sustainability

MDPI

Article

Stressors and Resilience within the Cassava Value Chain in Nigeria: Preferred Cassava Variety Traits and Response Strategies of Men and Women to Inform Breeding

Olamide Olaosebikan [1,*], Abolore Bello [1], Obaiya Utoblo [2], Benjamin Okoye [3], Nathaniel Olutegbe [4], Elisabeth Garner [5], Béla Teeken [1], Elizabeth Bryan [6], Lora Forsythe [7], Steven Cole [8], Peter Kulakow [1], Chiedozie Egesi [1,3,5], Hale Tufan [9] and Tessy Madu [3,*]

1 International Institute of Tropical Agriculture, Ibadan 200001, Nigeria; a.bello@cgiar.org (A.B.); b.teeken@cgiar.org (B.T.); p.kulakow@cgiar.org (P.K.); c.egesi@cgiar.org (C.E.)
2 Department of Plant Science and Biotechnology, University of Jos, Jos 930105, Nigeria; obaiyautoblo@gmail.com
3 National Root Crops Research Institute Umudike, Umudike 440109, Nigeria; okoyebenjamen@yahoo.com
4 Department of Agricultural Extension and Rural Development, University of Ibadan, Ibadan 200132, Nigeria; nathanielsiji@gmail.com
5 Center for International Forestry Research and World Agroforestry, Bogor 16115, Indonesia; e.garner@cgiar.org
6 International Food Policy Research Institute, Washington, DC 20005-3915, USA; e.bryan@cgiar.org
7 Natural Resources Institute, University of Greenwich, London SE10 9LS, UK; l.forsythe@greenwich.ac.uk
8 International Institute of Tropical Agriculture, Dar es Salaam 34441, Tanzania; s.cole@cgiar.org
9 College of Agriculture and Life Sciences, Cornell University, Ithaca, NY 14850, USA; hat36@cornell.edu
* Correspondence: d.olaosebikan@cgiar.org (O.O.); tessmadu@gmail.com (T.M.)

Abstract: This study investigated the trait preferences for cassava in the context of climate change and conflict stressors among value-chain actors in Nigeria to strengthen social inclusion and the community-resilience outcomes from breeding programs. Multi-stage sampling procedures were used to select and interview male and female value-chain participants in the Osun, Benue and Abia States. The results indicated that farmers preferred cassava traits such as drought tolerance, early bulking, multiple-product use and in-ground storability to strengthen resilience. Climate change and challenges related to social change shaped the response strategies from both genders, and influenced trait preferences, including the early re-emergence of cassava leaves, stems that had ratooning potential, and especially the root milking that was important among female respondents. The major response strategies employed by men included frequent farm visits to prevent theft and engaging in non-agricultural livelihoods. Those employed by women included backyard farming, early harvesting, having preferences for food with fewer processing steps, and depending on remittances. The resilience capacity was higher for men than for women due to their better access to assets, as well as their abilities to relocate their farms and out-migrate in search of other livelihoods. Considering gendered cassava traits, and enhancing their resilience and response strategies, can complement efforts to make breeding more socially inclusive, resilient, and anticipatory to future challenges created by climate and related social changes.

Keywords: breeding; cassava; climate change; conflict; trait preferences; response strategies; gender disparity

Citation: Olaosebikan, O.; Bello, A.; Utoblo, O.; Okoye, B.; Olutegbe, N.; Garner, E.; Teeken, B.; Bryan, E.; Forsythe, L.; Cole, S.; et al. Stressors and Resilience within the Cassava Value Chain in Nigeria: Preferred Cassava Variety Traits and Response Strategies of Men and Women to Inform Breeding. *Sustainability* **2023**, *15*, 7837. https://doi.org/10.3390/su15107837

Academic Editor: Teodor Rusu

Received: 3 December 2022
Revised: 22 March 2023
Accepted: 27 March 2023
Published: 10 May 2023

1. Introduction

This study investigates the gendered trait preferences in the cassava value chain (VC) that have the potential to contribute to building the resilience of VC actors facing economic, social, and climatic stressors in Nigeria. Bowen et al. [1] define resilience as the ability of households to prepare for, cope with and adapt to shocks in a way that protects their well-being, and preserve them from falling into or being trapped in poverty consequent upon facing the shock. Cassava possesses several well-documented resilient traits, establishing it

as a key crop essential for food security [2–7] and climate change (CC) adaptation [8]. In Nigeria, farmers have been responding to the impacts of climate variability by planting improved cassava varieties with resilient traits against extreme weather [9–11]. The cassava traits related to resilience, which are preferred by both male and female farmers, include its adaptability to different ecosystems and soil types, its tolerance to extreme stress conditions and its ability to act as a substitute for crops more sensitive to climate stress, such as potatoes, rice and maize [12–14]. Cassava is often prioritized over other starchy crops, especially among female farmers because it can be cultivated in relatively poor soils using low levels of labor, capital and time, and is often harvested piecemeal to meet women's immediate food and monetary needs [12,15–18]. Women process different cassava products that add substantial value to the crop, and enable it to be stored and used during times of food shortages [19]. The cassava VC creates other livelihood opportunities for women and vulnerable social groups [20] during times of crisis and famine driven largely by conflict, CC, and the recent COVID-19 pandemic.

Strengthening the resilience of individuals and households through cassava breeding programs is important because of the changing social, economic, and climatic conditions in communities that are dependent on cassava for overall livelihood security. In Nigeria, the cassava VC is gendered, whereby women primarily engage in activities such as processing and food products marketing while men prefer, and primarily engage in, production activities [5,6,14,21,22]. The gendered nature of the cassava VC makes understanding the trait preferences of women and men, that are in different market segments and who are from different socio-economic backgrounds, all the more necessary; this would inform the development of new/improved varieties that can help VC actors to respond (cope and adapt) to the climate change, social, and economic challenges they face.

Prior studies in and outside of Nigeria have identified different cassava traits that women and men prefer to enhance adoption and utilization [3,15,16,23–27]. Attempts to respond to the preferences and needs of different users have been made in the recent past to inform the development of cassava varieties that are high yielding [28], suppress weeds [29], require less drudgery during processing, result in a high food-product yield, have quality traits that consumers prefer [30,31], address social equity concerns [15,16], and mitigate vagaries of climatic change and increase stress tolerance [12]. However, studies reporting the interaction and multiple effects of the social and CC stressors in Nigeria are emerging but they are yet to consider the differential resilience capacities and cassava trait preferences that will enable male and female VC actors to better respond and adapt to stressors [32–35].

The Nigerian context presents a clear picture of how climate and social stressors interact, leading to economic challenges [32,33]. For instance, due to climate change, herders (who are primarily men and usually assisted by boys in Nigeria) and their cattle are often forced to navigate undefined routes to the relatively greener vegetated southern belt in search of feed [36–38]. In the process, some herders invade farms with their cattle that forage on crops and destroy seeds, thereby resulting in frequent land-use conflicts with cassava farmers and a loss of their livelihoods [39–46]. In extreme cases, conflict leads to some farmers migrating off their lands [33]. The effects of the interaction between climatic, social, and economic stressors are predicted to increase with rising temperatures [47], undermining the resilience capacities [36], livelihoods, and the food security of VC actors [48,49].

With the interconnected nature of stressors, it is expected that cassava farmers and other VC actors will adopt a set of coping and adaptation strategies to deal with climatic, economic, and social stressors [34]. Evidence shows that men and women are exposed and have different capacities to respond to stressors, as well as different preferences for how to respond [50,51]. Male and female farmers have been adopting practices in response to climate change challenges and other stressors, often adopting complementary response strategies that are reflective of their resilience capacities and gendered livelihood roles [52–57]. Improving the resilience of cassava VC actors through the breeding of

new/improved varieties that align with the trait preferences of women and men therefore deserves greater attention in the Nigerian context [3,58,59].

To align with the key objectives of public breeding [26,60] and to maximize positive outcomes in social, gender, climate change, nutritional, and environmental impact areas [61], this study investigates the cassava traits of interest to male and female VC actors as part of their coping and adaptive responses to climatic and social stressors.

Our research questions are:

1. What are the cassava traits that make it a resilient crop among male and female cassava value chain actors who are experiencing climate and social (e.g., conflict) stressors in Nigeria?
2. What are the response strategies that are adopted by male and female cassava value chain actors to better cope and adapt to climate and social stressors?
3. What is the resilience capacity of male and female value chain actors to climate and social stressors?

2. Methodology

2.1. Study Area

The selection of the study communities was informed by previous studies. Three States (Osun, Abia and Benue) were selected in Nigeria following Teeken et al. [16] and Wossen et al. [62]. These three states are part of the highest cassava producing and consuming states of Nigeria, representing three out of six different geopolitical zones: south-west (SW), south-east (SE) and north-central (NC). Among the inhabitants across the three states, agricultural livelihood is prioritized, especially in Benue State. This study prioritized the selection of rural communities that have experienced at least one stressor in the last 5 years. In Benue (NC), there is prolonged drought, erratic rainfall, and intense herder–farmer conflict. In Osun (SW) State, erratic rainfall and emerging herder–farmer conflict are prevalent, while in Abia State, erratic rainfall, communal clashes, and land conflicts are the main stressors. Observations and interactions with farmers and extension officers during the earlier piloted studies [15,16] assisted in the identification and selection of key and active cassava-producing communities, namely the Igbaiye and Opanda communities in Osun State, Ndiorie Ariam in Abia State, and Daudu in Benue State.

