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Farmers' Climate Change Adaptation Strategies and Cassava Production in Taraba State, Nigeria

HANNAH PUNARIMAM FIDELIS
Department of Agricultural Technology, Taraba State Polytechnic, Suntai

Abstract- This study assessed farmers' climate change adaptation strategies and their effects on cassava production in Taraba State, Nigeria. A multi-stage sampling technique was used to select 365 cassava farmers, and data were collected using structured questionnaires. Descriptive statistics and Likert scales were employed for data analysis. The results revealed that farmers perceived increased temperature (mean=3.58) and unpredictable rainfall (mean=3.55) as the most prevalent climate change events. The most widely used adaptation strategies were changing planting dates (mean=3.60) and crop diversification (mean=3.13), while irrigation (mean=1.20) and agroforestry (mean=1.37) were the least adopted due to high costs and technical constraints. Farmers agreed that adaptation strategies increased cassava yield (mean=4.12), improved soil fertility (mean=4.32), and reduced crop failure (mean=3.75). However, a majority (78.36%) agreed that the strategies were too expensive relative to the benefits, and farmers were undecided on their impact on household food security (mean=3.18). The study concludes that while farmers are actively adapting to climate change, the high cost of adaptation presents a significant barrier. It is recommended that policy efforts should focus on promoting affordable, climate-resilient practices and improving farmers' access to credit, drought-tolerant varieties, and timely climate information to enhance sustainable cassava production.

Keywords: Climate Change, Adaptation Strategies, Cassava Production, Smallholder Farmers, Taraba State.

I. INTRODUCTION

Climate change has emerged as one of the most formidable challenges to global agricultural sustainability and food security in the 21st century. Its impacts are particularly acute in sub-Saharan Africa, where economies are predominantly agrarian and heavily dependent on rain-fed agriculture (IPCC, 2022). Nigeria, as the most populous nation in Africa, faces significant threats from climate variability and change, manifested through rising temperatures, erratic rainfall patterns, increased frequency of extreme weather events like droughts and floods, and altered ecological conditions that favour pests and diseases (Oluwole et al., 2022). These changes directly undermine the productivity of the agricultural sector, which employs a substantial portion of the population and is a critical pillar for national food security and economic stability.

Within Nigeria's agricultural landscape, cassava (*Manihot esculenta Crantz*) holds a position of paramount importance. It is a staple food crop for millions of Nigerians, serving as a primary source of dietary carbohydrates and a key source of income for smallholder farmers and processors (Nwajiuba & Onyeneke, 2020). Nigeria is the world's largest producer of cassava, yet its yield potential remains largely unrealized due to a combination of biophysical and socio-economic constraints, which are now being severely exacerbated by climate change (Akinola et al., 2021). The crop, though known for its relative drought tolerance, is highly sensitive to specific climatic conditions; waterlogging from floods can cause root rot, prolonged dry spells can stunt tuber development, and higher temperatures can accelerate the proliferation of pests such as cassava green mites and diseases like cassava mosaic disease (Ewulo et al., 2020). Consequently, the resilience of cassava-based farming systems is under unprecedented threat.

Confronted with these observable changes, Nigerian farmers are not passive victims; they are actively developing and deploying a range of adaptation strategies to safeguard their livelihoods. These strategies are informed by indigenous knowledge, personal experience, and, to a lesser extent, external interventions from government and non-governmental agencies (Adeagbo et al., 2021). Common adaptations include the adoption of early-maturing or drought-tolerant varieties, adjustments to planting dates to align with new rainfall patterns, crop diversification, soil and water conservation techniques, and various forms of on-farm risk management (Tambo & Abdoulaye, 2022). However, the adoption of these strategies is not universal and is influenced by a complex interplay of factors including access to information, financial resources, land tenure security, and social capital (Ezezue et al., 2023).

Despite the recognized importance of these autonomous adaptations, there is a pressing need for empirical, location-specific research to systematically document and evaluate their effectiveness. The success of adaptation strategies is highly context-dependent, varying by agro-ecological zone, socio-economic conditions, and institutional support structures (Ajaero & Mozie, 2021). Therefore, a study focused on a major cassava-producing state like Taraba is crucial. Understanding which strategies are being used, their perceived efficacy in enhancing cassava yield and farmer resilience, and the barriers to their adoption is critical for informing policy (Onyeneke et al., 2022). This research seeks to fill this gap by providing evidence-based insights that can guide the development of targeted, culturally appropriate, and effective climate change adaptation policies and programs. Ultimately, supporting farmers in their adaptation efforts is not just essential for protecting cassava production but is fundamental to ensuring food security and alleviating poverty in Nigeria amidst a changing climate.

