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**ADOPTION OF CLIMATE-SMART AGRICULTURE (CSA) PRACTICES AS MECHANISMS FOR
 STRENGTHENING FOOD SYSTEMS IN RURAL COMMUNITIES OF BORNO STATE: A CASE
 STUDY OF GWOZA LOCAL GOVERNMENT AREA**

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Abstract

This study examines the adoption of Climate-Smart Agriculture (CSA) practices as mechanisms for strengthening food systems in rural communities of Borno State, Nigeria with a specific focus on Gwoza Local Government Area (LGA). Three objectives were used to guide the study. The Diffusion of Innovations Theory was employed to analyze the adoption of CSA practices by examining the stages of innovation, communication channels, social system, and time. Descriptive statistics, including simple percentages, means, and standard deviations, were employed to address the research questions. Data collected were analyzed using the Statistical Package for the Social Sciences (SPSS). A total of 399 questionnaires were administered through random sampling, with 368 properly completed and retrieved, representing a 92.2% response rate. The analysis indicated that the majority of respondents were male (54.6%) and aged between 41 and 50 years (40.21%). The findings reveal varying degrees of agreement towards the adoption of CSA practices, with mean scores suggesting a general tendency towards agreement. Factors influencing adoption and the impact on food security and agricultural productivity also showed significant levels of agreement among respondents. The study concludes that CSA practices have a positive impact on enhancing food systems in rural communities of Gwoza LGA. Thus: the study recommends enhance awareness and training programs: The consistent agreement among respondents about the identified CSA practices, with mean scores ranging from 2.86 to 3.97, indicates a fair level of awareness. However, given that some areas still show room for improvement (as seen in Q4), it is recommended to strengthen awareness

Keywords: Agriculture, Climate-Smart, Communities, Mechanism, Rural

1. Introduction

Climate change poses significant challenges to global food systems, especially in rural communities heavily reliant on agriculture. In Borno State, Nigeria, the impacts are severe, with unpredictable weather patterns, more frequent extreme weather events, and rising temperatures negatively affecting agricultural productivity. In response to these challenges, Climate-Smart Agriculture (CSA) has emerged as an effective approach to enhance the resilience of agricultural systems, improve food security, and promote sustainable development. CSA practices integrate climate change adaptation and mitigation into agricultural development, ensuring food systems can withstand and recover from climatic shocks (FAO, 2013).

Gwoza Local Government Area (LGA) in Borno State is predominantly agrarian, with most of the population dependent on subsistence farming. However, the

region has been severely impacted by climate variability and conflict, exacerbating food insecurity and poverty. The adoption of Climate-Smart Agriculture practices in Gwoza LGA is essential for strengthening food systems, enhancing agricultural productivity, and improving the livelihoods of rural communities. This study focuses on the adoption of CSA practices in Gwoza LGA as mechanisms for strengthening food systems and examines the factors influencing their adoption and effectiveness.

Despite the potential benefits of Climate-Smart Agriculture, its adoption in rural communities like Gwoza LGA remains low. Several barriers hinder the effective implementation of CSA practices, including limited access to information, inadequate infrastructure, financial constraints, and socio-cultural factors. Additionally, the ongoing conflict in the region has disrupted agricultural activities and displaced many farming households, further complicating the

adoption of CSA. Understanding the specific challenges and opportunities for CSA adoption in Gwoza LGA is crucial for designing targeted interventions that can strengthen food systems and enhance community resilience.

The main objective of this study is to examine the adoption of Climate-Smart Agriculture practices as mechanisms for strengthening food systems in rural communities of Borno State, with a specific focus on Gwoza Local Government Area. The specific objectives are:

- i. To identify the Climate-Smart Agriculture practices currently being adopted by farmers in Gwoza LGA.
- ii. To assess the factors influencing the adoption of Climate-Smart Agriculture practices in Gwoza LGA.
- iii. To evaluate the impact of Climate-Smart Agriculture practices on food security and agricultural productivity in Gwoza LGA.

2. Literature Review

2.1 Conceptual Issues

Concept of Climate-Smart Agriculture

Climate-Smart Agriculture: Climate-Smart Agriculture (CSA) is an approach that develops agricultural strategies to enhance productivity and resilience (adaptation) while reducing greenhouse gas emissions (mitigation) where possible (FAO, 2013). CSA integrates three main objectives: sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing or removing greenhouse gas emissions where appropriate. CSA practices include techniques such as conservation agriculture, agroforestry, improved water management, and the use of stress-tolerant crop varieties (Lipper et al., 2014).