2.2. Sampling

This study targeted individuals along the cassava VC. Producers were sampled for the quantitative data collected, and producers, processors and marketers were sampled for the qualitative data collected. For quantitative data, a three-stage sampling procedure was used to select one-hundred and eighty-seven cassava farmers. The first stage involved purposive selection of the communities in each State. These rural communities were selected based on their active engagement in cassava production. The second stage involved stratification by male and female individual cassava farmers from a list that was obtained from the Village Extension Agent (VEA) and Farmers representatives in each community. The third stage involved proportionate random sampling, aligning with the proportion of male and female listed farmers, to sample 35 male and 27 female cassava farmers in Osun, 24 male and 38 female farmers in Abia, and 33 male and 35 female farmers in Benue States (See Supplementary Table S1 on socio-economic characteristics of respondents). The entry point to the cassava VC-processing and product-marketing activities is cassava production. Hence, cassava producers (farmers) were prioritized to provide answers to the research question on cassava traits that strengthen resilience to stressors during the quantitative data collection, because many, especially female farmers, were processors and marketers. The 187 individual interviews constituted the basis to build the resilience capacity outcome indicator (see Section 2.3).

For the qualitative data, all the three types of actors—producers (farmers), processors and marketers—participated in key informant interviews (KIIs) and sex-disaggregated focus group discussions (FGDs). The KIIs served as entry points to engaging with com-

munity heads and identified the representatives of farmers, marketers, processors and one agricultural extension agent, for a total of 14 KIIs across the selected States. The majority of the key informants held leadership positions in the communities and within the cassava VC unit. These interviews were open discussions to provide greater insight into the VC activities in the area, the community histories, the stressors experienced and changes over time, and, in particular, the differences in access to assets, as well as the coping and adaptation strategies adopted.

Each of the sex-disaggregated FGDs comprised between 6 and 9 male or female famers in each of the communities. Processors and marketers were combined for a third set of FGDs, with one in each community. These were mostly female participants because cassava processing and marketing are most predominantly practiced by women in the rural communities in Nigeria [14,15,24]. This gave nine FGDs across the three sampled states.

2.3. Data Collection and Analysis

This study adopted the use of Computer Assisted Personal Interviewing (CAPI) due to its relative advantages in integrating data collection, data entries, editing, coding, and cleaning into a single process over the traditional paper-and-pencil techniques [63], among other benefits [64,65]. The survey was based on a structured questionnaire imputed to digital software Kobocollect [66,67] and collected using tablets or mobile phones. Our key variables, which included cassava traits, the consequences of stressors, and response strategies, were measured with a representative list of items obtained from the literature, the expert review/validation workshop, the pretest of research instruments, and qualitative sessions (see Table S2). The instruments were validated for content and construct by gender and cassava breeding experts. Thereafter, a pre-test exercise was conducted to ascertain the consistency with which the instruments measured the variable of interest. Data were uploaded to a server daily. The quantitative data were analyzed using SPSS (version 15.0) [68]. The descriptive and inferential statistics such as percentages and Analysis of Variance (ANOVA) were used to present the gender-disaggregated results for each state and pooled data sets. The measures of resilience capacity were guided by FAO's Resilience Index Measurement and Analysis (RIMA) Model [69], which measures resilience as a capacity including four pillars (adaptive capacity, assets, access to basic services, and social safety nets). Using factor analysis on items in each of these four pillars, an index of overall resilience capacity and for each of the four pillars was computed [70] and used in a two-way ANOVA gender and state interaction differential analysis using the agricolae [71] package in R [72]. In describing the resilience capacity status of households, the mean value of the computed index was used as a benchmark for categorizing respondents into high ($\geq$mean) and low (>mean) levels, respectively.

For the qualitative data, interview and focus group discussions were recorded and transcribed. Thematic areas were identified before transcript analysis, in line with the research question. These themes included cassava attributes that enhanced the resilience to conflict and climate change, the climate effect on value chain activities, the conflict effect on value chain activities, the coping strategies in response to climate change, the coping strategies in response to conflict, and transcripts were coded based on these themes.

3. Results and Discussion

The literature reviews show that the public crop-breeding programs in sub-Saharan Africa have been incorporating resilience traits into crops, such as cassava, and within crop-related livelihoods of households within rural communities by focusing on environmental biotic and abiotic stresses such as disease (e.g., cassava mosaic disease and cassava brown streak disease), pests, drought, and weed suppression. In the case of cassava, efforts were made through projects such as the Cassava Mosaic Disease Project and by Sustainable Weed Management Technologies for cassava, implemented by international and national institutions to improve the potential of cassava as a highly resilient crop. Cassava can withstand stress from drought and dry poor soils, and has relatively good productivity, despite little

attention given to it during its growth stage by some farmers (women and men) compared with other crops such as maize and yam. Since the 1980s, scientists have substantiated that, in addition to breeders, farmers and other VC actors have a role to play in improving agro-ecological resilience through selecting higher yielding varieties [73,74] and maintaining high levels of crop diversity [75]. From the 1990s onwards, initiatives were developed to improve societal resilience through participatory plant breeding [16,76,77]; in some cases, with a particular focus on the empowerment of women [78]. The valuable lessons learned from these studies are contributing to the mainstreaming of gender-responsive initiatives in ongoing and new crop breeding activities, and the future of agriculture [18,26,79].

The following sections present the results of the fieldwork of this study. Tables 1–3 highlight the types of social stressors (e.g., conflicts) and immediate consequences as experienced in—and peculiar to—each study location, as well as the response (coping and adaptation) strategies adopted by male and female cassava producers (farmers) to the social, climatic/environmental and economic stressors. Tables 4–6 highlight the selected cassava traits that were informed by previous studies and reports, and that were perceived by farmers (see Supplementary Table S2 for the sources of information on cassava traits and response strategies categories) to be contributing to resilience, for "what stressor", for "whom", "where" and "why" [58]. This is particularly to validate and better establish cassava as a resilient crop among male and female farmers in rural communities.

Table 1. Percentage distribution of social stressors (conflicts) and immediate consequences as identified by male and female cassava farmers.

Effects of Conflict Types	Benue		Osun		Abia		Pooled	
	M (%)	W (%)	M (%)	W (%)	M (%)	W (%)	M (%)	W (%)
Herders–farmers clash								
Destruction of farms	100	87	80	71	-	-	64	54
Burnt houses or farms	78	63	43	33	-	-	60	48
Relocated farm	78	83	14	–	-	-	46	42
Yield loss	86	77	80	85	-	-	83	81
Loss of livelihood	86	83	74	70	-	-	80	77
Land-use conflicts								
Reduced farming activities	-	-	-	-	63	74	63	74
Low harvest	-	-	-	-	21	26	21	26
Communal clashes								
Reduced farming activities	-	-	-	-	79	72	79	72
Crop loss	-	-	-	-	87	82	88	82
Destruction of farms	-	-	-	-	12	5	64	54

M = Men, W = Women.

Table 2. Percentage distribution of coping and adaptation strategies adopted by male and female farmers in response to conflict.

Coping and Adaptation Strategies to Conflict Stressor Types	Benue		Osun		Pooled	
	M (%)	W (%)	M (%)	W (%)	M (%)	W (%)
Herders–farmers clashes						
Early planting	13	20	11	15	12	18
Early harvesting	25	40	51	56	38	48
Backyard/neighborhood farming	53	60	37	41	45	51
Relocating farms	94	97	83	74	89	86
Managing multiple plots	36	57	31	26	34	42
Migrating	69	93	0	0	35	49
Intercropping	25	23	34	33	30	28
Crop diversification	25	33	34	41	30	37
Engaging in non-agricultural livelihood	11	17	17	4	14	11
Praying	33	50	3	0	18	25
Loans	0	0	9	7	5	4
Frequent farm visits/close monitoring	3	3	54	30	29	17
Vigilante security agents	0	0	25	37	13	19

Table 2. *Cont.*

Coping and Adaptation Strategies to Conflict Stressor Types	Benue		Osun		Pooled	
	M (%)	W (%)	M (%)	W (%)	M (%)	W (%)
Land-use conflicts/communal crises	Abia					
Early planting	17	13	-	-	-	-
Early harvesting	29	33	-	-	-	-
Backyard farming	53	69	-	-	-	-
Relocating farms	63	77	-	-	-	-
Managing multiple farms	0	0	-	-	-	-

M = Men, W = Women.

Table 3. Percentage distribution of coping and adaptation strategies adopted by men and women in response to climatic/environmental stressors.

