



Contents

EXECUTIVE SUMMARY	4
1 INTRODUCTION.....	9
2 RISK PROFILES: SNAPSHOTS BY AEZ	11
2.1 The Semi-Arid AEZ	13
2.2 The Sub-Humid AEZ	15
2.3 The Humid AEZ	17
3 ACROSS AEZ AND GENDER RESULTS	20
3.1 Self-reported Exposure and Future Expectations of Climate Hazards	20
3.2 Awareness and Adoption of Climate Adaptation Technologies, Practices, and Services	23
3.2.1 Measurement, Use, and Farmer Understanding of Improved, Hybrid, and GMO seeds	23
3.2.2 Non-seed Climate Adaptation Technologies and Practices	26
3.2.3 Understanding the Role of Weather Information and Advice on Adaptation.....	28
3.2.4 Gain versus Loss Message Framing	32
3.3 Risk Perceptions and the Role of Psychological Factors in Climate Adaptation	33
3.4 SSP Attitudes.....	35
3.5 What do Farmers Really Want?	37
4 CONCLUSION	38
REFERENCES	39
APPENDICES.....	43
APPENDIX 1: SSP Technology Adoption Pathway (Conceptual)	43
APPENDIX 2: Methodology	44
A2.1 Desk Review and Pre-Analysis	44
A2.2 Partnership Approach Involving Local Partners	45
A2.3 Sampling Strategies	45
APPENDIX 3. Some Specific Climate Stresses and Thresholds	47
APPENDIX 4: Other Background on Climate Risk: Exposure to Hazards and Vulnerability	48
A4.1: Self-reported Exposure and Vulnerability	48

A4.2 Exposure: Rainfall, Temperature, and Pest Stress in Satellite Data, Government Reports, and LSMS-ISA 51

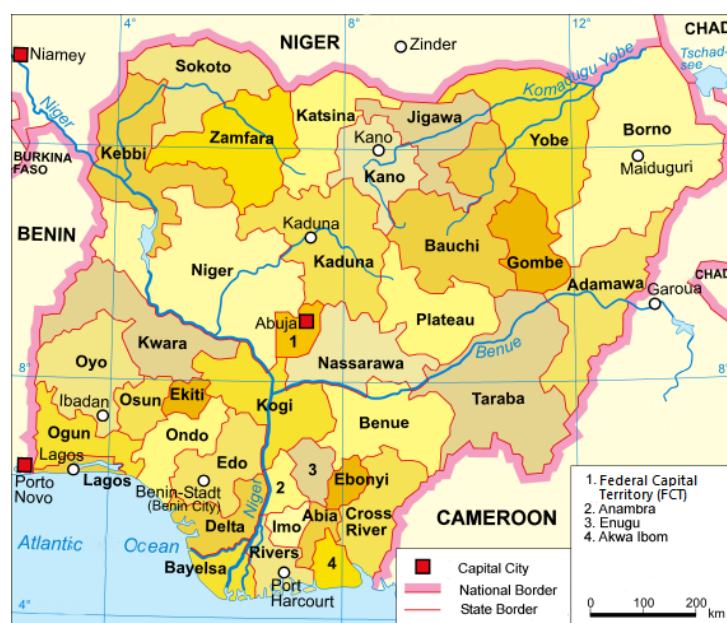
APPENDIX 5: Self-reported Versus Measured Drought Cross Tabs and Regressions 54

APPENDIX 6: Attitudes Regressions 57

APPENDIX 7: Snapshots by AEZ 59

ABBREVIATIONS

AEZ	Agro-ecological zone
AGRA	Alliance for a Green Revolution in Africa
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
CHIRTS	Climate Hazards Group InfraRed Temperature with Station data
CRIFS	Center for Risk and Inclusion in Food Systems
EPAR	Evans School Policy Research and Analysis
FHH	Female-headed household
FGD	Focus group discussion
GAEZ	Global Agro-ecological Zones
GHS	General Household Survey
HDD	Harmful degree day
LSMS-ISA	Living Standard Measurement Study - Integrated Surveys on Agriculture
NiMet	Nigerian Meteorological Agency
NLPS	National Longitudinal Phone Survey
SCP	Seasonal Climate Prediction
SSP	Small-scale producer
WHO	World Health Organization



EXECUTIVE SUMMARY

Our understanding of adoption decisions has come a long way from assuming that beneficial technologies will necessarily find their way into small-scale producers' hands and fields. The importance of the policy environment, functioning markets, delivery systems, and basic benefit-cost calculations for suppliers and consumers are generally recognized. Yet in Nigeria, for example, reported adoption of climate adaptation production technologies has declined despite farmers increasingly reporting exposure to climate shocks.

What are we missing? First, agriculture is inherently risky, with risk stemming from both variability and uncertainty. Second, we know almost nothing about how small-scale producers (SSPs) (Alia et al., 2025) view climate risk - the probability of a climate event, their likely exposure and their vulnerability. We do know from a growing literature that individual risk perceptions often differ from measured risk (Paek and Hove, 2017). Risk perceptions refer to the process of collecting, selecting, and interpreting signals about uncertain outcomes (Wachinger et al., 2013); a process that may depend on heuristics - cognitive shortcuts that govern judgement under uncertainty (Tversky and Kahneman, 1974) - and on qualitative dimensions of risk such as dread, controllability, and familiarity (Slovic, 1987). Third, production decisions have always been made under uncertainty and variability, so is there a meaningful way to distinguish production and adaptation? Improved seeds and fertilizer can affect both risk and return, depending on local contexts. Similarly, extension and information are central to both short-term production and longer-run adaptation. And finally, while investors and interventions consider the risk and benefit-cost of non-adoption, SSPs must also consider the relative risk and benefit-cost of moving from the status quo. Even measured and self-reported experienced drought shocks diverge, with up to 38% of households in Ethiopia and Malawi reporting drought experience despite not being exposed to abnormally low cumulative rainfall (Mayorga et. al., 2025). Some differences between measured and self-reported may be scale related, with local microclimate circumstances affecting one farm household more than another within the measured area. But initial analyses suggest that such local heterogeneity alone does not explain cross-household variation. How do we learn about, measure, and respond to SSP risk perceptions in a manner that increases the likelihood of technology uptake and possible subsequent impact? While we can observe behaviors linked to access and economics, and measure some indicators remotely or via satellite imagery, understanding to what degree misalignment between our measures of risk and SSPs' assessment requires asking them directly and establishing reasonable observable proxies.

Accordingly, our mixed-methods study first conducted a desk analysis of satellite weather and land use data, household surveys, and government statistics and reports. We then surveyed 695 farming households drawn from a nationally representative sample and conducted focus group discussions in 5 villages across Nigeria's three main agroecological zones (AEZs) to try and tease out the relative role of access, economics, information, and risk perceptions in SSPs' adaptation decisions. Our report is organized by AEZ, and where crop specific, focuses on maize. Using data from a variety of sources, we present key findings on measured climate risks relative to SSP risk perceptions, and discrepancies that might be feasibly addressed by policy and investments relative to those that are more intractable.

Key findings:

- **Climate extremes are becoming more frequent.** Meso-scale (~5km) weather time series data show increasing rainfall variability and rising temperatures across the three main agroecological zones.
- **Risk is predicated on exposure and harm.** The impact of rising temperatures or increasing precipitation variability depends on magnitude - human, livestock and plant biophysical thresholds - and the timing of crop lifecycles.
- **Awareness is low.** Only 20% of respondents reported knowing about hybrid seeds.

- **Adoption conditional on awareness is high:** Among the aware, 72% reported using hybrid seeds in the last agricultural season.
- **Measurement limitations likely mask actual adoption rates.** Key agricultural surveys ask farmers about “improved variety seed adoption”, producing estimates of use among male plot managers falling from 16% (2015-16) to 5% (2023-24). But our field work finds that farmers most commonly define “improved seeds” by where they were obtained, rather than their genetic traits. We found cases of both false positive (non-improved identified as improved) and false negative (improved identified as non-improved) misidentification. It is also unclear what “hybrid” means.
- **High upfront costs and persistent liquidity constraints constrain adoption despite high expected returns.** Among farmers aware of hybrid seeds, 96% expect them to increase profits, yet 28% don’t use them, citing expense as a top barrier to uptake.
- **More uncertainty around costs than benefits:** SSPs are more homogeneous in their beliefs around technology benefits than in their beliefs around technology costs, including labor and other inputs.
- **Farmers report feeling helpless against weather shocks but confident against pests.** 70% and 57% feel unable to control high wind and drought losses, respectively. Yet only 21% feel unable to control crop losses to pest outbreaks. Less perceived control may diminish the incentive to buy an expensive input.
- **Climate information often doesn’t translate to action.** 52% of farmers who received weather information didn’t act on it. Top reasons farmers cited were that information wasn’t relevant to their farm (27%), that they had no affordable way to respond (27%), or that it arrived too late (20%).
- **Fatalism:** While being generally optimistic despite beliefs in a worsening climate, over two-thirds of respondents felt that “if misfortune is meant to strike my farm, there is nothing I can do about it.”
- **AEZ variability:** there is considerable variability across AEZ in: expectations of future climate risk; knowledge and use of production technologies and crop and soil adaptation strategies (with water management consistently the least known across regions); and trusted sources of weather information. Reasons for not acting on information (timeliness and relevance) are more common.
- **Gender variability:** Women report being regularly affected by drought at twice the rate of men (30% vs. 15%) and by extreme heat at 1.5 times the rate (36% vs. 23%). They are significantly less likely to receive weather risk information (0.23 vs. 0.39, $p < 0.01$) and significantly less likely to be moved by loss-framed messages (0.35 vs. 0.56, $p < 0.01$), while gain-framing works about equally for both. Hybrid awareness among women is half that of men (11% vs. 22%) and conditional use is lower (57% vs. 73%).

Policy and investment implications:

First, adoption is conditional on knowing about, and having access to, beneficial options. Among our respondents, awareness of some technologies, such as hybrid seeds, is low. Beyond the clear need for more awareness and effectively communicating adaptation options, our findings suggest strategies based on what we are learning about SSP risk perceptions and innate attitudes:

Technology design and messaging:

- **Uptake is likely to be most effective if the method and the message focus on the (valid) perceived risks and net returns held by SSPs.** That is, don’t market to sell, message to inform. For example:
 - highlight the risks that SSPs believe they have some control over (e.g. pests or disease, rather than wind dislodging or drought);
 - provide clarity around total costs (e.g. annual seed purchases, fertilizer and labor costs, etc.);
 - provide considered alternatives given performance expectations under localized conditions, e.g. soil nutrients and water accessibility, plot slope, household labor, cropping choices;
 - minimize the risk of important “incorrect” pieces of information from a new information source. Be clear upfront about “testing” phases. Trust is easy to lose and may be hard to win back;

- where "hybrid" folds into an existing category, add qualifiers that isolate the performance trait rather than relying on the noun – "improved seed that should be purchased each season", "improved seed bred by crossing two parent varieties", "improved seed that increases pest resistance";
- where the concept does not translate at all, rely on description, demonstration, visuals, and analogy rather than a single translated word;
- gain-framed messaging, since "X% more harvest", "fewer sleepless nights over fall armyworm" is likely to be more effective once baseline trust is in place, as SSPs in our sample appeared open to GMOs, but media reports of GMO mistrust exist.
- **Scale out rather than across.** Given heterogeneity both across and within AEZs – in language, ethnicity, hazard, and attitude – start with locations that have a high probability of success rather than scaling uniformly across AEZ and SSP risk profiles, which may be counterproductive. Then leverage local and farmer-to-farmer channels in digital strategies to generate spillover.
- **Broaden the goal from agricultural technology to rural poverty reduction.** Yield and productivity are a starting point, but SSPs face the twin challenge of generating a surplus and navigating a market for both inputs and outputs. Complementary post-harvest investments that smooth income – cool storage, small-scale electrification – and support for livelihood diversity such as agro-processing and business training can raise farm-level investment incentives. Supporting co-operatives, producer groups, and aggregation hubs can facilitate information sharing, reduce transaction costs, and increase market power.
- **Understand demand.** Risk arises from uncertainty and variability. Uncertainty can be managed with information and advisories; variability largely cannot. Either way, behavior stems from SSPs' risk perceptions, not ours.

The most recent Agricultural Census survey (NASC, 2024) finds a high literacy rate among agricultural household heads, with 95% having completed primary education or higher. Understanding SSP demand may be more effective than "demand creation."

Targeting (observable proxies):

- **Across SSPs¹:** Acknowledge where:
 - fatalism is particularly high. Our findings suggest, for example, that fatalism is highest in the semi-arid (76%) and lowest in the humid AEZ (60%), and associated with observable proxies of (e.g. Quranic schooling). Consider imam or other allies in messaging.
 - time horizons are particularly short and emphasize near-term yield and productivity outcomes rather than longer-run adaptation benefits.
- **Across AEZ:** Consider significant differences likely affecting risk perceptions (bearing in mind some small sample sizes), and where customization may be more important.
 - In percent of households reporting "regularly affected over the past 5 years" across semi-arid to humid, the biggest ranges occurred for heat (16% to 40% in humid), drought (9% to 31%), and least in pest/disease (13% to 5%).
 - Extent of control was less variable, with most over pests and disease, least over high winds and gusts, followed by torrential rains in sub-humid and heat in humid AEZs.
 - Among those reporting past exposure, the percent of households expecting "likely" future occurrences in the next two years varied from almost 25% to about 50% for drought and pests or disease, with heat the most consistent at around 40%.
 - Knowledge of hybrid seeds was ~29% in semi-arid, 23% in sub-humid and only 7% in the humid AEZ. Among the aware, respective adoption rates were 72%, 75%, and 57%.
 - Among the aware and not adopting, the most cited reason across all AEZ's was "too expensive", semi-arid AEZ respondents also cited a lack of availability and support for training; and in the humid AEZ, complexity and time to provide benefits.

¹ Earlier work found a lower risk perception - and possibility a lower incentive to invest in risk managing technologies and strategies, associated with a fatalistic worldview, a risk-tolerant outlook, and optimism about the future. (Cullen et. al., 2017).

- **By gender:** Recognize women's adaptive needs.
 - Women receive significantly less weather information but are no less likely to act on what they receive, so the marginal return to reaching them may exceed the marginal return to reaching men, the more so because the productivity gain from the first packet of improved seed is larger when starting from a lower baseline (Anderson et al., 2017).
- To the extent possible, leverage The Nigerian Meteorological Agency's (NiMet) 2026 Seasonal Climate Prediction (SCP) Advisories, which includes temperature predictions for selected areas within all 36 states, rainfall predictions for 774 local government areas, and predictions of the onset of the rainy season and growing season cessation dates for different regions of the country. Advisories are often tied to recommendations to plant drought resistant or early maturing varieties, or in the case of livestock, administering vaccinations.

For extreme precipitation events where the technology is viewed as having low efficacy, or with fatalist farmers who view themselves as having low personal efficacy, messaging in terms of maximizing current productivity potential may be more salient than speaking about climate extremes and long-run adaptation to reduce crop loss. A positive future vision is not the same as a long-term one, and messaging around increasing returns is a form of risk management. All else equal, observable proxies associated with risk perceptions include education, assets, and access to information.

Second, there is an important communication complexity in the case of improved seed, where "improved" to the upstream supplier is defined as originating from a breeding program enhancing genetic traits, but to an SSP is associated with the downstream source - from whom the seed was obtained or purchased. As with fertilizer and other inputs, fraud and simple misidentification is an issue given the difficulty of measuring the underlying genetic traits in a seed. The quality or health of the seed, such as being disease free, can be more easily detected and certified, as occurs through national efforts in Nigeria. If these health certifications are trusted and well-understood, they may be a vehicle for communicating, packaging and disseminating the production, stress resistance, and other traits of "improved" seed.

Third, as expected but confirmed, challenges arise from agricultural seasonality and income smoothing, including the timing of when technologies are available in markets or elsewhere, the ability of sellers to stock, adequately store, and return inputs to meet demand, rather than erring on undersupplying to avoid waste, and the credit necessary for buyers to purchase inputs months before output value may be realized. Locally contextualized information is important, but the timing of that information is just as critical.

In summary: Actuarial and perceived risk both stem from uncertainty (incomplete information) and natural and human-induced variability. Upstream risk estimates and perceived risks do not necessarily align, but it is SSP perceptions and the associated expected benefit cost estimates that drive uptake. Some aspects of risk perceptions can be addressed through technology design, information and targeting that recognize AEZ differences across the type of hazard addressed, past exposure, controllability, and effective risk communication. Some sources of natural variability can be addressed through, for example, irrigation. Some natural stresses, such as heat, or human-induced, such as conflict driving fertilizer prices, less so. Some SSP attitudes, such as fatalism, may be more difficult to overcome and sufficiently SSP idiosyncratic as to be infeasible to address at scale.

Phone Survey findings at a glance:

Table ES1: Summary of findings

Finding	National	By AEZ			By respondent gender		Section
		Semiarid	Subhumid	Humid	Women	Men	
Hybrid seed awareness	20%	29%	23%	7%	11%	22%	3.2.1
Hybrid use among aware respondents in last season	72%	72%	75%	57%	57%	73%	3.2.1
GMO awareness	23%	35%	24%	9%	-	-	3.2.1
Received weather information	36%	35%	38%	34%	23%	39%	3.2.3
Did not act on weather information received	52%	48%	50%	57%	62%	50%	3.2.3
Top reason for not acting	Not relevant (27%) and no affordable option (27%)	Difficult to understand 38%	No options/ Too costly 33%	Not relevant 44%	-	-	3.2.3
Most trusted weather information source	Radio or TV 54%	Radio or TV 49%	Radio or TV 52%	Radio or TV 59%	-	-	3.2.3
Most influential weather information source among those who acted on it	Govt extension 34%	Farmers group coop 43%	Govt extension 50%	NiMet 47%	-	-	3.2.3
Loss framing was persuasive	52%	80%	54%	22%	35%	56%	3.2.4
Gain framing was persuasive	68%	53%	68%	82%	72%	67%	3.2.4
No control over high winds	70%	71%	65%	71%	92%	65%	3.3
No control over pests	21%	18%	24%	21%	25%	20%	3.3
Past-5yr drought exposure	48%	32%	48%	65%	59%	46%	3.1
Past-5yr heat exposure	47%	34%	38%	70%	59%	44%	3.1
Fatalistic worldview	69%	76%	72%	60%	61%	71%	3.4
Wants children to farm	67%	84%	66%	51%	48%	72%	3.4

Notes: Source is the Nigeria Risk Profile Phone Survey. - means not estimated by gender.

1 INTRODUCTION

Following the IPCC, risk is “the potential for adverse consequences.” (Reisinger et. al., 2020). The impact of, and responses to, adverse consequences are determined by exposure and vulnerability.

Exposure: According to the most recent Agricultural Census, over 40 million Nigerian households practice predominantly rainfed agriculture (NASC, 2024). Irrigation farming was mentioned in 27 percent of communities, suggesting an increase from estimates a decade ago of less than 1% percent of cultivated area under irrigation (Xie et al., 2017). Relying on rainfed production means that rising temperatures, frequent droughts and dry spells, and recurrent river-basin floods increasingly threaten yields and food security (World Bank, 2021). The exposure to shocks documented in the LSMS-ISA General Household Survey (GHS) in 2010-2023 showed an upward trend, with 30% of households reporting at least one climatic shock in the preceding three years (Nigeria GHS Waves 1-5). In the 2022 Census, communities interviewed also reported that on average, they experienced drought and flood about three times, heavy rainfall about four times, extreme wind three times, extreme temperature four times and fire disaster three times in the past three years. Reported 3-year averages were higher for flooding in Lagos state (10x), drought in Edo state (7x), and extreme temperature in Kebbi State (8x) p.35 (NASC, 2024). In the 2024 growing season a 33-state drought transitioned to flooding across 31 states, displacing over 640,000 people and destroying 17,000 hectares of farmland (, 2024).

The Nigerian Meteorological Agency’s (NiMet) announcement of their 2026 Seasonal Climate Prediction (SCP) begins by: “warning of variable rainfall patterns, prolonged dry spells, a severe August Break in some parts of the country, and generally warmer temperatures across Nigeria” (NiMet, 2026).

Vulnerability: The reported adoption of key agricultural technologies declined during this period, with an increasing number of households indicating that they were “doing nothing” in response to the shock. SSPs (rural agricultural households) are estimated to cultivate crops on an average of 0.91 hectares and have 0.72 Tropical Livestock Units (TLUs) (GHS, 2023-24).² Estimated average rural per capita household income is less than \$2/day in 2021 USD (\$1.94/day in 2021 PPP USD) (GHS, 2023-24).

Describing farmers, and in particular SSP vulnerability, typically relies on income, asset, and livelihood profiles. Following Food and Agriculture Organization (FAO) guidelines, agricultural surveys organize producers by legal status of landholdings, market orientation, land size, and economic characteristics to enable targeting and program design (FAO, 2015). For Nigeria, the National Survey and Segmentation of Smallholder Households segments farmers by characteristics such as demographics, poverty status, and crops planted (Anderson et al., 2017). The 2017 Africa Agricultural Status Report (AGRA, 2017) classifies farmers from Ethiopia, Ghana, and Tanzania by five categories of livelihood strategies: subsistence, pre-commercial, specializing commercial, transitioning, and diversified.³ Profiles and typologies such as these characterize farmers across important dimensions but rarely center on climate or risk management.

In contrast, for example, a risk profile for food safety includes identifying the hazards relevant for management decisions, potential consequences, perceptions of risk, and the distribution of risks and benefits (WHO, 1997). To adapt this definition to the analysis of Nigerian agriculture, we use the IPCC definition of climate risk that assesses the probability of a hazard conditioned on exposure and vulnerability (Reisinger et al., 2020). In this project, a risk profile means a synthesis of the main climate associated shocks affecting farmers, their exposure and sensitivity to those shocks, and their vulnerability or capacity to manage them. This approach recognizes that production and adaptation choices are risk management decisions, as farmers

² Average TLU per agricultural household listing of the NASC (2024) is 1.3.

³ These categories are based on segments of the non-farm income share of total income and the share of crop production sold.

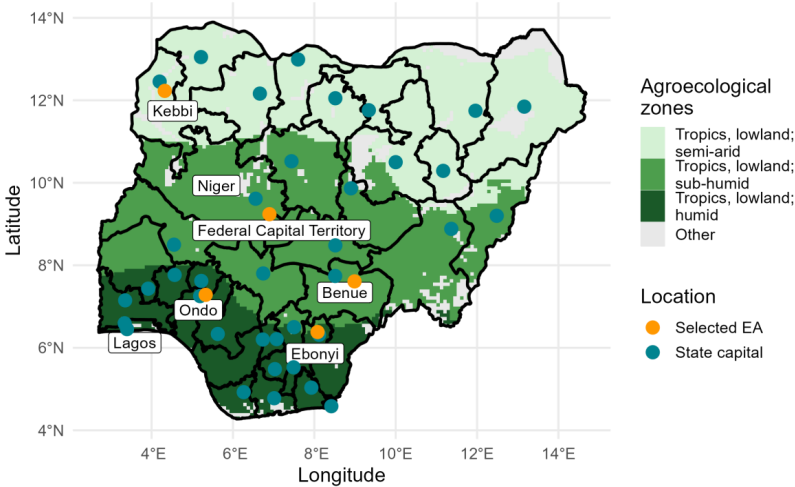
arguably weigh perceived probability and severity of climate hazards, expected effectiveness of responses, costs of adoption, and uncertainties of dis-adopting current practices. Critically, measured risk may diverge from subjective risk perception, and behavior follows perception rather than objective probabilities farmers cannot observe (Waldman et al., 2019). Perceived risk differs from measured risk in ways that are systematic rather than random. The perceived risk of an event is shaped by statistical assessment together with a suite of qualitative dimensions: reversibility; proximity, meaning immediate versus delayed; impacts across time, meaning chronic versus catastrophic; fairness, meaning how outcomes are distributed across a population; familiarity or dread; and control, meaning voluntary versus involuntary exposure. All of these are conditioned on innate risk-taking attitudes and worldview (Slovic, 1987).

