UTILISATION OF DIGITAL TECHNOLOGIES FOR MAIZE DISEASE MANAGEMENT BY MALE AND FEMALE FARMERS IN SOUTHWESTERN, NIGERIA- AN EX-ANTE APPROACH

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ABSTRACT

Studies have shown that digitalisation will change the agri-food chain, and the use of digital technologies will help diagnose and prevent losses due to crop diseases. However, some digital technologies are pushed to potential users. The study analysed male and female farmers' use of digital technologies for the management of maize diseases using an ex-ante approach. This refers to a method used to make informed decisions or predictions about the outcomes of using digital technologies for maize disease management. A multistage sampling procedure was used to select 456 maize farmers for the study. An electronic interview schedule (Kobo Collect) was used to collect the quantitative data from the respondents. Percentages, mean, and standard deviation were used to describe and summarise the data. Results show that the majority (79%) of male and (63.5%) female farmers were aware of the use of digital technology in agriculture. The majority of male and female farmers (83% and 84.6%), respectively *have used the WhatsApp digital platform. There was variation in the male and female farmers' knowledge of WhatsApp as revealed by their mean score (3.46 ± 1.52 and 3.15 ±.1.65 respectively. The male farmers (87.3%) had a high response, and about (58%) of female farmers had a low response to digital technologies usage for maize disease management. Male farmers possessed more economic and social power than the female farmers. Hence, it is predicted that male farmers will respond to digitalisation by substitution, while female farmers will respond by adding digitalisation to conventional maize disease management. Strategic efforts should be made on capacity-building programs on various digital tools that are related to agriculture, as this could bridge the gender gap and enhance quick access to information on available innovations in agriculture.*

Keywords: ***Digitalisation, Disease management, Gender,***

INTRODUCTION

The agricultural sector globally experiences notable financial losses due to crop diseases and pests. Crop diseases are significant because they result in lower yields, harm food crops, reduce farmers' income, and endanger food security, which eventually can lead to famine (Food and Agriculture Organisation, 2021). In recent years, the spread of crop pests and diseases has increased (FAO, 2021). There has been a proliferation of crop pests and diseases due to trade, globalisation, climate change, and agricultural intensification, which has led to a lower production system (FAO, 2021). Digital technology utilisation in agriculture is a concept that will drive agricultural transformation faster and at a lower cost (Kah, 2020). The growth and penetration of digital technology in rural areas is increasing at an alarming rate, especially the use of mobile phones. Hence, the need to integrate digital technology into the management of crop diseases is important in developing countries in Africa. Also, the coronavirus (COVID-19) pandemic has made all categories of people and sectors dependent on digital technologies. The COVID-19 pandemic created barriers and restricted extension agents from visiting farmers in

person due to physical distancing, which is one of the COVID-19 preventive measures, thereby compelling extension agents to rely on digital means to deliver services to farmers (Olagunju et al., 2021).

Although the pandemic poses numerous obstacles, it also presents potential for digital technologies to serve farmers better. The deployment of digital technologies for agricultural advisory services can create possibilities for information flow from various stakeholders in the agricultural sector. However, in the design and development of digital technology for crop disease management, there is inadequate involvement of end-users and stakeholders, leading to digital solutions that fail to meet their needs and neglect local perspectives (Steinke *et al.,* 2020). The literature reveals that there is a gender gap in the development, design, and creation of digital technologies (Avila *et al.,* 2018). It has also been observed that there is a technology gap between males and females globally (gender digital divide); females are seldom involved in the development and invention of digital technologies (Ozor *et al.*, 2025). Understanding stakeholders' (agricultural extension agents and farmers) response to technology is very significant for a comprehensive analysis of their adoption behaviour, which underpins sustainable innovation and technology utilisation for improved agricultural production and sustainable livelihood and development (Deji, 2020).