Importance of Climate-Smart Agriculture in Strengthening Food Systems

Climate-Smart Agriculture is crucial for strengthening food systems, particularly in regions vulnerable to climate change. By improving agricultural productivity and resilience, CSA practices help ensure food security, enhance livelihoods, and promote sustainable development. Studies have shown that CSA can significantly reduce risks associated with

climate variability, improve soil health, increase water-use efficiency, and enhance the overall sustainability of farming systems (Mbow et al., 2019). Additionally, CSA practices contribute to climate change mitigation by sequestering carbon and reducing greenhouse gas emissions from agricultural activities (Smith et al., 2014).

Organic Farming

Organic farming is a sustainable agricultural system that relies solely on plant and animal materials as fertilizers to support plant growth and development. This method is considered the best farming practice because it provides liming materials to reduce soil acidity, improves soil structure and texture, enhances soil pH, increases water-holding capacity and percolation, boosts the activity of soil microorganisms, and makes available the necessary nutrients for plant growth and development. Therefore, adopting sustainable organic farming practices is essential.

Types of Organic Natural Liquid Fertilizers

- i. Liquid Leguminous Fertilizer: Made from roughages such as silages, including groundnut and bean roughages, which are dried under anaerobic conditions?
- ii. Organic Reserve Fertilizer: Uses vegetable materials with broad leaves that grow quickly and decay easily.
- iii. Organic Liquid Manure: Derived from cow dung or poultry droppings.

Adoption of Climate-Smart Agriculture Practices

The adoption of Climate-Smart Agriculture practices is influenced by various factors, including socio-economic, cultural, institutional, and environmental conditions. According to Rogers' Diffusion of Innovations theory, the adoption process involves the decision to accept or reject a new idea or practice based on perceived benefits, compatibility, complexity, trialability, and observability (Rogers, 2003). In the context of CSA, factors such as access to information, availability of financial resources, land tenure security, and social networks play critical roles in influencing adoption decisions (Deressa et al., 2009).

Climate-Smart Agriculture Practices in Nigeria

In Nigeria, various Climate-Smart Agriculture practices have been promoted to address the

challenges of climate change and enhance agricultural productivity. These practices include conservation agriculture, agroforestry, integrated crop-livestock systems, and improved water management techniques (FAO, 2017). The adoption of these practices has been uneven across different regions, influenced by factors such as socio-economic conditions, institutional support, and environmental suitability (Jalloh et al., 2013).

Climate-Smart Agriculture Technologies and Practices

CSA technologies and practices offer opportunities to address climate change challenges while promoting economic growth and development in the agricultural sector. For this profile, practices are considered CSA if they enhance food security and at least one of the other CSA objectives (adaptation and/or mitigation). Numerous technologies and approaches worldwide fall under CSA. Evidence from the literature suggests that farmers are using several agricultural innovations developed from indigenous knowledge or introduced technologies to improve their adaptive capacity to climate change and variability. Some of these practices are ex-ante (based on pre-informed climatic events), while others are ex-post (measures adopted after a climatic event has occurred). Below are some promising agricultural technologies and practices in Borno State that achieve one or more of the three pillars of CSA: productivity, mitigation, and adaptation.

Hydroponics: Cultivation of crops in an enclosed environment that is different from natural land

Hydroponics is a climate-smart agriculture technology that involves the cultivation of crops in a controlled, enclosed environment, such as a greenhouse, rather than natural land. This method uses nutrient-rich water solutions to grow plants, often without soil, allowing precise control over growing conditions including temperature, humidity, and light. As a result, hydroponics can reduce water usage, minimize the need for chemical inputs, and increase crop yields. This technology is particularly effective for growing vegetables and herbs year-round, making it a sustainable option for urban and resource-limited settings, (Savvas, & Gruda, 2018).

There are several types of hydroponic systems, each with unique characteristics:

- i. Nutrient Film Technique (NFT): Plants grow in channels with a thin film of nutrient solution flowing over the roots.
- ii. Deep Water Culture (DWC): Plant roots are suspended in a continuously oxygenated nutrient-rich solution.
- iii. Ebb and Flow (Flood and Drain): Plants are periodically flooded with nutrient solution and then drained.
- iv. Drip Systems: Nutrient solution is dripped directly onto the plant base.
- v. Aeroponics: Roots are misted with nutrient solution at regular intervals.

Benefits of Hydroponics Hydroponics offer numerous benefits

- i. Year-round Production: Continuous crop production regardless of weather.
- ii. Higher Yields: Optimized growing conditions lead to higher yields.
- iii. Faster Growth: Consistent and optimal nutrient and water supply accelerates plant growth.
- iv. Reduced Land Use: Suitable for urban areas and places with limited arable land.
- v. Sustainable Practices: Reduced water usage and minimal need for chemical fertilizers and pesticides, (Savvas, & Gruda, 2018).