This study is the first country Risk Profile from the Center for Risk and Inclusion in Food Systems (CRIFS) at the University of Washington, supported by the Gates Foundation. CRIFS implemented a mixed-methods approach combining a phone survey of 695 farming households; focus group discussions (FGDs), farm visits, and agro-dealer interviews in five villages across Nigeria's three main agro-ecological zones; and LSMS-ISA households surveys, meso-scale weather time series, and statistical and administrative records such as the 2024 NAERLS. The analysis characterizes the climate risk landscape using CHIRPS precipitation data (Funk et al., 2015), CHIRTS temperature data (Funk et al., 2019), and self-reported shock exposure records. It then examines barriers to adoption of climate adaptation technologies and practices related to measurement validity, awareness, economic incentives, and risk perceptions.

Some initial findings are that: communication and measurement challenges stem from misalignment between upstream and downstream meanings of “improved” seed; liquidity constraints persist even when aware farmers expect strong returns from adoption; farmers exhibit differential perceived control across climate stresses; and farmers often fail to act on climate information they receive because they perceive limited relevance and/or viable options. We also find inconsistencies between meteorological records and SSP self-reported experiences that, in part, suggest the need for more robust climate measures, not just spatially, but also temporally as they relate to crucial points in the planting and growth cycles of different crops and might interact to cause simultaneous stresses such as heat and precipitation that impact crop and livestock productivity. That is, we need a more precise measure of local climate risk exposure that is relevant to SSP decision-making. The rest of this report is structured as follows. Drawing from multiple sources, Section 2 provides a summary snapshot of risk profiles by AEZ and includes the meteorological climate risk, combining exposure trends with the potential harm of that exposure based on precipitation thresholds of <480mm and degree days above 30 °C during the growing season, and aspects of SSP risk perceptions around future climate and options for managing risk. Section 3 offers more detailed findings and compares responses across AEZ, bundling some results by risk dimensions from Slovic (1987): subsection 3.1, 3.3, and 3.4 address exposure and proximity; control; and underlying attitudes and worldview, respectively. Section 4 concludes by describing CRIFS ongoing work to refine climate exposure metrics and with implications for policy, and technology design and delivery. Appendix 2 describes the methodology in detail, the biophysical crop thresholds used in the analysis, a conceptualized SSP adaptation decision-tree, some additional agricultural background from the LSMS-ISA and the most recent Nigeria Agricultural Census, and more detailed econometric results.

2 RISK PROFILES: SNAPSHOTS BY AEZ

Figure 1: Agroecological zones in Nigeria

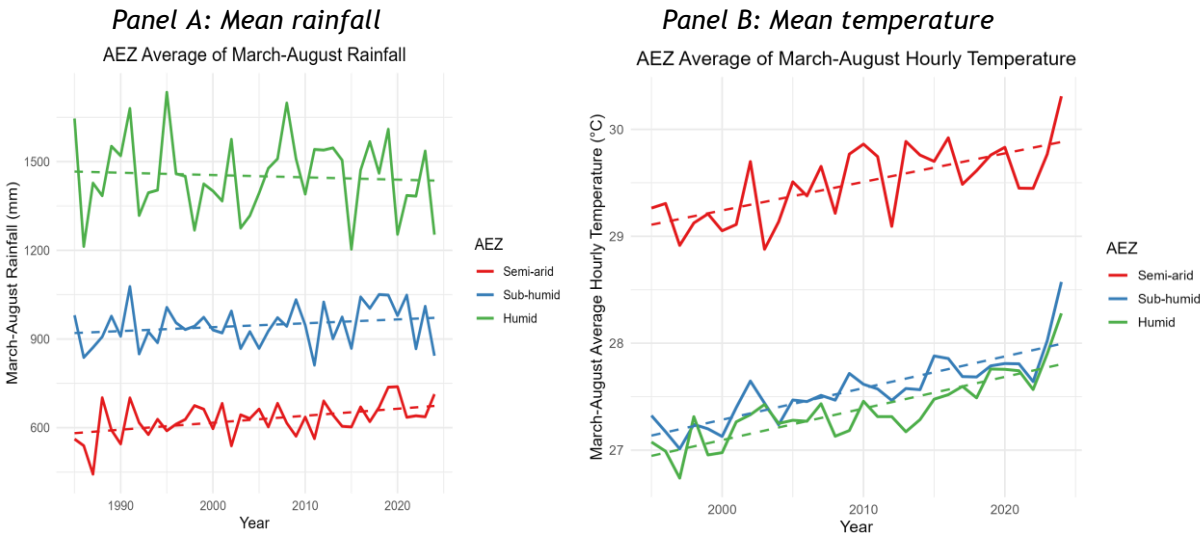


We conducted a phone survey and in-person focus groups in March 2025, timed to align with the planting season. The phone survey was a nationally representative sample of agricultural households drawn from the 2018-19 LSMS-ISA General Household Survey (GHS) and the National Longitudinal Phone Survey (NLPS). Of our initial sample of 778 farming households, 695 completed all sections of the phone survey. The in-person visits consisted of five rural villages in Kebbi, Niger, Benue, Ondo, and Ebonyi states. All these data were combined with climate satellite imagery to characterize SSPs' risk profiles.

Notes: Built using data on historical AEZs (1981-2010) data from GAEZ v4.

There are significant differences in climate and farm production practices across the main agroecological zones (AEZs) in Nigeria. The country is roughly divided into three east-west bands: the semi-arid AEZ in the north, the sub-humid AEZ in the center, and the humid AEZ in the south, as shown in Figure 1, where temperature decreases and rainfall increases when moving from north to south.

Figure 2: Mean rainfall and temperature by AEZ (1985-2024)

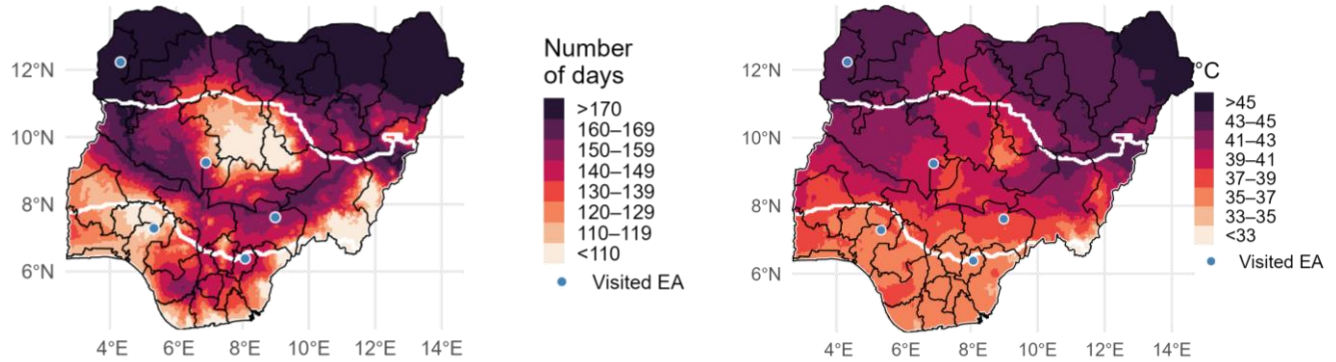


Notes: EPAR representation using CHIRPS monthly rainfall data (Funk et al., 2015) and CHIRTS daily minimum and maximum temperature data (Funk et al., 2019).

Figure 3: Heat stress in Nigeria

Panel A: Average Mar-Aug (1995-2024) days with Tmax above 30°C

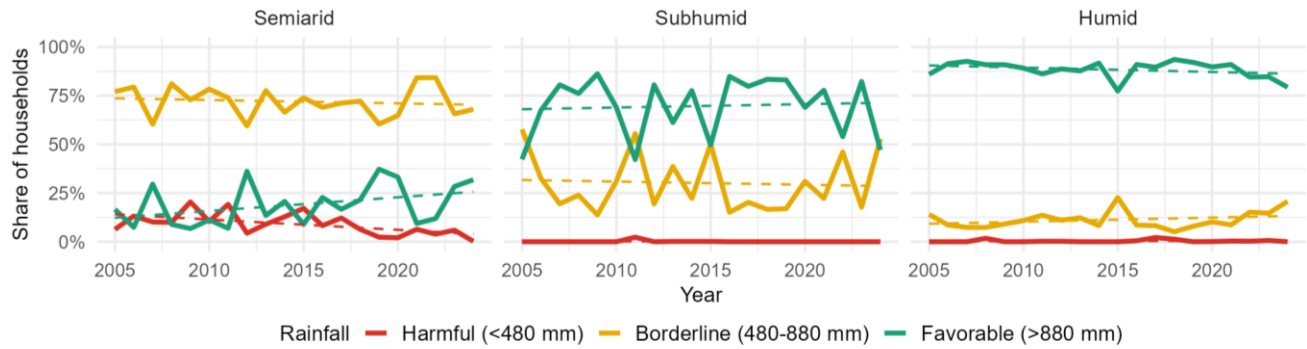
Panel B: Tmax in 2024 season



Source: EPAR representation using CHIRTS maximum daily temperature data (Funk et al., 2019).

Figure 4: Share of household exposure to weather conditions relevant to maize production

Panel A: Rainfall during growing season



Notes: Built using CHIRPS, CHIRTS, and GHS. Sample consists of rural agricultural households in GHS waves 1 to 5.

Figures 2 and 3 present long-term averages, by AEZ, in precipitation and temperatures. Long-term averages help to establish trends independent of annual variability. In general, the figures show that since 1985, average March to August rainfall has been declining in humid areas and increasing in sub-humid and semi-arid regions, though this masks sub-annual changes in the timing and intensity of precipitation, particularly relevant

to the agricultural season. For example, the NiMet 2026 Seasonal Climate Prediction⁴ is forecasting a shorter than normal rainy season in parts of the NE (noting that a predicted rainy season of 110 days is already less than half of the 260 days in the south) but with more than normal rainfall.

NiMet’s other predictions include severe dry spells for the North, the central and western border regions Oyo and Ogun states, and parts of the southern states and central region. Consistent with the historical trend, all regions now forecast to have average temperatures above 30 degrees in February and March, climbing above 40 degrees in April in regions of the north semi-arid AEZ.

Interpreting the impact of climate stress and trends depends on human, crop and livestock physiological thresholds around heat and precipitation volume, variability, and extremes. Based on the thresholds in the literature (Appendix 3), Figure 4 characterizes exposure trends since 2005 by AEZ. As illustrated, the annual variation is substantial in the Semi-arid and Subhumid zones. In the Semi-arid zone, the majority of households face borderline precipitation conditions and more than 1 harmful degree day (HDD) above 30°C.

2.1 The Semi-Arid AEZ

Figure 5: Millet plantation in Kebbi state (Fieldwork March 2025)



Notes: Millet is a heat-resistant crop that is well suited to the high temperatures of the semi-arid AEZ.

The semi-arid AEZ, which covers much of northern Nigeria including states such as Borno and Kebbi, is characterized by low and variable rainfall, recurrent heat, and short growing seasons. Most rural SSPs are located in areas with harmful or borderline harmful precipitation conditions, and about one-third are exposed to between 1 and 2 harmful degree days. Much of the region are savannah lands consisting of mixed grass and thorn tree. The region is subject to strong winds bringing sand.

Livelihoods in the region are centered on food crop farming, with sorghum (planted by 71% of SSPs), cowpea (55%), and millet (54%) among the most commonly planted crops (GHS 2023-24). Average livestock holdings include: 2.45 large ruminants, 7.94 small ruminants, and 7.75 poultry

units (GHS 2023-24). The two largest ethnic groups, the Hausa and Fulani, are Muslim, and Islamic culture is embedded within the region (GHS 2023-24).

Table 1: SSP Measured Risk in the Semi-arid AEZ

	Estimate	N
Exposure to climate risk		
Precipitation		
Long-term (2005-24) average precipitation	649.5 mm	
Trend (2005-24) in average precipitation	Constant	

⁶ The desk review began in the first semester of 2023, before the 2023-24 LSMS-ISA GHS (Wave 5) was published in November 2024.

% of rural SSPs exposed to harmful precipitation (< 480 mm)	0.5%	223
% of rural SSPs exposed to borderline precipitation (480-880 mm)	82.0%	223
% of rural SSPs exposed to favorable precipitation (> 880 mm)	17.5%	223
Temperature		
Long-term (2005-24) average temperature	29.7 °C	
Trend (2005-24) in average harmful degree days >30°C (HDD)	Constant	
% of rural SSPs in locations with HDD <1 in 2024	62.8%	223
% of rural SSPs in locations with HDD 1-2 in 2024	32.3%	223
% of rural SSPs in locations with HDD >2 in 2024	4.9%	223
Forecasts (NiMet SCP) 2026 growing season		
Precipitation	Borno: Late onset of rains, shorter than normal rainy season, but more than normal rainfall. Severe dry spell (>21 days) June-August	
Temperature	Warmer than normal: through April with some regions >40°C in April	
Population Vulnerability		
Total number of rural HHs engaged in farming	8.5 MM	GHS W5
% of rural SSPs female-headed HHs	9%	220
Average landholding (ha)	1.26	214
Average planted area (ha)	1.22	215
Average livestock holding (TLUs, 1 cow=1TLU)	1.09	220
Average daily consumption per capita (\$2021 PPP/person/day)	2.55	220
Average value of non-ag asset holding (\$2021 PPP)	1423.19	220
Average distance to nearest market (km)	62.50	223
Average distance to nearest population center with 20000 (km)	20.26	223

Notes: The sample consists of Phone Survey households. Precipitation and HDD data were constructed using CHIRPS and CHIRTS.

Table 2: SSP Risk Perceptions in the Semi-arid AEZ

	Estimate	N
Self-reported exposure to climate risk		
<i>In the last year, % of rural SSPs reported:</i>		
Late onset of rains (any exposure)	19%	223
Flood or torrential downpour	32%	223
Temperatures above 40°C	27%	223
High winds and gusts	14%	223
Pest/disease outbreak	30%	223
Awareness and use of technologies and practice		
% of rural SSPs reporting being aware of hybrid seeds	29%	223
Of SSPs aware, % reporting use during the last season	72%	65
% of rural SSPs reporting being aware of inorganic fertilizer	83%	223
Of SSPs aware, % reporting use during the last season	94%	186
% of rural SSPs reporting being aware of pesticide/herbicide	65%	223
Of SSPs aware, % reporting use during the last season	92%	145
Climate information		
Top two trusted providers of climate information		
% of rural SSPs reporting radio/Tv	49%	223
% of rural SSPs reporting farmers' associations	42%	223
% of rural SSPs who received any climate information	35%	223

Of SSPs who received, % who reported acting on the information	52%	77
Of SSPs who did not act, reported reasons include:		
Not relevant to my farm	11%	37
Lack of viable or affordable options	24%	37
Risk Perceptions: % of rural SSP that agree or strongly agree with:		
Capabilities/Aspirations		
I am confident in myself as a farmer	93%	223
I would like my children to become farmers	84%	223
I am interested in changing or expanding to new economic activity	85%	223
Worldview/Fatalism:		
If misfortune is meant to strike my farm, I cannot avoid it	76%	223
I believe that future climate will be more and more unpredictable	90%	223
Risk attitudes/Future orientation:		
I am willing to forgo a profit opportunity in the short-run in order to benefit from potential profits in the long-run	88%	223
I consider myself a person who is willing to take risks in farming	92%	223
I am optimistic about the future	95%	223

Notes: The sample consists of Phone Survey households.

2.2 The Sub-Humid AEZ

Figure 6: Cassava mounds in Benue state 1-2 months before the beginning of the planting season (Fieldwork, March 2025)



Notes: Cassava is planted year-round in Nigeria's subhumid AEZ.

The sub-humid AEZ covers Nigeria's Middle Belt and parts of the southern Guinea savanna belt, including states such as Benue, Niger, Kogi, and Oyo. It is widely recognized as one of Nigeria's more productive agricultural regions, with rainfall commonly in the 1,000-1,500 mm range, a longer growing season, and strong potential for mixed crop and livestock systems. While 36% of ag hhs are located in favorable rainfall areas, nearly two-thirds (64%) are still in areas with borderline precipitation conditions. Most SSPs located in areas with less than 1 harmful degree days.

Livelihoods in the region are centered on small-scale farming, with a wide range of crops. The main crops planted include maize (62%), yam (37%), sorghum (36%), and cassava (35%). Average livestock holdings

are: 2.84 large ruminants, 5.04 small ruminants, and 8.53 poultry units. The ethnic composition of the zone is highly diverse, with Yoruba and related sub-groups particularly prominent, alongside Hausa-Fulani populations found across several states as both crop producers and pastoralists.

Table 3: SSP Measured Risk in the Sub-humid AEZ

	Estimate	N
Exposure to climate risk		

Precipitation during growing season		
Long-term (2005-24) average precipitation	959.7 mm	
Trend (2005-24) in average precipitation	Constant	
% of rural SSPs exposed to harmful precipitation (<480 mm)	0.0%	242
% of rural SSPs exposed to borderline precipitation (480-880 mm)	64.0%	242
% of rural SSPs exposed to favorable precipitation (>880 mm)	36.0%	242
Temperature		
Long-term (2005-24) average temperature	27.7 °C	
Trend (2005-24) in average harmful degree days >30° C (HDD)	Constant	
% of rural SSPs in locations with HDD <1 in 2024	55.8%	242
% of rural SSPs in locations with HDD 1-2 in 2024	42.1%	242
% of rural SSPs in locations with HDD >2 in 2024	2.1%	242
Forecasts (NiMet SCP)2026 growing season		
Precipitation	Moderate dry spells predicted for Oyo and Kogi states Mar-May 2026.	
Temperature	Means 34° C - 40° C in March-May.	
Population Vulnerability		
Total number of rural SSP HHs engaged in farming	7.2 MM	GHS W5
% of rural SSPs female-headed HHs	10%	239
Average landholding (ha)	1.41	227
Average livestock holding (TLUs, 1 cow=1TLU)	0.94	239
Average daily consumption per capita (\$2021 PPP/person/day)	3.07	239
Average value of non-ag asset holding (\$2021 PPP)	1654.16	239
Average distance to nearest market (km)	73.65	242
Average distance to nearest population center with 20000 (km)	18.96	242
Notes: The sample consists of Phone Survey households. Precipitation and HDD data were constructed using CHIRPS and CHIRTS.		

Table 4: SSP Risk Perceptions in the Sub-humid AEZ

	Estimate	N
Self-reported exposure to climate risk		
<i>In the last year, % of rural SSPs reported:</i>		
Late onset of rains (any exposure)	35%	242
Flood or torrential downpour	14%	242
Temperatures above 40° C	33%	242
High winds and gusts	7%	242
Pest/disease outbreak	19%	242
Awareness and use of technologies and practice		
% of rural SSPs reporting being aware of hybrid seeds	23%	239
Of SSPs aware, % reporting use during the last season	75%	55
% of rural SSPs reporting being aware of inorganic fertilizer	77%	237
Of SSPs aware, % reporting use during the last season	90%	182
% of rural SSPs reporting being aware of pesticide/herbicide	71%	237
Of SSPs aware, % reporting use during the last season	92%	168
Climate information		
Top two trusted providers of climate information		
% of rural SSPs reporting radio/Tv	52%	242
% of rural SSPs reporting farmers' associations	31%	242
% of rural SSPs who received any climate information	38%	242

Of SSPs who received, % who reported acting on the information	50%	92
Of SSPs who did not act, reported reasons include:		
Not relevant to my farm	22%	46
Lack of viable or affordable options	33%	46
Risk Perceptions: % of rural SSP that agree or strongly agree with:		
Capabilities/Aspirations		
I am confident in myself as a farmer	96%	241
I would like my children to become farmers	66%	241
I am interested in changing or expanding to new economic activity	89%	241
Worldview/Fatalism:		
If misfortune is meant to strike my farm, I cannot avoid it	72%	241
I believe that future climate will be more and more unpredictable	81%	241
Risk attitudes/Future orientation:		
I am willing to forgo a profit opportunity in the short-run in order to benefit from potential profits in the long-run	88%	241
I consider myself a person who is willing to take risks in farming	88%	241
I am optimistic about the future	95%	241

Notes: The sample consists of Phone Survey households.

2.3 The Humid AEZ

Figure 7: Mango and palm oil trees in Ebonyi state
(Fieldwork, March 2025)



The humid AEZ covers much of southern Nigeria's forest and coastal belt, including states such as Ebonyi, Ogun, and Rivers, and is characterized by high rainfall, dense vegetation, and generally favorable moisture conditions for crop production. In the sample, 89.6% of rural SSPs are located in areas with favorable precipitation conditions, while only 10.4% are in borderline rainfall areas. Temperature conditions also appear relatively less severe, with all SSPs located in areas with less than one harmful degree days.

Livelihoods in the region are centered on small-scale farming with smaller average plots than other AEZs and planting cassava (86%), maize (43%), and yams (43%). Average livestock holdings in the sample are also smaller than in the sub-humid and semi-arid zones, averaging 0.1 large ruminants, 0.97 small ruminants, and 5.40 poultry units though average daily consumption per capita

(\$4.75 PPP) is somewhat higher than in the other AEZs. The zone is socially and ethnically diverse, including major groups across the southwest and the broader southern forest belt.

Table 5: SSP Measured Risk in the Humid AEZ

	Estimate	N
Exposure to climate risk		
Precipitation		
Long-term (2005-24) average precipitation (mm)	1466.3	230
Trend (2005-24) in average precipitation	Constant	
% of rural SSPs exposed to harmful precipitation (< 480 mm)	0.0%	230
% of rural SSPs exposed to borderline precipitation (480-880 mm)	10.4%	230

% of rural SSPs exposed to favorable precipitation (> 880 mm)	89.6%	230
Temperature		
Long-term (2005-24) average temperature	27.5 °C	
Trend (2005-24) in average harmful degree days (HDD) trend	Constant	
% of rural SSPs in locations with HDD <1 in 2024	100%	230
% of rural SSPs in locations with HDD 1-2 in 2024	0%	230
% of rural SSPs in locations with HDD >2 in 2024	0%	230
Forecasts (NiMet SCP)2026 growing season		
Precipitation	Ogun state predicted to have a severe dry spell March-May 2026.	
Temperature	Between 28°C and 31°C April and May. Most states temperatures up to 0.6°C above normal in May.	
Population Vulnerability		
Total number of rural HHs engaged in farming	9.1 MM	GHS W5
% of rural SSPs female-headed HHs	30%	229
Average landholding (ha)	0.56	207
Average livestock holding (TLUs, 1 cow=1TLU)	0.20	229
Average daily consumption per capita (\$2021 PPP/person/day)	4.75	229
Average value of non-ag asset holding (\$2021 PPP)	2827.40	229
Average distance to nearest market (km)	53.10	230
Average distance to nearest population center with 20000 (km)	20.27	230

Notes: The sample consists of Phone Survey households. Precipitation and HDD data were constructed using CHIRPS and CHIRTS.

Table 6: SSP Risk Perceptions in the Humid AEZ

	Estimate	N
Self-reported exposure to climate risk		
<i>In the last year, % of rural SSPs reported:</i>		
Late onset of rains (any exposure)	50%	230
Flood or torrential downpour	7%	230
Temperatures above 40°C	59%	230
High winds and gusts	12%	230
Pest/disease outbreak	16%	230
Awareness and use of technologies and practice		
% of rural SSPs reporting being aware of hybrid seeds	7%	215
Of SSPs aware, % reporting use during the last season	57%	14
% of rural SSPs reporting being aware of inorganic fertilizer	75%	215
Of SSPs aware, % reporting use during the last season	78%	161
% of rural SSPs reporting being aware of pesticide/herbicide	60%	207
Of SSPs aware, % reporting use during the last season	78%	124
Climate information		
Top two trusted providers of climate information		
% of rural SSPs reporting radio/Tv	59%	230
% of rural SSPs reporting farmers' associations	23%	230
% of rural SSPs who received any climate information		
Of SSPs who received, % who reported acting on the information	43%	79
Of SSPs who did not act, reported reasons include:		

Not relevant to my farm	44%	45
Lack of viable or affordable options	24%	45
<u>Risk Perceptions: % of rural SSP that agree or strongly agree with:</u>		
<i>Capabilities/Aspirations</i>		
I am confident in myself as a farmer	92%	230
I would like my children to become farmers	51%	230
I am interested in changing or expanding to new economic activity	80%	230
<i>Worldview/Fatalism:</i>		
If misfortune is meant to strike my farm, I cannot avoid it	60%	230
I believe that future climate will be more and more unpredictable	77%	230
<i>Risk-taking/on/future orientation:</i>		
I am willing to forgo a profit opportunity in the short-run in order to benefit from potential profits in the long-run	87%	230
I consider myself a person who is willing to take risks in farming	85%	230
I am optimistic about the future	91%	230

Notes: The sample consists of Phone Survey households.