Gender Response Theory (GRT) propounded by Deji (2020) provided a detailed theoretical background to understanding the gendered differences in responses to innovation and technology. However, there is a need for more empirical data on the understanding of the gender differences in the responses to the emerging digital technologies in agricultural production and management. Using an ex-ante approach, that is predicting an event before it occurs or evaluating an event before participants are aware of the event, the study seeks to gather information on stakeholders' response (maize farmers) to the development of digital technologies by examining the level of awareness and the variation in knowledge on digital technologies for maize disease management among male and female farmers in the study area.

The specific objectives of the study were to

i. ascertain the awareness of digital technology among male and female maize farmers;
ii. compare the variation in the farmers' knowledge of digital technologies; and
iii. determine the gender response of farmers to digital technologies for maize disease.

METHODOLOGY

The study was conducted in Southwestern Nigeria, which consists of Lagos, Ogun, Oyo, Osun, Ondo, and Ekiti States. The study area is located between Latitude 6º21` and 8º37` North and longitude 2º31` and 6º0` East. The sample population was maize farmers. The study used a mixed-method design, and a multistage sampling procedure was adopted to select the respondents. In the first stage, Ondo and Oyo States were purposively selected based on the preponderance of maize production. In the second stage, two Agricultural Development Programme (ADP) zones were purposively selected based on the high concentration of maize production from each State to make four agricultural zones, namely: Ondo and Owo zones from Ondo State, while Ibadan/Ibarapa and Oyo zones were selected from Oyo State. In the third stage, three LGAs from each agricultural zone known for high maize production were purposively selected to give a total of twelve LGAs. In the fourth stage, five per cent of the communities in each LGA were selected by simple random sampling techniques, giving a total of fifty-nine communities. At the last stage, male and

female maize farmers were selected using random sampling techniques from each farming community, making 456 maize farmers. The research instrument was scripted in Excel and uploaded to Kobo Collect. The data were collected by the researcher and other trained enumerators from February 2023 to June 2023. Percentages, mean, and standard deviation were used to describe and summarise data collected.

Awareness was determined by requesting the respondents to indicate if they had seen and heard about digital technology, with a "yes" or a "no" response. The level of awareness was measured at four levels: 1-not aware (not heard about), 2-rarely aware (heard), 3-moderately aware (seen) and 4-highly aware (experienced/used). Since it requires progressive responses, the maximum obtainable score was 4 multiplied by 8 digital tools listed, which gave 32, and the minimum was 8.

Knowledge: Respondents were asked to tick what they know about the different digital technologies, such as Viamo, Akilimo, Farm Crowdy, WhatsApp, Telegram, etc., with a knowledge checklist prepared from literature on various digital technologies presented. Each digital technology attracted a maximum score of 3 for 15 digital technologies. The highest obtainable aggregate score was 45, while the lowest score was 1. The aggregate score of the respondents was grouped using an equal interval approach.

Response to digital technology was derived using the gender response theory (Deji 2020), which was proven at four levels of response, namely: knowledge, attitude, behaviour, and socio-economic gender relations. The knowledge, attitude, and behaviour of an individual will influence the economic power, while the social or gender relation will influence the social power, otherwise known as decision-making power (Deji, 2019). The response index was generated using economic and social power.

The economic power index was derived from tangible costs using the estimated income of the farmers and intangible costs using statements that were associated with the possibility of acquiring digital technology if they had the money. **Economic Power** = Tangible cost + Intangible cost. Social power (Decision-making capacity) was measured thus: "I decide", "Joint decision" and "Someone else decides" and scored as 3, 2, and 1, respectively. Based on who decides on maize disease management in the various stages of disease management. Four indicators were used, namely: symptom identification, disease prediction of diseases, disease treatment of diseases, and monitoring after treatment. **Social Power** = Decision on symptoms identification + Decision on prediction + Decision on treatment + Decision on monitoring after treatment. Therefore, **Gender response score = Economic Power + Social Power**

RESULTS AND DISCUSSION

Awareness of digital technology for agriculture.

