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Producers' Perceptions on the Digitalization of Cotton Production in the Municipality of Banikoara in Northwestern Benin

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ABSTRACT

Precision agriculture is experiencing remarkable growth in developing countries. Although a majority of producers have adopted digital technologies, many do not have a good perception. This study examined the case of cotton producers in Northern Benin. In this context, a survey was carried out among 314 cotton producers in the Municipality of Banikoara. The proportion of cotton farmers surveyed having a positive perception of the usefulness of digitalization and the internet in cotton growing, the ease of use of digital technologies, the strengthening of social ties, satisfaction with services mobile money and security was higher than those who have a negative perception. However, a high proportion of cotton producers (63.69%) did not express an opinion on the level of security of digital platforms, and this trend was persisted regardless of gender, age, level of education and the area of cultivated land. Women (100%) had a more positive perception of the ease of use, satisfaction with mobile money services, and strengthening of social ties compared to men, except in terms of the usefulness of digitalization and the internet, where men (91.38%) were more represented than women (87.50%). Highly educated individuals (university level) had a higher percentage of positive perceptions of digital agricultural technologies, and uneducated individuals (100%) found these technologies easy to use and useful. This was also true for adult users of agricultural machinery (30 to 50 years old), except in terms of ease of use, where younger users (under 30) were more represented. Small-scale farmers (less than 5 hectares) dominated other producers in positive perceptions related to the usefulness of digitalization and the internet and the strengthening of social ties, while medium-scale producers (5 to 10 hectares) were the majority in terms of ease of use and satisfaction with mobile money services. Knowledge of this information is important for a better popularization policy for these technologies.

Keywords: perception, digital agricultural machines, cotton producers, Benin

INTRODUCTION

The quantity and quality of digital technologies available to farmers has increased significantly since the 1990s, when the use of computer and Internet technologies for managing agricultural and livestock operations began to expand (Mcfadden et al., 2022). Many factors, including increased computing power, faster internet and better connectivity, falling technology costs, and the rise of Big Data coupled with advanced analytics are driving the current wave of digitalization which is promising to help meet the challenges of sustainability, productivity and resilience objectives of commercial agriculture (Mcfadden et al., 2022).

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Thus, digital technologies have been identified as a solution to transform the agricultural sector in Sub-Saharan Africa and improve the livelihoods of 250 million smallholder farmers in the region (Bontsa et al, 2023). Indeed, agriculture is an essential livelihood sector in sub-Saharan Africa, representing 54% of the active population (FAO, IUT, 2022) and contributing 15% to gross domestic product, although maximums of 50% in Chad and minimums of 2% in South Africa have been recorded (OECD, FAO, 2016).

In Benin, agriculture contributes 27% to the GDP and is an essential part of the economy (AECD, 2023). It is practiced by 54.8% of the population and accounts for 75 to 90% of official exports (AECD, 2023). Cotton is the main cash crop, representing 13% of the GDP in terms of value added and 70% of the total export value in 2018 (INSAE, 2019).

Like most countries in the world, Benin has embarked on a digital transformation over the past decade, particularly since 2016. This transformation has led to significant reforms, substantial investments, and remarkable progress in the digital agriculture ecosystem (AECD, 2023). Numerous digital solutions and applications have emerged in the agricultural sector (Nacambo, 2020; Paget et al., 2022). Currently, fifty (50) digital agricultural solutions are deployed in Benin, primarily driven by the private sector (76%), followed by NGOs (Access Agriculture, Eclosio, Hedi, IFDC, and Technoserve) to a lesser extent (17%), and development and cooperation services (GIZ) and the public sector (National Chamber of Agriculture) jointly contributing 7% (AECD, 2023).

Despite the relevance and advantages of smart agricultural technologies, previous research has reported low acceptance and rare adoption of these technologies by farmers (Caffaro et al., 2022). Agricultural innovations sometimes do not align with the values and norms of producers. The efforts required for their implementation can be considerable due to their complexity. Furthermore, when the financial benefits of new methods are uncertain, other more subjective aspects can be decisive in the adoption decision (Kouboura et al., 2019). According to some authors (Adesina and Baidu-Forson, 1995; Sall et al., 2000), farmers' decisions to adopt agricultural innovations depend on complex factors, including their perceptions of new technologies. Farmers also base their choices on their experience, knowledge, and available information (Kouboura et al., 2019). Additionally, in Africa, many farmers are unwilling or unable to pay for tools such as advisory messages, relying instead on donor-funded support (CTA, 2021), which may or may not be sustainable in the long term.

