.

Institutional factors that influence cooperators' digitalization activities in the rice value chain

The Chi-square results on goodness of fit in relation to institutional factors that influence cooperators digitalization activities are shown in Table 5.

The size of cooperative society/turnover of business, cooperative society's credit support system, provision of training and education by the cooperative, credit provision and support by government as well as patent and legal issues regarding technology were significant at the 0.05 level of significance. The cooperative's ability to effectively provide the capital required as investment for members as loans will depend on its turnover and surpluses that are retained by the business. It is also important to note that training and education will remain important for members of cooperative societies to stay abreast with modern technologies that are critical to improving the profitability of their enterprises. Therefore, cooperatives must continuously strive to fulfill this role, as it is essential for their operations and survival. The continued government support to cooperatives through grants, loans, extension and policy would also explain why any deliberate intervention to scale up agriculture digitalization must target these member-based business enterprises.

Table 5. Chi-square test on institutional factors that influence digitalization of rice activities of cooperative patrons in Anambra State

Factors	X^2	P
Size of cooperative society / Turnover of business	15.23	0.0001**
Cooperative society's credit support system	8.62	0.0033**
Government/Extension Support	2.59	0.1075
Provision of training& Education by cooperative	7.18	0.0073**
Credit provision and support by government	33.61	0.0000**
Presence of Internet security Access	2.63	0.1048
Patent and legal issues on technology	6.78	0.0922**

Test at 0.05 level of significance.
** $p < 0.05$.
Measured with questions into 2 nominal categories of Accept or Reject – Do any of these stated institutional factors affect digitalization?
Source: field survey, 2023.

Technological Factors that Influence Cooperators Digitalization Activities in the Rice Value Chain

Technological factors that influence cooperators digitalization activities in the rice value chain are shown in Table 6.

Table 6. Chi-square test on technological factors that affect the digitalization of rice activities of members of cooperative societies in Anambra State

Factor	X^2	P
High cost of initial acquisition of digital tools	13.60	0.0002**
Infrastructure access deficiency	12.72	0.0004**
Internet connectivity (band-with) limitation	8.93	0.0028**
The presence of cyber insecurity and internet fraud	3.20	0.0736
High cost of maintenance and repairs of digital tools	10.12	0.0015**
The access of ICT and relevant technological skills	9.90	0.0016**

Test at 0.05 level of significance.
** $p < 0.05$. Measured with questions into 2 nominal categories of Accept or Reject – Do any of these stated technological factors affect digitalization?
Source: field survey, 2023.

The high cost of acquiring digital tools, infrastructure access deficiency, internet connectivity limitations, the high cost of maintenance and repairs of acquired digital tools and technologies as well as access to ICT and relevant technological skills are factors that affect how members of cooperatives utilize digital tools for the rice value chain in Anambra state. The result is in agreement with several other earlier studies in relation to technological issues affecting digitalization (Fielk et al., 2020; Birner et al., 2021).

CONCLUSION AND POLICY IMPLICATIONS

The study established the readiness and interest of members of cooperatives in all aspects of the rice value chain to utilize digital tools and technologies for enhancing the efficiency of their individual enterprises. However, this desire is constrained by the high investment costs required for their acquisition, which, in many cases, cooperatives are unable to meet because of size limitation and small turnover. Consequently, the application of these technologies has remained at a very rudimentary level, particularly in the use of mobile phones to access financial services, weather prediction and input delivery. Again, the individual cooperators' characteristics, conditioning institutional variables and technological factors continue to hinder the adoption of valuable digital technologies in the rice value chain. Improving the productivity and efficiencies in the rice value chain would therefore call for the Anambra state government to implement policies and programs to remove these encumbrances. There is an urgent need to provide high-level skills for adopting game-changing digital tools in agriculture. In this regard, it is important for digital solution service providers to institute a plan for users of their tools to undergo digital literacy and skill development on the tasks required in the application of their tools. Finally, the formation of digital solution cooperative societies should obviously be encouraged if any transformative outcome is to be registered in the field of agricultural digitalization in Nigeria.