Table 1 shows that the majority (79.7%) of male farmers and 63.5% of female farmers were aware of the use of digital technology for agriculture. This result is in tandem with the findings of Olagunju *et al*. (2021) and Deji *et al*. (2023) that the use of digital platforms has become a good alternative for farmers and extension agents during the Covid 19 and the post-COVID-19 era. The majority of the male farmers indicated that they use mobile phones to access timely and reliable information to support farmers' decision-making, while a majority of the female farmers preferred using their mobile phones to cut down on travel costs. This implies that both male and female farmers are well aware of the use of digital technology for

agricultural production. This finding implies that mobile digital technology has provided opportunities for rural farmers to obtain relevant knowledge and information on agricultural problems and issues, and also proffered appropriate solutions.

Table 1: Awareness of digital technologies among male and female farmers in agriculture

Awareness of Digital Technologies	Male Farmers %	Female Farmers %
Yes	79.7	63.5
No	20.3	36.5

Source: Survey, 2023

Level of awareness of digital technologies used for agriculture

Table 2 shows the mean scores of the respondents' awareness levels. The result indicated that the male and female farmers had seen and used WhatsApp, as revealed by their mean scores (3.5 ± 1.52 and 3.4 ± 1.65), respectively, while the Mobile banking app was also a digital technology that had been seen by both male and female farmers (2.0 ± 1.14 and 2.0 ± 1.31). The following digital technologies have been heard about by both male and female farmers; Telegram (1.5 ± 0.88 and 1.5 ± 1.05), GES-E-wallet (1.40 ± 0.69 and 1.1 ± 1.14), GPS (1.4 ± 0.87 and 1.3 ± 1.01), Internet browsing apps (1.4 ± 0.48 and 1.4 ± 0.32), USSD code (1.4 ± 0.47 and 1.3 ± 0.71). The male and female farmers indicated that they have not heard about Akilimo (1.0 ± 0.11 and 1.0 ± 0.24) and Hello tractor (1.00 ± 0.0 and 1.1 ± 0.29). This result implies that WhatsApp and Mobile banking apps have been seen and used by both male and female farmers for various agricultural purposes. Hence, maize farmers (male and female) are using WhatsApp and the mobile banking app, which is very popular amongst male and female farmers. This finding corroborates the study of Okoroji (2019) that WhatsApp emerged as the social media app that was popular among farmers in Abia State, Nigeria.

Table 2: Awareness level of digital technologies for Agriculture

Digital Technologies	Male Farmers (n=300) Mean	Std. Deviation	Female Farmers (n=156) Mean	Std. Deviation
WhatsApp	3.5	1.52	3.4	1.65
Mobile banking App	2.0	1.14	2.0	1.31
Telegram	1.5	0.88	1.5	1.05
GES E-wallet	1.4	0.69	1.1	1.14
GPS	1.4	0.87	1.3	1.01
Internet browsing	1.4	0.48	1.4	0.32
USSD Code	1.4	0.47	1.3	0.71
Akilimo	1.0	0.11	1.0	0.24
Hello Tractor	1.0	0.00	1.1	0.29

Source: Survey, 2023

Variation in the Male and Female farmers' knowledge of digital technologies

Results in Table 3 show that 83% of male and 84.6% female farmers knew WhatsApp can be used for socialising, idea sharing, and receiving information from fellow farmers, while 79% of males and 73.7% of females knew that it allows texts, voice, and video messaging. This implies that male and female maize farmers were knowledgeable that WhatsApp enables social interaction, idea sharing, and information exchange with peers and extension agents. Field observations show that WhatsApp is a familiar and frequently used platform among farmers and extension agents, making it a suitable channel for sharing maize disease management information. This is in tandem with the findings of Okoroji (2019).