Coping and Adaptation Strategies to Climatic Stressors Types	Benue		Osun		Abia	
	M (%)	W (%)	M (%)	W (%)	M (%)	W (%)
Environmental/Climate Pests and Disease						
Growing disease-resistant crops	3	10	6	7	8	18
Growing underground RTCs	17	33	9	-	9	21
Relatively low farm size	6	7	6	-	4	3
Selective crop cultivation	6	20	11	7	17	15
Sowing less	14	13	6	-	4	8
Migrating	3	7	6	-	8	5
Growing crops in upland case of flash floods	8	10	6	-	4	13
Use of chemicals	86	70	74	74	38	26
Erosion						
Growing underground RTCs	14	23	-	-	21	8
Relatively low farm size	6	3	-	-	-	3
Selective crop cultivation	14	17	-	-	-	3
Sowing less	3	13	-	-	-	3
Migrating	8	10	-	-	-	3
Growing crops in upland cases of flash floods	17	3	-	-	8	10
Nutrient depletion						
Relatively low farm size	8	13	-	-	-	3
Selective crop cultivation	11	33	11	7	-	8
Sowing less	11	7	-	-	-	5
Applying fertilizer	50	30	43	30	-	23
Applying manure	14	10	14	19	-	26
Droughts						
Growing crops tolerance to droughts	31	33	54	44	4	13
Growing underground RTCs	19	37	20	22	4	18
Relatively low farm size	6	7	6	3	4	3
Selective crop cultivation	17	20	23	15	4	8
High temperature						
Growing crops tolerant to high temperatures	14	20	3	4	17	15
Growing underground RTCs	25	30	-	4	38	33
Relatively low farm size	3	17	-	4	-	3
Selective crop cultivation	3	13	-	4	-	18
Sowing less	8	3	-	4	4	5
Migrating	3	17	-	4	4	3
Growing crops in upland cases of flash floods	6	3	-	4	4	13

M = Men, W = Women.

Table 4. Percentage distribution of respondents by cassava traits, which enhance resilience to "conflict" among male and female cassava farmers in Nigeria.

Cassava Traits Enhancing Resilience to Conflict	Benue		Osun		Abia	
	M (%)	W (%)	M (%)	W (%)	M (%)	W (%)
Complements other staples	69	77	80	85	83	74
Leaves scent/odour inedible to cattle	36	26	31	33	4	8
Thrives in any soil	72	83	80	93	75	85
Thrives with intercropping	44	43	77	93	50	49
Contributes to food during droughts	92	87	89	93	79	74
Provides diverse food during lean seasons	83	80	86	85	67	74
Long duration/late maturity	50	37	69	63	67	39
Short duration/early maturity	50	53	71	67	54	72

M = Men, W = Women.

Table 5. Percentage distribution of respondents by cassava traits, which enhance resilience to "environmental/climatic stressors" among male and female cassava producers in Nigeria.

Cassava Traits Enhancing Resilience to Environmental/Climatic Stress	Benue		Osun		Abia	
	M (%)	W (%)	M (%)	W (%)	M (%)	W (%)
Tolerance to pests and diseases	78	73	89	93	75	74
Survives in a water-logged area	44	50	40	41	21	36
In-ground storability	69	73	57	70	92	90
Thrives on low-nutrient soil	86	70	91	89	79	90
Tolerance to dry spells	83	87	91	93	75	80
Short duration/early bulking	56	60	80	78	75	67

M = Men, W = Women.

Table 6. Percentage distribution of respondents by cassava traits, which enhance resilience to "economic stress" among male and female cassava farmers in Nigeria.

Cassava Traits Enhancing Resilience to Economic Stress	Benue		Osun		Abia	
	M (%)	W (%)	M (%)	W (%)	M (%)	W (%)
High root yield	92	100	100	96	92	95
Minimal inputs and management requirements	83	76	91	78	67	64
Low cost of production	78	80	80	70	75	82
High stem yield	69	77	57	48	54	74
Flexible harvesting times	72	73	63	67	75	85
Root milking	31	37	48	60	25	31

M = Men, W = Women.

Among the study sites, the most severe consequence of herder–farmer conflicts include the destruction of farms by herders' cattle that forage on cassava crops and destroy stems, resulting in the loss of crop yield, stems, and the loss of livelihoods among farmers (Table 1). These negative impacts are experienced by more male than female farmers in Benue, and followed by Osun. In Abia, crop loss and reduced production activities are the most severe consequences of land-use-related conflicts that affect more women than men. It has been stated that farmers' output would continue to decline unless there was a way to stop the herders from depending on farmers' crops for feeding their livestock [80]. This finding is consistent with a recent study, which indicates that herder–farmer conflicts constitute a serious threat to the sustainability of common pool resources, other natural resources and, hence, food security, because the majority of farmers, for fear of attack, can no longer farm freely and harvest their farm produce [81].

The responses to shocks and stressors can be categorized in different ways. Coping strategies are usually short-term reactions to acute shocks and often result in a decline in well-being, such as when households consume less food or eat less-preferred foods following a climate shock. The adaptation responses tended to be more anticipatory and aimed at sustaining well-being outcomes in the face of longer-term or slow onset changes. Often the same response could be either coping or adaptive. For example, forced migration due to conflict would be considered a coping response, while migration for better economic opportunities may be viewed as adaptive. The strategies covered in this study represent a mix of adaptation and coping responses.

The results in Table 2 reveal that male and female cassava farmers adopted various coping and adaptation strategies in response to the conflict-stressor types.

Farmers in Osun, in addition to the commonly adopted relocation of farms, adopted early harvesting (51% and 56% for men and women, respectively) and frequent farm visits/close monitoring of farms, with a higher proportion of men (54%) adopting the latter practice, compared with women (30%). One of the community leaders in Igbaiye in the Osun State indicated:

> "*We (farmers) adjust to conflict by knowing the time we will plant, the variety to plant since some plants are resistant to drought and can mature within a shorter time to facilitate or enable early harvesting*". (*Man, KII, Osun State*).

Farmers stated that the security provided by agro-rangers have helped to minimize sudden farm destruction. One of the female FGD participants reiterated this:

> "*We have local security personnel (vigilante group) patrolling the community and farms. This is reducing fear and we are picking up our farming activities gradually now*". (*Woman FGD, Osun State*).

Female farmers adopted early harvesting practices across sites. Obviously, the labor burden of rural women, indicated by Doss et al. [82] exceeded that of men, making it difficult for the majority of the women to actively adopt most of the highlighted response strategies. The potential non-crop response strategies among participants included taking loans and engaging the services of vigilantes, which can be beneficial and effective if the right policies are put in place. In Osun, male and female farmers coped by practicing early harvesting and frequent visits to farms, while in Benue, male and female farmers migrated to secured and less conflict-prone states. While men can, and usually do, migrate alone to southern states where cases of conflict are less experienced, and where they continue to farm with a high level of security consciousness, women are made to move to close-by safe zones (this is mostly a family decision with extended families). In Benue, the study reveals that backyard farming was high for both men and women but higher among women (69%) than men (53%). Beyond the results that revealed the increasing vulnerable states of women, the results also show that men are becoming more vulnerable. The same pattern is observed in Abia, where a significant number of women (69%) and more than half of men (53%) resorted to backyard farming.

The results shown in Table 3 reveal that the use of chemicals was the most commonly adopted measure to reduce the effects of pests and diseases, and to boost soil fertility, with a higher level of use by male farmers than female farmers in Benue (86.1% and 70.0%), Osun (74.3% and 74.1%), and Abia (37.5% and 25.6%). The results further show that strategies to counter soil erosion are infrequently practiced by both male and female cassava farmers. The same is observed for strategies to counter drought and increasing temperature, which is indicative of inadequate institutional support towards withstanding and strengthening resilience against the environmental problems the cassava farmers are confronted with. The application of fertilizer appears to be relatively higher in use as a measure to reduce the effects of nutrient depletion, especially among men in Benue (50%) and Osun (43%) against 30% in each of the states. This result shows gender disparities in the use of different coping and adaptive strategies to environmental stressors, which is consistent with [83], who report that women make up a large share of farmers in sub-Saharan Africa yet tend to face greater constraints with regards to land ownership; access to credit and productive farm inputs such as fertilizers, pesticides and farming tools; support from extension services; and access to markets and other factors essential to their livelihood.

The gender differences in additional response strategies that came from the VC discussions revealed diversified sources of income as a major adaptive strategy. Men have mobility privileges, and can travel to learn and take on new vocations such as mechanics, carpentry, etc., in urban and peri-urban states. Women usually mentioned that they have to search for vocations such as assisting to carrying goods bought by buyers, sourcing firewood to sell, performing manual root-peeling labor, toasting gari, and other cassava food product-processing activities within the communities in which they reside, which might have influenced their lower resilience capacities compared with men as shown in Table 7.

Table 7. Percentage distribution of gendered and regional resilience capacity of male and female farmers in the study area.

State (Region)	Benue (NC)		Osun (SW)		Abia (SE)		Pooled	
Levels	Men	Women	Men	Women	Men	Women	Men	Women
Low	55.6	88.6	45.7	92.6	58.3	69.2	53.2	83.5
High	44.4	13.3	54.3	7.4	41.7	30.8	46.8	17.8

One of the key female informants in Daudu in Benue State noted thus:

"*Women venture into buying and selling of other goods, helping people to carry their goods at the marketplace or selling firewood, and working as a labourer for gari processors . . . .*" (*Woman, KII, Benue State*).

Some families respond to the effects of conflicts by marrying off their daughters at very early ages to reduce the burden of responsibility on them. Some households even have expectations for remittances while doing this.

"*Some of us give out their daughters in hand for marriage for foodstuffs just to survive the crisis. People also sell their goods at a low price to earn an income. We sometimes even sell off our unharvested crops (while still on the field in some extreme cases of hunger just to get some money to buy food*". (*Men, KII, Benue State*).