REFERENCES

Abdulai, A.R., Quarshire, P.T., Duncan, E., Fraser, E. (2023). Is agricultural digitalization a reality among smallholder farmers in Africa? Unpacking farmers' livid realities of engagement with digital tools and services in rural Northern Ghana. Agric. Food Secur., 12, 11. https://doi.org/10.1186/s40066-023-00416-6

Abdulai, A.R. (2022). A new green revolution or neoliberal entrenchment in agri-food system? Exploring narratives around digital agriculture, food systems and developments in sub-sahara Africa. J. Dev. Stud., 58(8), 1588–1604. https://doi.org/10.1080/00220388.2022.2032673

Ajena, F. (2018). Agriculture 3.0 or smart Agroecology. Green Eur. J., 20. Retrieved from: https://www.greeneuropean-journal.eu/agriculture-3-0-or-smart-agroecology

Albaom, M.A., Sidi, F., Jabar, M.A., Adbullah, R., Ishak, I., Yunikawati, M.A., Priambodo, M.P., Nusari, M.S., Ali, D.A. (2022). The moderating role of personal innovativeness in tourists' intention to use Web 3.0 based on updated information system success. Sustainability, 14(21), 13935. https://doi.org/10.3390/su142113935

Ayim, C.K., Addison, C., Tekinerdogan, B. (2022). Adopting of ICT innovations in agriculture sector in Africa: a review of the literature. Agric. Food Secur., 11(1), 1–16. Retrieved from: https://agricultureandfoodsecurity.biomedcentral.com/articles/10.1186/s40066-022-00364-7

Baumuller, A., Addon, B.K. (2020). The enabling environment for the digitalization of African Agriculture. In: D. Rensink, X. Diao, G. Tadesse (Eds.), Sustaining Africa's Agri-food Transformation: The role of public policies. International Food Policy Research Institute(IFPRI) (pp. 159–173). https://doi.org/10.2499/9780896293946_13

Bharadwaj, B. (2012). Role of cooperatives in poverty alleviation: a case of Nepal. Admin. Manag. Rev., 24(1), 120–139. Retrieved from: https://www.researchgate.net/profile/Bishal-Bharadwaj/publication/352817378_Roles_of_Cooperatives_in_Poverty_Reduction_A_Case_of/links/60db00c9458515d6fbe7f4a4/Roles-of-Cooperatives-in-Poverty-Reduction-A-Case-of.pdf

Birner, R., Daum, T., Pray, C. (2021). Who drives the digital revolution on agriculture? A review of supply side trends, players and challenges. Appl. Econ. Persp. Polic., https://doi.org/10.1002/aepp.13145

Cardona, M., Kretschmer, T., Strobel, T. (2013). ICT and productivity: conclusions from the empirical literature. Inf. Econ. Polic., 23, 109–125.

Cristobal-Fransi, E., Montegut-Salla, Y., Ferrer-Rosell, B., Daries, N. (2020). Rural cooperative in the digital age: An analysis of the Internet presence and degree of maturity of agri-food cooperatives' e-commerce. J. Rural. Stud., 74, 55–66. https://doi.org/10.1016/j.jrurstud.2019.11.011

Emelianoff, I.V.(1942). Economic Theory of Cooperation. Ann Arbur: Edward Brothers.

Fielke, S., Taylor, B., Jakku, E. (2020). Digitalization of agricultural knowledge and advice network: A state of-the-art review. Agric. Syst., 180, 102763. https:.//doi.org/10.1016/j.agsy.2019.102763

Foster, C., Graham, M., Mann, L., Waema, T., Mann, L. (2018). Digital control in value chains: challenges of connectivity of east African firms. Econ. Geogr., 94(1), 68–76. https://doi.org/10.1080/00130095.2017.1350104

Hansen, E., Robert, N., Bomford, M., Harbut, R., Mullinix, K. (2020). Response to the findings and recommendations of the B.C. food security task force. Richmond Britch Columbia: Institute for sustainable Food System, Kwanteen Polytechnic University. Retrieved from: https://www.kpu.ca/science/isfs/response-bc-food-security-task-force

Hidrobo, M., Palloni, G., Aker, J., Gilligan, D., Ledie, N. (2018). Paying for digital information: accessing farmers' willingness to pay for digital agriculture and nutrition services in Ghana. Econ. Dev. Cult. Change, 70(4). https://doi.org/10.1086/713974

Hussain, M.S. (2014). The role of cooperative organizations in rural community development in Nigeria: Prospects and Challenges. Acad. Res. Internat., 5(3), 189–197.

