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ANALYSIS OF THE ADOPTION OF GOOD AGRICULTURAL PRACTICES AMONG FARMERS OF ARABLE CROPS IN BORNO STATE, NIGERIA

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Abstract

This study examines the socioeconomic factors influencing the adoption of good agricultural practices (GAPs) among arable crop farmers in Borno State, Nigeria. Using a sample size of 390 respondents, socioeconomic characteristics and adoption levels were collected. The descriptive statistics revealed that the majority of the respondents were male (73.85%), married (76.15%), and had tertiary education (36.15%). The average age was 43 years, and the household size was 8 and the farm size was 3.31 hectares. A majority (90.26%) of farmers adopted GAPs, with 75.28% exhibiting majority adoption levels. Logit regression analysis identified farm size ($p < 0.05$), cooperative membership ($p < 0.01$), and access to credit ($p < 0.01$) as significant predictors of GAP adoption. The findings recommend that addressing key barriers, including input accessibility, credit facilities, and cooperative participation, is required to promote GAP adoption in Borno State. Targeted policy interventions, efficient extension services, and security improvements are crucial for regional sustainable agricultural development. Improved Input Supply: To boost GAP adoption, government and development agencies should ensure timely and adequate provision of essential inputs such as fertilizers, seeds, and pesticides at subsidized rates. Access to credit significantly influences GAP adoption. Government agencies, financial institutions, and cooperatives should develop flexible, low-interest credit schemes. Additionally, improving market access through better infrastructure, price stabilization policies, and digital marketing platforms will encourage adoption by ensuring profitability.

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INTRODUCTION

Nigerian agriculture aims to transition from low-productivity subsistence farming to a high-yield agro-industrial economy through the adoption of improved technology (Adenle *et al.*, 2017). Good agricultural practices (GAPs), introduced by the Food and Agriculture Organization (FAO), play a crucial role in enhancing rural farmers' productivity, efficiency, and income. GAPs contribute to sustainable agriculture by modernizing farming methods, ensuring food security and improving livelihoods (FAO, 2021). Despite government efforts, Nigerian agriculture faces challenges such as low technology adoption, market constraints, and environmental degradation (Onoja, 2023). Programs such as Fadama and N2Africa promote GAPs to address these issues, emphasizing climate-smart techniques, improved inputs, and better market access (N2Africa, 2015). However, empirical data on the adoption of GAP in Borno State remains limited. This study assesses the extent of GAP adoption among arable farmers, providing insights to enhance agricultural productivity and policy development in the region.

Objective of the study

1. To determine the socioeconomic characteristics of the farmers.
2. To determine the level of adoption of good agricultural practices among farmers; and
3. To determine the socio-economic factors influencing the adoption of GAPs

METHODOLOGY

Borno State, covering 61,435 km², is at latitude 12°08'60.00" N and longitude 12°53'59.99" E. It shares borders with Niger, Chad, Cameroon, and Nigerian states, including Adamawa, Gombe, and Yobe. The state comprises 27 local government areas (LGAs) and has a projected 2024 population of 7,171,104 in 2024, growing at an annual rate of 3% (NPC, 2021). Agriculture is the backbone of the economy, employing most residents. Annual rainfall varies from 600 mm in the north to 1,200 mm in the south, with a growing season of 100-180 days (World Bank, 2021). Temperatures range from 9.0°C to 31.9°C (Quick Projects, 2018). Farming is primarily small-scale and subsistence-based, producing arable crops such as maize, sorghum, and rice; legumes such as cowpeas and groundnuts; fruits including mango and guava; and livestock such as cattle, sheep, and poultry (FAO, 2021). Despite agriculture contributing 65% of the state's GDP, insecurity has drastically reduced local food production to only 5.9% of the state's needs, making Borno highly dependent on food imports and humanitarian aid (World Bank, 2018).