Women that were primarily engaged in cassava processing and the marketing of food products further mentioned a preference for cassava food products, such as *akpu/fufu and lafun*, with fewer processing steps, and dependence on remittances from adult family members as additional non-crop related strategies. With regards to the preference for cassava with fewer processing steps among processors, poundable cassava is a type that requires the least processing as it can be eaten cooked or boiled.

An immediate consequence of most conflict situations is the loss of livelihoods and productive resources; hence, food for survival is usually a priority. When zooming in on the cassava traits related to resilience, the results shown in Table 4 reveal that both female and male farmers perceived, and frequently mentioned, cassava traits such as "complements other staples" as an important cassava trait that enhances resilience. In Benue State, food vendors and consumers often mix cassava flour called lafun with maize or rice flour that can be preserved for long periods of time, and that can be used to prepare a dough-like food, which is cheaper than dough-like food prepared from only maize or only rice flour.

Female farmers consider the multiple-food uses of cassava and its ability to thrive in any soil (e.g., whether in backyard farming—on fertile soil but which facilitates close monitoring—or in forest farming—on fertile soils but with less monitoring and maintenance) as priority traits that also enhance resilience to ensure the availability of food during or after conflicts. Mostly women handle the post-harvest activities and the processing of fresh roots into diverse foods for home consumption and marketing. The processing of cassava by women into diverse food products drives and sustains the cassava root sales for male farmers, which explains why men validated the multiple-food-use cassava trait among women. One of the women in the Daudu community in Benue State stated:

"*We use cassava to make different types of foods: fufu, gari*, etc. *It is multi-purpose; we make soup using the edible leaves too*". (*Woman FGD, Benue State*).

With further probing, participants stated that the competition for survival and food among migrants in conflict-prone zones has resulted in the pilfering of cassava roots because of its multiple-food uses. The theft of cassava roots is an emerging stressor affecting productivity and reducing the quantity of roots harvested to be marketed and processed, particularly in Benue State. Cassava root theft experiences are low and perceived by most farmers as their contribution to reducing hunger among displaced individuals and households. However, intense and continuous conflict situations often keep farmers away from their farms for long periods, so farmers usually like to combine late and early maturing varieties. In Osun State, men prefer early bulking varieties to take turns in securing their farms through frequent visits to prevent root theft, fire outbreak incidences, and the sudden destruction of farms caused by herders with cattle. Frequent farm visits and early maturing varieties particularly benefit male farmers that sell cassava roots in large quantities because, within a short period, they are able to harvest and sell cassava roots. In Abia State, female farmers prefer early maturing varieties to ensure the continuous processing and marketing of akpu, which is a major food product with lesser processing steps compared with *gari*, in the south-east region. On the contrary, in Abia State, the

preference for late bulking varieties that demand less management efforts is prioritized among men to reduce the number of visits to farms or hours spent on the farm due to insecurity. Across the study states, female farmers prefer the cassava trait that can "thrive in any soil" to reduce the cost of, and time spent on, labor to apply fertilizer. Men and women in rural farming communities face different challenges and have different response options as they are embedded in different stressor-specific environments; hence, they prioritize different cassava traits to deal with stressors.

The results in Table 5 reveal that in relation to environmental stressors, cassava's tolerance to pests and diseases remains a key trait for both male and female farmers. These traits have been prioritized by most breeding programs. The cassava trait that "thrives on low nutrient soil" is rated the highest among female farmers, especially in Abia State. Women in the Daudu community in Benue State also prioritized high-yielding cassava varieties, especially in times of crisis, as illustrated by an FGD session with women:

> "*We also prefer high-yielding cassava in times of crisis with or without maintenance and fertilizer addition. Cassava with many big roots helps us to have hope of something to eat even with minimal level of activities on the farm*". (*Women FGD, Benue State*).

The multipurpose and continuous use of cassava roots depend on clean roots with no pest attacks or disease damage and on varieties that can thrive in depleted soils. Soil nutrient enhancing practices, such as shifting cultivation, are rarely practiced among male and female farmers, which may have influenced higher prioritization of the "thrives on low nutrient soil" trait. These results underscore the established position that climate stress is a threat to crop production and food availability. Ezekiel et al. [84] noted that environmental stress worsens land conflicts in Nigeria, which makes productive resources even more scarce. Drought and desertification, for example, have resulted in migration, leading to significant disputes over limited land resources, a leading cause of conflict in Nigeria. The conflicts between herders and farmers are borne out of land encroachments of the herders over farmlands. The conflicts over land have a high potential for aggravating food insecurity and weakening the sustainability of crop production. Although climate stress-induced traits were rarely mentioned by male and female cassava farmers in earlier studies [15,23,62], a focus on individual experiences in relation to cassava traits that enhance resilience within communities in this study revealed their importance. One of the men in Osun State described:

> "*If you plant cassava, and do not monitor it or manage it well, it can still endure many harsh weather conditions. Cassava is tolerant of harsh condition*". (*Man, FGD, Osun state*).

It is imperative that breeding efforts continue to prioritize drought tolerance, resistance to pests and diseases, and low input requirements as key traits for varietal improvements. The evaluation of improved cassava varieties, which are planted in different soil types and that have a varied nutrient/fertility composition (both fertile and less fertile soils) in different locations to ensure yield stability and other resilient traits, is pertinent [85].

High cassava-root yield remains a key trait for both male and female farmers, while flexible harvesting time and root milking (facilitated by in-ground storability of cassava) is an emerging preferred trait especially among women (Table 6). In Abia State, women further commented:

> "*You can continue to harvest cassava anytime the need arises. Cassava stays long in the soil, you can harvest for two years*". (*Woman FGDs, Abia state*).

Female farmers subsequently explained the root milking trait and procedure as: checking for root bulkiness by opening the soil, carefully removing a few mature roots from each cassava stand without removing the stand from the soil, and covering the remaining roots in the ground with soil to allow further growth of the roots. The piecemeal/flexible harvesting and root-milking cassava trait should be prioritized and incorporated into breeding programs as part of traits that enhance resilience, especially for economic recovery and

sustenance. Another important trait is the minimal or no-input requirement. Among study participants, the high stem-yield trait, which facilitates ratooning, was considered by men and prioritized by women in Benue and Abia States, respectively, as an important cassava trait, that enhances resilience. Ratooning practiced by the interviewed farmers is defined as the cutting of some cassava stems for the purpose of replacing or planting cassava stands destroyed by grazing cattle. The cutting is usually done from a branch that is matured (above six months) at above a 0.5 m height, while the roots; the uncut branches and the main stem of the plant are left intact to allow continuous regrowth of the cassava plant. The reason stated for the high stem-yield trait was reiterated during the men's focus group discussion in Osun State:

> "*Cassava is very easy to replant, tolerant to any condition, its ability to stay in the soil (in-ground storability), branches well and produces multiple stems for multiplication (ratooning) makes it resilient*". (*Men FGD, Osun*).

The analysis of variance results (Tables 8 and 9) show that men have a higher overall resilience capacity and access to assets. However, male and female farmers differed significantly ($p = 0.001$) in ownership of assets (Table 10). This result is in agreement with findings by Peterman, et al. [86], which explained that compared with men, women have less access to resources that are part of common property for products and services. In addition, women have less influence over the land and the land they do control is frequently of lower quality. As a strategy to address conflict, more women than men resorted to backyard farming, which possibly limits the farm size compared with farming on lands that are preserved for farming. The higher resilience-capacity status and asset ownership of male farmers, as revealed in Table 10, may have aided their response strategies in the form of being able to relocate farms and easily deciding to migrate, as reported earlier. This is consistent with an earlier study that reported that women tend to have lower access to, and control over, essential assets compared with men in rural settings [86]. Interestingly, Quisumbing et al. [87] estimated that minimizing the gender inequalities in human, physical and related assets in sub-Saharan Africa is capable of increasing the rural agricultural productivity by a margin of not less than 10%, and thereby enhancing resilience.

Table 8. Two-way analysis of variance for resilience capacity of farmers by gender and state.

Groups	Df	Sum-Sq	Mean-Sq	F-Value	Pr (>F)
State	2	177	88.6	0.677	0.509
Gender	1	795	795.0	6.073	0.0146 ***
State: gender	2	131	65.5	0.501	0.6069
Residuals	185	2283.8	130.9		

*** significant at 0.01.

Table 9. Two-way analysis of variance for Asset Ownership of Farmers by Gender and State.

Groups	Df	Sum_Sq	Mean_Sq	F_Value	Pr (>F)
State	2	349	175	0.961	0.384
Gender	1	8753	8753	48.201	0.000 ***
State: gender	2	751	375	2.067	0.129
Residuals	185	33,594	182		

*** significant at 0.01.

Table 10. Means (post hoc) of resilience capacity and ownership of assets by gender.

Gender	Resilience Score	Groups	Assets Ownership	Groups
Men	49.50	a	43.94	A
Women	45.39	b	30.22	B

In addition to the preferred traits among farmers in the face of climatic/environmental, conflict, and economic stressors, Table 11 summarized the findings on stressor types as

experienced in, and peculiar to, the study locations, corresponding to the crop-related and non-crop coping adaptation strategies and preferred cassava traits.

Table 11. Stressor types, coping and adaptation strategies, and cassava traits contributing to resilience.