Compared to the most recent Agricultural Census, our phone survey sample has fewer female-headed households in the semi-arid (9%) and semi-humid (10%) AEZs, and more in the humid AEZ (30%) than the national average of 15% from the GHS 2023-24. Average cultivated areas are slightly lower in the semi-arid and sub-humid AEZs, and much lower in the humid AEZ, in the phone sample than the 0.91 ha estimate in the GHS 2023-24. As we focused on households who report cultivating crops, perhaps not surprisingly the sample households also have below the national average 0.72 TLU (GHS 2023-24), particularly in the semi-humid and humid AEZs where there may be more crop only households compared to the semi-arid AEZ. Overall, the NASC (2024) reports livestock assets declining across all AEZs, with ownership falling from 70% (1993) to 48% (2022).

3 ACROSS AEZ AND GENDER RESULTS

The distribution of Phone Survey respondents by AEZ and gender is as follows: 223 (32%), 242 (35%), and 230 (33%) by Semi-arid, Subhumid, and Humid AEZ, respectively, and 547 (79%) and 148 (21%) by male and female, respectively. In this section, all tables and figures come from Phone Survey data unless otherwise noted.

The Phone Survey reveals a divergence between meteorological records and farmers' self-reports of climate hazards. While satellite data confirm increasing rainfall variability and high temperatures, most Phone Survey respondents reported not experiencing major climate shocks over the past five years, as shown in Figure 8. Over half of households experiencing meteorological drought conditions do not self-report being affected (see Appendix 5). This under-reporting is consistent with patterns observed in other African countries. In one of our studies on farming in Ethiopia and Malawi, we found that 38% of households report a drought experience despite no meteorological measure of exposure to abnormally low cumulative rainfall, and that farmers with more plots and diversified livestock holdings are less likely to report measured drought events, indicating that assets may buffer hazard sensitivity (Mayorga et al., 2026).

Regression results in Appendix 5 show female-headed households display marginally higher false positive (self-reported but not meteorologically measured events) rates for rainfall-based drought. Larger households and livestock holdings are associated with fewer false positive reporting. This suggests that larger (and more diversified) asset bases may provide resilience and sensitivity buffers. More extension access is association with less false negative (not self-reporting meteorological measured events) suggesting extension services may be linked to greater recognition of drought impacts when they occur.

3.1 Self-reported Exposure and Future Expectations of Climate Hazards

Not surprisingly, self-reported exposure varies across AEZ and hazard, though very high temperatures are the most commonly reported across all AEZs (see Figure 8). 70% of households in the coolest AEZ (humid) reported occasional or regular exposure to heat above 40°C, compared with 34% in the semi-arid AEZ, the zone with by far the most days above 40°C. The lower percent of respondents indicating “regular” for very high temperatures in the semi-arid AEZ relative to the sub-humid and humid AEZs, could reflect that these occurrences are not absolute measures, but rather perceptions relative to the norm. Prior exposure may have prompted adaptive behaviors that influence self-reports. Some baselines are more fixed, however, and certain decisions are only relevant above or below a threshold: heat above a plant or animal biophysical limit, or a cost, liquidity, or credit limit. The thresholds themselves are reported in Appendix 3. Regarding high rainfall, “Regular” torrential rainfall received a similar number of responses across AEZ, for regular occurrence, though “never” was highest in the Humid AEZ where there was massive, though not AEZ-wide, flooding in 2022 and 2024.

Among respondents, women are more likely than men to report being regularly affected by drought and extreme heat: 30% versus 15%, and 36% versus 23%, respectively (see Figure 9). Newer work across 31 African countries finds that women are also more likely than men to be engaged in agricultural employment in drought-prone areas and in areas affected by heat waves (Nico & Azzari, 2024). Work in Burkina Faso found that, in response to high temperatures men reduce work intensity more than women and shift more hours of outdoor work to the cooler morning and evening hours than women, and that women's Physiological Strain Index worsened (Eggert et al., 2025). There is no evidence that being female confers a physiological advantage in withstanding extreme heat; the evidence is that it increases exposure and reduces adaptive options (Yanovich et al., 2020; Giersch et al., 2025).

Figure 8: Percentage of households affected by climate events over the past 5 years

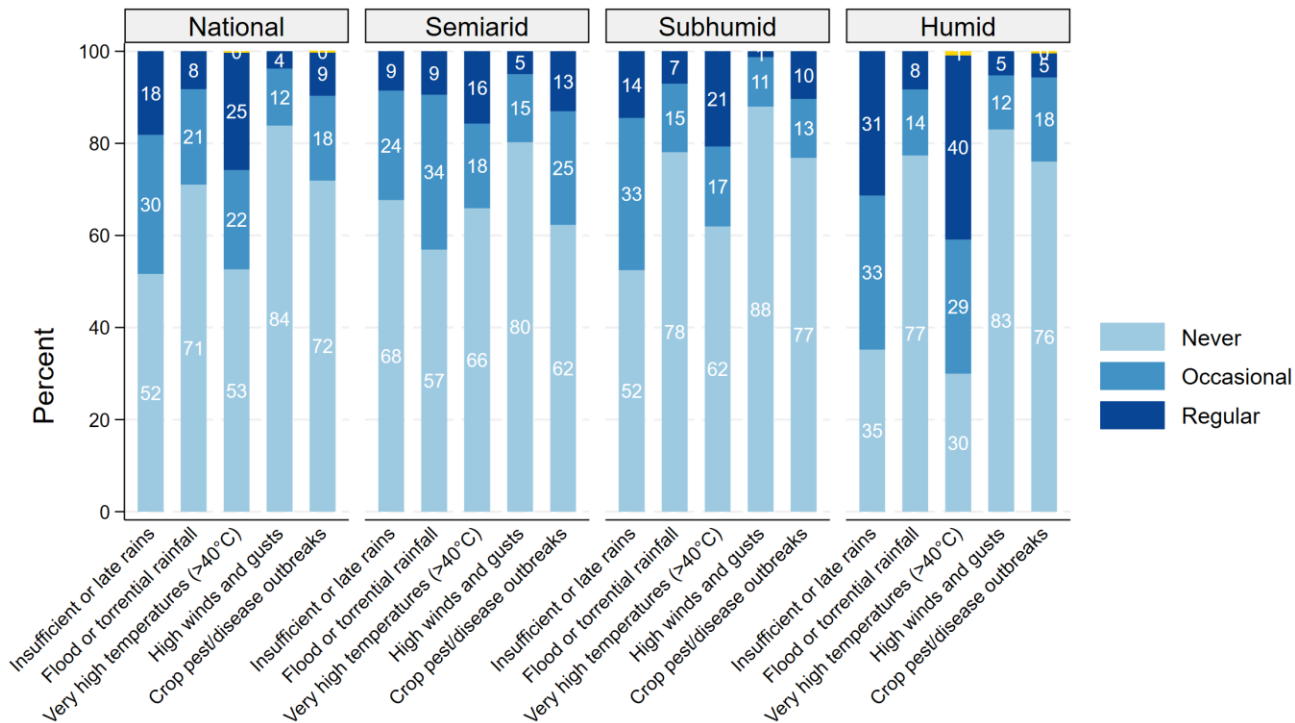
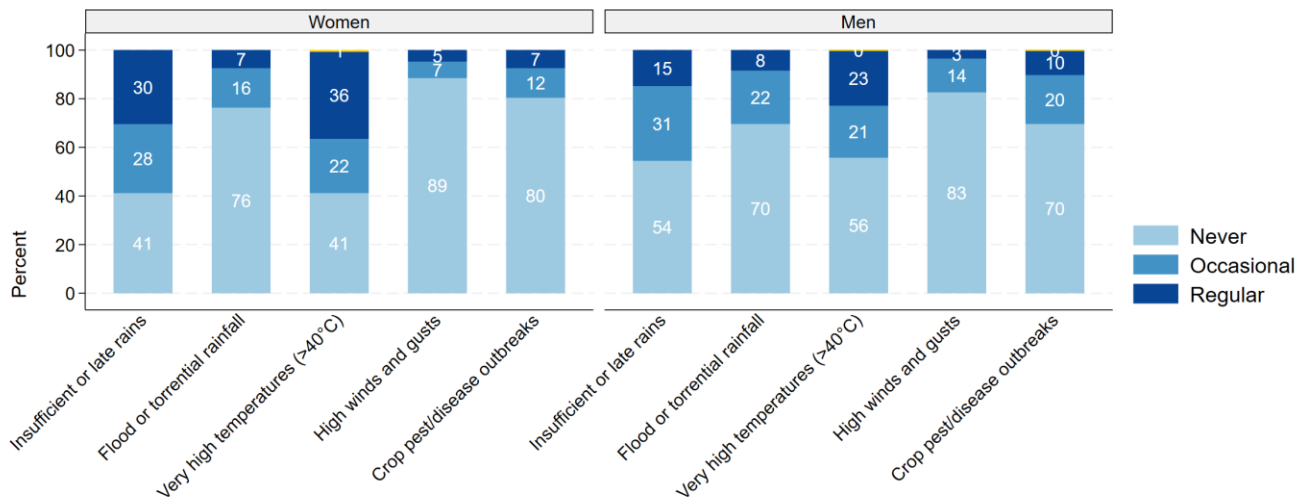


Figure 9: Percentage of respondents by gender affected by climate events over the past 5 years



When asked about the likelihood of future hazards, expectations varied by event type, but with seemingly less across AEZ and gender variance than self-reported exposure. Figure 10 shows that 42% of households considered pest and disease outbreaks likely between 31% and 53% by AEZ, and only about a third expected drought in the next two years. Women are more likely than men to consider drought and pest/disease outbreaks likely, as shown in Figure 11.

Figure 10: Among affected households, percentage expecting future occurrence of climate events by AEZ

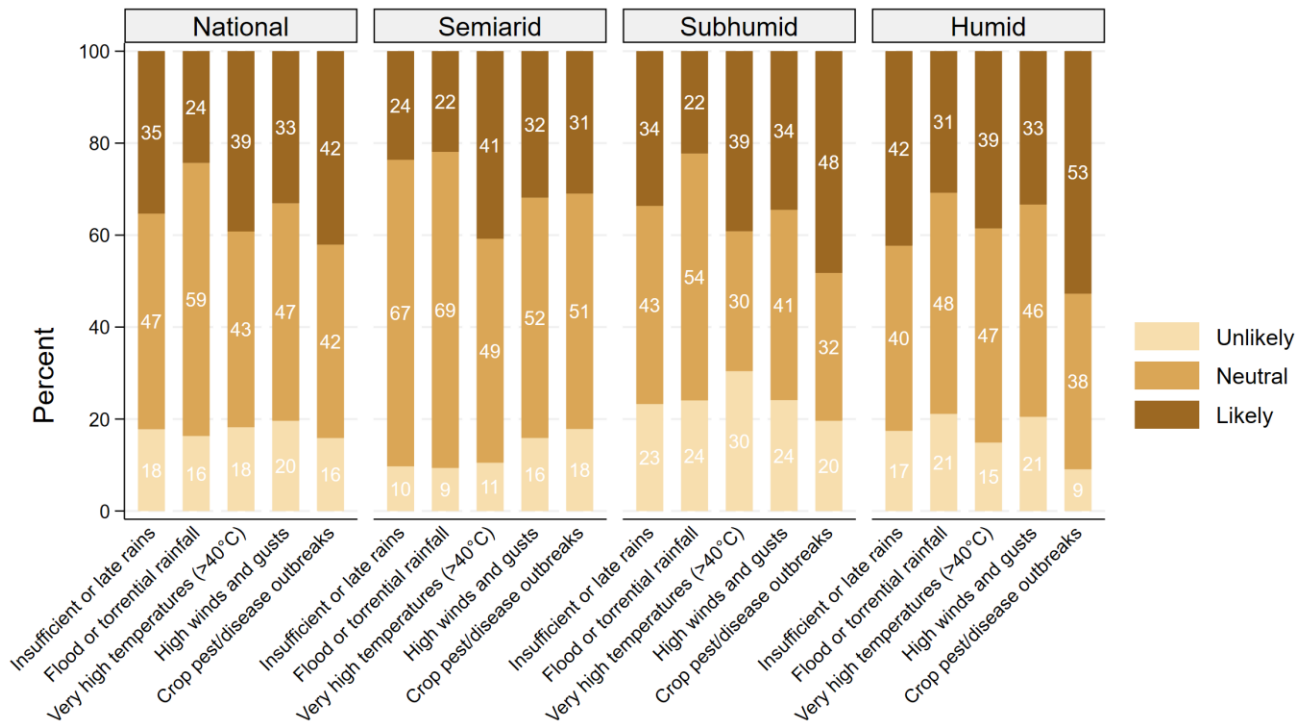
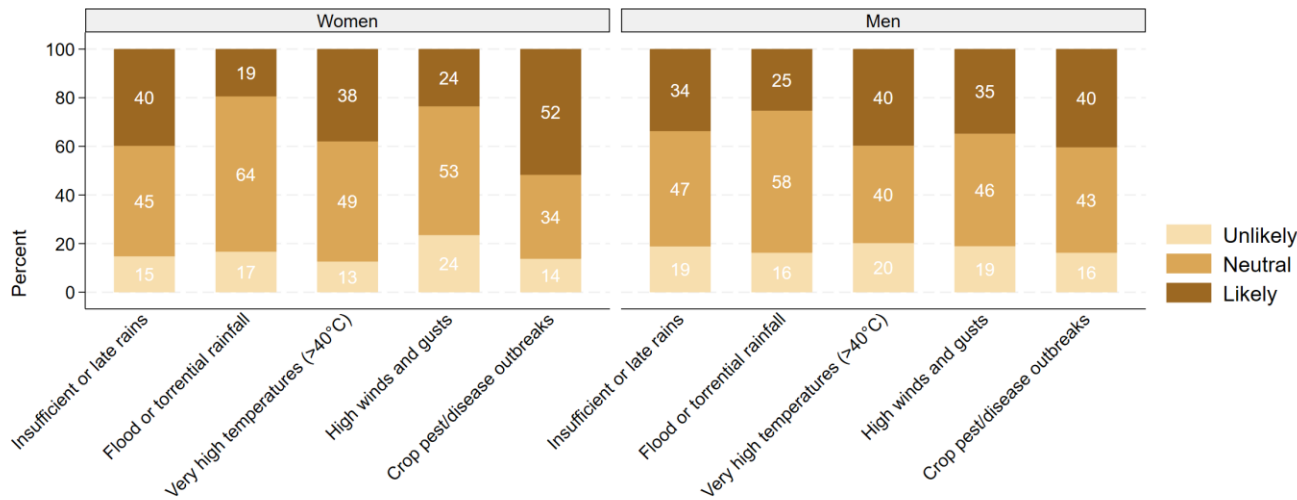


Figure 11: Among affected households, percentage expecting future occurrence of climate events by gender



Roughly 24-42% of respondents across all AEZs expect more future exposure to any given climate hazard. That means more than half do not. This matters for message design: for the majority who do not anticipate rising climate risk, messaging that offers behavior-change incentives beyond climate risk – managing market risk, for example, or straightforward productivity gain – is likely to be more widely taken up than messaging built on a worsening climate the recipient does not expect.

3.2 Awareness and Adoption of Climate Adaptation Technologies, Practices, and Services

Figure 12: Cassava storage in Ebonyi state (Fieldwork: March 2025)

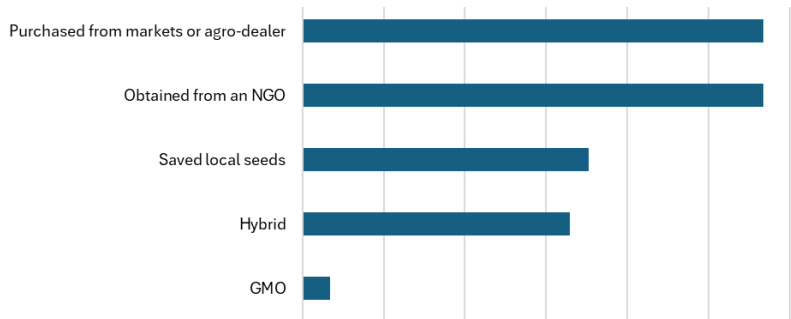


Hansen et al. (2019) review literature on the adoption of technologies, including stress-adapted germplasm, conservation agriculture, diversified production systems, and the use of inputs such as fertilizers and pesticides. They find that these technologies can stabilize agricultural production and farmer incomes under some circumstances, but their adoption rates remain low. Multiple factors are cited as limiting uptake, including unavailability, insufficient knowledge of certain practices, and labor shortages at critical times during the growing season (Giller et al., 2009; Kassam et al., 2009).⁵ We find that the biggest barrier, at least for hybrids, is awareness.

3.2.1 Measurement, Use, and Farmer Understanding of Improved, Hybrid, and GMO seeds

Improved seeds can enhance productivity growth (Takeshima et al., 2025), with stress-tolerant varieties outperforming standard cultivars under climate stress (Hansen et al., 2019). Below, we show reported awareness and adoption rates, reasons for not adopting hybrids seeds, farmer expectations of seed technologies, and other farmer responses.

Figure 13: What is an improved seed to you?



Notes: Source: Focus Group Discussions. Sample: 88 of the 96 farmers who reported knowing about improved seeds. The other 8 are excluded: 5 participants in a Kebbi State FGD who knew of millet improved seeds distributed by government, extension services, or farmers’ associations, and 3 participants in a Benue State FGD who knew of improved seeds distributed by government.

Despite decades of using the term “improved variety” in farm household surveys, there appears to be a mismatch between a farmers’ understanding (acquisition source) and the technology supplier meaning (sourced from a breeding program). In the focus group discussions (FGDs), participants were asked what an improved seed meant to them. Most respondents associated improved seeds with the source, whether purchased from markets or agro-dealers or obtained from an NGO, while a third identified improved seeds as hybrids, as shown in Figure 13. One farmer in a Niger state FGD claimed that

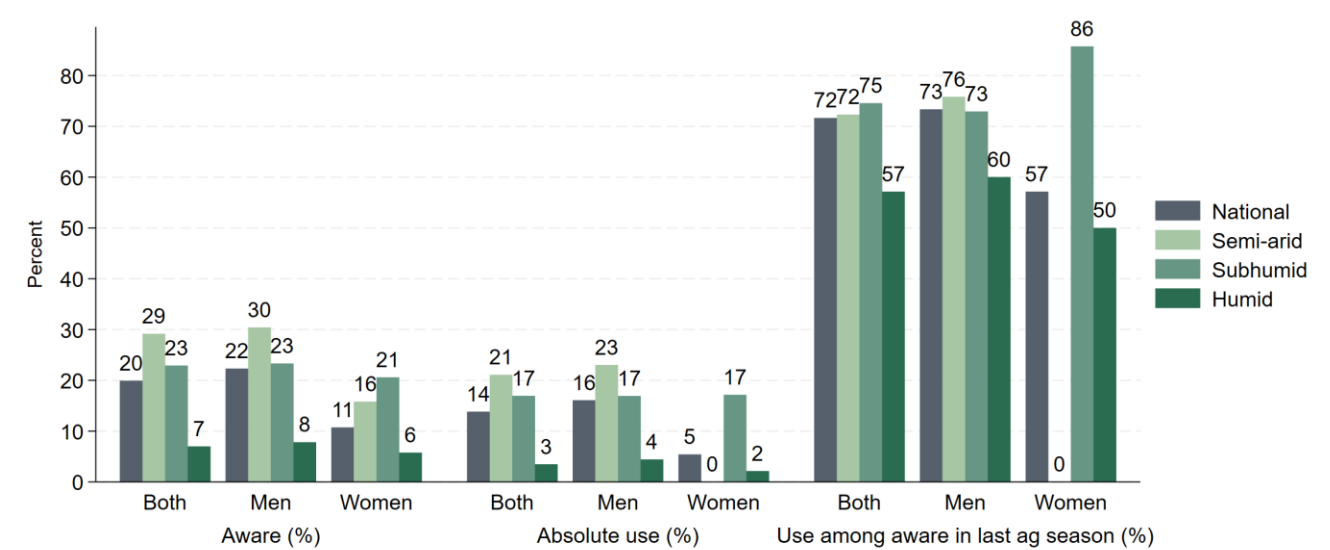
⁶ The desk review began in the first semester of 2023, before the 2023-24 LSMS-ISA GHS (Wave 5) was published in November 2024.

“We have heard about improved seeds but have not used it or been given it... I plant CP [and other rice varieties]”. This farmer was using an improved rice seed variety, CP, but was unaware that it was an improved seed.

Hybrid seeds

Figure 14 illustrates farmers’ knowledge and use of hybrid seeds. Only 20% of respondents reported knowing about hybrid seeds, among which, uptake was high: 72% reported using hybrid seeds in the last agricultural season, compared with 28% who did not. This suggests that once farmers know about hybrid seeds, a majority choose to adopt them. About 14% of farmers in the phone survey report using hybrid seeds, a share higher than the approximately 5% of self-reported improved seeds adoption from LSMS-ISA/GHS 2023-24.

Figure 14: Knowledge and use of hybrid seeds



Awareness and subsequent use of hybrids are both lower among women than men: 11% aware and 57% use among the aware, against 22% aware and 73% use for men. Disaggregating by gender and AEZ sharpens this. Of the 16% of women in the semi-arid AEZ who were aware of hybrid seed, none used it in either the last or the current agricultural season. Social and structural inequalities in access to improved varieties and productive resources appear more pronounced in the semi-arid AEZ than elsewhere, and this is the clearest case in the report where awareness alone is demonstrably insufficient for uptake.

Language is relevant in measuring adoption of hybrids through surveys. Over 500 indigenous languages are spoken across Nigeria. LSMS-ISA data suggest that around ten are primarily spoken in the home and that there is no single language common to SSPs (see Table 7). Some languages fold "hybrid" into a broader existing category rather than distinguishing it. In Yoruba the term for hybrid, "irugbin arabara", is also used for improved seed more broadly. In Hausa, hybrid seeds are "iri dan aure", which translates as "seed sourced from marriage". Others, such as Pidgin, lack an equivalent concept altogether. A competing and non-exclusive explanation for low humid-AEZ awareness is crop mix: two of the three largest crops by hectares planted in

that zone are tubers – cassava (86%), maize (43%), and yams (43%) per 2023-24 GHS estimates – for which hybrid options are fewer.

Figure 15: Farmer drying rice in Niger state
(Fieldwork: March 2025)



Table 7: Primary language besides English spoken in rural ag households

Primary language spoken in household	% of LSMS individual sample of rural ag household members
Hausa	39.4
Igbo	10.7
Fulfulde	5.7
Yoruba	3.2
Tiv	1.7
Kanuri	0.8
Only English	0.8
Ijaw	0.5
Edo	0.3
Pidgin	0.1
Others / missing	37.1
N	

Note: Source is LSMS-ISA GHS Wave 3 (2015-16). Observations are weighted by survey weights adjusted by rural-urban population.

