POLICY IMPLICATIONS OF THE ADOPTION OF PRECISION AGRICULTURE IN NIGERIA

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ABSTRACT

This paper examines the policy implications of adopting Precision Agriculture (PA) in Nigeria, emphasizing infrastructure, capacity-building, data regulation, and financial support. It highlights the transformative potential of PA and recommends policy frameworks to facilitate its sustainable integration into the agricultural sector. In Nigeria, where agriculture faces challenges including outdated practices, inadequate infrastructure, and climate vulnerabilities, PA offers a promising solution. Southwest States with soil health and irrigation technologies, lead adoption while regions like Sokoto in the Northwest leverage smart irrigation through donor-supported projects. Despite these advancements, significant barriers such as limited internet penetration, high costs, and low digital literacy hinder widespread uptake. Policy reforms are crucial, focusing on infrastructure development, financial incentives, specialized training, and data governance. Socioeconomic benefits of PA include improved yields, reduced waste, and environmental conservation, but equitable access for smallholder farmers is essential to ensure inclusive growth. Recommendations include public-private partnerships for infrastructure, pilot programs in agricultural belts, and capacity-building collaborations with international organizations. This will help Nigeria to transit towards sustainable agriculture.

Keywords: Precision Agriculture, Policy, Nigeria, Sustainable Development, Agricultural Technology

INTRODUCTION

Precision agriculture (PA) represents a paradigm shift in modern farming, leveraging technology for improved productivity, efficient resource use, and sustainability [1]. In Nigeria, agricultural productivity has remained suboptimal due to outdated farming practices, inadequate infrastructure, and climate vulnerabilities [2]. The adoption of PA could without doubt, revolutionize Nigerian agriculture, this is because precision agriculture integrates advanced technologies such as GPS, IoT, and data analytics to enhance farming efficiency and environmental sustainability [3].

However, these technologies are inadequate in Nigeria; and to successfully adopt PA in Nigeria will therefore require that robust policy frameworks addressing infrastructural deficits, financial support, and human capital development be put in place [4, 5]. Nigeria, is a country still grappling with food insecurity, land degradation, and climate change impacts and economic downturn. Adoption of PA therefore presents an opportunity as well a challenge.

Currently, data on the precise number of farmers using precision agriculture in Nigeria has not been systematically aggregated across the country. However, there are indications of growing adoption in specific locations and contexts.

While these examples highlight advancements, barriers such as limited internet penetration, high technology costs, and low digital literacy remain significant challenges. Some locations might be seeing progress due to private initiatives in solar-powered irrigation and market access platforms. This paper is therefore an attempt to do a political economic analysis of the adoption of Precision Agriculture in Nigeria. There is equally the need to do an x-ray of policy challenges and needs of transition from traditional agriculture to hi-tech agriculture like PA.

Digital agriculture tools such as AI-powered crop monitoring, mobile apps, and precision farming methods are gaining traction but remain concentrated in areas with better connectivity and infrastructure [6]. Statistics on farmers using high-tech agricultural practices in Nigeria vary by state and depend on factors like technology availability, education, and crop focus. In Northern Nigeria, High-tech adoption is driven by large-scale farmers' programs like the Anchor Borrowers. In South-West Nigeria, there is moderate adoption of precision agriculture, with emphasis on soil testing kits, mobile apps, and IoT tools for smart irrigation, largely facilitated by research collaborations and local government interventions. In the South-East farmers are notable for engaging in digital agriculture practices. The South-South region however, exhibit varied adoption rates. Niger and Benue States demonstrate efforts in deploying agricultural drones and mobile platforms for cassava farming, reflecting state-supported projects aimed at boosting crop yields [7]. Despite these efforts, challenges like inadequate infrastructure, cost barriers, and lack of technical training hinder broader adoption across most states.

Policy Challenges and Needs

- **Infrastructure Development**: A major bottleneck is the lack of basic infrastructure such as reliable power, high-speed internet, and rural connectivity. Policies must prioritize infrastructure investments that support PA technologies.
- **Education and Training**: A skilled workforce is critical for PA adoption. Government and private sector collaboration is needed to develop specialized training programs and integrate PA concepts into agricultural curricula.
- **Financial Support**: Many smallholder farmers lack the financial capacity to invest in PA technologies. Policies should introduce subsidies, grants, and low-interest loans to make these technologies accessible.
- **Regulatory Framework for Data Governance**: PA relies heavily on data collection and analysis. A regulatory framework is needed to address data ownership, privacy, and sharing protocols, ensuring farmer protection and fostering innovation.

Socioeconomic Impacts

Adopting PA in Nigeria could increase crop yields, reduce waste, and optimize input use, addressing food insecurity while conserving environmental resources. However, the transition must consider the digital divide and ensure equitable access for smallholder farmers, who constitute the bulk of Nigeria's agricultural workforce.

MATERIALS AND METHODS

Thirteen states within Nigeria were selected based on the higher level of food crop production taking place in these regions compared to other areas in Nigeria and due to the relative proximity of the ADPs (Agricultural Development Programmes) in the states which helped give direct access to the farmers who were the main target group of the research. Primary data collected with electronic means (smart phones with installed ODK apps) were mainly on level of adoption of climate smart agriculture, barriers mitigating the adoption of precision agriculture and level of internet connectivity in farming areas. Three local government areas (LGAs) with the highest record of climate-induced stress were purposively selected in each state based on the advice of state Agricultural Development Programme ADPs). In each selected LGA, four (4) villages were randomly selected and thirty (30) farming households were selected per village. With twelve villages per state and thirty farm households per village. A total of three hundred and sixty farm households were selected per state and this makes up a total sample a sample size of 4,680 households (respondents) interviewed for the study. Descriptive statistics such as frequencies, means and percentages were used to analyse the data and the results are presented below.