In this context, this research aims to analyze the perception of cotton producers in the Municipality of Banikoara on the digitalization of agriculture in the cotton sector through the use of machines and other digital tools.

MATERIALS AND METHODS

Description of the Study Area

The Municipality of Banikoara is located in the north-west of Benin, characterized by a Sudanian-Sahelian climate. It covers an area of 4,397.2 km², with approximately 49% of the land being arable and 50% designated as protected areas (Kate et al., 2014). Banikoara is bordered to the north by the Municipality of Karimama, to the south by the Municipality of Kérou and Gogounou, to the east by the Municipality of Kandi, and to the west by Burkina Faso. As of 2013, its population was 246,575 inhabitants, including 124,130 women (50.3%) (INSAE, 2015). The Municipality comprises ten districts and has been the leading cotton-producing area in terms of production quantity for several decades.

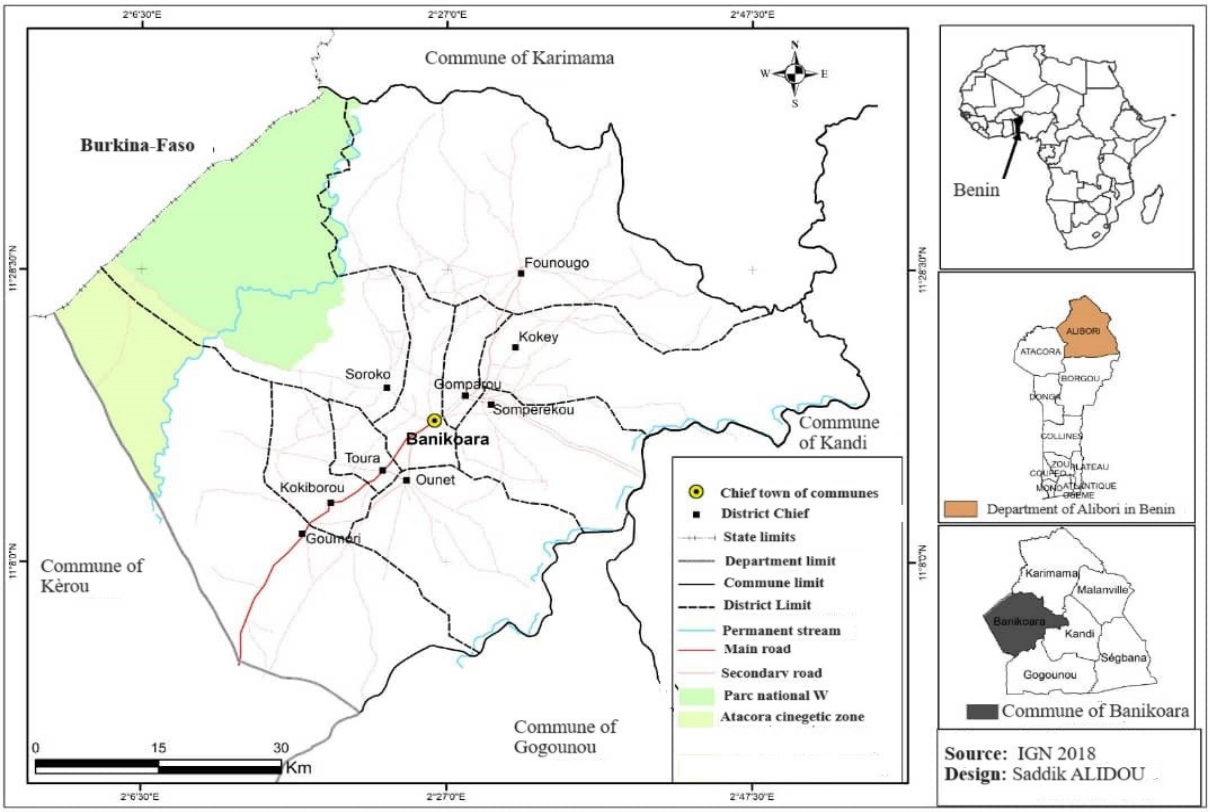

Figure 1: Map of the Study Area

Data Collection Method

The sample consisted of 314 producers distributed across the ten districts of the Municipality of Banikoara. Purposive sampling was used, taking into account factors such as gender, education level, age, and the total area cultivated by the producer, as shown in Table 1. The questions related to perception are structured according to the model presented in Table 2. In the sample, 66 producers, or 21%, used digital agricultural machines in their production activities, while the majority, 79%, do not used them. Women represented 19% of the sample, and the majority of producers (65%) were aged between 30 and 50 years. Most producers (75%) cultivate an area of less than 10 hectares.