Cassava is the cornerstone of food security and a critical source of livelihood for millions of smallholder farmers and households in Nigeria, the world's largest producer of the crop (Food and Agriculture Organization [FAO], 2023). Despite its socio-economic importance, cassava production systems in Nigeria are predominantly rain-fed and operated by smallholders with limited resources, making them exceptionally vulnerable to the adverse effects of climate change (Akinleye, 2022). The increasing variability and unpredictability of climatic patterns characterized by rising temperatures, erratic rainfall, prolonged droughts, and severe flooding pose a direct and escalating threat to cassava yields and tuber quality (Ewulo et al., 2020). These changes disrupt growing seasons, exacerbate water stress, and foster the spread of pests and diseases, thereby undermining the stability and productivity of the entire cassava value chain (Ikuemonisan et al., 2023).

In response to these palpable threats, Nigerian cassava farmers are not passive; they are actively employing various indigenous and innovative strategies to adapt to the changing climate. Common practices include altering planting dates, adopting drought-tolerant varieties, diversifying crops, and employing soil moisture conservation techniques (Tambo & Abdoulaye, 2022; Onyeneke et al., 2021). However, the adoption of these strategies is fraught with significant constraints. Critical barriers include limited access to improved planting materials, inadequate credit facilities, poor access to timely and reliable climate information, and insufficient technical knowledge on effective adaptation practices (Adeagbo et al., 2021; Ezezue et al., 2023). Consequently, there is a substantial gap between the availability of potential adaptation technologies and their widespread uptake and effective implementation by farmers at the grassroots level. The main objectives of this study is to assess farmers' climate change adaptation strategies and cassava production in Taraba State, Nigeria. the specific objectives are to:

i. examined the climate change events noticed by the cassava farmers and the level of occurrence;
ii. identify the strategies cassava farmers adopt to combat the effect of climate change and their level of use; and
iii. identified the effects of climate change adaptation strategies used by farmers on cassava production.

II. METHODOLOGY

Description of the Study Area

This study was conducted in Taraba State, Nigeria. Geopolitically, Taraba is situated in the North-East geopolitical zone of the country, a region characterized by significant agricultural potential alongside emerging climate security challenges (Okeke et al., 2023). The state lies between latitudes 6°30' and 9°30' North and longitudes 9°00' and 12°00' East. It shares domestic boundaries with Bauchi and Gombe States to the north, Adamawa State to the east, and Plateau, Nasarawa, and Benue States to the west, while its southern border forms an international boundary with the Republic of Cameroon (NBS, 2021).

Taraba State is renowned for its ecological diversity and is often referred to as "Nature's Gift to the Nation" due to its rich endowment of natural resources, including arable land, water bodies, and mineral deposits (Oruonye, 2020). The state covers a land area of approximately 60,291 km². According to the 2006 National Population Census, the population was 2,300,736. However, recent projections from the National Bureau of Statistics (NBS, 2021) estimate the population to be over 4.1 million people as of 2023, reflecting a growth rate that exerts considerable pressure on land and agricultural resources.

Administratively, the state is divided into sixteen (16) Local Government Areas (LGAs), grouped into three senatorial districts: Taraba North, Taraba Central, and Taraba South. This administrative structure manages a highly diverse population comprising over 80 distinct ethnic groups, including the Jukun, Kuteb, Chamba, Tiv, and Mambilla (Ahmadu et al., 2024). The state's agro-ecology exhibits a unique gradient, transitioning from the lush, forested vegetation and humid tropical climate in the south to the drier Sudan savanna in the north. This climatic variation results in a mean annual rainfall that ranges from over 2000 mm in the southern regions to approximately 800 mm in the northern zones (Eze et al., 2022). The climate is marked by a distinct wet season (April to October) and a dry season (November to March), with increasing reports of erratic rainfall patterns and rising temperatures linked to climate change (Ifeanyi-obi et al., 2022).