S/N	Stressor Types	Non-Crop Coping and Adaptation Strategies	Crop/Farming-Related Coping and Adaptation Strategies	Cassava Resilient Attributes
1	Climate changes	- Out-migration from the north to southern region	- Early planting - Cultivating improved varieties with high dry matter - Resistance to diseases, drought-tolerant and early maturing - Choosing food with less, easier and faster processing steps (cassava processed into akpu/fufu softens faster when there is prolonged heat and dries faster when processed into chips to be grated into lafun. Both fufu/akpu/lafun have less processing steps compared with gari. Especially in Benue State where female gari processors make use of a mobile grater)	- * Drought tolerant - * Early bulking - * High dry matter - * High tolerance to diseases and pests
2	Farmers–herdsmen clash	- Out-migration - Dependence on remittances for women - Some men give out their daughters in marriage in exchange for assets to continue production - Some people sell their produce/products at low prices to earn an income - Praying to God for protection.	- Backyard farming - Early harvesting - Farms relocation - Adoption or practicing of multiple cropping - Ratooning stems to re-establish destroyed or new farm.	- + Ability to rapidly regenerate leaves grazed upon by animals - + Stem-ratooning ability to replant destroyed farms - * Early bulking/maturity
3	Land conflicts	- Processors (mainly women) get loans in the form of cassava roots from farmers to pay back after the processing and marketing of the products - Reducing the number of meals per day; borrowing money from friends and the cooperative society	- Relocating farms - Growing crops with little or no input, and less management requirement - Piecemeal harvesting - Adoption of multiple cropping - Processing of food products with less processing steps and time (poundable cassava)	- * High yielding - * Ability to survive in marginal lands with little or no input and management - * Multiple food use (including poundable varieties) - * In-ground storability
	Communal clashes	- Diversified sources of income, such as petty trading for women and skilled vocations such as building construction for men	- Root milking and multiple food products	- * High yielding - * Inground storability - + Root milking

* Resilient traits incorporated/known to cassava breeding; + New/emerging cassava traits contributing to resilience.

The main findings on cassava traits that enhance resilience for women involved in the cassava VC activities (farming, processing and marketing), center on the utilisation facilitated by in-ground storability, piece-meal harvesting (using the-root milking procedure in some cases), and the ability to make diverse food products with fewer processing steps from cassava. Male farmers perceived agronomic traits, such as drought tolerance and the regeneration of leaves after cattle grazing, as cassava resilient traits of priority. However, both male and female farmers considered early bulking (which would aid early harvesting) and in-ground storability as cassava traits that enhance resilience at varying levels in different contexts facing specific shocks and stressors. For new and preferred traits, breeders could consider cassava traits such as its ratooning ability to replace destroyed stems, its rapid leaf-regeneration to sustain grazed cassava plants for farm re-establishment and productivity, and its root milking trait for food security. Relocating farms closer to the home and to locations that were less prone to conflicts was the most important response strategy by both male and female farmers, while migrating was state and gender specific. Gender disparities in the use of inputs, such as fertilizers to boost productivity in the face of environmental stressors, were evident. Considering gendered stressor-related preferences and response strategies could support efforts to make breeding programs more gender-responsive, socially-inclusive, and resilient. The key resilience-related cassava traits, such as ratooning highlighted by male farmers, and root milking by female farmers (and processors), need to be translated into measurable parameters, and have to be comple-

mented by studies on heritability and variation in breeding germplasm in order to explore the potential of incorporating these traits into newly bred or improved varieties targeting conflict-prone zones. Emerging stressors and response strategies may continue to alter the priorities and rationale for some cassava traits. It is, therefore, imperative that breeding programme periodically validate and review prioritized traits in accordance with expected and unexpected current and future stressors. Furthermore, there is potential to identify climate-resilient varieties among farmers and communities that have experienced climatic, economic, and social stressors. The varieties that were commonly cultivated and evaluated in these communities by farmers, processors, and marketers could provide important genetics to be used to address resilience in crossings, or they can simply be released. Several promising landraces were released earlier; 'Poundable' (2020) and TMEB 419 (2005) originated from farming communities in Ghana and Togo, respectively [62,88,89]. TMEB 419 is, to this day, a key reference with regards to the stem longevity, dry matter stability, drought tolerance [90], and the overall robustness especially suitable for large-scale farming, for industry and for intercropping small-scale farmers. Furthermore, Thiele [91] shows that many non-released (escaped) improved, and that varieties derived from (sprouted from seeds or that underwent genetic mutations) improved released varieties in Nigeria are used by farmers, so breeders might even profit from this selection by farmers and re-identify suitable, improved clones that would match social, economic, and climatic resilience. The adaptive capacities of smallholder farmers, especially women, in areas that are experiencing adverse climate change and conflict should be enhanced, and complemented by technical and institutional innovations. Agricultural policies, investments, and interventions by governmental and non-governmental organizations should prioritize the varietal improvements initiative, and support with funding, initiatives that are targeted at the coping and adaptation strategies of men and women who are engaged in the cassava VC to enhance food production and to protect their livelihoods, farms, and security.

4. Limitation of the Study

The findings, as presented, explored a VC approach but focused more on the production area of VC due to observed, easily understood, and relatable stressors such as climate change (drought, irregular rainfall, etc.) and conflict (land-use and communal clashes), which mostly affected the farming systems compared with the processing and marketing VC. The research team observed that these stressors were more suited to cassava farming than to other activities along the VC. Therefore, we limited our quantitative data collection to cassava farmers, while the qualitative data was representative of all the actors across the VC. Due to the security situation of some of the sites visited, the study could not explore broader social dimensions. Therefore, broader social stressors affecting the cassava processing and marketing VC should be considered in future research efforts. This will provide empirical information on the significance of resilience capacity in mediating the effects of shocks on the livelihoods of VC actors by gender. We believe this will more fully express the FAO's RIMA framework than what our current study was able to do. Other analytical possibilities illuminated by the qualitative information were not discussed in this manuscript [92]. It is thus recommended to explore an elaborate processing and marketing VC research approach in future studies, which would be embedded within social, gender, and livelihood frameworks.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su15107837/s1, Table S1: Socioeconomic characteristics of respondents by gender and state; Table S2: Cassava traits and response (coping and adaptation) strategies sources (literatures, expert review and validation and main survey).

Author Contributions: Conceptualization, T.M., O.O., E.G., B.O., N.O., O.U., A.B., B.T., L.F. and S.C.; methodology, O.O., T.M., A.B., B.O., N.O., O.U. and E.G.; software, N.O., B.O., O.O. and T.M.; validation, T.M., O.O., A.B., O.U., B.O., N.O., E.G., E.B., L.F., B.T. and S.C.; formal analysis, N.O., B.O., O.O., O.U., A.B. and T.M.; investigation, A.B., O.O., B.O., N.O., O.U., T.M., E.G. and B.T.;

resources, O.U., E.G., T.M., O.O., A.B., B.O., N.O. and H.T.; data curation, N.O., B.O., O.O., O.U., A.B. and T.M.; writing—original draft preparation, O.O., T.M., N.O., O.U., A.B., B.O., E.G. and B.T.; writing—review & editing, E.G., B.T., E.B., L.F., S.C., H.T., P.K., C.E., N.O., O.U., B.O., A.B., T.M. and O.O.; visualization, O.O., T.M., N.O., O.U., A.B., B.O., E.G. and B.T.; supervision, E.G., T.M., O.O., A.B., N.O., O.U., B.O., L.F., B.T., S.C., P.K. and H.T.; project administration, T.M., O.O., A.B., B.O. and O.U.; funding acquisition, H.T., T.M., P.K., O.O., A.B., B.O. and C.E. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by a seed grant from the Bill and Melinda Gates Foundation, Grant numbers: BMGF OPP1135615, BMGF OPP1019962, and INV-007637, NextGen Cassava Breeding Project and Gender Responsive Researchers Equipped for Agricultural Transformation (GREAT). Research was undertaken as part of Gender Responsive Researchers Equipped for Agricultural Transformation-Gender Responsive Root, Tuber and Banana Breeding (GREAT-RTB) research cluster training program.

Institutional Review Board Statement: The National Root Crops Research Institute (NRCRI), which led this study, has a national mandate for research into the genetic improvement, production, storage, processing, utilization, and socioeconomics of root and tuber crops of economic importance (cassava, yam, potato, sweet potato, cocoyam, ginger, sugar beet, living stone potato, turmeric, and arrow root). The study was conducted in accordance with the Declaration of Helsinki, and approved as part of the national mandate of the National Root Crops Research Institute (NRCRI) for studies involving humans.

Informed Consent Statement: Informed consent was obtained from all participants involved in the study.

Data Availability Statement: Anonymized data available at https://doi.org/10.25502/hpk1-yt38/d accessed on 13 January 2022).

Acknowledgments: The authors gratefully acknowledge the training and mentorship of Cornell University (USA), and Makerere University (Uganda) through GREAT-RTB provided to the fellows. Also appreciated are the dedicated cassava-breeding unit scientists and gender specialists in International Institute of Tropical Agriculture (IITA), the National Root Crops Research Institute (NRCRI), the University of Ibadan and the University of Jos, tricot lead farmers, and all respondents that participated in the entire study site. We express our sincere gratitude to reviewers for their invaluable time and suggestions in improving the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

Research Ethics: All participants gave their informed consent for inclusion before they participated in the study. The National Root Crops Research Institute (NRCRI), which led this study, has a national mandate for research into the genetic improvement, production, storage, processing, utilization, and socioeconomics of root and tuber crops of economic importance (cassava, yam, potato, sweet potato, cocoyam, ginger, sugar beet, living stone potato, turmeric, and arrow root).