Adoption and Cultivation of Bio-fortified Crops

Adoption and Cultivation of Bio-fortified Crops
Bio-fortified crops are genetically enhanced to increase their nutritional value, addressing micronutrient deficiencies in populations with limited access to diverse diets. The adoption and cultivation of these crops can be considered a climate-smart agricultural practice for several reasons:

- i. Nutritional Enhancement and Food Security
- ii. Climate Resilience and Sustainability
- iii. Economic and Social Benefits

Climate-Smart Agricultural Practice available

Bio-fortified crops contribute to climate-smart agriculture by:

- i. Enhancing resilience to climate change through drought tolerance and efficient resource use.

- ii. Improving food security and nutrition in vulnerable populations.
- iii. Promoting sustainable farming practices that reduce the environmental impact, (Low, Ball, & Arimond, 2017).

Conservation Agriculture (CA):

Practices: Minimum or zero-tillage, maintenance of soil cover through cover cropping or mulching, and crop rotation (Giller et al., 2009). Benefits: Increased biological yield of major food crops like maize, sorghum, and millet, economic benefits from diversified crop rotation, reduced runoff, increased water infiltration, improved soil organic matter, and improved soil moisture retention.

Intercropping/Crop Diversification

Practices: Mixed cropping/crop diversification and various intercropping approaches.

Benefits: Significant reduction in the risks of crop failure, providing farmers with safety nets if one crop fails. Commonly used combinations include maize-cowpea, millet-maize, millet-cowpea, and groundnut-maize.

Terracing

Practices: Innovative approaches such as terracing to reduce erosion and collect runoff water for farming activities.

Benefits: Reduces crop destruction and removal of topsoil caused by excess rains.

Improved Seeds

Practices: Adoption of weather-resistant and early-maturing crop varieties.

Benefits: Helps evade the consequences of reduced rainfall and withstand extreme weather conditions.

Integrated Soil Fertility Management:

Practices: Combining chemical fertilizers with other soil fertility improvement practices such as the application of animal manure and compost.

Benefits: Improves soil aggregate stability and nourishment, reduces the need for large quantities of synthetic fertilizers, and lowers GHG emissions (FAO, 2013).

Livestock Production

Practices: Seasonal migration for pastoralists, improved housing for animals, provision of quality water, feed conservation for off-season use, and improved medication.

Benefits: Helps shield animals from excessive heat and rainfall, reduces production costs, and ensures better health and productivity of livestock. In poultry production, common practices include routine vaccination and feed formulation using locally available materials.

Impact of Adopting Climate-Smart Agricultural Practices in Borno State, Nigeria

The adoption of Climate-Smart Agricultural (CSA) practices in Gwoza, Borno State, Nigeria, can significantly influence agriculture, the environment, and socio-economic conditions. Adebisi and Oyesola (2014) observed that CSA practices, such as improved crop varieties and integrated soil fertility management, increased agricultural productivity and food security in northern Nigeria. The adoption of CSA practices in Gwoza can enhance crop yields, ensuring more stable and increased food production, which is crucial for a region affected by conflict and food insecurity. Oyinbo et al. (2017) noted that CSA practices, such as using drought-tolerant crops and conservation agriculture, improved the resilience of farming systems in northern Nigeria to climate variability. Implementing CSA in Gwoza can help farmers better withstand climate-related shocks, reducing vulnerability and stabilizing incomes. Jalloh, Nelson, Thomas, Zougmore, and Roy-Macauley (2013) highlighted that CSA practices, including agroforestry and reduced tillage, contributed to lower greenhouse gas emissions in West Africa. The adoption of these practices in Gwoza can help mitigate climate change by reducing emissions from agricultural activities. Bationo et al. (2012) reported that CSA practices, such as crop rotation and organic amendments, improved soil health and biodiversity in the Sahel region. In Gwoza, these practices can lead to better soil structure, increased soil fertility, and enhanced biodiversity, contributing to sustainable agriculture. Zougmore et al. (2014) found that CSA practices led to increased farm incomes due to higher productivity and reduced input costs in West African countries. Farmers in Gwoza adopting CSA can benefit economically, improving their livelihoods and

reducing poverty levels. Tambo and Abdoulaye (2012) demonstrated that CSA practices, such as efficient irrigation systems, improved water use efficiency in Nigeria. Efficient water management practices are crucial for Gwoza, where water scarcity is a challenge, ensuring sustainable agricultural water use.

2.2 Theoretical Review

Diffusion of Innovations Theory

This theory explains how new ideas and technologies spread within a community or society. The adoption of Climate-Smart Agriculture practices in Gwoza can be analyzed by examining the following stages:

- i. **Innovation:** Climate-Smart Agriculture practices, including specific techniques like crop rotation, agroforestry, and water conservation methods.
- ii. **Communication Channels:** The means by which information about Climate-Smart Agriculture practices is shared, such as through farmer groups, extension services, and local media.
- iii. **Social System:** The community dynamics in Gwoza, including the roles of local leaders, cultural norms, and existing agricultural practices.
- iv. **Time:** The process of adoption over time, from initial awareness to full integration of Climate-Smart Agriculture practices into farming routines (Rogers, 2003).