Table 8: Farmer expectations regarding use of hybrids

Expectation	Yield	Profit	Labor time	Non-labor inputs
Increase %	93	96	53	51
Decrease %	2	2	38	37
No change %	4	1	8	11
Don't know %	1	1	1	1

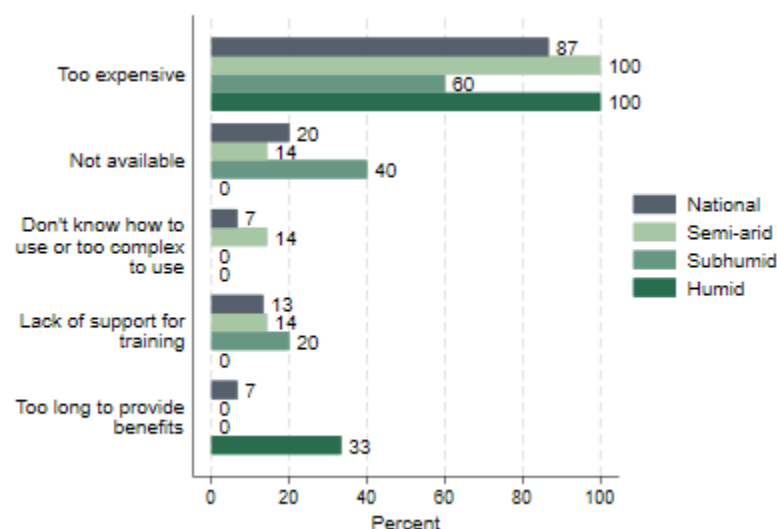
Notes: N=134 consisting of all but one of the 135 respondents aware of hybrids seeds.

change. Farmers in the FGDs shared similar expectations about time savings and productivity gains. One farmer from Niger state explained: “*The traditional rice variety usually takes about 8 months to mature [...] With improved [hybrid] seeds, we can plant rice in May and harvest in June or July, within 3 months.*”

Table 8 summarizes farmers’ expectations around adopting hybrid varieties among the aware. Farmers primarily anticipate positive outcomes: 93% expect yield to increase, and 96% expect higher profits. Expectations around input use are mixed. Just over half of respondents expect increases in labor time (53%) and non-labor input use (51%), while 38% and 37% expect these to decrease. A small share report no expected

Despite almost all respondents expecting hybrids to increase yield and profit, among those who are aware of hybrid seed, the most common reason respondents give for non-adoption is that they are too expensive (87%), as shown in Figure 16. This suggests that available resources (e.g., credit) was a limiting factor, and perhaps labor given that a majority of respondents expected hybrid seed to increase labor time. Unavailability was the second most cited factor at 20%. There is considerable variation, however, across AEZ, with complexity and the time to realize benefits the second most cited reason in the Semi-arid AEZ.

Figure 16: Reasons for not using hybrid seeds in the current year (never used or dis-adopting)



Notes: Sample consists of respondents who were aware of hybrid seeds and not using or not planning to them in the 2025 growing season (N=15).

Genetically Modified Organisms (GMOs)

We find a high willingness to adopt genetically modified crop varieties, conditional on awareness. Overall, only 23% of respondents said they were aware of GMO seeds, consistent with other studies in Tanzania and Nigeria that found very low awareness and knowledge of GMO crop technology (Lewis et al., 2010; Obi-Egbedi et al., 2020). But among the aware, 89% of farmers reported being willing to plant a GMO crop, while only 11% expressed reluctance. (Notable cross-AEZ differences are in blue font).

These results suggest a high level of openness to crop technologies that promise productivity gains. Although knowledge is particularly low in the humid AEZ, a stated willingness to adopt based on performance is high (85%), though not as high as the other AEZs (95%).

Table 9: Knowledge and willingness to use GMO seeds by AEZ

	National		Semi-arid		Sub-humid		Humid	
	Yes %	N	Yes %	N	Yes %	N	Yes %	N
Knowledge of GMO seeds	23	695	35	223	24	242	9	230
If aware, willingness to plant GMO seeds	89	148	86	76	93	54	89	18
If aware, willingness to eat produce of a GMO crop	89	157	92	78	91	58	71	21
If told that a new seed variety had been scientifically altered in a lab to have higher pest resistance and produce a greater yield, would plant it	91	694	95	223	95	241	85	230

3.2.2 Non-seed Climate Adaptation Technologies and Practices

Nationally, knowledge of inorganic fertilizers (78%), and herbicides or pesticides (65%) is higher than for hybrids (20%), as shown in Table 10. Among those with knowledge, reported use in the last agricultural season is high (88% for both). Awareness is low for management-related practices relative to input technologies, however, such as changing crops (10%), altering land or soil management (10%), and adjusting water management (4%). Actual use of these practices is also lower, where 70-83% of knowledgeable respondents adopted changes. Senyolo et. al., 2017, suggests that purchasable inputs are less knowledge- and labor-intensive than management practices, which makes the adoption of those inputs easier to scale. Knowledge and use of adaption strategies around changing crops and land and soil management is particularly low in the semi-arid and sub-humid AEZ. Knowledge and use of water management strategies is uniformly low.

Figure 17: Urea being sold in market in Kebbi state (Fieldwork: March 2025)



Focus group discussions did, however, suggest adaptation. One farmer from an Ebonyi state explained: “I adapt to the late rains and early stopping rains by changing planting timing.”

SSPs similarly expect inorganic fertilizer and pesticides or herbicides to increase yield and profit (98% of inorganic fertilizer, 96% for herbicide/pesticide). Two-thirds of inorganic fertilizer users expect labor time to increase, possibly due to the additional effort required for application and harvesting the surplus crop growth. Pesticide users are evenly split between expecting labor time to increase (47%) and decrease (48%), perhaps reflecting a trade-off between increased herbicide/pesticide application and reduced weeding labor. There is very little cross-AEZ variation.

Table 10: Awareness and use of non-seed technologies and practices by AEZ

	National		Semi-arid		Sub-humid		Humid	
	Percent	N	Percent	N	Percent	N	Percent	N
<i>Knows about inorganic fertilizer</i>	78	678	83	223	77	240	75	215
Used inorganic fertilizer previous ag season	88	529	94	186	90	182	78	161
Uses or plans to use inorganic fertilizer in current ag season	91	529	95	186	93	182	84	161
<i>Knows about pesticides and herbicides</i>	65	678	65	223	71	240	60	215
Used pesticides and herbicides in previous ag season	88	437	92	145	92	168	78	124
Uses or plans to use pesticides and herbicides in current ag season	92	437	97	145	94	168	84	124
<i>Knows about changing what to plant</i>	10	678	05	223	07	240	20	215
Changed what they plant in previous ag season	70	71	75	12	88	16	63	43
Changed or plans to change what they plant in current ag season	73	71	75	12	88	16	67	43
<i>Knows about changing how to manage their land/soil</i>	10	678	04	223	08	240	18	215
Changed how they manage their land/soil in previous ag season	83	64	75	8	89	18	82	38
Changed or plans to change how they manage their land/soil in current ag season	81	64	88	8	83	18	79	38
<i>Knows about changing how to manage water</i>	4	678	04	223	04	240	5	215
Changed how they manage water in previous ag season	76	29	90	10	67	9	70	10
Changed or plan to change how they manage water in current ag season	93	29	100	10	100	9	80	10

Table 11: Expectation of changes due to inorganic fertilizer use by AEZ

	National		Semi-arid		Sub-humid		Humid	
	Percent	N	Percent	N	Percent	N	Percent	N
<i>Yield</i>								
Increase	98	529	99	186	99	182	98	161
<i>Profit</i>								
Increase	98	529	100	186	99	182	96	161
<i>Labor time</i>								
Increase	67	529	67	186	70	182	64	161
<i>Non-labor inputs</i>								
Increase	74	529	77	186	73	182	71	161
Decrease	17	529	19	186	19	182	12	161
No change	9	529	4	186	8	182	16	161
Don't know	1	529	1	186	0	182	1	161

Table 12: Expectation of changes due to herbicide/pesticide use by AEZ

	National		Semi-arid		Sub-humid		Humid	
	Percent	N	Percent	N	Percent	N	Percent	N
<i>Yield</i>								
Increase	96	437	97	145	95	168	95	124
<i>Profit</i>								
Increase	95	437	97	145	95	168	94	124
<i>Labor time</i>								
Increase	47	437	51	145	42	168	48	124
<i>Non-labor inputs</i>								
Increase	64	437	59	145	61	168	73	124

3.2.3 Understanding the Role of Weather Information and Advice on Adaptation

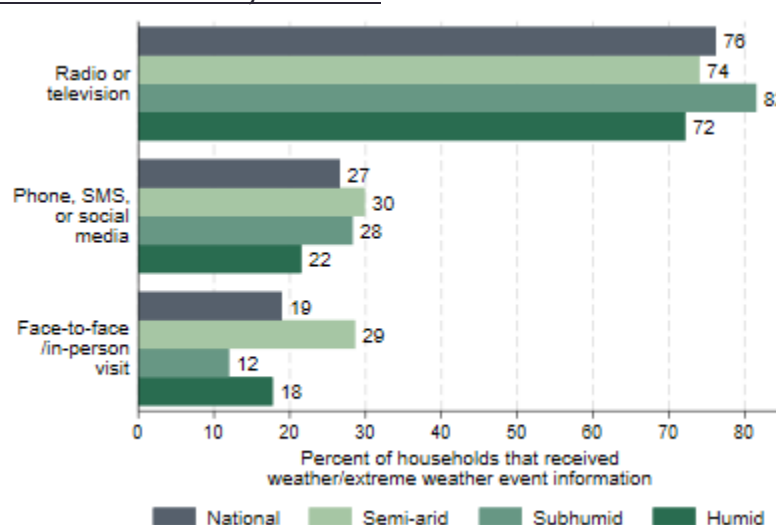
The most relevant weather information is timely and highly localized. While some SSA meteorological service may lack capacity (Vaughn et al., 2019), the NiMet issues annual season climate predictions tailored to farming, though it is unclear how frequently updated forecasts are broadcast. Limited integration of farmer priorities into the design of climate services, along with weak coordination among NGOs, extension systems, and national agencies, may form additional barriers (Hansen et al., 2019).

But at 17% of respondents, the National weather service scores poorly on trust, just above peer farmers (14%), and NGOs (12%), as shown in Table 13. Broadcast media is the most trusted source of climate and weather information in rural areas. Among the 695 respondents, radio and television programs are the most trusted providers (54%), followed by farmers' groups or cooperatives (30%) and government extension services (29%). The most recent Agricultural Census survey (NASC, 2024) reports that extension services are accessible in only 55% of agricultural communities.

Table 13: Trust in weather/extreme weather event information sources

Source of weather/extreme weather event information	National %	Semi-arid %	Subhumid %	Humid %
Government extension service	29	41	30	16
NGO	12	20	12	03
Farmers Group/Association/Co-Op	30	42	31	17
Farmer field school (FFS) or lead farm	10	19	9	3
Other peer farmers	14	24	11	8
Trader, market stakeholder, or private	10	20	9	1
National Weather Service	17	16	13	23
Radio or television program	54	49	52	59
Other	4	0	0	11
N	695	223	242	230

Figure 18: In what form did you receive weather/extreme weather event risk information?



Notes: N=248, the number of households surveyed that received weather information in the last 12 months (36% of all 695 respondents).

warnings in the semi-arid AEZ (see Figure 19). The type received varies by AEZ in a way that broadly tracks the dominant local hazard. Short-range forecasts were more common than long-range ones, but still reached under a quarter of SSPs.

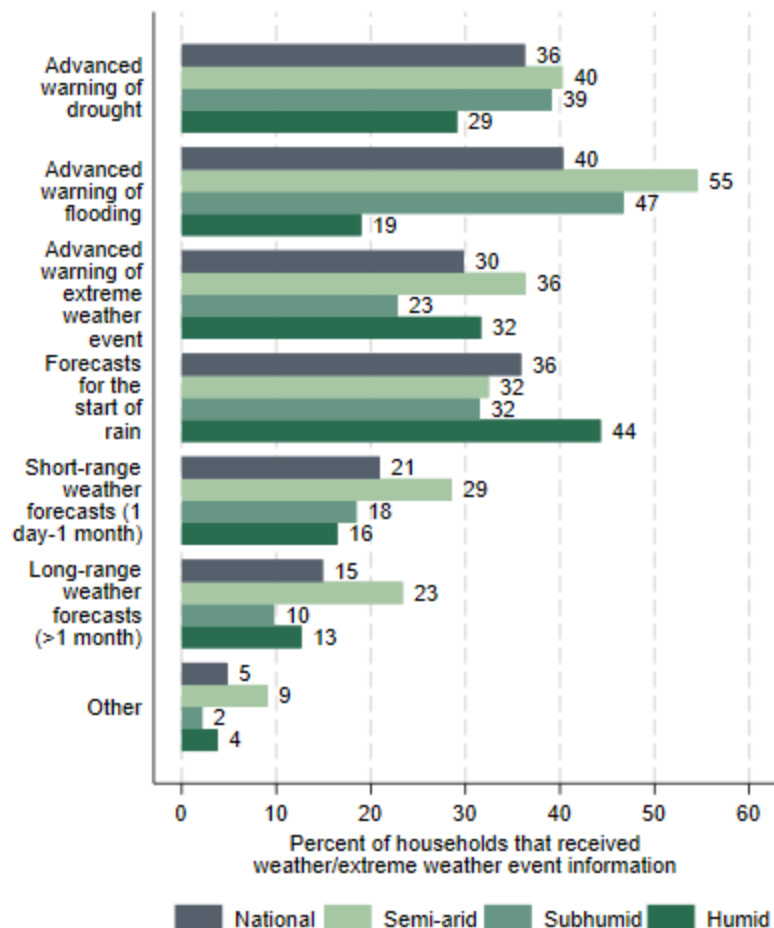
Whose information actually moved farmers to act? Whom SSPs trust and whose information they act on are not the same thing, and the gap is informative. Government extension, farmers' groups, and the National Weather Service were the providers most likely to influence farmers to act (see Table 14). Private extension, farmer field schools, peer farmers, and traders were least likely to.

What was the information used for? Among households who acted on weather information received in the last 12 months, 58-94% used it to change their planting time (see Figure 20). Far fewer changed income strategies

Traditional sources continue to dominate reach as well as trust: across NGA AEZs, 72-82% of SSPs who received information got it by radio or television, while only 12-29% report delivery during an in-person visit (see Figure 18). It is not clear whether low sourcing from face-to-face and extension services reflects availability or choice. In NGA, in-person sourcing is low across AEZs, yet trust in government extension and farmers' groups is high – which points to access rather than trust as the binding constraint. NASC (2024) reports extension services are accessible in only 55% of agricultural communities, which is consistent with that reading.

What kind of information did NGA SSPs receive? Fewer than half of SSPs received advance notice of any given weather event, the one exception being flood

Figure 19: Types of weather/extreme weather event risk information received



or relocated. This is the strongest single argument in the report for prioritizing immediacy: the information-to-action pathway that actually functions is the short one.

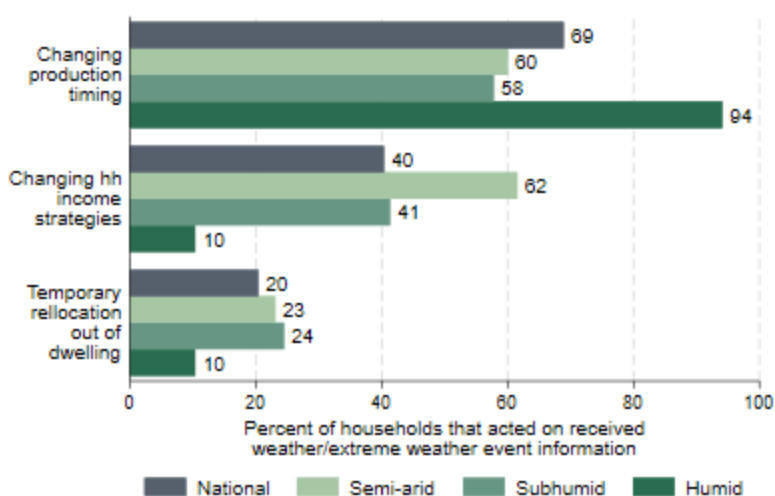
Notes: N=248, consisting of the households surveyed that received weather information in the last 12 months (37% of 695).

Table 14: Weather/extreme weather event information provider most likely to influence action

Weather/extreme weather event information provider	National %	Semi-arid %	Sub-humid %	Humid %
Government extension	34	33	50	15
Farmers' group / co-op	28	43	17	26
National Weather Service	27	10	26	47
Farmer field school (FFS) or lead farmer	3	5	2	0
Trader or private company	3	3	4	0
Private extension	2	5	0	0
Other peer farmer	2	0	0	6
Other	3	3	0	6
N	120	40	46	34

Note: Samples are the number of respondents that received weather information and acted on it.

Figure 20: How was the weather/extreme weather event information used?



Women are significantly less likely than men to receive weather risk information (see Table 15). The difference in acting on information once received is not statistically significant in this sample. Women report receiving information less often but are no less likely to act on it, and the productivity gain from the first packet of improved seed is larger when starting from a lower baseline (Anderson et al., 2017). Decades of evidence establish that female SSPs have less access to productive resources: lower quality plots, poorer soil, fewer improved inputs. The marginal return to closing the information gap for women may therefore exceed the marginal return to reaching men. Where structural barriers are

deepest, awareness is not sufficient for uptake, and information alone will not close the gap.

Attention is a scarce resource. If weather information is too cognitively demanding to use, ignoring it can be a rational decision rather than a failure of the recipient. The 52% non-action rate is therefore better read as a farmer problem, which is also the reading most consistent with this report’s central argument that behavior follows perceived rather than measured risk.

Table 15: Reception and use of weather/extreme weather event information by gender

	Both		Women		Men		Difference
	Share	N	Share	N	Share	N	
Received weather information	0.36	695	0.23	148	0.39	547	-0.16**
Acted on weather information	0.48	248	0.38	34	0.50	214	-0.12

Notes: Differences are calculated as the women’s share minus the men’s share. Statistical significance is based on two-sided t-tests: *** p<0.01; ** p<0.05; * p<0.10.

There are AEZ differences around trusted sources of weather information, and reasons

for not acting on information: the Humid AEZ (southern-most) is most unique in Nigeria. Trust was big reason for not acting on climate information, highlighting the importance of community leaders or other influential allies for messaging in rural communities (19% in humid AEZ, 8% in sub-humid AEZ). In Nigeria, radio or television program is the most trusted weather information source across all AEZs, followed by Farmers’ group / association / co-op and Government extension service in the semiarid and sub humid AEZ. The National Weather service (Nimet) is the second most trusted in the humid AEZ. Coupled with the most cited “lack of relevance,” the NiMet may help localize information with rainfall predictions for 774 local government areas. NiMet’s SCP in 2026 included temperature predictions for selected areas within all 36 states, rainfall predictions for 774 local government areas, and predictions of the onset of the rainy season and growing season cessation dates for different regions of the country. Advisories are often tied to seasonal (longer-term) recommendations to plant drought-resistant or early maturing varieties, or in the case of livestock, administering vaccinations.

Among the 248 respondents who had recently received climate information, a majority (52%) did not act on it (see Table 15). The most commonly cited reason was that the info was irrelevant to their farm (see Table 16). This pattern is perhaps not surprising, since broadcast information from the radio or TV - the most trusted source - is unlikely to be spatially very targeted.

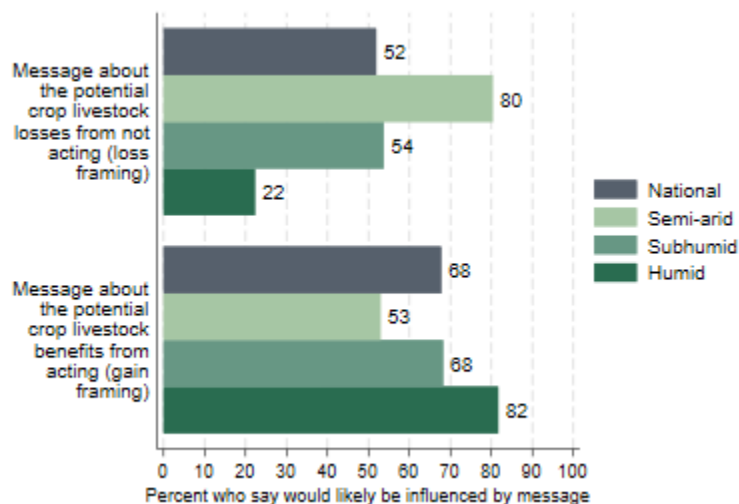
Among the 128 households that reported not using available weather or extreme-weather information, the most common reasons included having limited options or finding it too costly to respond (27%), perceiving the information as not relevant to their farm (27%), or receiving it too late to act (20%). Additional barriers included difficulty understanding the information (18%) and perceptions that the information is unreliable (13%), as shown in Table 16. One farmer from a Benue state FGD with mixed experiences with forecast accuracy reported: “I mostly get weather information from the radio. The forecast for high temperatures this year happened as predicted. I also got weather information that the rains will start in March, but it did not happen.” Overall, the results suggest that farmers rely on trusted information channels; however, the lack of timeliness, relevance, and usability of climate information is a barrier to effective uptake. The value of new information rests on helping the decision-maker judge whether the state of the world will fall above or below the relevant threshold (Raiffa, 1968).

Table 16: Reasons for not acting on climate information received

Reason for not acting	National %	Semi-arid %	Subhumid %	Humid %
Do not trust	13	8	9	22
Often wrong/Not reliable	13	11	11	16
Not timely	20	32	26	4
Difficult to understand	18	38	15	4
No options to respond/too costly to respond	27	23	33	24
Not relevant to my farm	27	11	22	44
Other	4	0	2	9
N	128	37	46	45

3.2.4 Gain versus Loss Message Framing

Figure 21: “Is the following message likely to influence you to act?” by AEZ



Weather and technology information can be framed to emphasize losses if an SSP does not act, gains if the SSP acts. The existing evidence suggests framing is most effective in terms of gains (such as increased productivity), or in curative terms (addressing an existing condition to improve outcomes). Loss framing applied to prevention can create a “double negative” that triggers avoidance rather than action (Ngo et al., 2022; Pope et al., 2018; Yanuarti et al., 2026). Our findings suggest this is mostly, but not universally, true.

In Nigeria, the likelihood of acting on gain versus loss framing varies significantly across AEZs, and the ordering reverses (see

Figure 21). In the humid and sub-humid AEZs gain framing is more compelling; in the semi-arid AEZ, SSPs report a higher likelihood of acting on loss framing.

Table 17: “Is the following message likely to influence you to act?” by gender

Message framing	Women share	Men share	Difference
Loss framing (potential losses from inaction)	0.35	0.56	–0.22***
Gain framing (potential gains from acting)	0.72	0.67	0.06
N	148	547	

Notes: Differences are calculated as the women's share minus the men's share. Statistical significance is based on two-sided t-tests: *** p<0.01; ** p<0.05; * p<0.10. The 0.06 difference in gain framing comes from rounded values.

Framing preference also differs by gender, and in a direction that reinforces the relative effectiveness of gain-framing (see Table 17). Men are significantly more likely than women to be influenced by loss-framed information

(0.56 vs. 0.35, p<0.01). Gain-framed messages work about equally for both (0.72 for women, 0.67 for men), with no significant difference. Gain framing is therefore the more even-reaching frame: it performs adequately with men and better with women, whereas loss framing is more effective with men than women. This finding suggests that gain framing is the safer default, both because it dominates in two of three zones and because it does not systematically underperform with women.

3.3 Risk Perceptions and the Role of Psychological Factors in Climate Adaptation

Overall, the phone survey data indicates that households perceive a very limited capacity to control crop and livestock losses resulting from most climate shocks, particularly sudden-onset events such as high winds, extreme heat, and heavy rainfall, while households show more confidence in managing pests and diseases (see Figure 22).