Agriculture is the predominant occupation, engaging over 80% of the state's populace (Taraba State Agricultural Development Project, 2023). Cassava is a critical staple and cash crop, particularly in the central and southern LGAs, providing food security and income for numerous households. The state's diverse ecology also supports the cultivation of yam, maize, rice, sorghum, millet, and cash crops like coffee and tea on the Mambilla Plateau. Livestock rearing and fishing along the Benue, Taraba, and Donga rivers are other vital sub-sectors (Bello et al., 2023). Despite this immense potential, agricultural productivity is constrained by infrastructural deficits, including poor road networks and limited access to modern processing facilities, which are further exacerbated by the increasing variability of the climate (Shehu et al., 2021). This confluence of factors makes Taraba State a critical and relevant location for assessing the constraints to climate change adaptation among cassava farmers.

Source and Methods of Data Collection

For the purpose of this study, primary data was used. This was obtained by the use of structured questionnaire which was administered to cassava farmers in the study area. The other sources of information consist of records from Taraba State Agriculture Development Programme (TADP) and other relevant information from Taraba State Value Chain Development Programme (VCDP)

Sampling procedure

Multi-stage and purposive sampling techniques was used in selecting the cassava farmers for the study. Firstly, three (3) Agricultural zones was selected out of the four (4) agricultural zones in the state base on their high involvement in cassava farming, second stage sampling involved a purposive selection of two (2) Local Government Area in each of the agricultural zones to give a total of six (6) Local Government Area, the third stage involved selection of three (3) wards in each of the selected Local Government Area to give a total of 18 wards for the study, four (4) stage involved random selection of three (3) village from each of the selected wards to give a total of 54 villages for the study. In stage five (5), a simple random sampling technique of 373 will be obtained from the population size of 5,647 using the Yamane's formula as given below. However only 365 questionnaires were return with useful information.

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

Where

N = Sample sizes

N = Number of farmers (sampling frame)

e = Margin error (usually 5%)

Methods of Data Analysis

A 4-point Likert scale was used to examined the climate change events noticed by the cassava farmers and the level of occurrence and identify the strategies cassava farmers adopt to combat the effect of climate change and their level of use. The mean scores of the responses were categorized as follows: > 3.26 = Very High; 2.51 – 3.25 = High; 1.76 – 2.50 = Moderate; < 1.75 = Low while a 5-point Likert scale was used to identified the effects of climate change adaptation strategies used by farmers on cassava production. The mean scores of the responses were categorized as follows: > 4.5 = Strongly Agree (SA); 3.5 – 4.4 = Agree (A); 2.5 – 3.4 = Undecided (U); 1.5 – 2.4 = Disagree; < 1.5 = Strongly Disagree

III. RESULTS AND DISCUSSION

Climate Change Events Noticed by the Cassava Farmers and the Level of Occurrence

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Table 1 presents the various climate change events observed by cassava farmers in Taraba State and their reported levels of occurrence. The findings show that the majority of farmers are already experiencing significant climate-related challenges affecting their farming operations. The results reveal that increased temperature (hotter days) ranked highest with a mean score of 3.58 (very high). This implies that cassava farmers in the study area have consistently observed hotter weather conditions over the years. Similar findings were reported by Apata et al. (2009), who noted that farmers across Nigeria perceive increasing temperatures as a major climate change manifestation. High temperatures affect cassava by increasing evapotranspiration, reducing soil moisture, and in some cases, causing stunted growth.

The second most widely noticed event was unpredictable rainfall patterns (mean = 3.55, high). Farmers observed late onset and early cessation of rainfall, which disrupts planting schedules. This agrees with the work of Ifeanyi-Obi et al. (2017), who found that erratic rainfall is one of the most severe climate stressors experienced by smallholder farmers in southern Nigeria. For cassava production, unpredictable rainfall can either delay planting or expose young cassava stands to drought stress.

Longer dry spells/drought also recorded a high occurrence (mean = 2.78). About 37.5% of farmers rated drought incidence as high. Drought is known to significantly reduce cassava yields, especially if it occurs during the crop's establishment stage (Nnamchi et al., 2021). Cassava is relatively drought-tolerant, but prolonged dry spells limit root development and reduce productivity.

Similarly, heavy rainfall and flooding had a mean of 2.85 (high). Over 39% of respondents experienced flooding challenges. Excessive rainfall can cause waterlogging, which affects root tuber formation and increases post-harvest losses. This observation is supported by Olanrewaju et al. (2019), who argued that flooding and erosion are emerging threats to food security in Nigeria due to climate variability.