Table 1 presents a detailed breakdown of the sample of producers in the Municipality of Banikoara according to several key variables. Regarding the use of digital agricultural machines, it is notable that 21.02% of producers have adopted this technology, while the majority, 78.98%, do not use it. In terms of gender distribution, men significantly outnumber women in the sample, comprising 80.89% compared to 19.11% for women. Education-wise, half of the producers (50.00%) have no formal education, while only 5.10% have attained a university level of education. Age distribution shows a significant predominance of producers aged 30-50 years, accounting for 64.65%, followed by those under 30 years (19.75%) and over 50 years (15.61%). Regarding total cultivated area, approximately 37.26% of producers manage less than 5 hectares, an equal percentage cultivate between 5 and 10 hectares, and 25.48% cultivate more than 10 hectares. These data provide a detailed portrait of the demographic characteristics and profiles of cotton producers in this region, crucial for assessing their perceptions and practices regarding digital agricultural technologies.

Table 1: Composition of the sample according to the variables used and their categories

Variables	Categories	Sample Size	Percentages
Use of digital agricultural machines	Yes	66	21.02%
	No	248	78.98%
Gender	Female	60	19.11%
	Male	254	80.89%
Education level	None	157	50.00%
	Literate	15	4.78%
	Non-conventional	11	3.50%
	Primary	62	19.75%
	Secondary	53	16.88%
	University	16	5.10%
Age	Under 30 years	62	19.75%
	30-50 years	203	64.65%
	Over 50 years	49	15.61%
Total cultivated area	Less than 5 hectares	117	37.26%
	5-10 hectares	117	37.26%
	More than 10 hectares	80	25.48%

Table 2 provides a detailed breakdown of users of digital agricultural machines in the Municipality of Banikoara across various demographic variables. All sampled users (100%) employ digital agricultural machines. Men constitute the majority of users, accounting for 72.73%, while women make up 27.27% of the users. The majority of users (54.55%) have no formal education. Primary and secondary education levels are represented by 25.76% and 12.12% respectively. Literate, non-conventional, and university-educated users each comprise smaller percentages, ranging from 1.51% to 4.55%. The largest group of users falls within the 30-50 age range, comprising 60.61%. Users under 30 years old represent 21.21%, while those over 50 years old constitute 18.18%. Users are distributed across different cultivated area categories: 45.46% manage between 5 and 10 hectares, 33.33% manage more than 10 hectares, and 21.21% manage less than 5 hectares. These findings provide insights into the demographic characteristics of digital agricultural technology users in Banikoara, highlighting a predominantly male user base, a significant proportion without formal education, and a concentration in the middle age groups managing medium to large land areas.

Table 2: Composition of users of agricultural machines according to the variables used and their categories

Variables	Categories	Sample Size	Percentages
Use of digital agricultural machines	Yes	66	100%
Gender	Female	18	27.27%
	Male	48	72.73%
Education level	None	36	54.55%
	Literate	1	1.51%
	Non-conventional	3	4.55%
	Primary	17	25.76%
	Secondary	8	12.12%
	University	1	1.51%
Age	Under 30 years	14	21.21%
	30-50 years	40	60.61%
	Over 50 years	12	18.18%
Total cultivated area	Less than 5 hectares	14	21.21%
	5-10 hectares	30	45.46%
	More than 10 hectares	22	33.33%

Data Analysis Method

The analysis of the data collected in this study was conducted in several methodical stages aimed at exploring and interpreting the perceptions and practices of cotton producers in the Municipality of Banikoara regarding the use of digital agricultural technologies. Here is a detailed overview of the analysis method used:

Data collected from structured questionnaires were prepared for analysis using R 4.2.2 software. This stage included data quality verification, cleaning of missing or aberrant data, and variable transformation as necessary.

For each studied variable (use of digital agricultural machines, gender, level of education, age, cultivated area), frequency tables were generated to present the number of individuals in each category along with corresponding percentages. This descriptive analysis provided a detailed portrait of the distribution of demographic and educational characteristics among the respondents.