RESULTS AND DISCUSSION

Table 1 shows the distribution of respondents according to their personal characteristics. The results revealed that majority of the farm household heads were male (67.43 %). This showed that men dominated farming activities in the study area. This result is also in line with [9] who implied that men dominated farming activities in Nigeria. In terms of age, majority of the respondents (about 80%) are young, falling between ages 18 and 59 years. About 21% of the respondents are within the age group of 60 years and above. This result show that majority of the farmers are able bodied young people within their economically active years of life. In terms of level of literacy, 17.5% of the respondents revealed that they had no form of formal education. However, 30.97% of the respondents had primary education, 28.13 % had secondary education while only 17.43% had tertiary education. This result shows that majority of the respondents were literate with at least primary education. Literacy will enable farmers to easily adopt new techniques of solving problems of climate change impact on their farms.

Table 2 show distribution of respondents according to access to telecommunication services and type of climate change risks experienced in the study area. Results revealed that in terms of access to telecommunication services in the study area, more than half of the respondents had no regular access to telecommunication services and 17.78 % of the respondents had smart phones. Majority of the respondents had no regular access to telecommunication services.

Results on variability to climate change revealed that 64.8 % of the respondents reported they experienced increased temperature and 78.3% reported they experienced decreased rainfall duration and intensity. About 34.3% of the respondents reported a disappearance in vegetation cover due to the climate change experienced. The respondents noted they experienced prolonged dry spell after the early rains which led to increased temperature and loss of crops.

Table 1. Distribution of respondents according to socioeconomic characteristics.

Variables	Frequency	Percentages	Mean category
Sex			
Male	3,156	67.43	
Female	1,524	32.57	
Age (years)			
18 – 31	500	10.68	
32 – 45	1,798	38.41	32 -45
46 – 59	1,339	28.61	
60 – 73	864	18.47	
74 and above	179	3.82	
Level of Education			
No formal education	858	18.33	
Primary education	1,449	30.96	
Secondary education	1,557	33.27	
Tertiary education	815	17.43	
Household size			
0 – 4	809	17.29	
5 - 9	2,613	55.83	5 – 9
10 – 14	998	21.32	
15 & above	260	5. 56	
Years of farming experience			
1 – 10	1,021	21.81	
11 – 20	1,670	35.69	11 – 20
21 – 30	974	20.83	
31 – 40	624	13.34	
41 and above	390	8.33	

Source: Field Survey

Table 2. Distribution of respondents according to access to telecommunication services and type of climate change risks experienced in the study area.

Variables	Frequency	Percentages
Category of mobile phone used		
Ordinary phone	3,760	80.34
Smart phone	832	17.78
No phone	88	1.88
Access and availability of telecommunication services		
No	3,878	82.86
Yes	802	17.15
Variability in climate change experienced?		
Increased temperature	3,033	64.8
Decreased temperature	744	15.9
Increased rainfall duration and intensity	1,048	22.4
Decreased rainfall duration and intensity	3,664	78.3
Increased sunlight intensity	2,3112	49.4
Decreased sunlight intensity	491	10.5
Disappearance of vegetation cover	1,605	34.3
Increased changes in vegetation type	997	21.3

Source: Field Survey

Table 3 reveals the extent to which climate change risks is experienced in the study area. About 43.64% of the respondents reported they always experience inadequate rainfall while 47.57 reported an occasional dry spell. More than half of the farmers (55.14 %) reported they occasionally experienced frequent crop failure due to erratic rain distribution of rainfall. About 65% reported an occasional shortage of food for households. Majority of the respondents reported an always or occasional experience of climate change risks in the study area. Only few of the respondents indicated they have never experienced any of the climate change risks identified except in cases of death of livestock and extinction of fishes and aquatic life due to climate change.

Table 3. Extent to which climate change risks is experienced.

Variables	Always (%)	Occasionally (%)	Never (%)
Inadequate rainfall	43.54	47.57	8.89
Frequent crop failure due to erratic distribution and dwindling rainfall	37.01	55.14	7.85
Incessant flood	37.57	55.83	6.60
Frequent crop failure due to incessant flood	8.88	59.72	31.39
Shortage of food for households	17.78	65.0 0	17.22
Reduction of forest cover and degradation of natural resources	22.29	62.6	15.07
Extinction of fishes and aquatic life	11.39	54.79	33.82
Death of livestock	11.04	38.40	50.56
Cattle invasion on farm due to inadequate grasses	31.04	48.82	20.14

Source: Field Survey

Recommendations

- Develop public-private partnerships to fund rural broadband and power projects.
- Establish centers for PA research and demonstration across the country.
- Create incentive schemes for local startups to develop affordable PA solutions tailored to Nigeria's agro-ecological zones.
- Implement pilot PA programs in key agricultural belts to assess scalability and economic impact.
- Encourage collaborations with international organizations for knowledge transfer and capacity-building initiatives.

CONCLUSION

The adoption of precision agriculture in Nigeria presents a pathway to achieving sustainable agricultural intensification, food security, and environmental conservation. Policymakers must create an enabling environment that bridges infrastructure gaps, fosters innovation, and ensures equitable access to PA technologies. The future of Nigerian agriculture depends on its ability to harness the transformative potential of precision farming.

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