3. Methodology

3.1 The Study Area

Gwoza is a local government area in Borno State, Nigeria, with its headquarters in the town of Gwoza, a border town approximately 135 kilometers southeast of Maiduguri. The terrain is rocky and hilly, featuring the Gwoza Hills, which rise about 1300 meters above sea level and form part of the Mandara Mountains. These mountains create a natural barrier between Nigeria and Cameroon, starting from Pulka. Gwoza LGA has been known as a notorious hideout for Boko Haram insurgents, who arrived in the area in 2009 from Maiduguri. The region has experienced significant violence due to the Islamist insurgency in Nigeria, and in 2014, it saw an influx of Boko Haram fighters fleeing Sambisa Forest.

In Gwoza, the wet season is hot, oppressive, and mostly cloudy, while the dry season is sweltering and partly cloudy. Throughout the year, temperatures typically range from 58°F to 104°F, rarely falling below 52°F or exceeding 108°F. (Adamu et. al., 2022)

3.2 Sample size

Sampling involves selecting a specific number of elements from a population to gather information that can be generalized to the larger population. In this study, the researcher utilizes the formula developed by Yamane (1964) to determine the sample size. The formula is outline

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

Where:

n = Sample size

N = Size of population

E = Precision level

Therefore:

$$n = 399$$

3.3 Instrument for data collection

Primary data was collected using a structured questionnaire developed by the researcher. The questionnaire was divided into two sections: A and B. Section A gathered information about the respondents' personal data, while Section B addressed the research questions. The data from Section B was analyzed using descriptive statistics. A total of 399 questionnaires were administered to respondents to gather information on the adoption of Climate-Smart Agriculture practices as mechanisms for strengthening food systems in Gwoza Local Government Area.

3.4 Method of Data Analysis

Descriptive statistics, including simple percentages, means, and standard deviations, were employed to address the research questions. Data collected was analyzed using the Statistical Package for the Social Sciences (SPSS). The study aimed to examine the adoption of Climate-Smart Agriculture practices as mechanisms for enhancing food systems in rural communities of Borno State, specifically focusing on Gwoza Local Government Area.

4. Results and Discussion

This section presents a detailed analysis of data collected through a field survey using a questionnaire. The questionnaire consisted of two sections: Section A, which included five questions on respondent demographics such as sex, age, marital status, and job status; and Section B, which comprised fifteen questions on the adoption of Climate-Smart Agriculture practices to strengthen food systems in rural communities of Borno State, specifically focusing on Gwoza Local Government Area. A total of 399 questionnaires were distributed, out of which 368, representing approximately 92.2% of the respondents, were returned completed and adequately filled out. The data collected via questionnaire were classified,

organized, and analyzed using the Statistical Package for the Social Sciences (SPSS), as presented below:

4.1 General Response Rate

Altogether, 399 copies of questionnaire were administered through the random sampling technique, a total of 368 questionnaires were retrieved properly and adequately completed. Thus, this represents a response rate of 92.2%. All fully completed and retrieved 368 questionnaires were used in the analysis of this study.

4.2 Socio-demographic Profile of the Respondents:

This section shows the reported demographic profile of the sample, showing distribution in terms of gender, age, academic qualification, marital status and job status

Table 1: Demographic Characteristics of the Respondents

Demographic Characteristics	No of Respondents	Percentage
Gender		
Male	201	54.61
Female	167	45.38
	368	
Age		
Below 30 years	63	17.11
31-40 years	148	40.21
41-50 years	103	27.98
Above years	54	14.67
	368	
Marital status		
Single	79	21.46
Married	198	53.80
Divorced	56	15.21
Widow	35	9.51
	368	
Job Status		
Civil servant	164	55.43
Farmer	204	54.61
	368	

Source: Researcher's Field Survey Result (2024)

The table above displays the distribution of gender, age, marital status, and job status within the sample population. It indicates that out of the total returned questionnaires, 201 were from male respondents, accounting for 54.6% of the sample, while 167 were from female respondents, representing 45.3% of the sample. This analysis suggests that a majority of the respondents were male. Additionally, a significant number of respondents, specifically 148 individuals

(40.21% of the total sample), were aged between 41 and 50 years. The next largest age group consisted of 103 respondents (27.98% of the total sample) aged between 31 and 40 years. There were 63 respondents (17.11% of the total sample) below the age of 30, and 54 respondents (14.68% of the total sample) were aged 51 years or older. This distribution highlights a predominantly middle-aged sample, with the 41-50 age group being the most represented. The data on

gender and age provides valuable insight into the demographic characteristics of the sample population, which is crucial for understanding the context and implications of the study's findings.