RESULTS

Overall Perception of Digitalization by Producers

Overall, the majority of the cotton producers surveyed found digitalization and the Internet useful, representing 47.45% of the sample (Table 3). However, 26.43% found no utility in them, and 24.20% found them only slightly useful. Regarding the strengthening of social relationships through digitalization, 50% of the cotton producers responded affirmatively, while 17.20% believed that digitalization does not contribute to strengthening social relationships, and 32.80% could not express an opinion on this matter. Concerning the level of security (risk) provided by digitalization through the use of digital platforms and information

sharing, 63.69% of the cotton producers could not express an opinion, compared to 24.84% who perceived a very good level of security. This indicates that most producers did not have enough information to assess the security level of digitalization and remained silent on this issue. On the other hand, 63.38% of the cotton farmers surveyed were satisfied with mobile money services, compared to 11.78% who were not satisfied, and 24.84% who did not provided a response on this topic. Regarding the ease of use of digital tools, 50.32% found them easy to use, compared to 5.75% who found them difficult; 15.61% gave a mixed response, and 28.34% could not give their opinion on this question. Overall, the proportion of cotton producers with a positive perception of the usefulness of digitalization and the Internet, the strengthening of social relationships, the security of digitalization, satisfaction with mobile money services, and ease of use was more significant than those with a negative perception of these criteria. However, it should be noted that 63.69% could not give their opinion on the level of security of digital services. More specifically, the results regarding the perception of users and non-users of digital agricultural machines based on certain social variables such as age, gender, educational level, and cultivated area are as follows:

Table 3: Overall Perception of Digitalization by Cotton Producers

Perceptions	Modalities	Percentages
Usefulness of the Internet and digitalization	Useless	26.43
	Little useful	24.20
	Very useful	47.45
	No response	1.91
Strengthening of social relationships	Yes	50.00
	No	17.20
	No response	32.80
Security of digitalization	Poor	6.05
	Average	2.23
	Good	3.18
	Very good	24.84
	No response	63.69
Satisfaction with mobile money services	Yes	63.38
	No	11.78
	No response	24.84
Ease of use	No idea	28.34
	Easy	50.32
	Neither easy nor difficult	15.61
	Difficult	5.73

Effect of Gender on Producers' Perception of Using a Digital Agricultural Machine

Users of digital agricultural machines, regardless of their gender (Table 4), found digitalization and the Internet very useful (90.91%). Among this group, the percentage of male users of digital agricultural machines (91.30%) was identical (P value = 0.365) to that of female users (87.50%). In contrast, non-users of these tools considered them useless or of little use (62.09%), which aligns with their disapproval of this technology.

Regarding the strengthening of social relationships, the security of digitalization, satisfaction with mobile money services, and ease of use of digital machines and services, the proportion of female users of digital agricultural machines was more significant than that of

males. The proportion of female users of digital agricultural machines who have a positive perception of these four explanatory variables was higher than that of males. Specifically, 100% of women responded "yes" regarding the strengthening of social relationships, satisfaction with mobile services, and ease of use of digital services; 75% of women found these platforms secure compared to 65.52% of men.

However, 25% of female users of digital agricultural machines and other digital tools could not comment on the security level of these digital technologies, compared to 24.14% of men. None of the women found the security level bad, unlike 6.90% of men who use digital machines and other technological tools. The concept of security on digital platforms was not well understood by a significant portion of users and non-users.

Women, therefore, had a more positive perception of these various variables compared to men, except for the usefulness of digitalization and the Internet, where the proportion of men was higher.

Table 4: Distribution of Producers Based on Their Perception of Using Digital Agricultural Machines and Gender

Perceptions	Modalities	Users of Digital Machine		Non-users of Digital Machine	
		Female	Male	Female	Male
Usefulness of the Internet and digitalization	Useless	0.00	1.72	30.77	33.67
	Little useful	12.50	5.17	44.23	25.00
	Very useful	87.50	91.38	23.08	39.29
	No response	0.00	1.72	1.92	2.04
Strengthening of social relationships	Yes	100.00	94.83	38.46	37.76
	No	0.00	0.00	28.85	19.90
	No response	0.00	5.17	32.69	42.35
Security of digitalization	Poor	0.00	6.90	3.85	6.63
	Average	0.00	0.00	1.92	3.06
	Good	0.00	3.45	0.00	4.08
	Very good	75.00	65.52	13.46	13.78
	No response	25.00	24.14	80.77	72.45
Satisfaction with mobile money services	Yes	100.00	89.66	46.15	58.67
	No	0.00	1.72	13.46	14.80
	No response	0.00	8.62	40.38	26.53
Ease of use	No idea	0.00	1.72	40.38	34.18
	Easy	100.00	94.83	25.00	41.84
	Neither easy nor difficult	0.00	1.72	23.08	18.37
	Difficult	0.00	1.72	11.54	5.61

Effect of Education Level on Producers' Perception of the Use of a Digital Agricultural Machine