Overall, only 21% of households surveyed expect that they would be fully able to control losses from drought or late onset rains, while 23% report being somewhat able, and a majority (57%) felt unable to prevent losses. A similar pattern emerges for floods or torrential downpours, where 16% perceived full control, 31% perceived some control, and 53% perceived no control. The timing of the flooding is relevant for the perception of control over flood-related crop losses. One farmer from a Niger state FGD described: “If I experience torrential downpours early in the planting season (immediately after planting), I replant the crops, but if the heavy downpour occurs much later in the season, like around September, I don’t plant again”. This strategy shows that late rains can make late-season replanting unviable.

For very high temperatures above 40°C, only 13% of respondents said they would be able to fully control losses, 35% reported that they could control losses to some extent, while 52% said they would not be able to control losses at all. The limited options for dealing with extreme heat were clear in farmer accounts. One farmer from an Ebonyi state FGD said: “I have been experiencing very high temperatures [...] I harvest cassava earlier [...] There is nothing I can do for yam and cassava plants that are not ready for harvesting.” Farmers seem to have limited options for dealing with extreme heat if it occurs after planting and before optimal harvest dates. Notably, farm households perceive the strongest limitations due to high winds: only 8% perceived full control, 21% some control, and 71% felt completely unable to prevent losses from wind-related damage.

Households perceive the greatest capacity to respond to pest and disease outbreaks: 31% said they could fully control losses, 48% were somewhat able, and only 21% reported having no control. This suggests that preventive measures such as chemical treatments, pest-resistant varieties, or local knowledge are likely more effective for biological risks than for climatic risks. This greater sense of control arguably reflects the availability of pesticides and herbicides in local markets. One farmer from a Kebbi state FGD explained: “I have had insect infestation [...] I buy insect killer powder from Jega market to kill the insects.” This ability to deal with crop pest and disease outbreaks contrasts with the limited ability to cope with weather-related hazards.

Figure 22: Extent of control over losses caused by climate events by AEZ

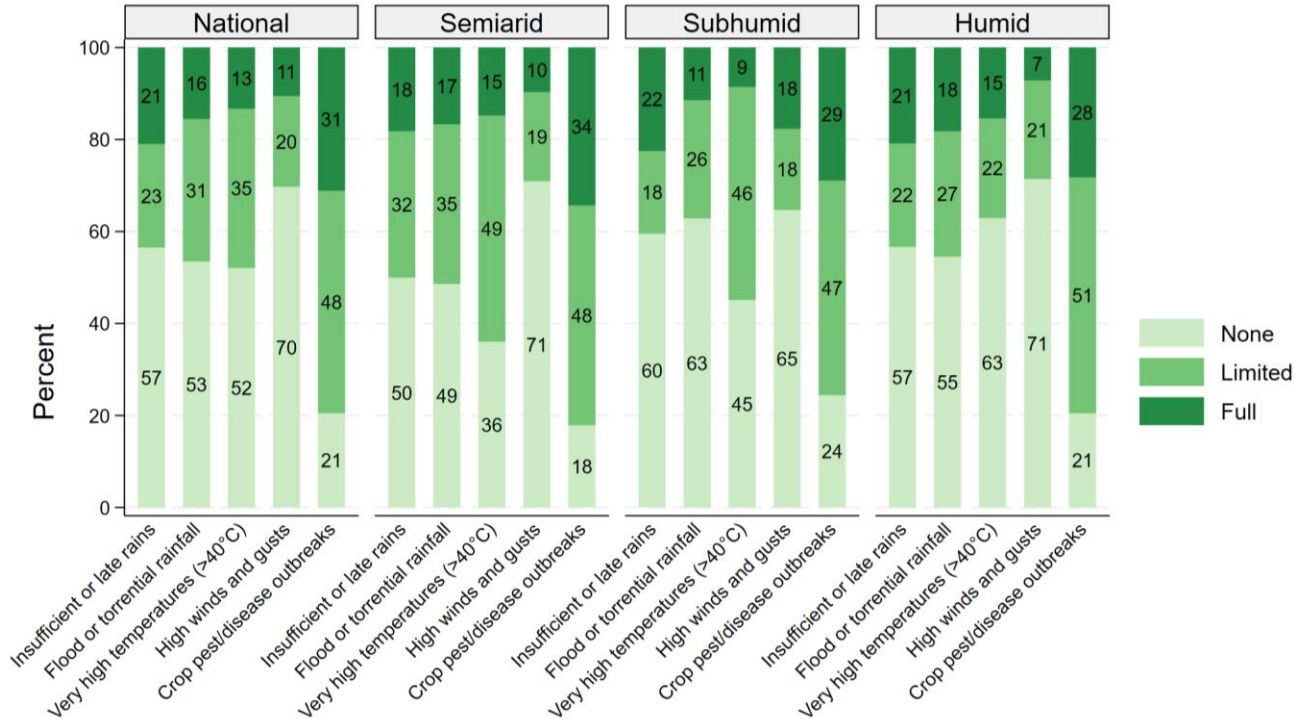
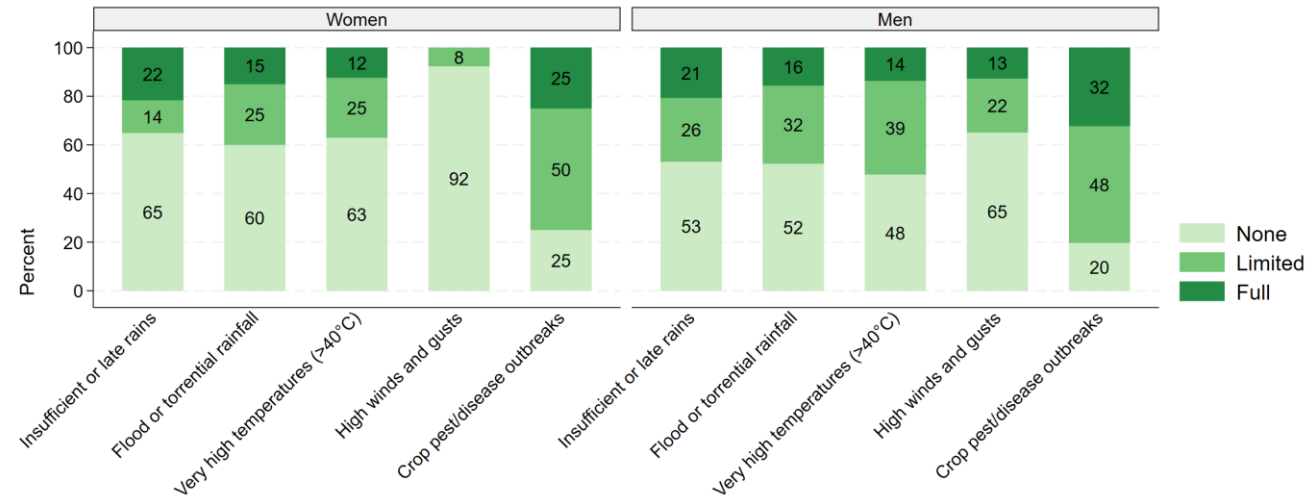


Figure 23: Extent of control over losses caused by climate events by gender



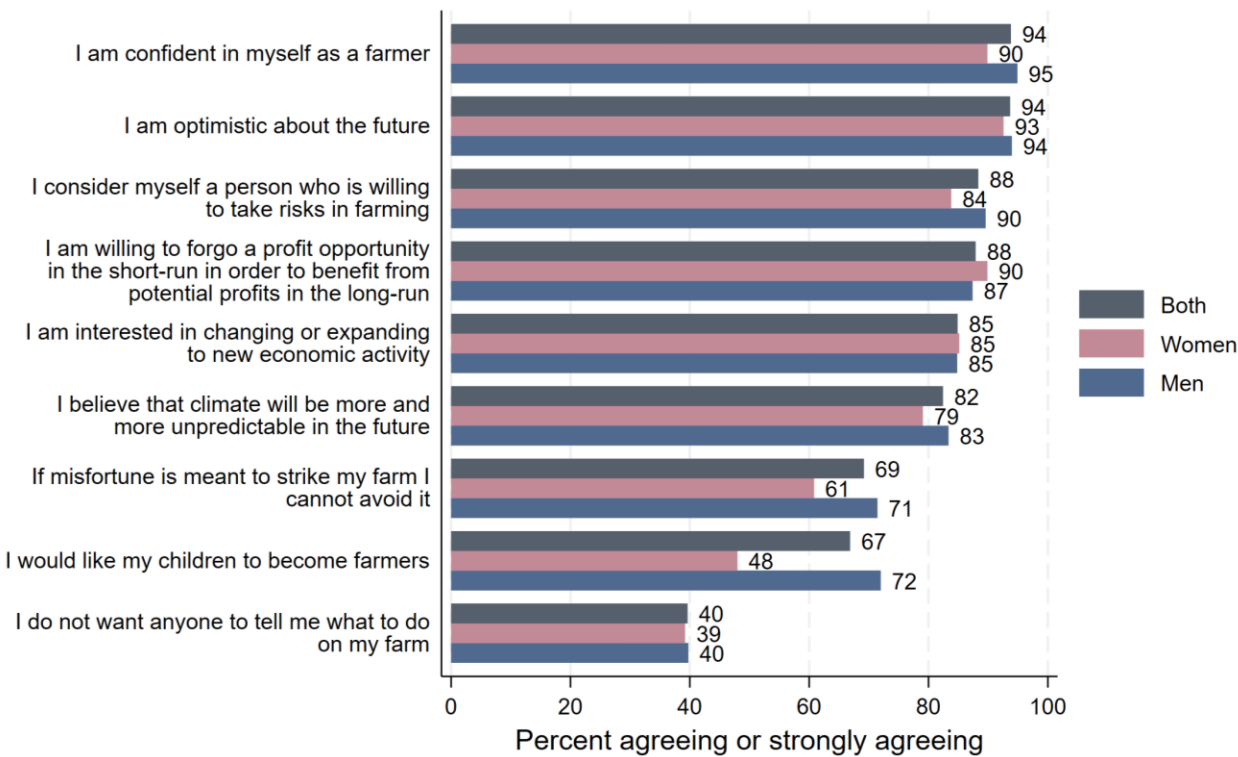
Across all AEZs in NGA the most control is felt over pest and disease and the least over high winds (see Figure 22). Lowest past exposure to, and most control over, wind and heat in the semi-arid AEZ follow the same pattern, as do the highest share of households in the humid AEZ reporting past exposure to drought and expectations of future drought (humid AEZ). There are no patterns for flooding or pests and disease.

By gender, we observe that women respondents are more likely than men to report having no control across all hazards (see Figure 23).

What are the links between risk perceptions and behaviors? Evidence from experiments largely in the U.S. and Europe suggests that individuals regularly overestimate the risk of small, dreaded, unfamiliar, unfair, and involuntary events (Cullen and Anderson, 2017; Cullen et al., 2018; Castellini et al., 2024). High winds and extreme heat fit that category for the SSPs in our sample, and the control results are consistent with it.

3.4 SSP Attitudes

Figure 24: Future aspirations, patience, risk-taking, and worldview by gender



Notes: N=694.

The Phone Survey also gathered data on farmers’ aspirations, patience, risk-taking, and worldview. Overall, the findings suggest that farm households are confident, forward-thinking, and optimistic, but have concerns about climate variability (see Figure 24). Of 694 respondents, the attitudinal questions suggest a high level of confidence in themselves as farmers (94%), alongside a high degree of fatalism: 69% of farmers believe that if misfortune is meant to strike their farm, they cannot avoid it. Similarly, 94% are optimistic about the future, though 82% believe that climate will become more unpredictable in the future and only 67% want their children to become farmers. The majority express a willingness to take risks (88%), with the same number expressing a willingness to forgo a profit opportunity in the short run in order to benefit from potential profits in the long run, and 85% interested in changing or expanding to a new economic activity. However, only 67% would like

their children to become farmers, reflecting a more cautious view of farming as a livelihood for the next generation. By gender, the largest attitude difference is in wanting their children to become farmers: 48% of women and 72% of men, with a 24-percentage point difference.

Sentiments of autonomy were highest in the semi-arid AEZ (45%) region and lowest in the sub-humid AEZ (34%), not wanting to be told what to do on their farm, though a majority disagree with this sentiment (see Table 18). The strongest desire for autonomy, coupled with the highest fatalism in the semi-arid AEZ, may render incentives to adapt the lowest, despite the climate extremes. One farmer from a Kebbi state FGD said: *“I have not done anything different to adapt to climate change, I just trust God”*, while another farmer from a different Kebbi state FGD expressed: *“Sometimes I replant the crops that were damaged.”*

Table 18: Future aspirations, patience, risk-taking, and worldview by AEZ

Attitude	Semi-arid			Sub-humid			Humid		
	Disagree %	Neutral %	Agree %	Disagree %	Neutral %	Agree %	Disagree %	Neutral %	Agree %
I am confident in myself as a farmer	2	5	93	4	0	96	6	2	92
I would like my children to become farmers	10	5	84	29	5	66	37	12	51
I am interested in changing or expanding to new economic activity	8	7	85	5	6	89	14	6	80
I am optimistic about the future	1	4	95	2	3	95	5	3	91
I am willing to forgo a profit opportunity in the short-run in order to benefit from potential profits in the long-run	7	5	88	8	4	88	9	3	87
I consider myself a person who is willing to take risks in farming	5	3	92	8	4	88	12	3	85
I believe that climate will be more and more unpredictable in the future	3	8	90	12	7	81	13	10	77
If misfortune is meant to strike my farm I cannot avoid it.	16	8	76	23	5	72	32	8	60
I do not want anyone to tell me what to do on my farm	49	6	45	62	4	34	53	7	40
N	223			241			230		

After controlling for observable socio-economic household characteristics and exposure to low rainfall shocks in recent years, across-AEZ differences in attitudes remain (see Tables 6a and 6b in Appendix 6):

- Age is positively associated with farming confidence and negatively associated with interest in changing or expanding to a new economic activity.

- Women are less likely than men to want their children to become farmers.
- SSPs in the sub-humid and humid AEZs are less likely to want their children to become farmers than those in the semi-arid. Where that is true, technology adoption competes not only with the status quo but with exit from farming altogether.
- SSPs in the semi-arid AEZ are more likely to believe climate will be more unpredictable in future, while also being the most fatalistic. Both attitudes reduce investment incentives, and they occur in the zone with the greatest measured exposure.
- Qur'anic or Integrated Islamic education as highest educational attainment is associated with a higher degree of fatalism and autonomy. In predominantly Islamic communities an imam, often appointed by a village chief, may have a role in risk communication; easing credit constraints may also be more challenging given social norms.

3.5 What do Farmers Really Want?

Figure 25: Ondo state women farmers telling the research team that they want “women’s empowerment”



During fieldwork visits across the five selected enumeration areas, conversations with farmers revealed aspirations beyond what structured surveys could capture. Farmers spoke about needs ranging from education regarding improved seeds to increased availability of inorganic fertilizer and rural infrastructural investments. But the most striking moment, captured in the photo in Figure 25, came from a group of women farmers in Ondo state who approached the research team to announce that what they wanted was “women’s empowerment”. Climate adaptation can advance this empowerment if adaptation resources become available to female and male SSPs who currently lack access to credit, inputs, or productive assets.

4 CONCLUSION

Our analysis shows that Nigeria is exposed to rising climate variability and weather extremes. Despite this increased exposure, adoption of climate adaptation technologies does not appear to be rising. Empirical findings may simply be affected by measurement challenges around terms such as “improved” seed. But phrasing aside, a lack of awareness, limited availability, financial constraints, inadequate climate information services, and perceived limited agency over climate-related risks appear to contribute. Some of our main findings are:

First, the lack of clarity in the terminology of some agricultural production technologies affects measurement. The term “improved seeds” is vague, with farmers associating it with the source of acquisition rather than genetic or performance characteristics. Farmers sometimes consider some improved seeds to be unimproved and vice versa. When a more precise term like “hybrid” is used, among the 20% of farmers who are aware of hybrid seeds, 72% reported using them. 89% of farmers aware of GMO seeds expressed a willingness to plant them. This suggests that increasing awareness is of first-order importance.

Second, cost and availability represent the main barriers to adoption among aware non-adopters. Even among the 96% of respondents who expected hybrids to increase profit, cost was cited as the primary constraint to adoption. It may be that access to cash or credit for the initial input investment is limited. Availability of technologies in local markets or agro-dealer shops may be a function of timing, mistaken estimates of demand, or under-stocking as sellers do not want to be left with unpurchased perishable product.

Third, farmers perceive significantly different levels of control over various types of climate risks. Most farmers said they feel unable to control losses from high winds and drought, while only 20% reported no control over pest and disease outbreaks. This differential sense of agency may help explain patterns in the adoption of technologies and practices. Farmers show a high uptake of herbicides and pesticides and these inputs are widely available in markets and agro-dealer stores. Meanwhile, adoption of agricultural practices such as changing what to grow or changing soil and land management remains limited.

Fourth, climate information services are reaching farmers but most are failing to act on it. The main reasons cited were a lack of relevance or timely delivery to their farm and an inability to respond due to limited options or high costs. This may reflect that broadcast media are the most trusted sources of climate information, but by their very nature, are less localized.

Fifth, it is critical to acknowledge what for some is the chronic grind of agricultural risk. The ex-post (realized) consequences of risk are visible and are typically modelled as discrete events – a crop lost to catastrophic infestation, a flood that destroys land and livestock. But the ex-ante costs of risk - the hourly, daily, and annual decisions made to manage the risks in one’s life - are repetitive, incremental, and compromise growth potential (Dercon, 2006, p.6).

Preliminary recommendations are in the Executive Summary. The summary conclusion is that while suppliers are understandably focused on the risk of non-adoption, SSPs must also consider the risk of adoption, and moving from the status quo. Ensuring the availability of the most relevant technology is primary, but after addressing economic constraints (e.g. all costs, credit, etc.), uptake is likely to be most effective if the marketing also addresses the perceived risks of SSPs.

REFERENCES

- AGRA (2017). Africa Agriculture Status Report 2017; The Business of Smallholder Agriculture in Sub-Saharan Africa. The Alliance for a Green Revolution in Africa (AGRA).
- Alia, D. Y., Toole, B., Trindade, F., & Anderson, C. L. (2025, August 15). Who is a small-scale producer? A proposed operational definition (CRIFS Technical Brief). University of Washington, Evans School of Public Policy & Governance, Evans School Policy Analysis and Research (EPAR).
- Anderson, J., Marita, C., Musiime, D., & Thiam, M. (2017). National survey and segmentation of smallholder households in Nigeria. Understanding Their Demand for Financial, Agricultural, and Digital Solutions.
- Bidinger, F. R., Vadez, V., Hash, C. T., & Kholova, J. (2012). Phenotyping pearl millet for adaptation to drought. *Frontiers in physiology*.
- Carter, M. R. (2019). *The economics of poverty traps*. C. B. Barrett, M. R. Carter, & J. P. Chavas (Eds.). Chicago: University of Chicago Press.
- Castellini, G., Pinel, H., Acampora, M., Lucini, L., Barello, S., & Castiglioni, C. (2024). Understanding the role of hope in climate change risk perception: a cross-sectional study. *Journal of risk research*, 27(7), 789-805.
- Cullen, A.C. and Anderson, C.L. (2017), Perception of Climate Risk among Rural Farmers in Vietnam: Consistency within Households and with the Empirical Record. *Risk Analysis*, 37: 531-545.
<https://doi.org/10.1111/risa.12631>
- Cullen, A.C., Anderson, C.L., Biscaye, P. and Reynolds, T.W. (2018), Variability in Cross-Domain Risk Perception among Smallholder Farmers in Mali by Gender and Other Demographic and Attitudinal Characteristics. *Risk Analysis*, 38: 1361-1377. <https://doi.org/10.1111/risa.12976>
- Dercon, S. (2006). Risk, Growth, and Poverty: What do we know, what do we need to know?. *Department of Economics, Oxford University*, 148, 1-27.
- Djanaguiraman, M., Perumal, R., Ciampitti, I. A., Gupta, S. K., & Prasad, P. V. V. (2018). Quantifying pearl millet response to high temperature stress: thresholds, sensitive stages, genetic variability and relative sensitivity of pollen and pistil. *Plant, cell & environment*, 41(5), 993-1007.
- Dunne et al., 2013. Dunne, J. P., Stouffer, R. J., & John, J. G. (2013). Reductions in labour capacity from heat stress under climate warming. *Nature Climate Change*, 3(6), 563-566.
- Eggert, E., Gunga, H. C., Sié, A., Ouermi, L., Ouédraogo, W. A., Kwaro, D., ... & Maggioni, M. A. (2025). Physical effort during labour and behavioural adaptations in response to heat stress among subsistence farmers in Burkina Faso: a gender-specific longitudinal observational study. *The Lancet Planetary Health*, 9(12).
- Flores-Najera, M. J., Vélez-Monroy, L. I., Sánchez-Duarte, J. I., Cuevas-Reyes, V., Mellado, M., & Rosales-Nieto, C. A. (2020). Milk yield and composition and body weight of offsprings of mixed-breed goats on semi-arid rangelands with different rainfall. *Tropical Animal Health and Production*, 52(6), 3799-3808.
- Funk, C., Peterson, P., Landsfeld, M., Pedreros, D., Verdin, J., Shukla, S., ... & Michaelsen, J. (2015). The climate hazards infrared precipitation with stations—a new environmental record for monitoring extremes. *Scientific data*, 2(1), 1-21.

- Funk, C., Peterson, P., Peterson, S., Shukla, S., Davenport, F., Michaelsen, J., ... & Mata, N. (2019). A high-resolution 1983-2016 T max climate data record based on infrared temperatures and stations by the Climate Hazard Center. *Journal of Climate*, 32(17), 5639-5658.
- Giersch, G. E., Greenfield, A. M., Brazelton, S. C., Alba, B. K., Bodurtha, P. O., Caldwell, A. R., ... & Charkoudian, N. (2025). Distinct physiological responses to heat acclimation in males and females lead to similar thermal adaptations in both sexes. *Journal of Applied Physiology*, 139(3), 863-872.
- Giller, K. E., Witter, E., Corbeels, M., & Tittonell, P. (2009). Conservation agriculture and smallholder farming in Africa: the heretics' view. *Field crops research*, 114(1), 23-34.
- Grogan, D., Frolking, S., Wisser, D., Prusevich, A., & Glidden, S. (2022). Global gridded crop harvested area, production, yield, and monthly physical area data circa 2015. *Scientific data*, 9(1), 15.
- Hadebe, S. T., Modi, A. T., & Mabhaudhi, T. (2017). Drought tolerance and water use of cereal crops: A focus on sorghum as a food security crop in sub-Saharan Africa. *Journal of Agronomy and Crop Science*, 203(3), 177-191.
- Hansen, J. W., Vaughan, C., Kagabo, D. M., Dinku, T., Carr, E. R., Körner, J., & Zougmore, R. B. (2019). Climate services can support african farmers' context-specific adaptation needs at scale. *Frontiers in Sustainable Food Systems*, 3, 21.
- Jagadish, S. V. K., Craufurd, P. Q., & Wheeler, T. R. (2007). High temperature stress and spikelet fertility in rice (*Oryza sativa* L.). *Journal of Experimental Botany*, 58(7), 1627-1635.
- Jo, J., & Lee, H. (2025). Impact of relative humidity on heat stress responses in early-lactation Holstein cows. *Animals*, 15(11), 1503.
- Kamara, A. Y., Kamai, N., Omoigui, L. O., Togola, A., Ekeleme, F., & Onyibe, J. E. (2020). *Guide to Maize Production in Northern Nigeria*. IITA.
- Kang, S., Kim, D. H., Lee, S., Lee, T., Lee, K. W., Chang, H. H., ... & Choi, Y. H. (2020). An acute, rather than progressive, increase in temperature-humidity index has severe effects on mortality in laying hens. *Frontiers in Veterinary Science*, 7, 568093.
- Kassam, A., Friedrich, T., Shaxson, F., & Pretty, J. (2009). The spread of conservation agriculture: justification, sustainability and uptake. *International Journal of Agricultural Sustainability*, 7(4), 292-320.
- Kim, H. R., Ryu, C., Lee, S. D., Cho, J. H., & Kang, H. (2024). Effects of heat stress on the laying performance, egg quality, and physiological response of laying hens. *Animals*, 14(7), 1076.
- Kjellstrom, T., Holmér, I., & Lemke, B. (2009). Workplace heat stress, health and productivity - an increasing challenge for low and middle-income countries during climate change. *Global Health Action*, 2.
- Lewis, C. P., Newell, J. N., Herron, C. M., & Nawabu, H. (2010). Tanzanian farmers' knowledge and attitudes to GM biotechnology and the potential use of GM crops to provide improved levels of food security. A Qualitative Study. *BMC Public Health*, 10(1), 407.
- Lobell et al., 2011. Lobell, D. B., Bänziger, M., Magorokosho, C., & Vivek, B. (2011). Nonlinear heat effects on African maize as evidenced by historical yield trials. *Nature Climate Change*, 1, 42-45.