4.3 Descriptive Analysis of Data on Relevant Variables:

This section examines how respondents answered statements regarding the adoption of Climate-Smart Agriculture practices to strengthen food systems in rural communities of Borno State, with a specific

focus on Gwoza Local Government Area. Respondents were asked to choose from options such as "strongly agree", "agree", "undecided", "disagree", or "strongly disagree" in response to these statements. Below, the tables present the frequency, percentage, and mean distribution of responses, along with their interpretations.

- i. Identify the Climate-Smart Agriculture practices currently being adopted by farmers in Gwoza LGA.

Table 2: Adoption rates of Climate-Smart Agriculture practices by farmers in Gwoza LGA

S/No	Item statement	SA %	A %	U %	SD %	D %	$\bar{x}$	σ^2
Q1	To what extent do you agree that mulching is a Climate-Smart Agriculture practice currently being adopted by farmers in Gwoza LGA	36.41	24.18	12.23	17.39	9.78	3.60	0.05
Q2	Do you believe that crop rotation is widely practiced as a Climate-Smart Agriculture strategy among farmers in Gwoza LGA	42.12	21.47	3.53	14.13	18.75	3.54	0.04
Q3	Use of drought-resistant crop varieties as a Climate-Smart Agriculture practice	53.80	21.20	1.63	15.22	8.15	3.97	0.04
Q4	Use of agroforestry techniques for CSA is prevalent among farmers in Gwoza LGA	27.45	11.68	6.79	27.17	26.90	2.86	0.07
Q5	Use of integrated pest management (IPM) is a common Climate-Smart Agriculture practice adopted by farmers in Gwoza LGA	47.83	14.13	11.14	12.77	14.13	3.69	0.03

Source: Researcher's Field Survey Result (2024)

The table above illustrates the frequency and percentages reflecting the adoption of Climate-Smart Agriculture practices by farmers in Gwoza LGA. For Q1, 17 respondents (17.39%) strongly disagree with the statement, while 45 (12.23%) are neutral, 89 (24.18%) agree, and 134 (36.41%) strongly agree. A significant 36 respondents (9.79%) disagree. The mean score of 3.60 suggests a tendency towards agreement among respondents.

In Q2, a large portion of respondents, 155 (42.12%), strongly agree with the statement, while 79 (21.42%) also agree. Only 13 (3.53%) are neutral, 69 (18.75%) disagree, and 52 (14.13%) strongly disagree. The mean score of 3.54 indicates a leaning towards agreement.

Q3 shows that the highest number of respondents, 198 (53.80%), strongly agree with the statement, while 78 (21.20%) agree. Additionally, 56 (15.22%) strongly disagree, 30 (8.15%) disagree, and 6 (1.63%) are neutral. The mean score of 3.97 indicates a strong tendency towards agreement.

In Q4, a significant number of respondents, 101 (27.45%), strongly agree with the statement, while 43 (11.68%) agree. Additionally, 100 (27.17%) strongly disagree, 99 (26.91%) disagree, and 10 (2.72%) are neutral. The mean score of 2.86 indicates a strong leaning towards disagreement.

For Q5, a majority of respondents, 176 (47.83%), strongly agree, while 54 (14.69%) agree. Meanwhile, 47 (12.77%) strongly disagree, 52 (14.13%) disagree,

and 41 (11.14%) are neutral. The mean score of 3.69 indicates a tendency towards agreement among respondents.

ii. Assess the factors influencing the adoption of Climate-Smart Agriculture practices in Gwoza LGA.

Table 3: The factors influencing the adoption of Climate-Smart Agriculture practices in Gwoza LGA

S/No	Item statement	SA %	A %	U %	SD %	D %	$\bar{x}$	σ^2
1	To what extent do you agree that the use of Climate-Smart Agriculture practices has significantly improved crop resilience and productivity among farmers in Gwoza LGA?	54.62	18.21	4.89	11.14	13.59	3.96	0.03
2	Do you agree that the adoption of Climate-Smart Agriculture practices has led to a noticeable reduction in farming costs for farmers in Gwoza LGA	51.09	13.59	7.88	14.95	12.50	3.76	0.04
3	Training and extension services have effectively promoted the adoption of Climate-Smart Agriculture practices among farmers in Gwoza LGA	62.23	18.21	14.13	9.78	13.86	4.60	0.03
4	Adoption of Climate-Smart Agriculture practices have improved soil health and fertility in Gwoza LGA	45.38	26.63	5.71	12.23	10.05	3.85	0.03
5	Do you believe that the community of farmers in Gwoza LGA has a positive perception of Climate-Smart Agriculture practices and their benefits?	50.54	26.36	9.24	6.25	7.61	4.06	0.02

Source: Researcher's Field Survey Result (2024)

The table below presents the frequency and percentages of responses regarding the factors influencing the adoption of Climate-Smart Agriculture practices in Gwoza LGA. The results indicate that for Q1, a majority of respondents, 201 (54.62%), strongly agreed with the statement. Furthermore, 67 (18.21%) agreed, 50 (13.59%) disagreed, and 41 (11.14%) strongly disagreed. Meanwhile, 18 (4.89%) remained neutral. The mean score of 3.96 suggests a strong inclination towards agreement among the respondents.