Users of digital agricultural machines with a university education level mainly found that they are very useful and easy to use, strengthen social relationships and that mobile money services are satisfactory (Table 5). This category of users also represented the highest proportion (80%) of those who believed that digital services are very secure. Whatever the level of education, most users of agricultural machines perceived a strong usefulness, a strengthening of social relations and an ease of use of digitalization and the Internet except the literates who were unable to comment on 100% on the ease of use of digital services and who

found the level of security poor in the same way as those with an unconventional level of education (Bible and Koranic school). A small proportion (38.46%) of users of digital agricultural machines with a secondary education level attributed very good security to digitalization while 53.86% of them were unable to give an answer on the level of security of digitalization. This shows the difficulty in assessing the level of security by some educated people, while a large proportion of those who have no level of education or who have a primary or university level attributed a good level of security to digital platforms. However, all users of agricultural machinery with no level of education perceived ease of use of digital technologies; this is explained by the fact that the uneducated manage to use digital technologies.

Table 5: Distribution of producers according to their perception of the use of digital agricultural machines and their level of education

Perceptions	Terms	Users of digital machine							No users of digital machine						
		None	Literate	Unconventional	Primary	Secondary	University	Total	None	Literate	Unconventional	Primary	Secondary	University	Total
Usefulness of the Internet and digitalization	Useless	3.45	0.00	0.00	0.00	0.00	0.00	1.52	**41.41**	**7.14**	22.22	21.74	37.50	9.09	33.06
	Not very useful	3.45	0.00	0.00	18.75	0.00	0.00	6.06	28.91	35.71	0.00	**45.65**	17.50	18.18	29.03
	Very useful	**89.66**	**100.00**	**100.00**	**81.25**	**100.00**	**100.00**	**90.91**	25.78	**57.14**	**77.78**	32.61	**45.00**	**72.73**	**35.89**
	No response	3.45	0.00	0.00	0.00	0.00	0.00	1.52	3.91	0.00	0.00	0.00	0.00	0.00	2.02
Strengthening social relationships	Yes	**89.70**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**95.50**	26.56	**50.00**	22.22	**56.52**	**45.00**	**63.64**	37.90
	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.31	7.14	22.22	32.61	22.50	9.09	21.77
	No response	10.30	0.00	0.00	0.00	0.00	0.00	4.50	**53.13**	42.86	**55.56**	10.87	32.50	27.27	**40.32**
Security of digitalization	Bad	0.00	**100.00**	**100.00**	6.25	0.00	0.00	6.06	5.47	21.43	22.22	2.17	2.50	9.09	6.05
	Average	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.69	0.00	0.00	0.00	2.50	0.00	2.82
	Good	3.45	0.00	0.00	0.00	7.69	0.00	3.03	0.78	14.29	0.00	4.35	2.50	18.18	3.23
	Very good	**79.31**	0.00	0.00	**75.00**	38.46	**80.00**	**66.67**	10.94	14.29	**44.44**	17.39	15.00	0.00	13.71
	No response	17.24	0.00	0.00	18.75	**53.85**	20.00	24.24	**78.13**	**50.00**	33.33	**76.09**	**77.50**	**72.73**	**74.19**
Satisfaction with mobile money services	Yes	**86.21**	**100.00**	**50.00**	**100.00**	**92.31**	**100.00**	**90.91**	38.28	**57.14**	**66.67**	**76.09**	**75.00**	**100.00**	**56.05**
	No	0.00	0.00	0.00	0.00	7.69	0.00	1.52	18.75	0.00	22.22	15.22	7.50	0.00	14.52
	No response	13.79	0.00	50.00	0.00	0.00	0.00	7.58	**42.97**	42.86	11.11	8.70	17.50	0.00	29.44
Ease of use	No idea	0.00	**100.00**	0.00	0.00	0.00	0.00	1.52	**48.44**	14.29	22.22	13.04	35.00	18.18	35.48
	Easy	**100.00**	0.00	**100.00**	**93.75**	**92.31**	**100.00**	**95.45**	30.47	**57.14**	**77.78**	34.78	**47.50**	**54.55**	**38.31**
	Neither easy nor difficult	0.00	0.00	0.00	0.00	7.69	0.00	1.52	17.19	21.43	0.00	**36.96**	10.00	18.18	19.35
	Difficult	0.00	0.00	0.00	6.25	0.00	0.00	1.52	3.91	7.14	0.00	15.22	7.50	9.09	6.85

Effect of Age on Producers' Perception of Using Digital Agricultural Machines

Fourteen (14) users of digital agricultural machines representing 21.21% were under the age of 30 years, forty (40) were between the ages of 30 and 50 years, representing 60.61% of

this group of cotton producers, while twelve (12) were over 50 years old, accounting for 18.18% of this sample. Adults were therefore the largest users of digital agricultural machines and other tools in the sample (Table 6).