References

1. Bowen, T.; del Ninno, C.; Andrews, C.; Coll-Black, S.; Gentilini, U.; Johnson, K.; Kawasoe, Y.; Kryeziu, A.; Maher, B.; Williams, A. *Adaptive Social Protection: Building Resilience to Shocks*; World Bank: Washington, DC, USA, 2020. [CrossRef]
2. Frenken, K. *Irrigation in Africa in Figures: AQUASTAT Survey, 2005*; Food & Agriculture Org.: Rome, Italy, 2005; Volume 29.
3. Theis, S.; Bryan, E.; Choufani, J.; Ringler, C.; Meinzen-Dick, R.S. *Building Resilience for All: The Gender and Social Dynamics of Resilience*; International Food Policy Research Institute: Washington, DC, USA, 2018; Volume 11.
4. Ceballos, H.; Iglesias, C.A.; Pérez, J.C.; Dixon, A.G.O. Cassava Breeding: Opportunities and Challenges. *Plant Mol. Biol.* **2004**, *56*, 503–516. [CrossRef]
5. Forsythe, L.; Martin, A.M.; Posthumus, H. Cassava Market Development: A Path to Women's Empowerment or Business as Usual? *Food Chain* **2015**, *5*, 11–27. [CrossRef]
6. Forsythe, L.; Posthummus, H.; Martin, A.M. A Crop of One's Own? Women's Experiences of Cassava Commercialization in Nigeria and Malawi. *J. Gend. Agric. Food Secur.* **2016**, *1*, 110–128.
7. Forsythe, L.; Tufan, H.; Bouniol, A.; Kleih, U.; Fliedel, G. An Interdisciplinary and Participatory Methodology to Improve User Acceptability of Root, Tuber and Banana Varieties. *Int. J. Food Sci. Technol.* **2021**, *56*, 1115–1123. [CrossRef]
8. Pushpalatha, R.; Gangadharan, B. Assessing the Influence of Climate Model Biases in Predicting Yield and Irrigation Requirement of Cassava. *Model. Earth Syst. Environ.* **2021**, *7*, 307–315. [CrossRef]

9. Haider, H. *Climate Change in Nigeria: Impacts and Responses. K4D Helpdesk Report 675*; IDS: Brighton, UK, 2019; Available online: https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/14761 (accessed on 11 March 2023).
10. FAO; ICRISAT; CIAT; CCAFS. *Climate-Smart Agriculture in Borno State of Nigeria*; Food and Agriculture Organisation of the United Nations: Rome, Italy, 2019; Available online: https://cgspace.cgiar.org/handle/10568/106076 (accessed on 11 March 2023).
11. Fawole, B.E.; Aderinoye-Abdulwahab, S. Farmers' Adoption of Climate Smart Practices for Increased Productivity in Nigeria. In *African Handbook of Climate Change Adaptation*; Springer International Publishing: New York, NY, USA, 2020.
12. Ikeogu, U.N.; Okereke, N.R.; Uchendu, K.; Okwuonu, I.C.; Onyeka, J.T.; Egesi, C.N. Genomic Designing for Abiotic Stress-Resistant Cassava. In *Genomic Designing for Abiotic Stress Resistant Technical Crops*; Springer: Cham, Switzerland, 2022; pp. 1–16. [CrossRef]
13. Raji, P.; Shiny, R.; Byju, G. Impact of Climate Change on the Potential Geographical Suitability of Cassava and Sweet Potato vs. Rice and Potato in India. *Theor. Appl. Climatol.* **2021**, *146*, 941–960. [CrossRef]
14. Walker, T.; Alene, A.; Ndjeunga, J.; Labarta, R.; Yigezu, Y.; Diagne, A.; Andrade, R.; Andriatsitohaina, R.M.; De Groote, H.; Mausch, K.; et al. *Measuring the Effectiveness of Crop Improvement Research in Sub-Saharan Africa from the Perspectives of Varietal Output, Adoption, and Change: 20 Crops, 30 Countries, and 1150 Cultivars in Farmers' Fields*; Report of the Standing Panel on Impact Assessment (SPIA), CGIAR Independent Science and Partnership Council (ISPC) Secretariat; FAO: Rome, Italy, 2014; Volume 19. [CrossRef]
15. Teeken, B.; Olaosebikan, O.; Haleegoah, J.; Oladejo, E.; Madu, T.; Bello, A.; Parkes, E.; Egesi, C.; Kulakow, P.; Kirscht, H.; et al. Cassava Trait Preferences of Men and Women Farmers in Nigeria: Implications for Breeding. *Econ. Bot.* **2018**, *72*, 263–277. [CrossRef] [PubMed]
16. Teeken, B.; Garner, E.; Agbona, A.; Balogun, I.; Olaosebikan, O.; Bello, A.; Madu, T.; Okoye, B.; Egesi, C.; Kulakow, P.; et al. Beyond "Women's Traits": Exploring How Gender, Social Difference, and Household Characteristics Influence Trait Preferences. *Front. Sustain. Food Syst.* **2021**, *5*, 490. [CrossRef]
17. Egesi, C.N.; Olasanmi, B.; Ekwe, K.C.; Ndukwe, I.; Ilona, P.; Okogbenin, E.; Onwuka, S.; Ewa, F. Participatory Breeding for Pro-Vitamin A Enriched Cassava in Nigeria. In *Proceedings of the Eleventh Triennial Symposium of the International Society of Tropical Root Crops, Africa Branch, 4–8 October, 2010*; Okechukwu, R.U., Ntawuruhunga, P., Eds.; IITA: Ibadan, Nigeria; Kinshasa, Democratic Republic of the Congo, 2012; pp. 236–240.
18. Gaby, E.; Mbanjo, N.; Rabbi, I.Y.; Ferguson, M.E.; Kayondo, S.I.; Eng, N.H.; Tripathi, L.; Kulakow, P.; Sebastian, J. Technological octoberInnovations for Improving Cassava Production in Sub-Saharan Africa. *Front. Genet.* **2021**, *11*, 1829. [CrossRef]
19. Burns, A.; Gleadow, R.; Cliff, J.; Zacarias, A.; Cavagnaro, T. Cassava: The Drought, War and Famine Crop in a Changing World. *Sustainability* **2010**, *2*, 3572–3607. [CrossRef]
20. Butterworth, R.; Abdulsalam-Saghir, P.; Martin, A.M. Gender and Diversity Report: Nigeria. *Gates Open Res.* **2019**, *3*, 238.
21. Olaomo, O.K.; Molnar, J.J. Building an Inclusive Value Chain: Gender Participation in Cassava Marketing and Processing in Nigeria. *Environ. Sci. Ecol. Curr. Res.* **2022**, *3*, 1078. [CrossRef]
22. Ilona, P.; Bouis, H.E.; Palenberg, M.A.; Moursi, M.; Oparinde, A. Vitamin A Cassava in Nigeria: Crop Development and Delivery. *Afr. J. Food Agric. Nutr. Dev.* **2017**, *17*, 12000–12025. [CrossRef]
23. Bently, L.A.F.; Kretschmer, M.; Dudenbostel, T.; del Carmen Calatrava Moreno, M.; Radauer, A. *Strengthening the Position of Press Publishers and Authors and Performers in the Copyright Directive*; University of Glasgow: Glasgow, UK, 2017.
24. Ndjouenkeu, R.; Ngoualem Kegah, F.; Teeken, B.; Okoye, B.; Madu, T.; Olaosebikan, O.D.; Chijioke, U.; Bello, A.; Oluwaseun Osunbade, A.; Owoade, D.; et al. From Cassava to Gari: Mapping of Quality Characteristics and End-User Preferences in Cameroon and Nigeria. *Int. J. Food Sci. Technol.* **2021**, *56*, 1223–1238. [CrossRef]
25. Olaosebikan, O.; Kulakow, P.; Tufan, H.; Madu, T.; Egesi, C.; Teeken, B. A Case Study of Cassava Trait Preferences of Men and Women Farmers in Nigeria: Implications for Gender-Responsive Cassava Variety Development. *Case Stud Pract.* **2018**, *3*, 35–43.
26. Polar, V.; Teeken, B.; Mwende, J.; Marimo, P.; Tufan, H.A.; Ashby, J.A.; Cole, S.; Mayanja, S.; Okello, J.J.; Kulakow, P.; et al. Building Demand-Led and Gender-Responsive Breeding Programs. In *Root, Tuber and Banana Food System Innovations: Value Creation for Inclusive Outcomes*; Thiele, G., Friedmann, M., Campos, H., Polar, V., Bentley, J.W., Eds.; Springer International Publishing: Cham, Switzerland, 2022; pp. 483–509. [CrossRef]
27. Tufan, H.A.; Grando, S.; Meola, C.; Grando, S.; Vasquez, Z.; Lima, R.-C. State of the Knowledge for Gender in Breeding: Case Studies for Practitioners, Volume 3. 2018. Available online: https://cgspace.cgiar.org/handle/10568/92819 (accessed on 10 March 2023).
28. Bakare, M.A.; Kayondo, S.I.; Aghogho, C.I.; Wolfe, M.D.; Parkes, E.; Kulakow, P.; Egesi, C.N.; Rabbi, I.Y.; Jannink, J. Exploring Genotype by Environment Interaction on Cassava Yield and Yield Related Traits Using Classical Statistical Methods. *PLoS ONE* **2022**, *17*, e0268189. [CrossRef] [PubMed]
29. Atser, G.; Dixon, A.; Ekeleme, F.; Chikoye, D.; Dashiell, K.; Ayankanmi, T.; Adekoya, E. *The ABC of Weed Management in Cassava Production in Nigeria: A Training Manual*; IITA: Ibadan, Nigeria, 2017.
30. Dufour, D.; Hershey, C.; Hamaker, B.R.; Lorenzen, J. Integrating End-User Preferences into Breeding Programmes for Roots, Tubers and Bananas. *Int. J. Food Sci. Technol.* **2021**, *56*, 1071–1075. [CrossRef]
31. Aghogho, C.I.; Eleblu, S.J.Y.; Bakare, M.A.; Kayondo, I.S.; Asante, I.; Parkes, E.Y.; Kulakow, P.; Offei, S.K.; Rabbi, I. Genetic Variability and Genotype by Environment Interaction of Two Major Cassava Processed Products in Multi-Environments. *Front. Plant Sci.* **2022**, *13*, 974795. [CrossRef]