In Q2, 29 (7.88%) respondents were neutral. Additionally, 50 (13.59%) agreed with the statement, while 46 (12.50%) disagreed. Among the rest, 188 (51.09%) strongly agreed, and 55 (14.95%) strongly

disagreed. The mean score of 3.76 indicates a general tendency towards agreement.

For Q3, the majority of respondents, 229 (62.23%), strongly agreed with the statement. Additionally, 52 (14.13%) were neutral, and 36 (9.78%) disagreed. The remaining respondents, 67 (18.21%) and 51 (13.86%), agreed and disagreed, respectively. The mean score of 4.60 indicates a strong inclination towards agreement.

In Q4, a substantial number of respondents, specifically 167 (45.38%), strongly agreed with the statement, while 98 (26.63%) agreed. 21 (5.71%) were neutral, 45 (12.23%) strongly disagreed, and 37 (10.05%) disagreed. The mean score of 3.85 indicates a strong tendency towards agreement.

Finally, in Q5, the majority, 186 (50.54%), strongly agreed with the statement. Additionally, 97 (26.36%) agreed, 28 (7.61%) disagreed, 23 (6.25%) strongly disagreed, and 34 (9.24%) were neutral. The mean score of 4.06 indicates a strong tendency towards agreement.

- iii. Evaluate the impact of Climate-Smart Agriculture practices on food security and agricultural productivity in Gwoza LGA.

Table 4: Impact of Climate-Smart Agriculture practices on food security and agricultural productivity in Gwoza LGA

S/No	Item statement	SA %	A %	U %	SD %	D %	$\bar{x}$	σ^2
1	Climate-Smart Agriculture practices have enhanced food security in Gwoza LGA	47.83	25.82	14.40	6.25	5.71	4.04	0.02
2	Adoption of Climate-Smart Agriculture practices has led to increased agricultural productivity in Gwoza LGA	51.09	32.61	1.36	9.51	5.43	4.14	0.03
3	Climate-Smart Agriculture practices have reduced the vulnerability of farmers to climate-related risks in Gwoza LGA	54.62	26.09	5.71	12.23	1.36	4.20	0.03
4	Climate-Smart Agriculture practices have contributed to sustainable farming in Gwoza LGA	26.63	45.38	5.71	8.15	14.13	3.62	0.02
5	Implementation of Climate-Smart Agriculture practices has improved the overall livelihood of farmers in Gwoza LGA	18.21	51.09	6.52	15.49	8.70	3.55	0.04

Source: Researcher's Field Survey Result (2024)

The table above presents the responses of participants regarding the impact of Climate-Smart Agriculture practices on food security and agricultural productivity in Gwoza LGA. In Q1, it shows that the majority of respondents, specifically 176 (47.83%), strongly agreed with the statement. Additionally, 95 (25.82%) agreed, while 23 (6.25%) strongly disagreed. 21 (5.71%) respondents disagreed, and the remaining 53 (14.40%) were undecided. The mean score of 4.04 suggests that most respondents are strongly leaning towards agreement.

In Q2, a large number of respondents, 188 (51.09%), strongly agreed with the statement, and 120 (32.61%) agreed. Only 35 (9.51%) strongly disagreed, and 20 (5.43%) disagreed with the statement. 5 (1.36%) respondents were undecided. The mean score of 4.14

indicates that most respondents are strongly leaning towards agreement.

For Q3, a significant number of respondents, 201 (54.62%), strongly agreed with the statement, while 96 (26.09%) agreed. 45 (12.23%) respondents strongly disagreed, 5 (1.36%) disagreed, and 21 (5.71%) were neutral. The mean score of 4.20 suggests that most respondents are strongly leaning towards agreement.

In Q4, the majority of respondents, precisely 167 (45.38%), agreed with the statement, and 98 (26.63%) strongly agreed. 30 (8.15%) respondents strongly disagreed, 52 (14.13%) disagreed, and 21 (5.71%) were neutral. The mean score of 3.62 indicates that most respondents are leaning towards agreement.

In Q5, 67 (18.21%) respondents strongly agreed with the statement, 188 (51.09%) agreed, 57 (15.49%) strongly disagreed, 32 (8.70%) disagreed, and 24 (6.52%) were undecided.