Adult users of agricultural machines (aged between 30 and 50) represented the highest proportion among those who perceived the usefulness of digitalization and the internet positively (97.50%), the enhancement of social relationships (100%), the security of digital services (72.50%), and satisfaction with mobile money services (95%). Regarding the perception of ease of use of digital services, young users (under 30) were more represented (100%), followed by adults and then older individuals, which can be attributed to their agility in using digital technologies. Therefore, ease of use of digital technologies decreases with age.

However, these young users were less satisfied with mobile money services (78.57%) and were less represented (71.43%) among those who found digitalization and the internet very useful and those who believed in enhancing social relationships (85.71%) through digitalization. It should be noted that the proportion of older individuals with a positive perception of the usefulness of digitalization, enhancement of social relationships, and satisfaction with mobile money services was higher than that of young people.

Regarding the security of digital services, it should be noted that 50% of older individuals (over 50 years old) had a positive perception, while the remaining 50% did not responded to the question, similar to 35.71% of young people (under 30 years old) and 12.50% of adults. These older individuals are therefore more hesitant about the security of digital services compared to young people and adults.

Table 6: Distribution of Producers Based on Their Perception of Using Digital Agricultural Machines and Age

Perceptions	Terms	Users of digital machine				No users of digital machine			
		Under 30	30-50 years old	Over 50 years old	Total	Under 30	30-50 years old	Over 50 years old	Total
Usefulness of the Internet and digitalization	Useless	0.00	2.50	0.00	1.52	31.25	34.97	27.03	**33.06**
	Not very useful	21.43	0.00	8.33	6.06	25.00	30.06	29.73	29.03
	Very useful	**71.43**	**97.50**	**91.67**	**90.91**	39.58	33.74	40.54	**35.89**
	No response	7.14	0.00	0.00	1.52	4.17	1.23	2.70	2.02
Strengthening social relationships	Yes	**85.71**	**100.00**	**91.67**	**95.45**	35.42	37.42	43.24	37.90
	No	0.00	0.00	0.00	0.00	20.83	20.86	27.03	21.77
	No response	14.29	0.00	8.33	4.55	43.75	41.72	29.73	40.32
Security of digitalization	Bad	0.00	10.00	0.00	6.06	14.58	4.29	2.70	6.05
	Average	0.00	0.00	0.00	0.00	0.00	3.68	2.70	2.82
	Good	0.00	5.00	0.00	3.03	6.25	3.07	0.00	3.23
	Very good	**64.29**	**72.50**	**50.00**	**66.67**	12.50	12.88	18.92	13.71
	No response	35.71	12.50	**50.00**	24.24	**66.67**	**76.07**	**75.68**	**74.19**
Satisfaction with mobile money services	Yes	**78.57**	**95.00**	**91.67**	**90.91**	50.00	57.06	59.46	56.05
	No	7.14	0.00	0.00	1.52	22.92	12.27	13.51	14.52
	No response	14.29	5.00	8.33	7.58	27.08	30.67	27.03	29.44
Ease of use	No idea	0.00	2.50	0.00	1.52	47.92	34.36	24.32	35.48
	Easy	**100.00**	**95.00**	**91.67**	**95.45**	37.50	38.04	40.54	38.31
	Neither easy nor difficult	0.00	2.50	0.00	1.52	14.58	19.63	24.32	19.35
	Difficult	0.00	0.00	8.33	1.52	0.00	7.98	10.81	6.85

Effect of Land Size on Farmers' Perception of the Use of Digital Agricultural Machinery

Small-scale farmers (less than 5 hectares), medium-scale farmers (5 to 10 hectares), and large-scale farmers (more than 10 hectares) represented respectively 21.21%, 45.46%, and 33.33% of users of digital agricultural machines (Table 7).

Small-scale farmers in their entirety (100%) endorsed the high utility of digitalization and the internet, as well as the enhancement of social relationships, compared to medium-scale (5 to 10 hectares) and large-scale farmers (over 10 hectares). However, medium-scale farmers (45.46% of the sample), who constituted the majority of agricultural machine users, showed a higher proportion in their perception of the security of digital services (83.33%), satisfaction with mobile money services (93.33%), and ease of use of digital technologies (100%). Small-scale agricultural farmers using agricultural machines were very hesitant about the security of digital services (50% did not respond). Medium-scale producers showed a higher proportion of positive perceptions across all five variables compared to large-scale producers.