32. Ifeanyi-obi, C.C.; Henri-Ukoha, A. Strengthening Climate Change Adaptive Capacity of Rural Women Crop Farmers through Reduced Social Exclusion in Nigeria. *Eur. J. Agric. Food Sci.* **2022**, *4*, 54–60. [CrossRef]
33. Olagunju, T.E.; Adewoye, S.O.; Adewoye, A.O.; Opasola, O.A. Climate Change Impacts on Environment: Human Displacement and Social Conflicts in Nigeria. In *IOP Conference Series: Earth and Environmental Science*; IOP Publishing Ltd.: Bristol, UK, 2021; Volume 655. [CrossRef]
34. Chukwuone, N.A.; Amaechina, E.C. Factors Affecting Climate Change Coping Strategies Used by Smallholder Farmers under Root Crop Farming Systems in Derived Savannah Ecology Zone of Nigeria. *Environ. Dev.* **2021**, *39*, 100627. [CrossRef]
35. Ebele, N.E.; Emodi, N.V. Climate Change and Its Impact in Nigerian Economy. *J. Sci. Res. Rep.* **2016**, *10*, 1–13. [CrossRef]
36. Smith, J.M.; Olosky, L.; Fernández, J.G. The Climate-Gender-Conflict Nexus Amplifying Women's Contributions at the Grassroots. 2021. Available online: www.greenink.co.uk (accessed on 11 March 2023).
37. Lindfors, L. All about Scarce Resources? *Untangling the Dynamics of Farmer-Herder Violence in Nigeria.* 2019. Available online: http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=8975884&fileOId=8975889 (accessed on 16 June 2022).
38. Musa, S.; Shabu, T.; Igbawua, M. Resource Use Conflict between Farmers and Fulani Herdsmen in Guma Local Government Area of Benue State, Nigeria. *J. Def. Stud. Resour. Manag.* **2016**, *4*, 1. [CrossRef]
39. Cotula, L.; Toulmin, C.; Quan, J. *Better Land Access for the Rural Poor: Lessons from Experience and Challenges Ahead*; IIED: London, UK, 2006.
40. Turner, M.D. Political Ecology and the Moral Dimensions of "Resource Conflicts": The Case of Farmer–Herder Conflicts in the Sahel. *Polit. Geogr.* **2004**, *23*, 863–889. [CrossRef]
41. West Africa Network for Peace Building (WANEP). Policy Brief: Addressing Armed Banditry in the North-West Region of Nigeria: Exploring the Potentials of a Multi-Dimensional Conflict Management Approach. Available online: https://wanep.org/wanep/index.php?option=com_content&view=article&id=1537:policy-brief-addressing-armed-banditry-in-the-north-west-region-of-nigeria-exploring-the-potentials-of-a-multi-dimensional-conflict-management-approach&catid=25:news-releases&Itemid (accessed on 29 May 2020).
42. Orji, S. Nigeria Farmers Form Vigilante Groups to Confront Bandits. Nigeria, Al Jazeera. 2019. Available online: https://www.aljazeera.com/indepth/features/nigeria-farmers-form-vigilante-groups-confront-bandits-190514064544456.html (accessed on 29 May 2020).
43. Adisa, R.S. Land Use Conflict between Farmers and Herdsmen—Implications for Agricultural and Rural Development in Nigeria. In *Rural Development—Contemporary Issues and Practices*; Adisa, R.S., Ed.; InTech: London, UK, 2012; pp. 101–118. [CrossRef]
44. Ofuoku, A.U. The Role of Community Development Committees in Farmer-Herder Conflicts in Central Agricultural Zone of Delta State, Nigeria. *J. Altern. Perspect. Soc. Sci.* **2009**, *1*, 921–937.
45. Sangotegbe, N.S.; Oguntoyinbo, A.B.; Oluwasusi, J.O. Effectiveness of Role of Local Government Peace and Security Committee (PSC) In Farmer-Pastoralist Conflict Pre-Vention In Ibadan/Ibarapa Agricultural Zone Of Oyo State, Nigeria. *Trop. Agric. Res. Ext.* **2015**, *17*, 95–104. [CrossRef]
46. Tonah, S. State Policies, Local Prejudices and Cattle Rustling Along the Ghana-Burkina Faso Border. *Africa* **2000**, *70*, 551–567. [CrossRef]
47. Bagamba, F.; Bashaasha, B.; Claessens, L.; Antle, J. Assessing Climate Change Impacts and Adaptation Strategies for Smallholder Agricultural Systems in Uganda. *Afr. Crop Sci. J.* **2012**, *20*, 303–316.
48. Mobjörk, M.; Krampe, F.; Tarif, K. Pathways of Climate Insecurity: Guidance for Policymakers. SIPRI Policy Brief. 2020. Available online: https://www.sipri.org/sites/default/files/2020-11/pb_2011_pathways_2.pdf (accessed on 11 March 2023).
49. Koubi, V. Climate Change and Conflict. *Annu. Rev. Polit. Sci.* **2019**, *22*, 343–360. [CrossRef]
50. Theis, S.; Bryan, E.; Ringler, C. *Addressing Gender and Social Dynamics to Strengthen Resilience for All*; International Food Policy Research Institute: Washington, DC, USA, 2019.
51. Huyer, S.; Simelton, E.; Chanana, N.; Mulema, A.A.; Marty, E. Expanding Opportunities: A Framework for Gender and Socially-Inclusive Climate Resilient Agriculture. *Front. Clim.* **2021**, *3*, 718240. [CrossRef]
52. Bernier, Q.; Meinzen-Dick, R.; Kristjanson, P.M.; Haglund, E.; Kovarik, C.; Bryan, E.; Ringler, C.; Silvestri, S. *Gender and Institutional Aspects of Climate-Smart Agricultural Practices: Evidence from Kenya*; CCAFS: Washington, DC, USA, 2015.
53. Ngigi, M.W.; Mueller, U.; Birner, R. Gender Differences in Climate Change Adaptation Strategies and Participation in Group-Based Approaches: An Intra-Household Analysis From Rural Kenya. *Ecol. Econ.* **2017**, *138*, 99–108. [CrossRef]
54. Twyman, J.; Green, M.J.B.; Bernier, Q.; Kristjanson, P.M.; Russo, S.L.; Tall, A.; Ampaire, E.L.; Nyasimi, M.K.; Mango, J.; McKune, S.L.; et al. *Adaptation Actions in Africa: Evidence That Gender Matters*; CCAFS: Washington, DC, USA, 2014.
55. Chikaire, J.U.; Ani, A.O.; Anaeto, F.C.; Echetama, J.; Ejiogu-Okereke, N. Crop Farmers and Pastoralists—Coping Strategies during Violent Agricultural Land Use Conflicts in Abia State, Nigeria. *J. Agric. Econ. Ext. Sci.* **2017**, *3*, 68–76.
56. Saruni, P.L.; Urassa, J.K.; Kajembe, G.C. Forms and Drivers of Conflicts between Farmers and Pastoralists in Kilosa and Kiteto Districts, Tanzania. *J. Agric. Sci. Technol. A* **2018**, *8*, 333–349. [CrossRef]
57. Yekinni, O.T.; Adeniyi, R.T.; Adebisi, S.A. Crop Farmers'Adaptation Strategies to Mitigate Conflicts with Nomads in Oyo State. *Niger. J. Rural Sociol.* **2017**, *17*, 19–26.
58. Quinlan, A.E.; Berbés-Blázquez, M.; Haider, L.J.; Peterson, G.D. Measuring and Assessing Resilience: Broadening Understanding through Multiple Disciplinary Perspectives. *J. Appl. Ecol.* **2016**, *53*, 677–687. [CrossRef]