Sampling technique

Borno State has three agricultural zones (Zone 1, Zone 2, and Zone 3), each of which has nine LGAs. The study employed a multi-stage sampling technique as follows:

1. First Stage: Three LGAs were purposively selected from each zone based on agricultural intensity:
   i. Zone 1: Biu, Kwaya Kusar, and Bayo
   ii. Zone 2: Bama, Konduga, and Jere
   iii. Zone 3: Magumeri, Nganzai, and Monguno

(Total: 9 LGAs)

2. Second Stage: A proportionate selection of 131 agricultural blocks and 119 extension cells was performed.
3. Third Stage: Using BOSADP records, the sampling frame was formed by 15,450 registered farmers. The Yamane (1969) formula determined the sample size as follows:

n=N1+N(e)2n = \frac{N} {1 + N(e)^2} Substituting N=15,450N = 15,450 and e = 0.05e = 0.05, the sample size was 390, adjusted to 410 (+5%) to account for invalid entries.

4. Final Stage: The 410 farmers were proportionally distributed across the selected LGAs based on registered farmer populations.

Table 3.1: Sampling procedure.

S/N	L.G. A	Extension blocks	Select the extension block	Extension cells	Selection of extension cells	Registered farmers	Farmers selected
1.	Biu	16	11	30	15	2900	77
2.	Bayo	10	7	12	9	1100	29
3.	KwayaKusar	13	9	16	10	1400	37
4.	Bama	80	54	28	14	1500	40
5.	Konduga	11	8	16	9	1000	27
6.	Jere	14	10	12	8	1600	42
7.	Magumeri	15	11	20	13	2000	53
8.	Nganzai	12	10	12	9	1000	27
9.	Monguno	16	11	25	14	2950	78
Total	9	187	131	171	119	15450	410

Source: Field Survey of 2023

Data analysis

Descriptive and inferential statistics were used in the analysis of the collected data. Descriptive statistics in the form of frequencies, mean, and percentage were used to achieve objectives (i). A five-point Likert scale (was used to further determine objective ii) of the mean score was used to determine the level of adoption of GAPs: 5+4+3+2+ 1 = 15/5 = 3 (3.2)

The mean value of the scale of 3 was used as the cutoff point to rank the responses. Any mean response of ≥ 3 is considered a high adopter, whereas a mean score of ≤ 2 is considered a low adopter. Inferential statistics in the form of binary logit regression was used to achieve objective (III), which is the socioeconomic factors influencing the adoption of GAPs. Binary logit regression analysis was used to measure the influence of socioeconomic institutional factors on farmers' level of adoption of GAPs. Ochieng *et al.* (2017) used binary logit regression to analyze the level of GAP adoption in Kenya. The model is stated as follows:

$$Log\ (Y_i) = Ln\left[\frac{P_1}{1-P_1}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + e \ldots (3.4)$$

$$Yi = \begin{cases} 1 \text{ if the } ith \text{ farmer is a high adopter*} \\ 0 \text{ if the } ith \text{ farmer is a low adopter} \end{cases}$$

*If an with farmer's mean score in the level of adoption of GAP is 3 and above, s/he is considered a high adopter; however, if the mean score is less than 3, the farmer is considered a low adopter. Where: X_1 = sex (1= male, 0= female), X_2 = education (number of years spent in formal education), X_3 = farm size (hectares), X_4= Membership of Farmer Cooperative (1= yes, no =0), X_5= Access to credit (1= yes, 0= no), X_6 = access to extension contact (1= yes, 0= no).

RESULTS AND DISCUSSION

Socioeconomic characteristics of the respondents

The study examined key socioeconomic characteristics of arable crop farmers, including gender, marital status, education, land ownership, farm size, income, and access to credit and extension services. Males constituted 73.85% of the respondents, indicating male dominance in arable crop production due to family responsibilities.