The farmers also reported a very high occurrence of increased pest attacks (mean = 2.62). Cassava mosaic disease, mealybugs, and whiteflies thrive under changing climatic conditions, leading to significant yield reduction. A similar trend was highlighted by Onyeneke (2020), who reported that warmer conditions and irregular rainfall have contributed to the resurgence of pests and crop infestations in Nigeria.

On the other hand, crop diseases (mean = 2.38, moderate) and strong winds (mean = 2.16, moderate) were perceived as less severe climate events compared to temperature and rainfall variability. Although moderate, these stressors still affect cassava growth. For instance, strong winds often damage cassava leaves and stems, while crop diseases such as cassava bacterial blight remain a concern under fluctuating climate conditions (FAO, 2020).

Table 1: Climate Change Events Noticed by the Cassava Farmers and the Level of Occurrence

Climate Event	Very High	High	Moderate	Low	Total	Mean	Remark
Increased Temperature (hotter days)	271 (74.25)	57 (15.62)	13 (3.56)	24 (6.58)	1305	3.58	Very High
Unpredictable Rainfall (late start/early stop)	246 (67.40)	86 (23.56)	20 (5.48)	13 (3.56)	1295	3.55	High
Longer Dry Spells/Drought	95 (26.03)	137 (37.53)	83 (22.74)	50 (13.70)	1007	2.78	High
Heavy Rainfall/Flooding	109 (29.86)	143 (39.18)	61 (16.71)	52 (14.25)	1039	2.85	High
Increased Pest Attacks	103 (28.22)	75 (20.55)	131 (35.89)	56 (15.34)	955	2.62	Very High
Increased Crop Diseases	87 (23.84)	46 (12.60)	149 (40.82)	83 (22.74)	867	2.38	Moderate

Strong Winds	39 (10.68)	34 (9.32)	237 (64.93)	55 (15.07)	787	2.16	Moderate

Note: > 3.26 = Very High; 2.51 – 3.25 = High; 1.76 – 2.50 = Moderate; < 1.75 = Low

The Strategies Cassava Farmers Adopt to Combat the Effect of Climate Change and Their Level of Use

Table 2 presents the adaptation strategies used by cassava farmers in Taraba State to cope with the effects of climate change, alongside their level of use. The findings show varying degrees of adoption across strategies, reflecting both farmers' awareness and their resource constraints. The results indicate that the most widely used strategy is changing planting dates (waiting for stable rainfall), with a mean score of 3.60 (very high). About 73% of respondents reported that they always adjust their planting periods to align with rainfall patterns. This shows that farmers rely heavily on rainfall observations to minimize risks associated with erratic weather. This finding is consistent with Ifeanyi-Obi et al. (2017), who reported that adjusting planting dates is one of the most common strategies among Nigerian farmers due to its low cost and practicality.

Crop diversification (mean = 3.13, high) is also a major strategy, with nearly half of the farmers (46.58%) always practicing it. By planting different crops alongside cassava, farmers spread risk and improve food security. This agrees with the findings of Ndamani and Watanabe (2015) in Ghana, who emphasized that diversification reduces vulnerability to climate-induced crop failure.

Other moderately adopted strategies include planting improved/drought-tolerant cassava varieties (mean = 2.47), mixed cropping (mean = 2.26), soil conservation practices such as mulching and cover cropping (mean = 2.09), use of organic manure/compost (mean = 2.17), and seeking weather information before planting (mean = 2.30). These strategies are important but are not consistently practiced, possibly due to lack of access to improved varieties, poor extension services, limited knowledge, and high labor demands. Onyeneke (2020) similarly reported that while Nigerian farmers are aware of improved varieties and soil conservation methods, their adoption is often constrained by financial and technical limitations.

However, irrigation (mean = 1.20, low) and agroforestry/planting trees (mean = 1.37, low) were the least adopted strategies. This implies that most cassava farmers in Taraba State rely solely on rain-fed production, with little or no supplementary water supply. Irrigation is often capital-intensive, requiring pumps or boreholes, which are beyond the reach of most smallholder farmers. This aligns with the findings of Deressa et al. (2009), who reported that irrigation adoption among African smallholders is very low due to cost and infrastructural barriers. Similarly, agroforestry is poorly practiced because of land scarcity and long gestation periods before trees become beneficial, as highlighted by Olanrewaju et al. (2019).