Jorge-Vazquez, J., Chivite-Cebolla, M.P., Salinas-Ramos, F.(2021). The digitalization of the European agri-food cooperative sector. Determining factors to embrace Information and Communication Technologies. Agriculture, 11, 514. http://dx.doi.org/10.3390/agriculture11060514

Lio, M., Liu, M.C. (2006). ICT and agricultural productivity: Evidence from cross country data. Agric. Econ., 34, 221–228. https://doi.org/10.1111/j.1574-0864.2006.00120.x

Lu, L., Reardon, T., Zilberman, D. (2016). Supply chain design and adoption of indivisible technology. Oxford University Press. https://doi.org/10.1093/ajae/aaw076

Majee, W., Hoyt, A. (2011). Cooperatives and community development: a perspective on the use of cooperative in development. J. Comm. Pract., 19(1), 48–61. Retrieved from: https://www.tandfonline.com/doi/full/10.1080/10705422.2011.550260

Maria, Onofrio (nd). Top Issues in Farmer Cooperatives. www.challenge.org

Metemilola, S., Elegbede, I. (2017). The challenges of food security in Nigeria. Open Access Libr. J 4: e4185. https://doi.org/10.4236/Oalib.1104184

Muslem, A., Yusuf, Y.Q., Juliana, R. (2018). Perceptions and barriers to ICT use among English Teachers in Indonesia. Teach. Eng. Technol., 18(1), 3–23. Retrieved from: https://www.researchgate.net/publication/323164666_Perceptions_and_barriers_to_ICT_use_among_english_teachers_in_Indonesia

NBS (National Bureau for Statistics) (2021). Annual collaborative survey of socio-economic activities in Nigeria. Main Statistical Report 1.

NCC (National Communications Commission) (2012). Challenges of technology penetration in an infrastructure deficit economy (Nigeria perspective) http://www.ncc.gov.ng/docman.main/research.development/976

NPC (2006). National population census report. Abuja: National Population Commission.

Okeke, M.N., Nwoye, I.I., Kadiri, A.O. (2020). Assessment of information and communication technology (ICT) utilization among rural women rice farmers in Ayamelum local Government of Anambra State, Nigeria. Int. J. Agric. Innov. Res., 8(5), 2319-1473. Retrieved from: https://www.researchgate.net/publication/341781638_Assessment_of_Information_and_Communication_Technology_ICT_Utilization_among_Rural_Women_Rice_Farmers_in_Ayamelum_Local_Government_Area_of_Anambra_State_Nigeria

Olagunju, O., Adetarami, O., Koledoye, G.A., Olumoyegun, A.T., Nabana, I.S. (2021). Digitalization of agricultural

extension system for effective management of emergency in Nigeria. *Journal of Agricultural Extension* 25(4), 81–91. http://dx.doi.org/10.11226/v25i4

Organization of European Community Development OECD (2022). The digitalization of agriculture: a literature review and emerging policy issues. OECD Food Agric. Fish., 1, 58, 176. https://doi.org/10.1787/18156797

OCDC (Overseas Cooperative Development Council) (2022). Cooperatives: Building a more prosperous, democratic and inclusive world. A Policy Paper Washington D.C: OCDC.

Philips, R. (1953). Economic nature of cooperative association. J. Farm Econ., 35(1), 74–87. https://doi.org/10.2307/1233642

Royer, J. (1987). Cooperative Theory: New approaches. United States Department of Agriculture, Agricultural Cooperative Service ACS Service Report No Washington DC: USDA.

Saunders, C., Driver, T., Mowat, A., Kaye-Blake, W., Payn, T., Bayne, K. (2016). Driving better programme investment and accelerating challenge impact through a prioritization matrix of international and national perspectives. Retrieved from: https://ourlandedwater.nz/wp-content/uploads/2019/03/Matrix_report-B-2016-09-30-002-FINAL-OLW.pdf

Shepherd, M., Turner, J.A., Small, B., Wheeler, D. (2020). Priorities for science to overcome hurdles thwarting the full promise of digital agriculture revolution. J. Sci. Food Agric. 100(14), 5083–5092. https://doi.org/10.1002/jsfa.9346 USAID (United States Agency for International Development) (2022). Nigeria Power Africa fact sheet. https://www.usaid.gov/powerafrica/Nigeria

USDA (United States Department of Agriculture) (2022). Rural Development Bulletin. Washington D. C: Cooperative Service Branch

Wield, D., Chataway, J., Bolo, M. (2010). Issues in the political economy of agriculture biotechnology. J. Agrar. Change, 10(3), 342–366. https://doi.org/10.1111/j.1471-0366.2010.00274.x

Wiseman, L., Sanderson, J., Zhang, A., Jakku, E. (2019). Farmers and their data: an examination of farmers' reluctance to share their data through the lens of the laws impacting smart farming. NJAS-Wageningen J. Life Sci, 90–91. https://doi.org/10.1016/j.njas.2019.04.007

World Bank Group (2021). Population total for Nigeria. Retrieved Aug 10th 2023 from: www.worldbank.org/