The lower participation of women as a result socio-cultural and religious factors. However, women play vital roles in farming activities such as seed sowing, harvesting, and processing. Marital status analysis revealed that 76.15% of farmers were married, reflecting their responsibility for family welfare, which drives their engagement in farming. This finding aligns with the findings that married individuals are more involved in agriculture to support their households. This study concurred with Nwaobiala *et al.* (2019).

Table 1. Distribution of respondents based on socioeconomic factors (n = 390).

Gender	**Frequency**	**Percentage**
Male	102	73.85
Female	288	26.15
Marital status		
Divorced	25	6.41
Married	297	76.15
Single	68	17.44
Level of education		
Non-formal	80	20.51
Primary	41	10.51
Secondary	128	32.82
Tertiary	141	36.15
Cooperative membership		
No	184	47.18
Yes	206	52.82
Access to credit		
No	284	72.82
Yes	106	27.18
Access to Extension Services		
No	365	93.59
Yes	25	6.41
Land ownership system		
Family	137	35.13
Hired	150	38.46
None	1	0.26
Others	20	5.13
Personal	82	21.03

Source: Fieldwork (2023)

This study examined the socioeconomic characteristics of arable crop farmers, including gender, marital status, education, land tenure, farm size, income, and access to credit and extension services. Males made up 73.85% of the respondents, indicating male dominance in production, although women still play key roles in sowing, harvesting, and processing. Approximately 76.15% of farmers were married, supporting findings that marital responsibility drives farming involvement (Ogunbameru, Idrisa, & Shehu, 2008). Education also influenced the adoption of GAPs, with 36.15% having tertiary education and 32.82% having secondary education, suggesting high literacy and ability to understand agricultural messages, although education alone does not determine GAP adoption (Oluwatayo & Oluwaseyo, 2024; Onya *et al.*, 2019; HumAngle, 2020).

Over half (52.82%) of farmers belonged to cooperatives, which improve access to inputs, information, and credit (Yusuf *et al.*, 2021; Akomdo *et al.*, 2023). However, 72.82% of farmers lacked access to credit, limiting investment in seeds, fertilizers, and machinery, unlike southwestern Nigeria, where 45% accessed credit (Olagunju & Ayanwale, 2019; Nwaru *et al.*, 2011). Access to extension services was extremely low, with 93.59% lacking support, compared to 77% in rural Ghana (Akomdo et al., 2023). However, extension is critical for knowledge dissemination and productivity (Oluwatayo & Oluwaseyo, 2024). Land tenure posed challenges: 38.46% hired land, 35.13% used family land, and only 21.03% owned land. Hiring reduces investment capacity, whereas tenure security promotes land improvement (Fasona *et al.*, 2020; Idowu, 2021). Overall, education, cooperative membership, credit, extension, and land security significantly affect GAP adoption and productivity. Addressing these gaps is crucial for the agricultural development of Borno State.

Table 2 Descriptive statistics of some continuous socioeconomic variables.

Variables	Mean	Std	Minimum	Maximum
Age	43.015	12.778	19	80
Household Size	8.104	5.92	1	34
Farm size	3.314	2.02	0.45	10
Average annual income	1176219	1438386	10,000	9,000,000

Source: Fieldwork (2023)

The study shows that farmers averaged 43 years in age, 8 household members, 3.3 hectares of land, and an annual income of about ₦1.18 million, though with wide disparities. These figures indicate active, family-labor–driven, small- to medium-scale farming, consistent with findings across Nigeria. Larger households support labor but strain resources, while limited land and unequal income reflect tenure and credit challenges affecting productivity.

Adoption and level of adoption of GAPs

This section presents an analysis of the adoption of GAPs among arable crop farmers in Borno State, Nigeria. This study examines the extent and level of adoption among the sampled farmers, focusing specifically on the 352 respondents out of 390 who have adopted GAPs. Of the 390 farmers surveyed, 352 (90.26%) have adopted GAPs, while only 38 (9.74%) have not (Table 3).