4.4 Discussion of Results

Objective one: Identify the Climate-Smart Agriculture practices currently being adopted by farmers in Gwoza LGA

The result indicates that, 17 respondents strongly disagree (17.39%), 45 neutral (12.23%), 89 agree (24.18%), 134 strongly agree (36.41%), and 36 disagree (9.79%). The majority of respondents tend to agree with the statement in Q1. The mean score of 3.60 reflects a general agreement, suggesting that most farmers see the value in the CSA practice in question. However, there is a notable proportion of respondents who are neutral or disagree, indicating some variability in opinions. 155 respondents strongly agree (42.12%), 79 agree (21.42%), 13 neutral (3.53%), 69 disagree (18.75%), and 52 strongly disagree (14.13%). Q2 also shows a strong leaning towards agreement, with a significant portion of respondents strongly agreeing with the statement. The low percentage of neutral responses suggests a relatively clear consensus on the benefits or acceptance of the CSA practice in this case. 198 respondents strongly agree (53.80%), 78 agree (21.20%), 56 strongly disagree (15.22%), 30 disagree (8.15%), and 6 neutral (1.63%). The responses for Q3 indicate a very strong agreement with the statement. The high mean score of 3.97 reflects a clear and predominant acceptance of the CSA practice, with a minimal number of neutral and disagreeing responses. The result further shows that 101 respondents strongly agree (27.45%), 43 agree (11.68%), 100 strongly disagree (27.17%), 99 disagree (26.91%), and 10 neutral (2.72%). Unlike previous questions, Q4 shows a more polarized response. The mean score of 2.86 indicates a tendency towards disagreement, with nearly equal proportions of respondents strongly disagreeing and agreeing. This suggests that there is significant contention or mixed feelings about the CSA practice addressed in Q4. 176 respondents strongly agree (47.83%), 54 agree (14.69%), 47 strongly disagree (12.77%), 52 disagree (14.13%), and 41 neutral (11.14%). The results demonstrated a strong overall

agreement, with a high proportion of respondents strongly agreeing with the statement. The mean score of 3.69 reflects a positive reception of the CSA practice, though there are still a notable number of respondents who are neutral or disagree.

Objective two: Assess the factors influencing the adoption of Climate-Smart Agriculture practices in Gwoza LGA.

The result from objective two shows that 201 strongly agreed (54.62%), 67 agreed (18.21%), 50 disagreed (13.59%), 41 strongly disagreed (11.14%), and 18 were neutral (4.89%). The responses to Q1 indicate a robust inclination towards agreement, with a majority strongly agreeing with the statement. The mean score of 3.96 suggests that respondents generally view the factor in question as significantly favourable towards adopting CSA practices. The relatively small percentages of disagreement and neutrality highlight a broad consensus on this factor. Also, 29 respondents are neutral (7.88%), 50 agreed (13.59%), 46 disagreed (12.50%), 188 strongly agreed (51.09%), and 55 strongly disagreed (14.95%). Q2 also shows a tendency towards agreement, with over half of the respondents strongly agreeing with the statement. The mean score of 3.76 reflects overall positive sentiment, though the presence of both strong agreement and disagreement suggests that while many respondents are in favour, there is some level of contention or mixed feelings regarding this factor. Furthermore 229 strongly agreed (62.23%), 52 neutral (14.13%), 36 disagreed (9.78%), 67 agreed (18.21%), and 51 disagreed (13.86%). Q3 demonstrates the strongest agreement among all questions, with a significant majority strongly agreeing. The very high mean score of 4.60 indicates a strong consensus and a clear positive view of the factor related to CSA adoption. The higher number of strongly agreed responses compared to other categories suggests this factor is particularly influential or favourable. 167 strongly agreed (45.38%), 98 agreed (26.63%), 21 neutral (5.71%), 45 strongly disagreed (12.23%), and 37 disagreed (10.05%). The responses to Q4 show a strong tendency towards agreement, with nearly half of the respondents strongly agreeing. The mean score of 3.85 reflects a favourable view of the factor, although the presence of significant disagreement and neutrality indicates some variability in opinions. The positive skew towards agreement, however, suggests

that the factor is generally seen as beneficial for CSA adoption. 186 strongly agreed (50.54%), 97 agreed (26.36%), 28 disagreed (7.61%), 23 strongly disagreed (6.25%), and 34 neutral (9.24%). Q5 also reflects a strong agreement, with the highest mean score of 4.06. The majority of respondents strongly agreed with the statement, indicating a strong positive perception of the factor in question. The relatively low percentages of disagreement and neutrality suggest that this factor is widely accepted and seen as beneficial for CSA adoption.

Objective three: Evaluate the impact of Climate-Smart Agriculture practices on food security and agricultural productivity in Gwoza LGA.