Overall, more than 24% of the cotton producers using digital machine did not provided a response regarding the level of security of digitalization.

Table 7: Distribution of farmers according to their perception of the use of agricultural machinery and their total land size

Perceptions	Terms	Users of digital machine				No users of digital machine			
		Less than 5 ha	5-10 ha	More than 10 ha	Total	Less than 5 ha	5-10 ha	More than 10 ha	Total
Usefulness of the Internet and digitalization	Useless	0.00	0.00	4.55	1.52	28.16	31.03	44.83	33.06
	Not very useful	0.00	6.67	9.09	6.06	36.89	21.84	25.86	29.03
	Very useful	**100.00**	**93.33**	**81.82**	**90.91**	33.01	45.98	25.86	35.89
	No response	0.00	0.00	4.55	1.52	1.94	1.15	3.45	2.02
Strengthening social relationships	Yes	**100.00**	**96.67**	**90.91**	**95.45**	33.98	44.83	34.48	37.90
	No	0.00	0.00	0.00	0.00	24.27	22.99	15.52	21.77
	No response	0.00	3.33	9.09	4.55	41.75	32.18	50.00	40.32
Security of digitalization	Bad	7.14	3.33	9.09	6.06	8.74	5.75	1.72	6.05
	Average	0.00	0.00	0.00	0.00	2.91	3.45	1.72	2.82
	Good	7.14	0.00	4.55	3.03	0.97	4.60	5.17	3.23
	Very good	**35.71**	**83.33**	**63.64**	**66.67**	14.56	18.39	5.17	13.71
	No response	**50.00**	**13.33**	**22.73**	24.24	72.82	67.82	86.21	74.19
Satisfaction with mobile money services	Yes	**92.86**	**93.33**	**86.36**	**90.91**	49.51	63.22	56.90	56.05
	No	7.14	0.00	0.00	1.52	18.45	12.64	10.34	14.52
	No response	0.00	6.67	13.64	7.58	32.04	24.14	32.76	29.44
Ease of use	No idea	0.00	0.00	4.55	1.52	32.04	31.03	48.28	35.48
	Easy	**92.86**	**100.00**	**90.91**	**95.45**	38.83	42.53	31.03	38.31
	Neither easy nor difficult	0.00	0.00	4.55	1.52	20.39	20.69	15.52	19.35
	Difficult	7.14	0.00	0.00	1.52	8.74	5.75	5.17	6.85

DISCUSSION

The perception of digitalization among selected cotton producers using digital agricultural machines was analyzed in this study through the lenses of the utility of digitalization and the internet, ease of use, enhancement of social relationships, security, and satisfaction among cotton producers. The impact of production-related factors (farm size) and sociological aspects (gender, age, and education level) on perception was also evaluated.

Caffaro et al. (2020) similarly highlighted in their work that ease of use, utility, security, reliability, and perceived socio-economic characteristics positively impact the propensity to use innovations. They noted that perceptions towards digital technologies are linked to utility, productivity enhancement, cost reduction, efficiency, and workload reduction.

Cotton producers using digital agricultural machines who had a positive perception of the utility of digitalization, ease of use, enhancement of social relationships through digitalization, satisfaction with mobile money services, and the security provided by digital platforms outnumber those with a negative perception. However, concerning the perception of security, a significant portion of the surveyed cotton producers did not provided a response, indicating hesitancy or difficulty in assessing security on digital platforms. These results align with Abdulai et al. (2023), who affirmed that farmers generally have a positive perception of digitization, believing it benefits small-scale agriculture and foreseeing digital solutions and services as the future of agriculture in the region.

In terms of gender perspective, the proportion (91.38%) of male users of agricultural machines and other digital tools with a positive perception of the utility of digital technologies in agriculture was higher than that of females (87.50%). However, regarding ease of use, satisfaction with mobile money services, enhancement of social relationships, and security level, the proportion of women with a positive perception of these variables was higher than that of men. These findings are consistent with Murage et al., (2015), who found that a higher percentage of women perceived technology as very effective compared to men, possibly due to technological features that favored women's preferences.