59. Huyer, S.; Partey, S. Weathering the Storm or Storming the Norms? Moving Gender Equality Forward in Climate-Resilient Agriculture. *Clim. Chang.* **2020**, *158*, 1–12. [CrossRef]
60. Ceballos, H.; Hershey, C.; Iglesias, C.; Zhang, X. Fifty Years of a Public Cassava Breeding Program: Evolution of Breeding Objectives, Methods, and Decision-Making Processes. In *Theoretical and Applied Genetics*; Springer Science and Business Media: Berlin/Heidelberg, Germany, 2021; pp. 2335–2353. [CrossRef]
61. Donovan, J.; Rutsaert, P.; Spielman, D.J.; Shikuku, K.M.; Demont, M. Seed Value Chain Development in the Global South: Key Issues and New Directions for Public Breeding Programs. *Outlook Agric.* **2021**, *50*, 366–377. [CrossRef]
62. Wossen, A.; Girma, T.; Tessema, G.; Abdoulaye, T.; Rabbi, I.; Olanrewaju, A.S.; Bentley, J.; Alene, A.; Feleke, S.; Kulakow, P.A.; et al. *The Cassava Monitoring Survey in Nigeria: Final Report*; IITA: Ibadan, Nigeria, 2017.
63. Gravlee, C.C. Mobile Computer-Assisted Personal Interviewing with Handheld Computers: The Entryware System 3.0. *Field Methods* **2002**, *14*, 322–336. [CrossRef]
64. Choumert-Nkolo, J.; Cust, H.; Taylor, C. Using Paradata to Collect Better Survey Data: Evidence from a Household Survey in Tanzania. *Rev. Dev. Econ.* **2019**, *23*, 598–618. [CrossRef]
65. De Leeuw, E.D. *The Effect of Computer-Assisted Interviewing on Data Quality: A Review of the Evidence*; Utrecht University: Ultrecht, The Netherlands, 2008.
66. Kobo Inc. Harvard Humanitarian Initiative Kobotoolbox. 2009. Available online: https://www.kobotoolbox.org/ (accessed on 13 January 2022).
67. Jakasania, A.; Shringarpure, K.; Kapadia, D.; Sharma, R.; Mehta, K.; Prajapati, A.; Kathirvel, S. "Side Effects—Part of the Package": A Mixed Methods Approach to Study Adverse Events among Patients Being Programmatically Treated for DR-TB in Gujarat, India. *BMC Infect. Dis.* **2020**, *20*, 918. [CrossRef]
68. SPSS 15.0. January 2006. Available online: https://spss.software.informer.com/15.0/ (accessed on 7 January 2023).
69. Food and Agriculture Organization of the United Nations. *RIMA-II: Resilience Index Measurement and Analysis—II*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2016; Available online: https://www.fao.org/3/i5665e/I5665E.pdf (accessed on 13 January 2022).
70. Upton, J.; Constenla-Villoslada, S.; Barrett, C.B. Caveat Utilitor: A Comparative Assessment of Resilience Measurement Approaches. *J. Dev. Econ.* **2022**, *157*, 102873. [CrossRef]
71. De Mendiburu, F.; Yaseen, M. Agricolae: Statistical Procedures for Agricultural Research. 2020. Available online: https://myaseen208.github.io/agricolae/https://cran.r-project.org/package=agricolae (accessed on 13 January 2022).
72. R Development Core Team. *R: A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2010.
73. Ceccarelli, S.; Grando, S.; Bailey, E.; Amri, A.; El-Felah, M.; Nassif, F.; Rezgui, S.; Yahyaoui, A. Farmer Participation in Barley Breeding in Syria, Morocco and Tunisia. *Euphytica* **2004**, *122*, 521–536. [CrossRef]
74. Sperling, L.; Loevinsohn, M.E.; Ntabomvura, B. Rethinking the Farmer's Role in Plant Breeding: Local Bean Experts and On-Station Selection in Rwanda. *Exp. Agric.* **1993**, *29*, 509–519. [CrossRef]
75. Teshome, A.; Baum, B.R.; Fahrig, L.; Torrance, J.K.; Arnason, T.J.; Lambert, J.D. Sorghum [*Sorghum bicolor* (L.) Moench] Landrace Variation and Classification in North Shewa and South Welo, Ethiopia. *Euphytica* **2004**, *97*, 255–263. [CrossRef]
76. Biermayr-Jenzano, P. *The Use of Participatory Methodologies to Increase Women Farmers' Access to Productive Resources*; UN Women: New York, NY, USA, 2011.
77. Ceccarelli, S.; Grando, S. Decentralized-Participatory Plant Breeding: An Example of Demand Driven Research. *Euphytica* **2007**, *155*, 349–360. [CrossRef]
78. Galiè, A.; Jiggins, J.; Struik, P.C.; Grando, S.; Ceccarelli, S. Women's Empowerment through Seed Improvement and Seed Governance: Evidence from Participatory Barley Breeding in Pre-War Syria. *NJAS Wagening. J. Life Sci.* **2017**, *81*, 1–8. [CrossRef]
79. Agbona, A.; Peteti, P.; Teeken, B.; Olaosebikan, O.; Bello, A.; Parkes, E.; Rabbi, I.; Mueller, L.; Egesi, C.; Kulakow, P. *Data Management in Multi-Disciplinary African RTB Crop Breeding Programs BT—Towards Responsible Plant Data Linkage: Data Challenges for Agricultural Research and Development*; Williamson, H.F., Leonelli, S., Eds.; Springer International Publishing: Cham, Switzerland, 2023; pp. 85–103. [CrossRef]
80. Ofuoku, A.U.; Isife, B.I. Causes, Effects and Resolution of Farmer-Nomadic Cattle Herders Conflict in Delta State, Nigeria. *Int. J. Sociol. Anthropol.* **2009**, *1*, 47–54.
81. Olutegbe, N.S.; Ogungbaro, O.O. Efficacy of the Ekiti State Anti-Grazing Law. Key Stakeholders' Perspectives. *Afr. Focus* **2020**, *33*, 117–136. [CrossRef]
82. Doss, C.R. *The Role of Women in Agriculture 1 Prepared by the SOFA Team*; AgEcon Search: St. Paul, MN, USA, 2011.
83. World Bank; ONE Campaign. *Levelling the Field: Improving Opportunities for Women Farmers in Africa*; World Bank: Washington DC, USA, 2014.
84. Ezekiel, C.N.; Oyedele, O.A.; Kraak, B.; Ayeni, K.I.; Sulyok, M.; Houbraken, J.; Krska, R. Fungal Diversity and Mycotoxins in Low Moisture Content Ready-To-Eat Foods in Nigeria. *Front. Microbiol.* **2020**, *11*, 615. [CrossRef]
85. de Sousa, K.; van Etten, J.; Madriz, B. ClimMobTools: API Client for the "ClimMob" Platform. Available online: https://cran.r-project.org/web/packages/ClimMobTools/index.html (accessed on 24 January 2023).
86. Peterman, A.; Quisumbing, A.; Behrman, J.A.; Nkonya, E.M. Understanding the Complexities Surrounding Gender Differences in Agricultural Productivity in Nigeria and Uganda. *J. Dev. Stud.* **2011**, *47*, 1482–1509. [CrossRef]

87. Quisumbing, A.R.; McClafferty, B. *Using Gender Research in Development. Food Security in Practice Technical Guide Series 2*; International Food Policy Research Institute (IFPRI): Washington, DC, USA, 2006. [CrossRef]
88. Egesi, C.; Njoku, D.; Parkes, E.; Kulakow, P. Nomination of Cassava Variety, Poundable (TMEB693), for Registration and Release for Fresh Roots Markets in Nigeria. 2021. Available online: https://repo.mel.cgiar.org/handle/20.500.11766/66970 (accessed on 20 March 2023).
89. Egesi, C.; Rabbi, I.; Njoku, D.; Jiwuba, L.; Kayondo, I.; Agbona, A.; Parkes, E.; Onyeka, J.; Kulakow, P. Nomination for Registration and Release of Four Multipurpose Cassava Varieties for Food Security (HOPE and BABA-70) and Industry (GAME CHANGER and OBASANJO-2) Product Profiles in Nigeria. 2021. Available online: https://repo.mel.cgiar.org/handle/20.500.11766/66971 (accessed on 20 March 2023).
90. Hauser, S.; Wairegi, L.; Asadu, C.L.A.; Asawalam, D.O.; Jokthan, G.; Ugbe, U. *Cassava System Cropping Guide*; Africa Soil Health Consortium: Nairobi, Kenya, 2014.
91. Thiele, G.; Dufour, D.; Vernier, P.; Mwanga, R.O.M.; Parker, M.L.; Schulte Geldermann, E.; Teeken, B.; Wossen, T.; Gotor, E.; Kikulwe, E.; et al. A Review of Varietal Change in Roots, Tubers and Bananas: Consumer Preferences and Other Drivers of Adoption and Implications for Breeding. *Int. J. Food Sci. Technol.* **2021**, *56*, 1076–1092. [CrossRef]
92. Cole, S.M.; Feleke, S.; Manda, J.; Gondwe, T.; Akinwale, G. Who Does What and Why? Intra-Household Roles and Explanatory Models for Sourcing Soybean Seed from the Formal Sector in Malawi. *Outlook Agric.* **2021**, *50*, 315–327. [CrossRef]