Table 3. Adoption and Level of Adoption of Good Agricultural Practices among Arable Crop Farmers in Borno State, Nigeria

Variables	Frequency	Percentage
Not adopted	38	9.74
Adopted	352	90.26
Adoption level		
High	265	75.28
Low	87	24.28
Total	352	100

Source: Fieldwork (2023)

The study shows a high adoption of GAPs in Borno State, with 75.28% of farmers adopting at high levels and 24.28% at low levels. GAPs boost productivity, sustainability, and food security (Lal, 2004). Extension services, financial incentives, and community influence drive adoption (Feder et *al.*, 1985; Conley & Udry, 2010). However, limited resources, training gaps, and financial constraints have hindered some farmers (Doss, 2006). Targeted support can enhance adoption, reduce disparities, and promote inclusive agricultural development.

Respondents' Level of Adoption of Good Agricultural Practices

This section presents an analysis of the adoption of GAPs among arable crop farmers in Borno State, Nigeria. This study examines the extent and level of adoption among the sampled farmers, focusing specifically on the 352 respondents out of 390 who have adopted GAPs. Of the 390 farmers surveyed, 352 (90.26%) have adopted GAPs, while only 38 (9.74%) have not (Table 4).

Table 4: Respondents' distribution based on the level of adoption of GAPS.

Good agricultural practices	Mean	Standard deviation	Remarks
Hybrid seeds	2.371795	1.16597	Low
Timely land preparation	4.069231	.83666	High
Fertilizer used for planting	3.774359	.99568	High
Timely and clean weeding	3.946154	1.01768	High
Insect pest control (field)	3.671795	1.41945	High
Timely harvesting	3.464103	.99536	High
Proper drying of the crops (using the recommended moisture level)	2.758974	.96503	Low
Seed treatment	3.984615	1.05339	High
Intensified application of manure	3.671795	1.03763	High
Mulching	3.438462	1.09326	High
Value addition	3.320513	1.06272	High
Market linkage	3.571795	1.16272	High
Site selection technique	3.774359	1.30555	High
Use of the recommended dosage of herbicides and insecticides.	3.851282	1.03019	High
Improved storage method	2.633333	1.02932	Low
Inter- and intra-raw recommended spacing	3.892308	1.30893	High

Crop rotation	3.55641	1.11947	High
Successive cropping	2.461538	1.00457	Low
Use of deep urea placement	2.371795	1.01645	Low
Timely planting	3.528205	1.05452	High

Source: Fieldwork (2023)

Adoption of Good Agricultural Practices (GAPs) among arable crop farmers in Borno State varies across practices. Hybrid seeds (mean: 2.37), proper drying (2.76), improved storage (2.63), successive cropping (2.46), and urea deep placement (2.37) are largely adopted, owing to high costs, limited access, and low awareness (Nzeh & Eboh, 2019; Oladipo, 2023). In contrast, land preparation (4.07), fertilizer use (3.77), weeding (3.95), pest control (3.67), seed treatment (3.98), and manure application (3.67), which boost productivity and soil health, are highly adopted (Oluyede *et al.*, 2020; Nwachukwu, 2020). Practices such as proper spacing (3.89), market linkage (3.57), value addition (3.32), mulching (3.44), timely planting (3.53), and rotation (3.56) improve yields, reduce risks, and enhance sustainability (Musa *et al.*, 2021; Yusuf *et al.*, 2020). However, financial constraints, weak extension services, and poor infrastructure remain major barriers. Strengthening training, subsidies, and facilities will further improve GAP adoption

Socioeconomic factors influencing the level of adoption of GAPs

The logistic regression analysis (Table 5) examines the socioeconomic factors influencing the adoption of GAP among 352 farmers. The model is statistically significant (LR Chi² = 21.61, p = 0.0014) with low multicollinearity (VIF = 1.24) and no influential outliers. Access to credit positively influences adoption, whereas agricultural association membership shows an unexpected negative effect. These findings highlight the need for targeted policies to enhance the adoption of GAP.