Also, most male farmers had the knowledge of mobile banking functions, including access to bank accounts (95.3%) and mobile financial transactions (90.7%), while female farmers knew it was used for agricultural payments (77.6%) and mobile financial transactions (66.7%). This high knowledge level indicates that mobile banking features can be integrated into digital technologies for maize disease management.

Table 3 shows that 42.7% of male farmers knew that Telegram is used for sending messages, photos, videos, and files, while 34.7% were aware of its broadcasting and groups features (up to 200,000 members). Among female farmers, 50.6% used Telegram for socialising and information exchange, and 42.9% knew its messaging functions. Overall, farmers demonstrated moderate knowledge of Telegram, indicating its potential for maize disease management.

Approximately 50% of male and 69% of female farmers knew that GES E-wallet provides information on fertiliser purchase, while fewer than half (41.0% of males and 46.8% of females) knew it also covers soft loans and input tracking, indicating moderate knowledge of its features.

Table 3: Respondents' knowledge of digital technologies for agricultural purposes

Digital Technologies	**Male Farmers (n=300)**		**Female Farmers (n=156)**	
WhatsApp	**Freq.**	**%**	**Freq.**	**%**
Allows texts, voice, and video messaging.	237	79.0	115	73.7
Socializing, idea sharing, and receiving information from fellow farmers	249	83.0	132	84.6
Mobile Banking App				
Used for agricultural payments	203	67.7	121	77.6
Easy access to bank account and fund transfers	286	95.3	96	61.5
Easy mobile financial transactions	272	90.7	104	66.7
Telegram				
Used for sending messages, photos, video and files.	128	42.7	67	42.9
Allows broadcasting and group creation of up to 200,00 members	104	34.7	45	28.8
Used for socialising and information exchange	93	31.0	79	50.6
GES E-wallet				
Provides information on fertiliser purchase	151	50.3	107	68.6
Cover soft loans and input tracking	123	41.0	73	46.8

*Multiple responses**, Source:** Survey, 2023

Gender response of farmers to Digital Technology for maize disease management

Results in Tables 4 and 5 show the economic and social power of male and female maize farmers, which is used to determine gender response as explained in the Gender Response Theory (Deji, 2019).

Economic power

The economic power index includes the tangible cost (₦440,166.67 and ₦304,179.49, which were the mean annual incomes of male and female maize farmers with standard deviation of ₦101,738.63 and ₦88,292.98, respectively) and the intangible cost that was associated with using digital technology. Tangible cost was measured using the estimated income of the farmers. Statements that were associated with the possibility of acquiring digital technology if they have the money, and statements that were associated with skill acquisition and training, were used to measure the intangible costs.

The findings show that the tangible cost (estimated annual income) of the male farmers was greater than that of the female farmers, MF>FF, which could enhance the males' economic power and promote their likely response by substituting the previous method of disease management with digital technologies for maize disease management. Also, about eleven statements measuring the intangible cost had positive responses (11:4 MF>FF) from male farmers, which was greater than female farmers' responses. This indicates that the male farmers' economic power is greater than the female farmers' economic power as regards their intangible costs. Due to the higher economic power of the male farmers, it can be predicted that MF may likely respond by substitution, while the FF may likely respond by addition, to any future digital technologies for crop disease management, thereby confirming the Gender Response Theory (Deji, 2019).

Table 4: Economic power on digital technologies for maize disease management

Cost	MF (n=300) Mean	S.D.	FF (n=156) Mean	S.D.	Gender Response Index
A. Tangible Cost (₦)	₦440,166.67	±₦101,738.63	₦304,179.49	±₦88,292.98	MF>FF
B. Intangible Cost					
I will adopt digital technology if I have the money and if it is effective.	3.84	0.58	3.81	0.67	MF>FF
I don't have the money to adopt digital technology even if digital technology is more effective.	3.83	0.65	3.85	0.62	MF<FF
I am ready to use digital technology if it will be available at no cost	3.83	0.63	2.72	0.91	MF>FF
I will adopt digital technology if I get financial support from my spouse	3.81	0.62	3.16	0.95	MF>FF
I am ready to use digital technology if it will be available at affordable cost	3.76	0.793	3.78	0.78	MF<FF
I can adopt digital technology if I have the money	3.72	0.55	3.51	0.47	MF>FF
I am ready to use digital technology if it will be available at any cost	3.71	0.83	3.30	0.86	MF>FF
I am ready to use the digital technology if it will not involve any financial risk	3.66	0.91	3.46	0.52	MF>FF