Regarding the impact of education level on perception, cotton producers using agricultural machines with no formal education have a positive perception of the use of digital technologies in cotton production. All respondents with no education (100%) found these technologies easy to use. Those with a very high formal education level (university) were more representative in terms of positive perceptions than those with primary or secondary education. However, those with a secondary education level were very hesitant regarding security, with 53.85% unable to provide a response, compared to 18.75% for those with a primary education level and 20% for those with a university education. All respondents who were literate in local languages or educated in biblical or Quranic schools had a negative perception of the security level of digital platforms. These results contrast with those of Bontsa et al. (2023), who revealed that an increase in education was associated with negative perceptions towards digital technologies. Kaur and Singh, (2021), also observed that factors such as age, education, and agricultural experience of farmers determine their perception of digital technologies.

According to our study results, the perception of ease of use of digital technologies decreases with the age of machine users. Indeed, 100% of users under the age of 30 found these technologies easy to use, compared to 95% of users aged 30 to 50 and 91.67% of the oldest users (over 50). Elderly users (over 50) of digital agricultural machines were also very hesitant about the security of digital technologies (50% did not respond). This result aligns with Bontsa et al. (2023), who demonstrated that increasing age is associated with increased negative perceptions towards digital technologies among small farmers in local municipalities in Port St Johns and Ingquza Hill, South Africa. Da Silveira et al., (2023), also supported this finding, indicating that older farmers exhibit negative perceptions towards technologies due to their resistance to change. However, these results partially contradict our study findings regarding the perception of the utility of digital technologies, enhancement of social relationships, and satisfaction with mobile money services, where the proportion (91.67%) of older individuals (over 50) with a positive perception was more significant than that (71.43%) of young people (under 30); adults (30 to 50 years old) being more representative (97.50%) among those who perceived these technologies as very useful.

Farm size is also a determining factor in the perceptions of users of digital agricultural machines and other tools. In our study, all small-scale farmers (less than 5 hectares) using digital agricultural machines were in favor of the high utility of digitalization and the internet, as well as enhancement of social relationships. Bontsa et al. (2023) corroborate this through their findings, showing that animal production on 2 to 4 hectares and maize production on less than 1 hectare were associated with positive perceptions towards the use of digital technologies. These authors also found that small-scale farmers selling between 150 and 200 kg of maize had a positive perception of the use of digital technologies, as did small farmers who sold less than 50 kg and consumed less than 50 kg of cabbage.

Users of digital agricultural machines and other tools were unable to provide a response regarding security but are still largely satisfied with mobile money services. This result is consistent with Bocqueho et al. (2011), who found that farmers are accustomed to facing risks and are generally tolerant of risks, but like all entrepreneurs, they are more sensitive to the risk of losses. Menapace et al. (2013) examined the risk behavior of Italian fruit growers. Their results showed that risk perceptions are linked to preferences; the more risk-averse an individual is, the more they perceive the risk of losses (Menapace et al., 2013).

CONCLUSION

The objective of this study is to analyze the perceptions of users of digital agricultural machines and other tools in cotton farming in the Municipality of Banikoara, focusing on five explanatory variables: utility, ease of use, enhancement of social relationships, security, and satisfaction with mobile money services. This analysis takes into account socio-economic factors such as age, education level, gender, and cultivated land area. The conceptual framework used combines theories of reasoned action, planned behavior, and interpersonal behavior.

The study revealed that, apart from utility, women have a more positive perception than men regarding the ease of use of digital technologies in agriculture, security level, satisfaction with mobile money services, and enhancement of social relationships.

Cotton producers using digital agricultural machines and other tools with a very high formal education level (university) were most representative in their perceptions of the five variables, followed by those with primary education, then those with intermediate education (secondary). It is noteworthy that the majority of those with no formal education also had a positive perception of digital technologies, with all of them (100%) finding these technologies easy to use despite their illiteracy.

Regarding the impact of age on the perceptions of the sample, the percentage of adults (30 to 50 years old) with a positive perception of the different variables was higher than that of elderly individuals (over 50 years old) and young people (under 30 years old), except for ease of use where the proportion of young people was stronger than that of adults and elderly individuals.

Small-scale farmers (less than 5 hectares) using digital agricultural machines and other tools all had a positive perception of the utility of digital technologies and the enhancement of social relationships through these technologies. However, the proportion of these small-scale farmers was lower than that of medium-scale farmers (5 to 10 hectares) concerning positive perceptions related to satisfaction with mobile money services and ease of use. Regarding security level, less than 50% of small-scale farmers using digital agricultural machines and other tools found these technologies to be of good security compared to medium-scale and large-scale farmers.

Overall, 63.69% of the surveyed cotton producers were unable to provide a response regarding the security level of digital technologies, with only 23.84% perceiving them to be of very good security level and 3.18% of good security level.

Further research is needed to elucidate the silence and the exact stance of this large portion of the sample regarding their perception of the security level of digital platforms.

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