Table 2: The Strategies Cassava Farmers Adopt to Combat the Effect of Climate Change and Their Level of Use

Adaptation Strategy	Always Use	Often Use	Rarely Use	Never Use	Total	Mean	Remark
Planting improved/drought-tolerant cassava varieties	73 (20)	97 (26.58)	122 (33.42)	73 (20)	900	2.47	Moderate
Changing planting dates (waiting for stable rain)	268 (73.42)	61 (16.71)	24 (6.58)	12 (3.29)	1315	3.60	Very High
Crop diversification (planting different crops)	170 (46.58)	109 (29.68)	49 (13.42)	37 (10.14)	1142	3.13	High
Mixed cropping (intercropping cassava with other crops)	56 (15.34)	71 (19.45)	150 (41.10)	88 (24.11)	825	2.26	Moderate

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Soil conservation (e.g., mulching, cover crops)	37 (10.14)	64 (17.53)	158 (43.29)	106 (29.04)	762	2.09	Moderate
Using organic manure/compost to improve soil	49 (13.42)	85 (23.29)	110 (30.14)	121 (33.15)	792	2.17	Moderate
Using irrigation (e.g., watering cans, pumps)	0 (0)	0 (0)	73 (20)	292 (80)	438	1.2	Low
Planting trees (agroforestry)	10 (2.74)	26 (7.12)	54 (14.79)	275 (75.34)	501	1.37	Low
Seeking weather information before planting	65 (17.81)	77 (21.10)	125 (34.25)	198 (54.25)	839	2.30	Moderate

Note: > 3.26 = Very High; 2.51 – 3.25 = High; 1.76 – 2.50 = Moderate; < 1.75 = Low

Effects of Climate Change Adaptation Strategies on Cassava Production

Table 3 shows the perceptions of cassava farmers regarding the effects of the climate change adaptation strategies they practice on cassava production in Taraba State. The results highlight both positive and constraining outcomes. The results indicate that most farmers agreed that adaptation strategies have increased cassava yield (mean = 4.12). About 56.7% of respondents strongly agreed with this statement. This suggests that strategies such as adjusting planting dates, crop diversification, and use of improved cassava varieties have enhanced productivity. This finding is consistent with Apata et al. (2009), who noted that the adoption of adaptive practices significantly improves crop yields in Nigeria. Similarly, Nnamchi et al. (2021) reported that the use of climate-smart practices contributes positively to cassava output despite adverse weather conditions.

Another notable effect is that adaptation strategies have improved the quality of cassava tubers (mean = 3.87). More than 70% of respondents agreed, indicating that tubers are healthier and of better size when farmers apply adaptive measures. This finding corroborates FAO (2020), which emphasized that climate-smart agriculture improves both yield and quality of crops through soil fertility management, pest reduction, and use of resilient varieties.

Farmers also agreed that adaptation strategies have helped to reduce crop failure (mean = 3.75). About 40.6% were uncertain, but a larger proportion (55.9%) agreed or strongly agreed. This shows that adaptation strategies have at least cushioned the risks of complete losses due to unpredictable rainfall and drought. This result aligns with Onyeneke (2020), who noted that farmers perceive adaptation as a safety net against crop failure, even if yields are not always maximized.

Regarding socio-economic benefits, farmers agreed that adaptation strategies increased their income from cassava sales (mean = 3.48). About 28.5% strongly agreed, while 26.6% were uncertain. This suggests that adaptation indirectly improves livelihoods by stabilizing yields and providing more marketable surpluses. This finding is in line with Ifeanyi-Obi et al. (2017), who argued that climate change adaptation not only secures food supply but also enhances farmers' income.

On the other hand, farmers were undecided about the effect of adaptation strategies on household food security (mean = 3.18). While some agreed, a significant share (35.6%) disagreed or strongly disagreed. This may be because household food security depends on multiple factors (income diversification, food prices, storage, and household size), not just cassava yields. This observation resonates with Deressa et al. (2009), who found that even when adaptation improves farm output, its impact on household-level food security may be limited due to socio-economic constraints.

Interestingly, the majority of respondents strongly agreed that adaptation strategies have improved soil fertility (mean = 4.32). Over 66% of farmers strongly agreed, showing that practices like mulching, use of organic manure, and crop diversification contribute to long-term soil health. This aligns with IPCC (2022), which highlighted soil fertility management as a key co-benefit of adaptation strategies.