Cost	MF (n=300) Mean	S.D.	FF (n=156) Mean	S.D.	Gender Response Index
I don't need any financial support from my spouse to adopt the digital technology	3.64	0.97	3.00	0.34	MF>FF
I will adopt digital technology no matter the cost	2.87	0.76	2.67	0.61	MF>FF
I am ready to undergo the training to acquire skill for digital technology utilization	3.85	0.60	3.84	0.61	MF>FF
I will be available for training to acquire skill on digital technology	3.83	0.69	3.85	0.62	MF<FF
I will not be available for training for skill acquisition on digital technology	2.25	0.47	2.62	0.66	MF<FF
My spouse will be available to undergo the training on my behalf	2.18	0.38	2.33	0.51	MF>FF
Grand Mean	3.49		3.28		11:4 (MF>FF) MF>FF

Source: Field Survey, 2023

Social power

The social power index measures the symptoms identification, prediction, treatment and monitoring of maize diseases management. This was measured thus: "I decide", "Joint decision" and "Someone else decides" and scored as 3, 2 and 1, respectively. Results in Table 5 show that male and female farmers decide the symptoms individually (2.77 ± 0.76 and 2.72 ± 0.45). It also reveals that both male and female farmers handled the prediction of maize diseases individually (2.70 ± 0.46 and 2.70 ± 0.46). It also shows that they can handle treatment individually (2.71 ± 0.45 and 2.69 ± 0.46). It also indicates that they can monitor the treatment individually too (2.72 ± 0.44 and 2.68 ± 0.47). Findings indicate that the social power of the MF on digital technologies for maize diseases management was 3:1 (MF>FF). The gender response indicator in Table 5 reveals that MF possessed more social power than the FF. Hence, it is predicted from the above findings that MF may likely respond by substitution, while the FF may likely adopt by addition, thereby confirming the Gender Response Theory (Deji 2019).

Table 5: Social power of farmers on digital technologies for maize disease management

Maize disease management (Fall army worm)	MF (n=300) Mean	S.D.	FF (n=156) Mean	S.D.	Gender Response Indicator
Symptoms Sight	2.77	0.76	2.72	0.45	MF>FF
Prediction Experience	2.70	0.46	2.70	0.46	MF=FF
Treatment Agrochemicals	2.71	0.45	2.69	0.46	MF>FF
Monitoring	2.72	0.44	2.68	0.47	MF>FF
GRAND MEAN					3:1 (MF>FF)

Source: Field Survey, 2023

CONCLUSION AND RECOMMENDATION

The awareness and knowledge on the use of digital technology on mobile phone

applications for maize disease management were welcomed by the majority of the respondents. Male farmers possessed more economic and social power than the female farmers. Hence, it is predicted that male farmers will respond to digitalisation by substitution, while female farmers will respond by adding digitalisation to conventional maize disease management. This could be as a result of economic power and social power, or the decision-making power of the male farmers. Strategic efforts should be made on capacity-building programmes for farmers on various digital tools that are related to agriculture, as this could bridge the gender gap and enhance quick access to information on available innovations in agriculture. Also, both male and female farmers should be encouraged to be active participants in the acquisition of digital skills for various activities in agriculture because we are in the information age. Digital technology developers should involve the end users when designing and developing digital tools, and such technology should be gender-inclusive.

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