- Marcos-Garcia, P., Carmona-Moreno, C., & Pastori, M. (2024). Intra-growing season dry-wet spell pattern is a pivotal driver of maize yield variability in sub-Saharan Africa. *Nature Food*, 5(9), 775-786.
- Mayorga, J., Villacis, A. H., & Mishra, A. K. (2025). Farm-level agricultural productivity and adaptation to extreme heat. *American Journal of Agricultural Economics*.
- Mayorga, J., Alia, D., & Anderson, C.L. (2026). Understanding discrepancies between self-reported and measured drought: Evidence from Ethiopia and Malawi.
- Mohamoud, M. A., Abdalla, A. S., Elhag, M. M., & Yousif, L. A. (2019). Water Requirement and Water Productivity of Cowpea (*Vigna unguiculata* [L.] Walp.) Crop in Two Agro-ecological Zones of Sennar State, Sudan. *Sudan Journal of Desertification Research*, 11(1).
- NAERLS (2024). 2024 Wet Season Agricultural Performance in Nigeria: National Report. National Agricultural Extension and Research Liaison Services, Ahmadu Bello University, Zaria and the Federal Ministry of Agriculture and Food Security, Abuja: NAERLS Press.
- National Agricultural Sample Census (NASC) Report 2022 (june 2024).
- Ngo, C. C., Poortvliet, P. M., & Klerkx, L. (2022). The persuasiveness of gain vs. loss framed messages on farmers' perceptions and decisions to climate change: A case study in coastal communities of Vietnam. *Climate Risk Management*, 35, 100409.
- Nico, G., & Azzarri, C. (2024). Climate change and sex-specific labor intensity: An empirical analysis in Africa. *Global Food Security*, 42, 100799.
- Nigerian Meteorological Agency. (2026, February 10). *NiMet unveils 2026 Seasonal Climate Prediction, forecasts variable rainfall, prolonged dry spells and warmer temperatures*. <https://nimet.gov.ng/news?id=194>
- Obi-Egbedi, O., Oluwatayo, I. B., & Ogungbite, O. (2020). Genetically modified crops' technology and its awareness among smallholder farmers in Nigeria. *Scientific Journal Warsaw University of Life Sciences*, 20(4), 58-67.
- Owusu Danquah, E., Danquah, F. O., Frimpong, F., Dankwa, K. O., Weebadde, C. K., Ennin, S. A., ... & Opoku, A. Y. (2022). Sustainable intensification and climate-smart yam production for improved food security in West Africa: a review. *Frontiers in agronomy*, 4, 858114.
- Paek, Hye-Jin, and Thomas Hove, 'Risk Perceptions and Risk Characteristics' (29 Mar. 2017), in Matthew Powers (ed.), *Oxford Research Encyclopedia of Communication* (New York, NY, online edn, Oxford Academic, 3 Dec. 2015 -), <https://doi.org/10.1093/acrefore/9780190228613.013.283>, accessed 9 May 2026.
- Pope, J. P., Pelletier, L., & Guertin, C. (2018). Starting off on the best foot: A review of message framing and message tailoring, and recommendations for the comprehensive messaging strategy for sustained behavior change. *Health communication*, 33(9), 1068-1077.
- Raiffa, H. (1968). Decision analysis: Introductory lectures on choices under uncertainty.
- Reisinger, Andy, Mark Howden, Carolina Vera, et al. (2020) The Concept of Risk in the IPCC Sixth Assessment Report: A Summary of Cross-Working Group Discussions. Intergovernmental Panel on Climate Change, Geneva, Switzerland. pp155.C. Sherwood, & M. Huber, An adaptability limit to climate change due to heat stress, Proc. Natl. Acad. Sci. U.S.A. 107 (21) 9552-9555, <https://doi.org/10.1073/pnas.0913352107> (2010).

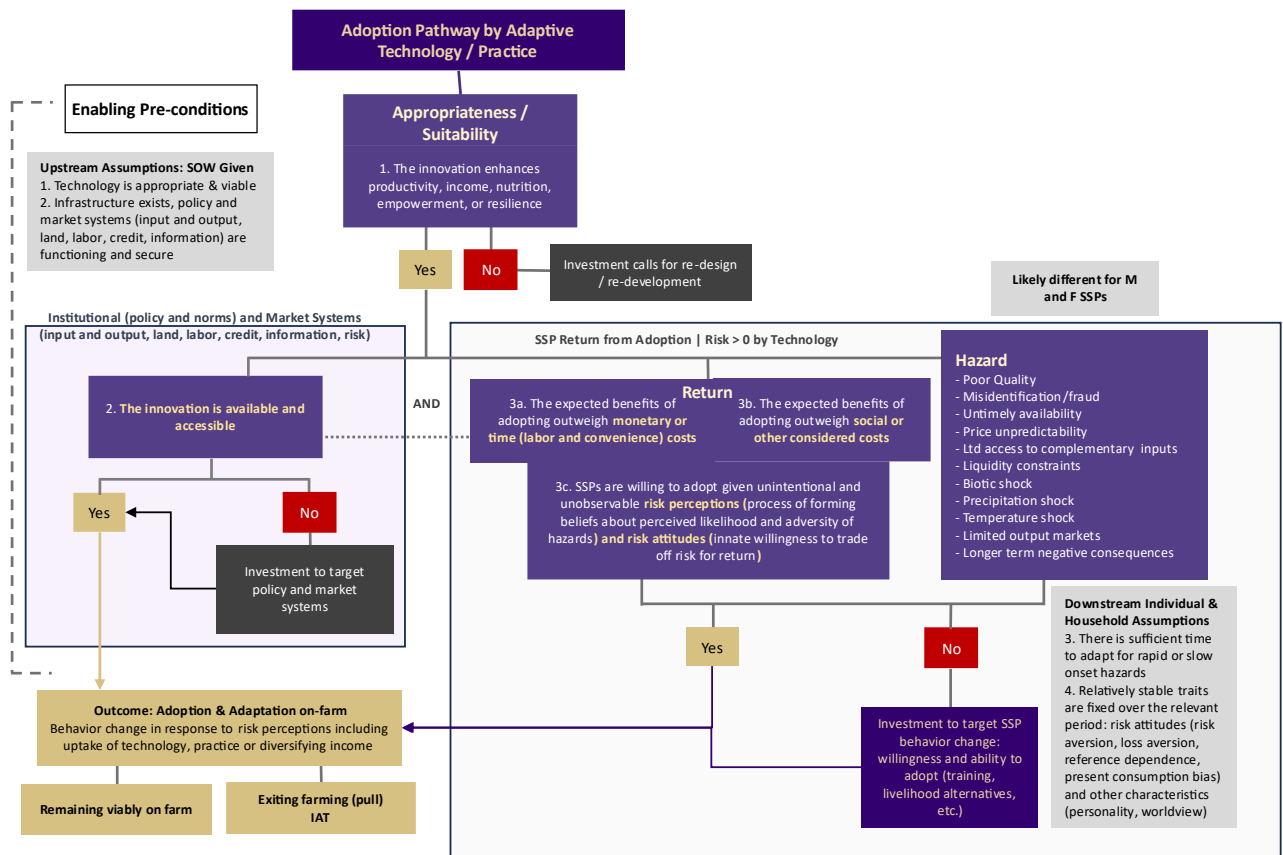
- Santanoo, S., Vongcharoen, K., Banterng, P., Vorasoot, N., Jogloy, S., Roytrakul, S., & Theerakulpisut, P. (2022). Physiological and proteomic responses of cassava to short-term extreme cool and hot temperature. *Plants*, 11(17), 2307.
- Senyolo, M. P., Long, T. B., Blok, V., & Omta, O. (2018). How the characteristics of innovations impact their adoption: An exploration of climate-smart agricultural innovations in South Africa. *Journal of cleaner production*, 172, 3825-3840.
- Sherwood, S. C., & Huber, M. (2010). An adaptability limit to climate change due to heat stress. *Proceedings of the national academy of sciences*, 107(21), 9552-9555.
- P. Slovic (Ed.), (1987) *The perception of risk*, VA: Earthscan.
- Reisinger, Andy, Mark Howden, Carolina Vera, et al. (2020) The Concept of Risk in the IPCC Sixth Assessment Report: A Summary of Cross-Working Group Discussions. Intergovernmental Panel on Climate Change, Geneva, Switzerland. pp15
- Takeshima, H., Ragasa, C., Bamiwuye, T., Andam, K. S., Spielman, D. J., Edeh, H. O., ... & Wossen, T. (2025). Seed certification, certified seeds use and yield outcomes in Nigeria: Insights from nationally-representative farm panel data and seed company location data. *Agricultural Systems*, 224, 104268.
- Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases: Biases in judgments reveal some heuristics of thinking under uncertainty. *science*, 185(4157), 1124-1131.
- Vaughan, C., Hansen, J., Roudier, P., Watkiss, P., & Carr, E. (2019). Evaluating agricultural weather and climate services in Africa: Evidence, methods, and a learning agenda. *Wiley Interdisciplinary Reviews: Climate Change*, 10(4), e586.
- Wachinger, G., Renn, O., Begg, C., & Kuhlicke, C. (2013). The risk perception paradox—implications for governance and communication of natural hazards. *Risk analysis*, 33(6), 1049-1065.
- Waldman, K. B., Vergopolan, N., Attari, S. Z., Sheffield, J., Estes, L. D., Caylor, K. K., & Evans, T. P. (2019). Cognitive biases about climate variability in smallholder farming systems in Zambia. *Weather, Climate, and Society*, 11(2), 369-383.
- World Health Organization. (1997). Risk Management and Food Safety: Report of a Joint FAO/WHO Consultation, Rome, Italy, 27 to 31 January 1997 (Vol. 65). Food & Agriculture Org..
- Xie, H., You, L., & Takeshima, H. (2017). Invest in small-scale irrigated agriculture: A national assessment on potential to expand small-scale irrigation in Nigeria. *Agricultural Water Management*, 193, 251-264.
- Yanovich, R., Ketko, I., & Charkoudian, N. (2020). Sex differences in human thermoregulation: relevance for 2020 and beyond. *Physiology*.
- Yanuarti, R., Hariyati, Y., Srisompun, O., Supriono, A., Kuntadi, E. B., Kusmiati, A., ... & Suwali, S. (2026). Loss-Gain Framing Effects on Maize Farmers' Contract Farming Decisions for Enhancing Farm Economic Sustainability. *Jurnal Agrinika: Jurnal Agroteknologi dan Agribisnis*, 10(1), 127-140.

APPENDICES

We include seven appendices for further detail: Appendix 1 is the CRIFS conceptual model of an SSP technology adoption decision pathway; Appendix 2 lays out the methodology behind this report and the Nigeria field work; Appendix 3 presents some biophysical thresholds from the literature; Appendix 4 presents other relevant background, mostly from the LSMS-ISA GHS, and Appendix 5 presents more detailed econometric results.

APPENDIX 1: SSP Technology Adoption Pathway (Conceptual)

Figure 1a: SSP Adoption Pathway



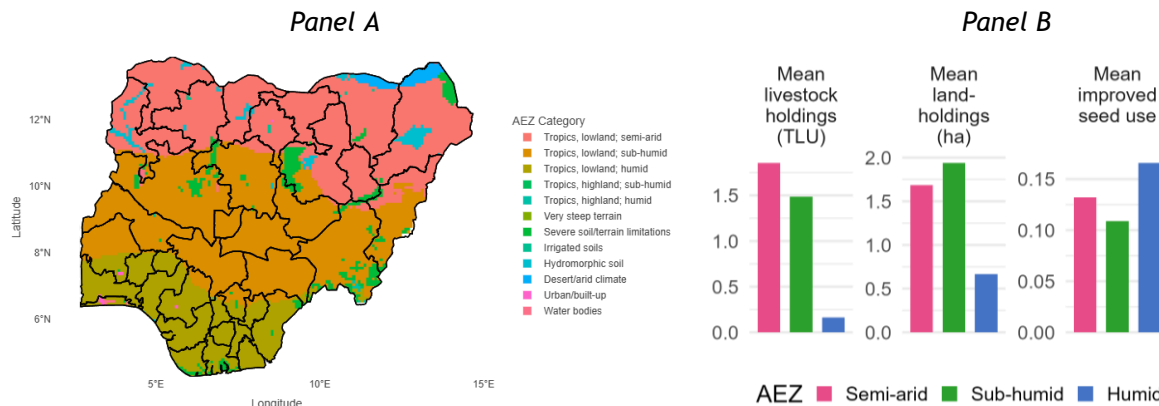
APPENDIX 2: Methodology

A2.1 Desk Review and Pre-Analysis

Prior to fieldwork, to understand how Nigeria’s climate and agricultural landscape vary across regions and over time, we conducted a desk review combining household surveys and climate data. The LSMS-ISA General Household Survey waves 1 to 4, covering the years 2010-11, 2012-13, 2015-16, and 2018-19⁶, and the National Longitudinal Phone survey (NLPs) provided evidence on agricultural practices. Geospatial data were used to understand the environmental factors driving household experiences, with Agro-ecological zones (AEZs) information coming from Global Agro-Ecological Zones (GAEZ) data (Grogan et al., 2022) for basic information about agro-climatic characteristics across regions. We complemented that information with rainfall records from CHIRPS (Funk et al., 2015) and temperature records from CHIRTS (Funk et al., 2019) to capture weather trends.

The desk review revealed significant differences in climate and farm production practices across the main agroecological zones in Nigeria. The country is roughly divided into three east-west bands: the semi-arid AEZ in the north, the sub-humid AEZ in the center, and the humid AEZ in the south, as shown in Panel A of Figure 2a, where temperature decreases and rainfall increases when moving from north to south. Panel B of Figure 2a shows that livestock holdings are larger, the planted area is greater, and improved seed use adoption is lower in the semiarid AEZ compared to the subhumid and humid AEZs.

Figure 2a: Agricultural production practices in Nigeria



Notes: The Panel A map was plotted with GAEZ data, and the Panel B chart was built using 2018-19 LSMS-ISA GHS (Wave 4) data. The sample consists of rural households engaged in farming. Improved seed use is a dummy variable equal to one if the household used improved seeds and zero otherwise. The landholding variable is winsorized at top and bottom 1%.

In combination with the empirical findings from our desk review, the CRIFS small-scale producers (SSP) adaptation decision tree, shown in Figure 1a, guided our research approach. The decision tree conceptualizes farmers’ adaptation decisions as a sequential process assuming the appropriateness of the innovation and supportive policy and market conditions ensuring availability. Should those assumptions hold, the SSP evaluates whether the time, financial, social, and cognitive benefits of adoption outweigh the costs. The framework acknowledges that uncertainty involves some unintentional decision biases, such as anchoring, and that SSP risk perceptions, affected by the qualitative dimensions of a hazard, such as control, reversibility, and familiarity, may differ from the purely quantitative probabilities assigned to exposure and affect adoption decisions.

⁶ The desk review began in the first semester of 2023, before the 2023-24 LSMS-ISA GHS (Wave 5) was published in November 2024.

Our mixed-methods approach has two main components: a nationally representative phone survey to identify broad patterns, and in-person visits to villages across Nigeria’s three AEZs to provide context to interpret quantitative findings. The fieldwork used a single instrument for the phone survey, and multiple instruments for the in-person visits, including focus group discussion (FGD), and typical farm, village informant, and agro-dealer interviews. Table 2a lists the sections that were ultimately included in our phone survey and FGD instruments.

Table 2a: Sections of Phone Survey and FGD Instruments

Section	Phone Survey	FGD
Climate Information and Advice	✓	✓
Improved Seeds		✓
GMO Seeds	✓	✓
Technologies and Practices	✓	✓
Risk Perceptions	✓	✓
Time Use and Productivity		✓
Gendered Language	✓	✓

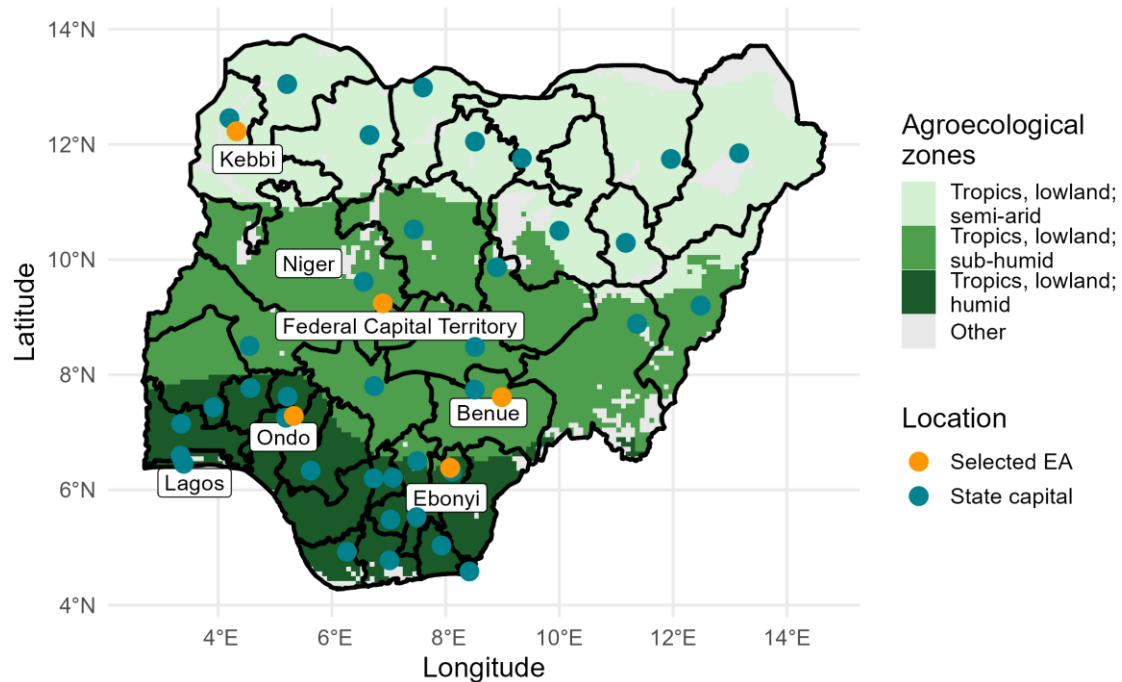
A2.2 Partnership Approach Involving Local Partners

The project required close partnerships with local organizations to complement EPAR’s research expertise with in-field operational capacity and contextual knowledge. EPAR partnered with the Nigerian National Bureau of Statistics (NBS) and DevAfrique.

The NBS had access to households from the confidential LSMS-ISA GHS, enabling linking existing and future LSMS-ISA data with the Risk Profiles phone survey. During preparation, NBS checked that EPAR’s proposed FGD villages were accessible by car, coordinated entry into FGD villages, provided facilities, and collaborated in training both the phone survey and FGD enumerators. During fieldwork, NBS conducted phone survey enumeration and provided direct translations for communication between EPAR members and FGD participants. The NBS drew on their longstanding relationships with interviewees to contribute to the richness of the gathered FGD data. Additionally, DevAfrique coordinated transportation and lodging for EPAR team members in Nigeria for fieldwork. Besides managing these logistics, DevAfrique supported translation and audio recording during FGDs and helped facilitate typical farmer and agro-dealer interviews.

A2.3 Sampling Strategies

Figure 2b: Sampling for focus group discussions (FGDs)



Notes: Own construction based on GAEZ and LSMS-ISA data.

For the phone survey, a nationally representative sample was drawn from the 2018-19 GHS and the NLPS. We selected households classified as agricultural households in both surveys, and that answered section 14 (Expectations on Climate Extremes and Past Experience) of the NLPS Round 8. Of our initial sample of 778 farming households, 695 completed all sections of the phone survey. The phone survey data were combined with the Nigeria LSMS-ISA and NLPS, as well as climate satellite imagery, to characterize SSPs' risk exposure and adaptation decisions.

For in-person data collection, the sampling procedure consisted of selecting villages in EAs that were: i) in states without advisory warnings from the United States Department of State, ii) in rural areas, iii) within 100 kilometers of state capitals, and iv) accessible by car according to NBS staff. The final group of villages of in-person visits consisted of a total of five villages in Kebbi, Niger, Benue, Ondo, and Ebonyi states, and across the three main agro-ecological zones in the country (see Figure 2b).

The phone survey and in-person visit data were gathered in March 2025. This date was ideal because most planting in Nigeria is concentrated in March-August (Mayorga et al., 2025), so the fieldwork preceded or was scheduled at the beginning of the main planting season. It was expected that under this timing, the interviews were close enough to the previous growing season for reliable farmer recall of weather conditions and farmer practices, and that farmers would not yet be busy with planting activities and could participate in our surveys.

APPENDIX 3. Some Specific Climate Stresses and Thresholds

Table 3a: Crop Thresholds

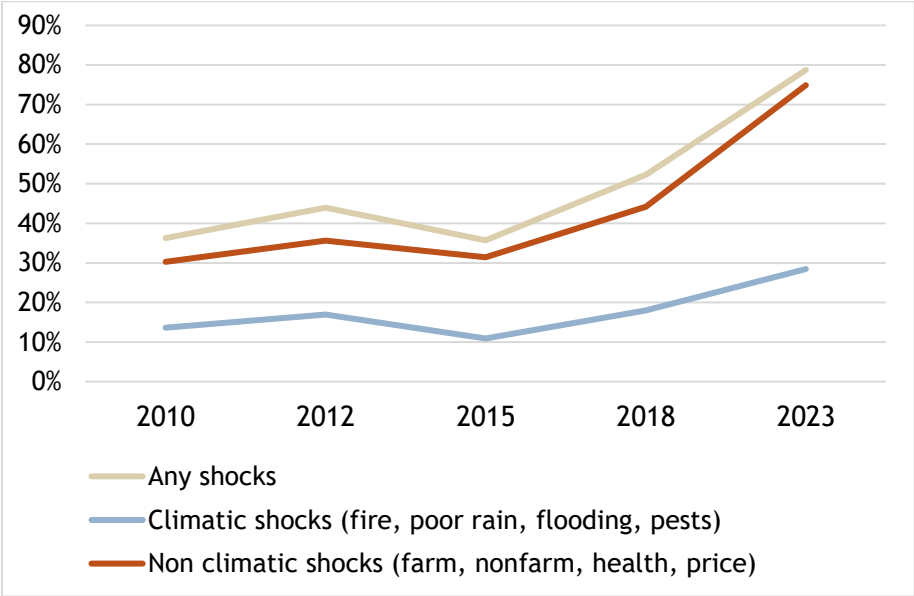
Target	Temperature	Rainfall and humidity	Weather variability
Humans	Labor productivity declines with wet bulb globe temperature (WBGT) greater than 26-30°C (Kjellstrom et al., 2009; Dunne et al., 2013).		
Maize	Yield declines by 1% and 1.7% under optimal and drought conditions, respectively, per degree-day above 30°C (Lobell et al., 2011).	Minimal range of 480-880 mm of well-distributed rain is adequate for maize (IITA, 2020)	Patterns of “dry-dry-dry-dry” or “wet-dry-dry-dry” as measured by the SPEI during the four subperiods of the growing season reduce maize yield (Marcos-Garcia et al., 2024).
Rice	Spikelet sterility increases sharply above 33°C during flowering (Jagadish et al., 2007).	Seasonal water requirement of 450-940 mm, although sensitive to variability (Hadebe et al., 2017).	
Sorghum		Seasonal water requirement of up to 450-650mm although it requires a rooting depth of up to 2m to enable deep water extraction.	
Millet	Seed yields decrease abruptly when maximum temperatures surpass 36°C (Djanaguiraman et al., 2018).	Typically grown in areas with limited rainfall of 300-500 mm (Vadez et al., 2012)	
Cowpea		Can grow under rainfall ranging from 400 to 700 mm (Mohamoud et al., 2019) .	
Cassava	Heat stress threshold is 37C (Santanoo et al., 2022).		
Yam	Temperature above 30C reduces yield (Danquah et al., 2022).		
Cattle		An increase in relative humidity from 50% to 80% decreases milk yield (Jo & Lee, 2025).	
Ruminants		Highest daily milk yield for goats in 221 mm annual rainfall (Flores-Najera et al., 2020).	
Poultry	Continuous exposure above 30°C increases physiological stress, and reduces egg production (Kim et al., 2025).		Heat spikes (24 to 32C in one hour) linked with higher mortality for laying hens (Kang et al., 2020).