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However, farmers also agreed that adaptation strategies are too expensive relative to the benefits (mean = 3.95). About 78% of respondents either strongly agreed or agreed, underscoring the economic burden of implementing adaptive practices. High costs of improved cassava varieties, fertilizers, irrigation tools, and extension services often discourage smallholders from scaling up adaptation. Olanrewaju et al. (2019) similarly reported that affordability remains a major barrier to sustainable climate adaptation in Nigeria.

the effects of climate change adaptation strategies used by farmers on cassava production.

Statement	SA	A	U	D	SD	Total	Mean	Remark
The adaptation strategies have increased my cassava yield.	207 (56.71)	65 (17.81)	33 (9.04)	48 (13.15)	12 (3.29)	1502	4.12	Agree
They have improved the quality (size/health) of my cassava tubers.	54 (14.79)	257 (70.41)	22 (6.03)	17 (4.66)	15 (4.11)	1413	3.87	Agree
They have helped to reduce crop failure.	91 (24.93)	113 (30.96)	148 (40.55)	4 (1.10)	9 (2.47)	1368	3.75	Agree
They have improved my household food security.	85 (23.29)	96 (26.30)	54 (14.79)	59 (16.16)	71 (19.45)	1160	3.18	Undecided
They have increased my income from cassava sales.	104 (28.49)	85 (23.29)	97 (26.58)	41 (11.23)	38 (10.41)	1271	3.48	Agree
They have made my soil more fertile.	241 (66.03)	102 (27.15)	3 (0.82)	8 (2.19)	11 (3.01)	1649	4.32	Agree
They are too expensive relative to the benefits.	105 (28.77)	181 (49.59)	51 (13.97)	12 (3.29)	16 (4.38)	1442	3.95	Agree

Note: > 4.5 = Strongly Agree (SA); 3.5 – 4.4 = Agree (A); 2.5 – 3.4 = Undecided (U); 1.5 – 2.4 = Disagree; < 1.5 = Strongly Disagree

IV. CONCLUSION AND RECOMMENDATIONS

Conclusion

The study concludes that cassava farmers in Taraba State are actively experiencing significant climate change impacts, primarily increased temperatures and unpredictable rainfall. In response, they predominantly utilize low-cost, knowledge-based adaptation strategies like adjusting planting dates and crop diversification, while more capital-intensive measures like irrigation see minimal adoption due to high costs. Although these adopted strategies are perceived to positively impact yield, soil fertility, and reduce crop failure, their overall effectiveness is severely constrained by the overwhelming financial burden they place on farmers, creating a significant barrier to building greater resilience

Recommendations

Based on the conclusions of this study, the following recommendations are proposed:

i. Promotion of Affordable and Accessible Technologies: Government and agricultural development agencies should prioritize the development and dissemination of low-cost, climate-resilient technologies. This includes: Establishing a sustainable seed system to ensure wider availability and affordability of improved, drought-tolerant cassava varieties to farmers. Promoting and providing training on low-external-input soil fertility management practices, such as the production and use of organic manure and compost.

ii. Enhanced Extension Services and Climate Information: There is a need to strengthen agricultural extension services to provide tailored, actionable advice to farmers. This should be coupled with: Investing in the provision of timely, reliable, and locally-specific weather and climate information to farmers via accessible channels like radio and mobile phones to support decision-making, particularly on planting dates.

iii. Financial Support and Incentives: To address the critical barrier of cost, policy interventions should include: Facilitating farmers' access to credit and soft loans through cooperative societies and microfinance banks to enable them to invest in adaptive technologies. Designing and implementing targeted subsidy programs for critical inputs like improved seeds and small-scale irrigation equipment.

iv. Research and Development: Agricultural research institutions should: Conduct participatory on-farm trials to develop and demonstrate context-specific, integrated adaptation packages (e.g., drought-tolerant varieties combined with soil moisture conservation techniques) that are both effective and economically viable for smallholder farmers. Focus research on developing and promoting less capital-intensive irrigation options, such as rainwater harvesting techniques and treadle pumps.

v. Policy Integration: The government should mainstream climate change adaptation into agricultural policies and programs. This includes: Incorporating climate resilience as a core objective in the state's agricultural development plans. Supporting community-based adaptation initiatives and fostering partnerships between researchers, extension agents, and farmers to ensure solutions are practical and widely adopted.

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