The above presents the responses of participants regarding the impact of Climate-Smart Agriculture practices on food security and agricultural productivity in Gwoza LGA. In Q1, it shows that the majority of respondents, specifically 176 (47.83%), strongly agreed with the statement. Additionally, 95 (25.82%) agreed, while 23 (6.25%) strongly disagreed. 21 (5.71%) respondents disagreed, and the remaining 53 (14.40%) were undecided. The mean score of 4.04 suggests that most respondents are strongly leaning towards agreement. 188 respondents strongly agreed (51.09%), 120 agreed (32.61%), 35 strongly disagreed (9.51%), 20 disagreed (5.43%), and 5 were undecided (1.36%). Q2 reveals a strong tendency towards agreement with the statement, with over half of the respondents strongly agreeing. The high mean score of 4.14 indicates a robust positive sentiment towards the factor in question, suggesting it is seen as highly favourable or influential in adopting CSA practices. The minimal percentage of undecided respondents, coupled with relatively low disagreement, underscores a general consensus on the importance or positive impact of this factor. 201 strongly agreed (54.62%), 96 agreed (26.09%), 45 strongly disagreed (12.23%), 5 disagreed (1.36%), and 21 were neutral (5.71%). Q3 shows an even stronger inclination towards agreement compared to Q2, with the highest mean score of 4.20. A significant majority of respondents strongly agreed with the statement, indicating a very positive view of the factor. The low percentage of disagreement and neutral responses further reinforces the strong positive perception of this factor, marking it as highly influential or favourable for CSA adoption. The result

shows that 167 respondents agreed (45.38%), 98 strongly agreed (26.63%), 30 strongly disagreed (8.15%), 52 disagreed (14.13%), and 21 were neutral (5.71%). The responses to Q4 indicate a leaning towards agreement, though with less intensity compared to Q2 and Q3. The mean score of 3.62 suggests that while there is a general tendency to view the factor positively, there is also a notable level of disagreement. This factor appears to have a more mixed reception, with a significant proportion of respondents either disagreeing or remaining neutral. 67 strongly agreed (18.21%), 188 agreed (51.09%), 57 strongly disagreed (15.49%), 32 disagreed (8.70%), and 24 were undecided (6.52%). For Q5, the majority of respondents agreed with the statement, and a significant number strongly agreed. However, there is a considerable proportion of strong disagreement and some undecided responses. This suggests that while a majority views the factor positively, there is a notable level of contention or indecision, indicating that this factor might not be universally accepted or might have varying implications for different respondents.

5. Conclusion and Recommendations

The analysis of Climate-Smart Agriculture (CSA) practices in Gwoza LGA reveals diverse respondent opinions, highlighting key trends in adoption, influencing factors, and impacts on food security and productivity. In terms of identifying CSA practices, respondents generally showed agreement across questions, with mean scores ranging from 2.86 to 3.97. Notably, Q3 had the highest agreement, while Q4 indicated a strong leaning towards disagreement.

Regarding factors influencing CSA adoption, the majority of respondents strongly agreed with the statements, reflected in high mean scores (3.76 to 4.60). Q3 had the strongest agreement, while Q2 showed a moderate agreement. These responses underscore the significant factors driving CSA adoption in the region.

The impact of CSA practices on food security and agricultural productivity also saw strong agreement among respondents. Mean scores ranged from 3.62 to 4.20, indicating a general consensus on the positive effects of CSA practices. The highest agreement was

seen in Q3, further emphasizing the perceived benefits of CSA practices.

Overall, the analysis highlights a prevalent agreement among respondents about the identification, influential factors, and positive impacts of CSA practices in Gwoza LGA. This consensus underscores the importance of promoting CSA practices to enhance food security and agricultural productivity in the region following these recommendations.

- i. **Enhance Awareness and Training Programs:** The consistent agreement among respondents about the identified CSA practices, with mean scores ranging from 2.86 to 3.97, indicates a fair level of awareness. However, given that some areas still show room for improvement (as seen in Q4), it is recommended to strengthen awareness campaigns and training programs. These should focus on increasing understanding of less familiar practices and their benefits.

- ii. **Address Key Influencing Factors:** The high mean scores (3.76 to 4.60) on factors influencing CSA adoption highlight critical areas that need attention. For instance, ensuring access to necessary resources and addressing socio-economic barriers can significantly enhance adoption rates. Efforts should be made to support farmers with the requisite tools, technologies, and financial resources to adopt CSA practices effectively.
- iii. **Leverage the Positive Impact on Food Security and Productivity:** The strong agreement on the positive impact of CSA practices on food security and agricultural productivity (mean scores from 3.62 to 4.20) underscores the benefits of these practices. It is recommended to scale up successful CSA interventions and share best practices widely. Additionally, supporting policies and programs that enhance the sustainability and resilience of agricultural systems in Gwoza LGA should be prioritized.

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