APPENDIX 4: Other Background on Climate Risk: Exposure to Hazards and Vulnerability

We study data from the five waves of the LSMS-ISA GHS covering 2010-2023, which asked households about exposure to shocks and coping strategies. Figure 4a shows that the percentage of Nigerian farming households self-reporting an experience of any climatic and non-climatic shocks increased between 2015-2023. This upward trend is consistent with rising rainfall variability and heat stress in remote sensing data.

A4.1: Self-reported Exposure and Vulnerability

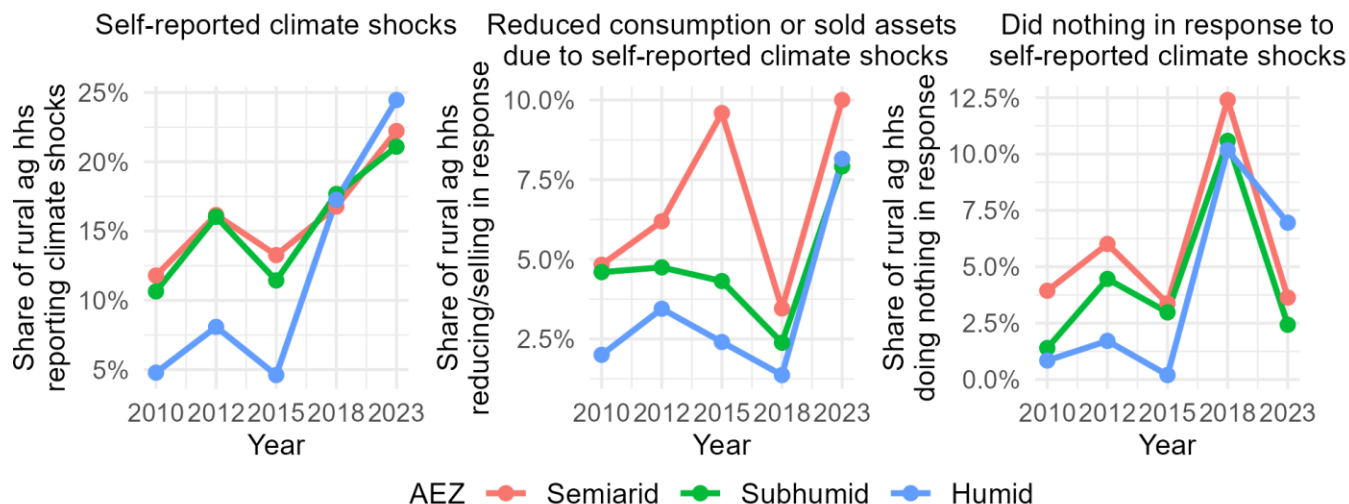
Figure 4a: Percentage of rural agricultural population affected by shocks over time - LSMS-ISA GHS



Notes: Constructed from Nigeria LSMS-ISA GHS data. From 2010-2018, the data captures shocks in the preceding 5 years and in 2023 in the preceding 3 years.

The LSMS-ISA GHS asks respondents about exposure and responses to shocks. Figures 4b and 4c show that when asked how they coped with the climate shocks, almost 80% of households in 2018-19 said they did nothing. Other top coping mechanisms are the sale of assets such as livestock or land, and reduced consumption, consistent with declining asset ownership. These reactions to shocks can reduce a household’s ability to cope with future shocks and increase the likelihood that households fall poverty traps (Carter, 2019).

Figure 4b: Self-reported climate shocks



Notes: Built using GHS. The sample consists of rural households engaged in farming. Landholding area and value of other assets are winsorized at top and bottom 1%.

Figure 4c: Percentage of households affected by climate shocks reporting the use of different coping strategies, including doing nothing Notes: Nigeria LSMS-ISA/GHS Waves 2010 and 2015-2023. ⁷

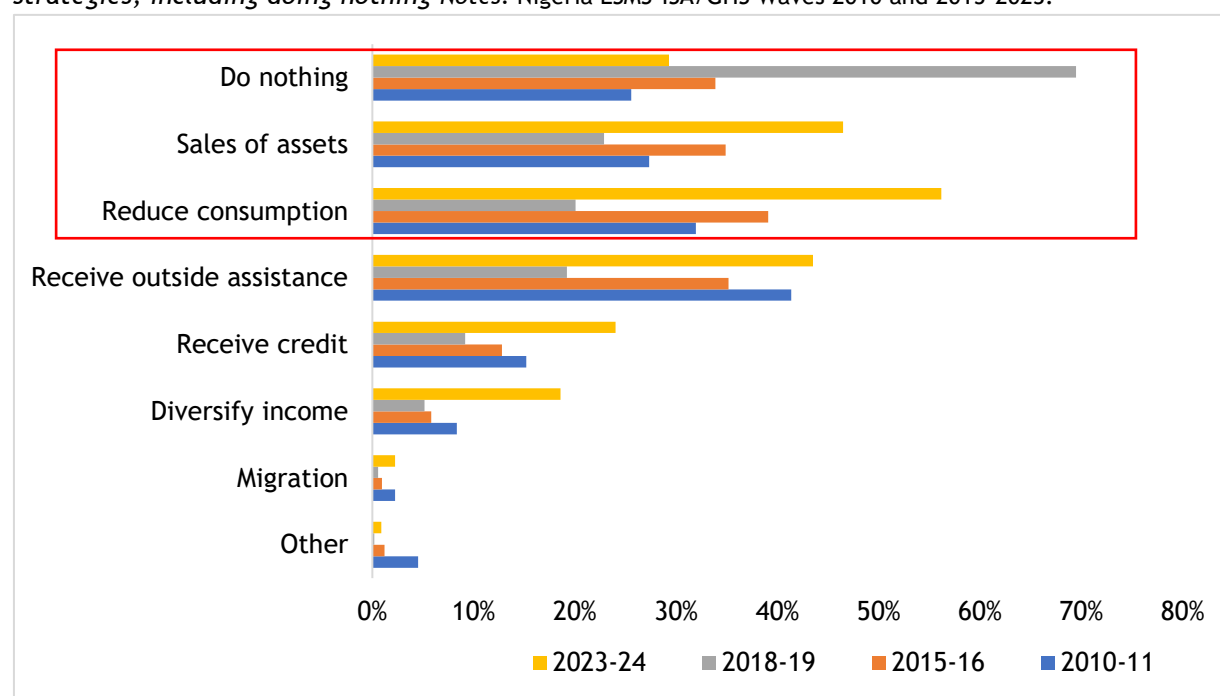
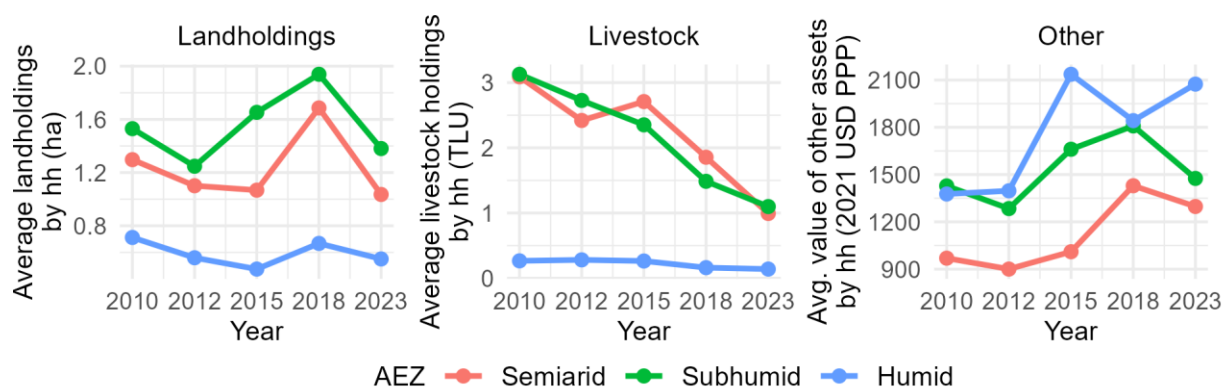


Figure 4d: Asset ownership

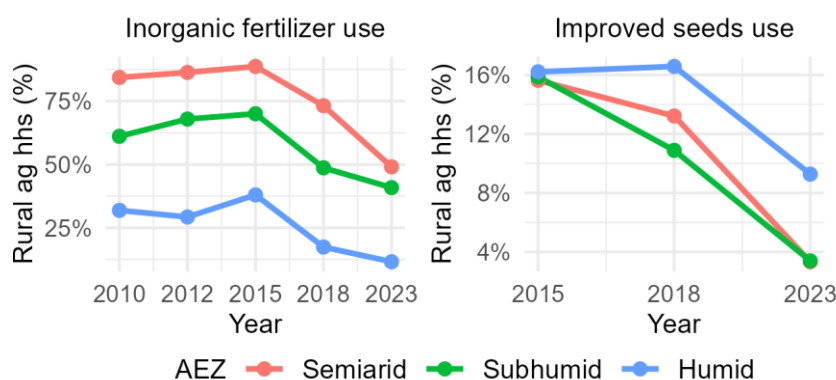
⁷ Notes: From 2010-2018, the data captures shocks in the preceding 5 years and in 2023 in the preceding 3 years.



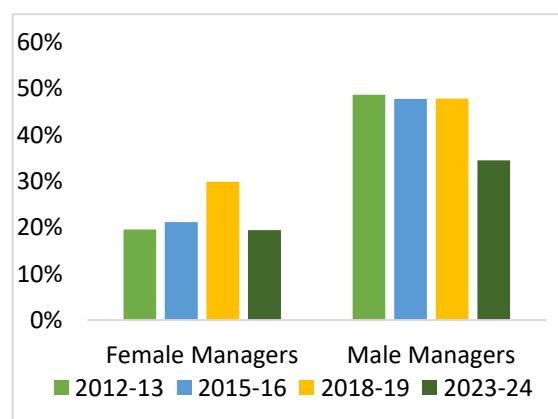
Notes: Built using GHS. The sample consists of rural households engaged in farming. Landholding area and value of other assets are winsorized at top and bottom 1%.

In addition to depleting assets, coping with shocks may also limit opportunities for productive investments. Figure 4f shows the percentage of plot managers in the LSMS-ISA GHS growing crops who self-report using inorganic fertilizers, such as urea, NPK, and others.

Figure 4e: Input use



Note: Built using LSMS-ISA GHS. The sample consists of rural households engaged in farming.



Among female plot managers, inorganic fertilizer use reached 30% in 2018-19 but dropped to 19% in 2023-24. For male plot managers, reported inorganic fertilizer use fluctuated between 48%-49% in the 2012-2018 waves but decreased to 35% in 2023-34. While the decline in the use of inorganic fertilizer is sharp and recent, we do not observe an earlier-starting downward trend.

Figure 4f: Percentage of rural plot managers growing crops self-reporting using inorganic fertilizer in Nigeria

Source: Nigeria LSMS-ISA/GHS Waves 1-5

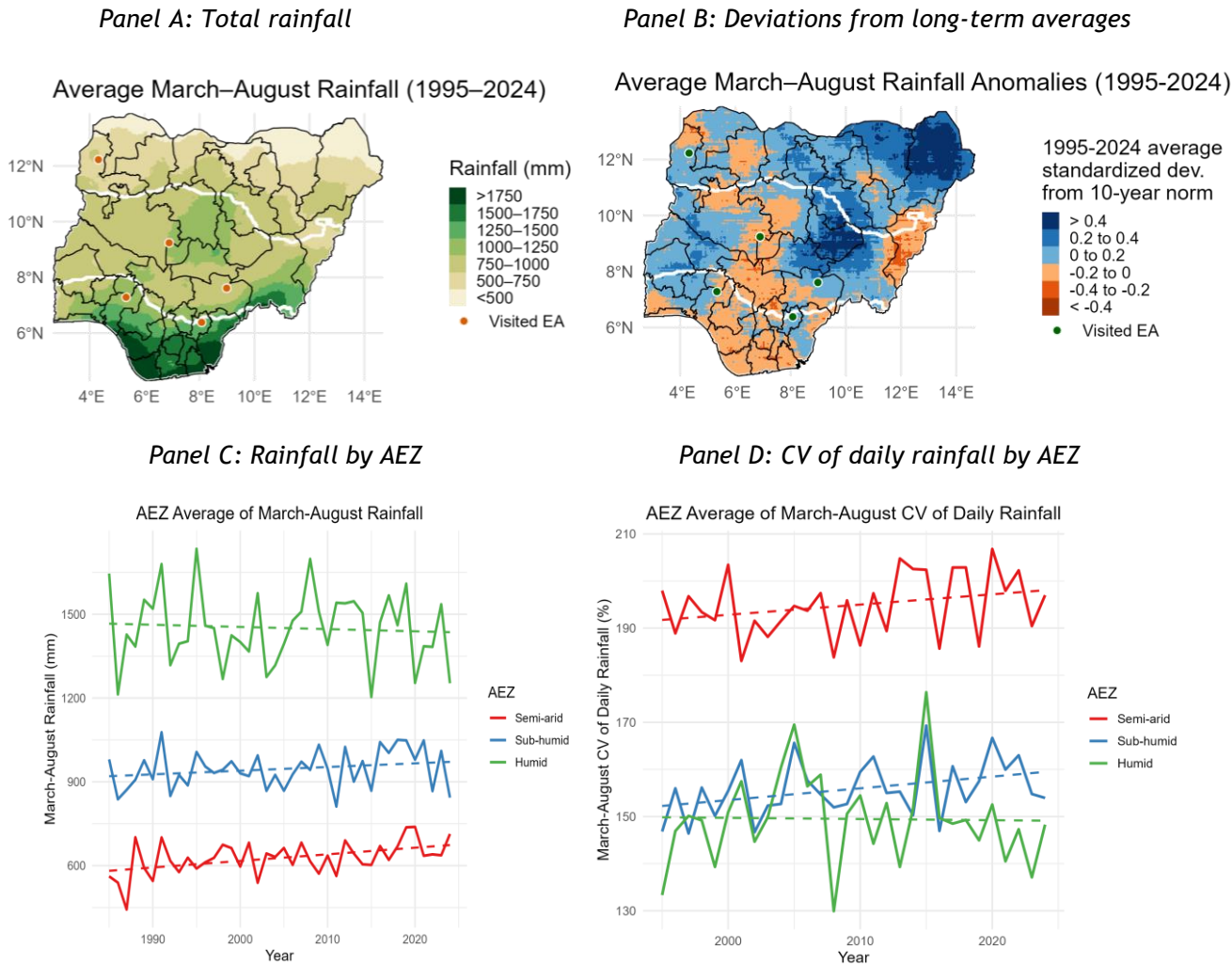
Data from the Nigeria LSMS-ISA GHS shows that on average, less than one in ten farming households report using improved variety seeds. The match between the improved seeds use data from the LSMS-ISA seems disconnected from certified seed distribution data. The state with the highest distribution of certified maize

seeds in 2024 was Bayelsa, with 7500 MT, but less than 10% of households in the South-South geopolitical region, of which Bayelsa is part, reported using improved seeds in the LSMS-ISA. This low rate of adoption is consistent with the research on certified seed use in Nigeria, which argues that most seeds used in the country are recycled by farmers in previous years (NAERLS, 2024).

A4.2 Exposure: Rainfall, Temperature, and Pest Stress in Satellite Data, Government Reports, and LSMS-ISA

How variable is Nigeria’s weather, and how has it changed over time? Figure 4g shows space and temporal variations in rainfall in Nigeria. Panel A shows that the country was normally driest in the north and wettest in the south in 1995-2024, while Panel B reveals that rainfall deviations from 10-year were on average negative in some areas in that same period, especially in the humid AEZ. Panels C and D show temporal trends. Consistent with the map on 10-year deviations, Panel C shows a slight downward trend for mean total rainfall in the humid AEZ. Interestingly, Panel D shows that rainfall variability, as measured by the coefficient of variation of daily rainfall, is trending upwards. Together, the two rainfall time series graphs suggest that mean rainfall remains roughly constant after accounting for year-to-year variations but the variance in daily rainfall is increasing, suggesting that fewer but more intense rainfall events are becoming the norm.

Figure 4g: Rainfall in Nigeria

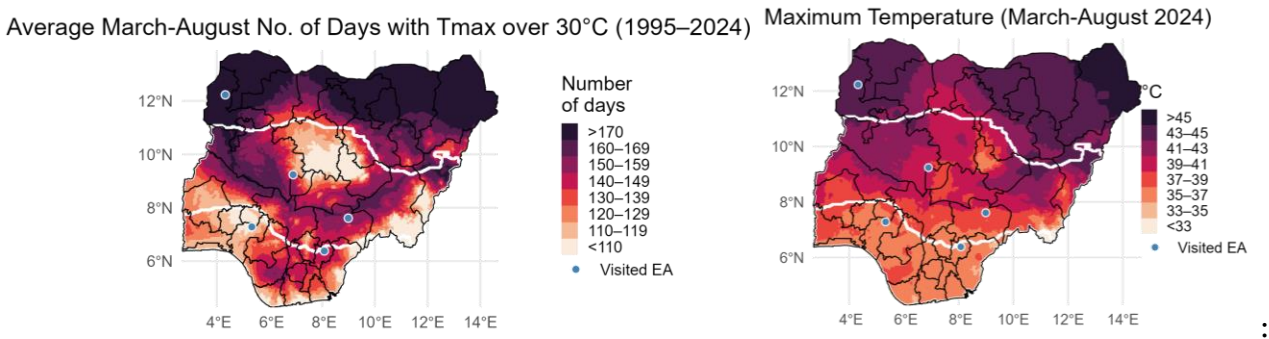


Notes: EPAR representation using CHIRPS monthly rainfall data (Funk et al., 2015). The dots on the maps represent the EAs where the team conducted FGDs. The coefficient of variation is calculated as the AEZ-wide mean of the average coefficient of variability of daily rainfall by pixel.

Figure 4i characterizes temperature patterns across Nigeria. Panel A shows that the agroecological zones with the most and least days with temperatures above 30°C are the semi-arid and humid, respectively. In particular, about half the semiarid AEZ of the country experiences temperatures above 30°C in over 170 out of 183 days during the March-August growing season. Meanwhile, Panel B reveals that across most of Nigeria in 2024, the maximum temperature exceeded 35°C, the threshold above which heat stress is experienced (Sherwood and Huber, 2010). As per shown in the main report, average temperature during the growing season trended upwards from 1995 to 2024.

Figure 4h: Temperature in Nigeria

Panel A: Days with maximum temperature above 30°C Panel B: Maximum temperature in 2024 growing season



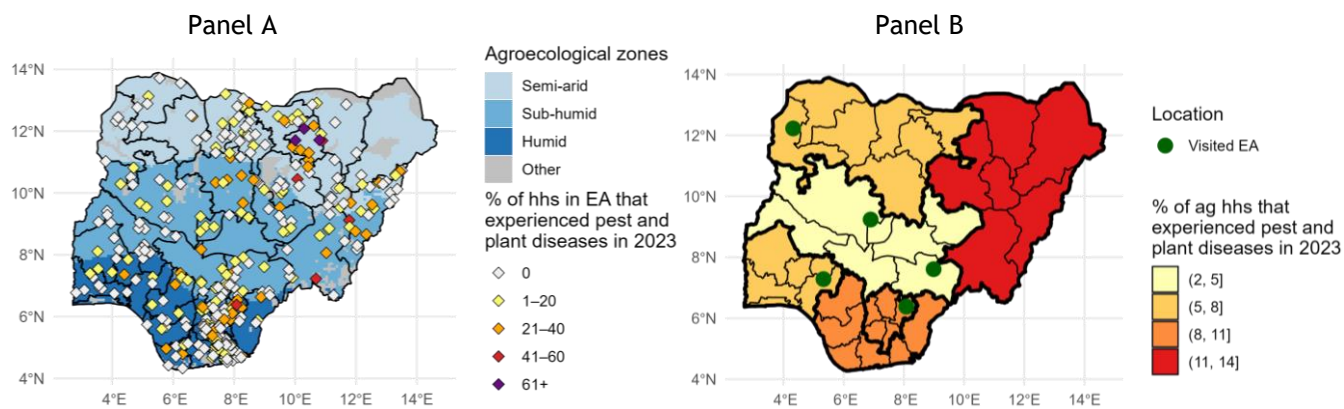
Source: EPAR representation using CHIRTS (Funk et al., 2019), maximum and minimum daily temperature data (Funk et al., 2018).

Notes: EPAR representation using CHIRPS monthly rainfall data (Funk et al., 2015). The dots on the maps represent the EAs where the team conducted FGDs. The coefficient of variation is calculated as the AEZ-wide mean of the average coefficient of variability of daily rainfall by pixel.

Pest infestation is another major threat to Nigerian SSPs. Figure 4h displays the share of households reporting lost harvest dues to pests in the 2023-24 LSMS-ISA GHS. In most GHS EAs, between 0% and 20% of households report harvest losses due to pests (Panel A). The South-East, South-South, and North-Eastern zones were the most affected geopolitical zones, with 8% to 14% of households reporting pest-induced harvest failure.

While the LSMS-ISA GHS captures household-level exposure, the 2024 NAERLS report indicates estimates of the impact of these hazards on crop area and production volume. According to this report, pests and diseases caused crop losses averaging 35 to 45 percent in affected areas, destroying about 54,000 hectares of land across 26 states in 2024 (NAERLS, 2024). Cereal and legumes, root and tubers, fruits, vegetables, and tree crops were pest-affected in all 36 states of Nigeria as well as the Federal Capital Territory or FCT (NAERLS, 2024). Focusing on maize, Figure 4i shows that fall armyworm caused maize yield losses of up to 80% across Nigerian states, with Kaduna, Kwara, and Ogun affected the most. Among pest management strategies, the most reported by farmers was insecticide spraying (NAERLS, 2024).

Figure 4i: Share of Households Reporting Pest and Plant Diseases in 2023



Note: Built using GHS Wave 5 (2023-24). The sample consists of agricultural households located in rural EAs (N=2972 after excluding 5 observations with missing values).

Figure 4j: Fall armyworm maize infestation by state



States where Fall Armyworm Infested maize

Preliminary Source: NAERLS 2024

APPENDIX 5: Self-reported Versus Measured Drought Cross Tabs and Regressions

Table 5a: Abnormally low rain and self-reported drought shocks

Panel A: Cumulative rainfall in Nigeria				
Cumulative rainfall shock (z-score<-1)	Self-reported drought shock			Chi-square test
	No	Yes	Total	
No	224	73	297	$\chi^2(1) = 29.29$ p < 0.001
	(75.42%)	(24.58%)	(100%)	
Yes	193	158	351	
	(54.99%)	(45.01%)	(100%)	
Total	417	231	648	
	(64.35%)	(35.65%)	(100%)	

Panel B: CDD in Nigeria				
CDD shock (z-score>1)	Self-reported drought shock			Chi-square test
	No	Yes	Total	
No	336	77	490	$\chi^2(1) = 15.60$ p < 0.001
	(68.57%)	(31.43%)	(100%)	
Yes	81	77	158	
	(51.27%)	(48.73%)	(100%)	
Total	417	231	648	
	(64.35%)	(35.65%)	(100%)	

Note: Rainfall variables from 2024 growing season (March-August) were constructed using CHIRPS.