Table 5. Logit result on socio-economic factors influencing GAP adoption level.

Variables	**Coefficient**	**Standard error**	**z-value**	**Prob >|z|**
Sex	-0.0238925	0.2944263	-0.08	0.935
Education	-0.0704216	0.3695659	-0.19	0.849
Farm Size	-0.1250464**	0.0606829	-2.06	0.039
Cooperative membership	-0.9392567***	0.3042572	-3.09	0.002
Access to credit	1.240503***	0.3491348	3.55	0.000
Access to the extension service	-0.1028168	0.292443	-0.35	0.725
Constant	1.873584	0.5216463	3.59	0.000
LR Chi2	21.61***			
Prob > Chi2	0.0014			
Mean VIF	1.24			
Hatsq	-0.1900711	0.2773972	-0.69	0.493
Pearson Chi2	108.90			
Prob > Chi2	0.3776			

Source: Fieldwork (2023)

*** Significant at the 1% level ** Significant at the 5% level, LR is the log likelihood ratio, VIF is the variance inflation factor.

The regression analysis examined factors influencing the adoption of GAPs among farmers. Gender had no significant effect, consistent with studies showing that access to resources and socio-economic conditions

outweigh gender in technology adoption (Gebre *et al.,* 2019; Doss, 2001; Ragasa, 2012; Peterman & Quisumbing, 2014; Kilic, Palacios-Lopez, & Goldstein, 2015; Marenya & Barrett, 2007). Education was also non-significant, as formal schooling often does not directly translate into agricultural practice adoption, with experiential knowledge, social norms, and resource access playing stronger roles (Kabunga *et al.,* 2012; Asanteat *et al.,* 2021; Manda et al., 2016; Ogada *et al.,* 2014).

Farm size had a significant negative effect ($p = 0.039$), indicating that smaller farms are more likely to adopt GAPs. This reflects their greater exposure to risks, reliance on community networks, and environmental vulnerabilities, whereas larger farms may favor capital-intensive methods (Marra *et al.,* 2003; Wossen *et al.,* 2015; Noltze, Schwarze, & Qaim, 2012). Association membership also had a significant negative effect ($p = 0.002$), structural barriers, poor governance, and reinforcement of conventional practices can discourage GAP adoption. Conversely, access to credit had a strong positive effect ($p < 0.001$), confirming that financial resources are critical for overcoming liquidity constraints and investing in GAPs (Akuduguet *et al.,* 2010; Oyewole & Olagunju, 2024; Feder *et al.,* 1985). The model confirms that farm size, cooperative membership, and credit access significantly influence GAP adoption. Smaller farms and access to credit promote adoption, whereas association membership reduces it. Gender, education, and extension services were not significant. The fit of the model was good (LR Chi2 = 21.61, $p = 0.0014$; Pearson Chi2 $p = 0.3776$), with low multicollinearity (mean VIF = 1.24).

Recommendations;

1. Enhancing access to credit and market linkages

Access to credit significantly influences the adoption of GAP. Government agencies, financial institutions, and cooperatives should develop flexible, low-interest credit schemes. Additionally, improving market access through better infrastructure, price stabilization policies, and digital marketing platforms will encourage adoption by ensuring profitability.

2. Strengthening agricultural cooperatives and extension services

The existing cooperative structures should be reformed through capacity-building programs to effectively disseminate GAP knowledge. Extension services should be expanded by increasing the number of trained agents and using digital platforms to reach more farmers.

3 Creating policies promoting secure land tenure and leasing arrangements will encourage long-term investment in sustainable practices and **encourage adoption of key GAPs through incentives and policy support.** The low adoption of hybrid seeds, improved storage methods, and successive cropping necessitates targeted interventions, including subsidies and awareness campaigns. Stronger government policies should facilitate access to inputs, strengthen agricultural institutions, and drive widespread GAP adoption.

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