Cross-tabulations show partial misalignment between measured and self-reported drought in Nigeria. For cumulative rainfall, among households not exposed to low rainfall shocks, 24.58% report being affected by drought (false positives), while among those exposed to measured drought, 54.99% fail to report being affected (false negatives). Chi-square tests reject the null hypothesis of independence between measured drought exposure and self-reported drought ($\chi^2 = 29.29$, $p < 0.001$). For CDD-based drought, FP and FN rates are 31.43% and 51.27%, respectively, with tests also rejecting independence ($\chi^2 = 15.60$, $p < 0.001$). Both measures show that over half of households experiencing meteorological drought conditions do not self-report being affected.

Table 5b: Mismatch between abnormally low rainfall shocks and self-reported drought

	Rainfall		CDD	
	(1)	(2)	(3)	(4)
	False positive	False negative	False positive	False negative
Female-headed household (dummy)	0.135* (0.077)	0.063 (0.076)	0.076 (0.077)	0.100 (0.092)
Number of HH members	-0.015** (0.006)	0.005 (0.010)	-0.014** (0.006)	0.006 (0.016)
Landholdings (ha)	0.006 (0.018)	0.015 (0.022)	-0.015 (0.014)	-0.044 (0.032)
Number of plots	-0.015 (0.021)	0.005 (0.025)	-0.006 (0.020)	0.019 (0.042)
Total livestock holdings (TLU)	-0.008*** (0.003)	-0.058 (0.036)	-0.006 (0.004)	-0.005 (0.130)
Livestock concentration index	0.137 (0.133)	-0.440* (0.252)	0.151 (0.129)	-0.014 (0.370)
Broadcast access (dummy)	0.076 (0.052)	-0.034 (0.084)	0.031 (0.054)	-0.112 (0.191)
Extension access (dummy)	-0.014 (0.044)	-0.106* (0.063)	0.007 (0.039)	-0.131 (0.142)
Elevation (m)	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	-0.001*** (0.000)
Days since end of CDD			0.000 (0.001)	-0.015 (0.011)
Z-score bin dummies	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Observations	<u>295</u>	<u>350</u>	<u>490</u>	<u>156</u>
R-squared	0.353	0.207	0.253	0.324

Note: Rainfall variables from 2024 growing season (March-August) were constructed using CHIRPS. A total of 2, 1, 0, and 2 observations drop from the sample in columns 1, 2 3, and 4, respectively, due to collinearity. Standard errors clustered at EA level. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$. FP = false positive; FN = false negative

Regression results from table 5b find that female-headed households display marginally higher FP rates for rainfall-based drought (13.5 percentage points, $p < 0.10$). Household size is negatively associated with FP reporting for both drought measures (1.5 percentage points per additional member for rainfall and 1.4 for CDD, both $p < 0.05$). Livestock holdings are negatively associated with FP for rainfall-based drought (0.8 percentage points per TLU, $p < 0.01$) and livestock concentration is negatively associated with FNs (44.0 percentage points, $p < 0.10$). This suggests that larger and more diversified asset bases may provide resilience and sensitivity buffers. Extension access shows a negative association with FN reporting for rainfall measures (10.6 percentage points, $p < 0.10$), suggesting extension services may be linked to greater recognition of drought impacts when they occur. The regressions from table 5c reveal that, after controlling for socio-economic and hazard characteristics, households from the semi-arid AEZ are less likely to report CDD FNs.

Table 5c: Mismatch between abnormally low rainfall shocks and self-reported drought using AEZ fixed effects

	Rainfall		CDD	
	(1)	(2)	(3)	(4)
	False positive	False negative	False positive	False negative
Semi-arid AEZ (dummy)	-0.074 (0.084)	0.070 (0.131)	-0.076 (0.064)	-2.704*** (0.984)
Humid AEZ (dummy)	0.140 (0.123)	-0.094 (0.081)	0.034 (0.098)	-0.102 (0.118)
Socio-economic controls	Yes	Yes	Yes	Yes
Hazard controls	Yes	Yes	Yes	Yes
Observations	<u>297</u>	<u>351</u>	<u>490</u>	<u>158</u>
R-squared	0.234	0.033	0.109	0.150

Note: Rainfall variables from 2024 growing season (March-August) were constructed using CHIRPS. The omitted AEZ category is the Subhumid AEZ. Standard errors clustered at EA level. * p<0.10 ** p<0.05 *** p<0.01.

APPENDIX 6: Attitudes Regressions

Table 6a: Correlates of attitudes using state fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	I am confident in myself as a farmer	I would like my children to become farmers	I am interested in changing to a new economic activity	I am optimistic about the future	I am willing to forego an economic opportunity in the short-run	I consider myself someone who is willing to take risks in farming	I believe that climate will be more unpredictable in the future	If misfortune is meant to strike my farm I cannot avoid it	I do not want anyone to tell me what to do on my farm
Female (dummy)	-0.052 (0.032)	-0.103* (0.057)	0.046 (0.045)	-0.017 (0.031)	0.042 (0.040)	-0.062 (0.045)	0.004 (0.050)	-0.069 (0.061)	-0.023 (0.060)
Age	0.002* (0.001)	0.000 (0.001)	-0.004*** (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	0.000 (0.001)	0.000 (0.001)	-0.001 (0.001)
Schooling: None or missing (dummy)	0.057* (0.030)	0.042 (0.051)	0.034 (0.034)	-0.028 (0.030)	0.043 (0.037)	-0.030 (0.040)	-0.010 (0.040)	0.071 (0.052)	0.044 (0.057)
Schooling: Quranic (dummy)	0.031 (0.046)	-0.018 (0.054)	0.021 (0.063)	0.035 (0.042)	-0.007 (0.064)	0.067** (0.031)	-0.050 (0.055)	0.142*** (0.053)	0.194** (0.075)
Schooling: Primary school (dummy)	0.034 (0.040)	0.019 (0.073)	-0.045 (0.070)	0.025 (0.042)	0.043 (0.043)	-0.034 (0.055)	0.045 (0.056)	-0.036 (0.090)	0.186* (0.097)
Schooling: Junior secondary school (dummy)	0.048** (0.024)	-0.033 (0.046)	-0.034 (0.041)	0.025 (0.027)	0.025 (0.036)	-0.008 (0.033)	-0.085** (0.039)	0.055 (0.049)	0.132** (0.052)
Female-headed household (dummy)	0.007 (0.034)	-0.031 (0.068)	-0.077 (0.048)	-0.010 (0.040)	-0.099** (0.047)	-0.012 (0.049)	-0.055 (0.058)	-0.032 (0.070)	0.016 (0.069)
Number of hh members	-0.002 (0.003)	-0.005 (0.005)	0.001 (0.004)	-0.004 (0.003)	-0.006 (0.004)	-0.006 (0.004)	-0.006 (0.005)	-0.005 (0.006)	0.006 (0.005)
Land size (ha)	0.011* (0.006)	0.003 (0.017)	-0.009 (0.013)	0.012* (0.007)	-0.008 (0.014)	0.025** (0.010)	0.015 (0.014)	-0.006 (0.018)	0.017 (0.017)
Number of plots	0.004 (0.010)	0.003 (0.019)	-0.003 (0.016)	-0.004 (0.010)	0.019 (0.013)	-0.012 (0.015)	-0.015 (0.017)	0.018 (0.020)	-0.032 (0.020)
Total HH livestock holdings (TLU)	0.002 (0.002)	0.005 (0.003)	-0.000 (0.005)	0.002 (0.002)	-0.003 (0.005)	0.006** (0.003)	0.006 (0.004)	0.002 (0.003)	-0.010* (0.005)
Livestock concentration index	0.013 (0.050)	0.110 (0.096)	-0.127 (0.087)	0.082 (0.059)	0.016 (0.091)	0.049 (0.076)	-0.041 (0.102)	0.015 (0.108)	-0.103 (0.125)
Rainfall shocks controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	646	646	646	646	646	646	646	646	646
R-squared	0.109	0.232	0.101	0.096	0.091	0.102	0.133	0.130	0.185

Note: The dependent variable is a dummy equal to one if the respondent agrees or strongly agrees with the statement on the column title. The omitted schooling category is senior secondary school or higher. 2 observations have no schooling and 137 missing schooling. The hazard controls dummies for exposure to abnormally low rainfall or high CDD experience in 2022, 2023, and 2024. Rainfall variables (March-August) were constructed using CHIRPS. Standard errors clustered at EA level. * p<0.10 ** p<0.05 *** p<0.01. Key results are highlighted in yellow.

Table 6b: Correlates of attitudes using AEZ fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	I am confident in myself as a farmer	I would like my children to become farmers	I am interested in changing to a new economic activity	I am optimistic about the future	I am willing to forego an economic opportunity in the short-run	I consider myself someone who is willing to take risks in farming	I believe that climate will be more unpredictable in the future	If misfortune is meant to strike my farm I cannot avoid it	I do not want anyone to tell me what to do on my farm
Subhumid AEZ	0.056** (0.026)	-0.166*** (0.054)	0.026 (0.046)	-0.010 (0.030)	-0.011 (0.036)	-0.075* (0.042)	-0.077* (0.041)	0.017 (0.057)	-0.095 (0.069)
Humid AEZ	0.053 (0.034)	-0.218*** (0.073)	-0.054 (0.054)	-0.052 (0.040)	-0.031 (0.051)	-0.083 (0.055)	-0.133** (0.063)	-0.045 (0.071)	-0.086 (0.083)
Socio-economic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hazard controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	646	646	646	646	646	646	646	646	646
R-squared	0.049	0.115	0.052	0.039	0.029	0.037	0.051	0.054	0.056

Note: The dependent variable is a dummy equal to one if the respondent agrees or strongly agrees with the statement on the column title. Socio-economic controls are a dummy equal to one if the participant is female, dummies for highest schooling levels, dummy equal to one if the hh is female-headed, the number of hh members, land size in hectares, number of plots, total livestock holdings in TLU, and livestock concentration index. The hazard controls dummies for exposure to abnormally low rainfall or high CDD experience in 2022, 2023, and 2024. Rainfall variables (March-August) were constructed using CHIRPS. Standard errors clustered at EA level. * $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$.

APPENDIX 7: Snapshots by AEZ

Table 7a: Snapshot by AEZ

	National				Semi-arid AEZ				Sub-humid AEZ				Humid AEZ			
Variables	Mean	Median	SD	N	Mean	Median	SD	N	Mean	Median	SD	N	Mean	Median	SD	N
Past 5 year climate hazard exposure (Dummy for any exposure)																
Insufficient/Late rainfall (Drought)	0.48	0	0.5	695	0.32	0	0.47	223	0.48	0	0.5	242	0.65	1	0.48	230
Torrential rainfall (Flood)	0.29	0	0.45	695	0.43	0	0.5	223	0.22	0	0.41	242	0.23	0	0.42	230
Very high temperatures (>40°C)	0.47	0	0.5	693	0.34	0	0.48	223	0.38	0	0.49	242	0.7	1	0.46	228
High winds and gusts	0.16	0	0.37	695	0.2	0	0.4	223	0.12	0	0.33	242	0.17	0	0.38	230
Pest/disease outbreak	0.28	0	0.45	694	0.38	0	0.49	223	0.23	0	0.42	242	0.24	0	0.43	229
Experienced climate hazard in the last 12 months (Dummy)																
Insufficient/Late rainfall (Drought)	0.35	0	0.48	695	0.19	0	0.4	223	0.35	0	0.48	242	0.5	0	0.5	230
Torrential rainfall (Flood)	0.18	0	0.38	695	0.32	0	0.47	223	0.14	0	0.35	242	0.07	0	0.26	230
Very high temperatures (>40°C)	0.4	0	0.49	695	0.27	0	0.45	223	0.33	0	0.47	242	0.59	1	0.49	230
High winds and gusts	0.11	0	0.31	695	0.14	0	0.35	223	0.07	0	0.26	242	0.12	0	0.32	230
Pest/disease outbreak	0.21	0	0.41	695	0.3	0	0.46	223	0.19	0	0.39	242	0.16	0	0.37	230
Likelihood of a future hazard occurrence in 2 years _conditional - (Dummy for likely)																
Insufficient/Late rainfall (Drought)	0.35	0	0.48	337	0.24	0	0.43	72	0.34	0	0.47	116	0.42	0	0.5	149
Torrential rainfall (Flood)	0.24	0	0.43	202	0.22	0	0.42	96	0.22	0	0.42	54	0.31	0	0.47	52
Very high temperatures (>40°C)	0.39	0	0.49	329	0.41	0	0.49	76	0.39	0	0.49	92	0.39	0	0.49	161
High winds and gusts	0.33	0	0.47	112	0.32	0	0.47	44	0.34	0	0.48	29	0.33	0	0.48	39
Pest/disease outbreak	0.42	0	0.49	195	0.31	0	0.47	84	0.48	0	0.5	56	0.53	1	0.5	55
Likelihood of a future hazard occurrence in 2 years_ unconditional - (Dummy for likely)																
Insufficient/Late rainfall (Drought)	0.17	0	0.38	695	0.08	0	0.27	223	0.16	0	0.37	242	0.27	0	0.45	230
Torrential rainfall (Flood)	0.07	0	0.26	695	0.09	0	0.29	223	0.05	0	0.22	242	0.07	0	0.25	230
Very high temperatures (>40°C)	0.19	0	0.39	695	0.14	0	0.35	223	0.15	0	0.36	242	0.27	0	0.44	230
High winds and gusts	0.05	0	0.22	695	0.06	0	0.24	223	0.04	0	0.2	242	0.06	0	0.23	230
Pest/disease outbreak	0.12	0	0.32	695	0.12	0	0.32	223	0.11	0	0.32	242	0.13	0	0.33	230
Climate Information (dummy)																
Received climate information	0.36	0	0.48	695	0.35	0	0.48	223	0.38	0	0.49	242	0.34	0	0.48	230
Acted of climate information received	0.48	0	0.5	248	0.52	1	0.5	77	0.5	0.5	0.5	92	0.43	0	0.5	79
Did not act on it b/c: Not relevant to my farm	0.27	0	0.44	128	0.11	0	0.31	37	0.22	0	0.42	46	0.44	0	0.5	45
Did not b/c: Lack of viable or affordable options	0.27	0	0.45	128	0.24	0	0.43	37	0.33	0	0.47	46	0.24	0	0.43	45
Top two trusted providers of climate information (share)																

Trusted providers of climate information (Share)																
Government extension service	0.29	0	0.45	695	0.41	0	0.49	223	0.3	0	0.46	242	0.16	0	0.36	230
NGO	0.12	0	0.32	695	0.2	0	0.4	223	0.12	0	0.33	242	0.03	0	0.17	230
Farmers Group/Association/Co-Op	0.3	0	0.46	695	0.42	0	0.49	223	0.31	0	0.47	242	0.17	0	0.37	230
Farmer field school (FFS) or lead farm	0.1	0	0.3	695	0.19	0	0.39	223	0.09	0	0.29	242	0.03	0	0.17	230
Other peer farmer	0.14	0	0.35	695	0.24	0	0.43	223	0.11	0	0.31	242	0.08	0	0.27	230
Trader, market stakeholder, or private	0.1	0	0.3	695	0.2	0	0.4	223	0.09	0	0.29	242	0.01	0	0.09	230
National weather service	0.17	0	0.38	695	0.16	0	0.37	223	0.13	0	0.34	242	0.23	0	0.42	230
Radio or television program	0.54	1	0.5	695	0.49	0	0.5	223	0.52	1	0.5	242	0.59	1	0.49	230
Other	0.04	0	0.19	695	0	0	0.07	223	0	0	0.06	242	0.11	0	0.31	230
Why didn't your household make use of the information on weather/extreme weather event risk?																
Do not trust	0.13	0	0.34	128	0.0811	0	0.28	37	0.09	0	0.28	46	0.22	0	0.42	45
Often wrong/Not reliable	0.13	0	0.33	128	0.11	0	0.31	37	0.11	0	0.31	46	0.16	0	0.37	45
Not timely	0.2	0	0.4	128	0.32	0	0.47	37	0.26	0	0.44	46	0.04	0	0.21	45
Difficult to understand	0.18	0	0.39	128	0.38	0	0.49	37	0.15	0	0.36	46	0.04	0	0.21	45
No options to respond/too costly to respond	0.27	0	0.45	128	0.24	0	0.43	37	0.33	0	0.47	46	0.24	0	0.43	45
Not relevant to my farm	0.27	0	0.44	128	0.11	0	0.31	37	0.22	0	0.42	46	0.44	0	0.5	45
Other	0.04	0	0.19	128	0	0	0	37	0.02	0	0.15	46	0.09	0	0.29	45
GMO seeds (dummy)																
Knowledge of GMO seeds	0.23	0	0.42	695	0.35	0	0.48	223	0.24	0	0.43	242	0.09	0	0.29	230
If aware, willingness to plant GMO seeds	0.89	1	0.32	148	0.86	1	0.35	76	0.93	1	0.26	54	0.89	1	0.32	18
If aware, willingness to eat product of GMO seeds	0.89	1	0.31	157	0.92	1	0.27	78	0.91	1	0.28	58	0.71	1	0.46	21
If you were told that a new seed variety had been scientifically altered in a lab to have higher pest resistance and produce a greater yield, would you plant it?	0.91	1	0.28	694	0.95	1	0.23	223	0.95	1	0.23	241	0.85	1	0.36	230
Awareness and use of technologies and practices (Share)																
Knows hybrid seeds	0.2	0	0.4	678	0.29	0	0.46	223	0.23	0	0.42	240	0.07	0	0.26	215
Used hybrid seeds in previous ag season	0.72	1	0.45	134	0.72	1	0.45	65	0.75	1	0.44	55	0.57	1	0.51	14
Uses hybrid seeds in current ag season	0.89	1	0.32	134	0.89	1	0.31	65	0.91	1	0.29	55	0.79	1	0.43	14
Knows inorganic fertilizer	0.78	1	0.41	678	0.83	1	0.37	223	0.77	1	0.42	240	0.75	1	0.43	215
Used inorganic fertilizer previous ag season	0.88	1	0.33	529	0.94	1	0.25	186	0.9	1	0.3	182	0.78	1	0.42	161

Use inorganic fertilizer in current ag season	0.91	1	0.28	529	0.95	1	0.22	186	0.93	1	0.26	182	0.84	1	0.36	161
Knows pesticides and herbicides	0.65	1	0.48	678	0.65	1	0.48	223	0.71	1	0.45	240	0.6	1	0.49	215
Used pesticides and herbicides in previous ag season	0.88	1	0.32	437	0.92	1	0.28	145	0.92	1	0.27	168	0.78	1	0.41	124
Used pesticides and herbicides in current ag season	0.92	1	0.27	437	0.97	1	0.18	145	0.94	1	0.24	168	0.84	1	0.37	124
Knows changing what to plant	0.1	0	0.31	678	0.05	0	0.23	223	0.07	0	0.25	240	0.2	0	0.4	215
Changed what they plant in previous ag season	0.7	1	0.46	71	0.75	1	0.45	12	0.88	1	0.34	16	0.63	1	0.49	43
Changed what they plant in current ag season	0.73	1	0.45	71	0.75	1	0.45	12	0.88	1	0.34	16	0.67	1	0.47	43
Knows changing how manage their land/soil	0.1	0	0.29	678	0.04	0	0.19	223	0.08	0	0.26	240	0.18	0	0.39	215
Changed how manage their land/soil in previous ag season	0.83	1	0.38	64	0.75	1	0.46	8	0.89	1	0.32	18	0.82	1	0.39	38
Changed how manage their land/soil in current ag season	0.81	1	0.39	64	0.88	1	0.35	8	0.83	1	0.38	18	0.79	1	0.41	38
Knows changing how manage water	0.04	0	0.21	678	0.04	0	0.21	223	0.04	0	0.19	240	0.05	0	0.22	215
Changed how manage water in previous ag season	0.76	1	0.44	29	0.9	1	0.32	10	0.67	1	0.5	9	0.7	1	0.48	10
Changed how manage water in current ag season	0.93	1	0.26	29	1	1	0	10	1	1	0	9	0.8	1	0.42	10

Table 7b: Attitudes Snapshot by AEZ

	<i>National</i>			<i>Semi-arid AEZ</i>			<i>Sub-humid AEZ</i>			<i>Humid AEZ</i>		
	<i>Disagree</i>	<i>Neutral</i>	<i>Agree</i>	<i>Disagree</i>	<i>Neutral</i>	<i>Agree</i>	<i>Disagree</i>	<i>Neutral</i>	<i>Agree</i>	<i>Disagree</i>	<i>Neutral</i>	<i>Agree</i>
Attitudes now												
I am confident in myself as a farmer	0.04	0.02	0.94	0.02	0.05	0.93	0.04	0	0.96	0.06	0.02	0.92
I would like my children to become farmers	0.26	0.07	0.67	0.1	0.05	0.84	0.29	0.05	0.66	0.37	0.12	0.51
I am interested in changing or expanding to new economic activity	0.09	0.06	0.85	0.08	0.07	0.85	0.05	0.06	0.89	0.14	0.06	0.8
I am optimistic about the future	0.03	0.04	0.94	0.01	0.04	0.95	0.02	0.03	0.95	0.05	0.03	0.91
I am willing to forgo a profit opportunity in the short-run in order to benefit from potential profits in the long-run	0.08	0.04	0.88	0.07	0.05	0.88	0.08	0.04	0.88	0.09	0.03	0.87
I consider myself a person who is willing to take risks in farming	0.09	0.03	0.88	0.05	0.03	0.92	0.08	0.04	0.88	0.12	0.03	0.85
I believe that climate will be more and more	0.1	0.08	0.82	0.03	0.08	0.9	0.12	0.07	0.81	0.13	0.1	0.77

unpredictable in the future												
If misfortune is meant to strike my farm I cannot avoid it.	0.24	0.07	0.69	0.16	0.08	0.76	0.23	0.05	0.72	0.32	0.08	0.6
I do not want anyone to tell me what to do on my farm	0.55	0.06	0.4	0.49	0.06	0.45	0.62	0.04	0.34	0.53	0.07	0.4
Attitudes 5 years ago												
I am confident in myself as a farmer	0.05	0.02	0.93	0.02	0.05	0.93	0.04	0	0.96	0.09	0.02	0.89
I would like my children to become farmers	0.28	0.07	0.65	0.1	0.05	0.85	0.32	0.06	0.63	0.4	0.1	0.5
I am interested in changing or expanding to new economic activity	0.11	0.06	0.83	0.08	0.08	0.85	0.09	0.06	0.85	0.16	0.05	0.79
I am optimistic about the future	0.04	0.04	0.92	0.01	0.04	0.95	0.05	0.03	0.92	0.07	0.05	0.88
I am willing to forgo a profit opportunity in the short-run in order to benefit from potential profits in the long-run	0.11	0.04	0.85	0.07	0.05	0.88	0.13	0.04	0.83	0.11	0.03	0.86
I consider myself a person who is willing to take risks in farming	0.1	0.04	0.86	0.05	0.03	0.92	0.1	0.05	0.85	0.15	0.03	0.81
I believe that climate will be more and more unpredictable in the future	0.1	0.08	0.82	0.03	0.08	0.9	0.12	0.08	0.8	0.15	0.1	0.76
If misfortune is meant to strike my farm I cannot avoid it.	0.24	0.07	0.69	0.16	0.08	0.76	0.24	0.05	0.71	0.32	0.08	0.6
I do not want anyone to tell me what to do on my farm	0.54	0.06	0.4	0.49	0.07	0.44	0.61	0.04	0.35	0.53	0.07	0.41