

RESEARCH ARTICLE

DROUGHT ADAPTATION STRATEGIES USE BY SMALLHOLDER MAIZE FARMERS AND MAIZE PROFITABILITY IN THE SUDAN SAVANNA REGION OF KANO STATE, NIGERIA.

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ABSTRACT

This study investigated drought adaptation strategies of smallholder maize farmers in Sudan Savanna Regions of Kano State, Nigeria, and the maize profitability of the farmers. The study sought to achieve three objectives namely: describe the socioeconomic characteristics of smallholder maize farmers in the Sudan Savanna; examine the drought adaptation strategies adopted by smallholder maize farmers before and after drought in the Sudan Savanna and estimate the profitability of maize production by smallholder maize farmers in the Sudan Savanna. Through multistage sampling, primary data was collected from 373 farmers using structured questionnaires and STATA for analysis. Descriptive statistics and Gross Margin Analysis (GMA) were used to achieve the study's objectives. Maize is primarily produced by married, male farmers with an average age of 43, with an average of 11 people living in the farming household, farming a mean 1.68 hectares of farmland. Key ex-ante drought adaptation strategies employed included crop diversification, income diversification, planting early maturing maize variety and changing crop variety. Key ex-post drought adaptation strategies by maize farmers included crop diversification, mixed farming, irrigation and changing cropping patterns. Maize farming is profitable with a gross margin of N264, 071.19, operating ratio of 28.3% and ROI of 2.14. The study recommended maize as a profitable farming business in the Sudan Savanna and also recommended training to be provided to smallholder maize farmers on proper use of the top drought adaptation strategies to manage drought effects.

KEYWORDS

Drought adaptation strategies, smallholder maize farmers, Sudan Savanna, maize profitability, Gross Margin Analysis, Kano State, Nigeria.

1. INTRODUCTION

In order to guarantee food security with the growing global population, there is need for increased sustainable food and agricultural production. However, agricultural farming faces a great deal of difficulty due to climate change, which is characterised by erratic rainfall patterns, and rising temperatures, especially in dry and semi-arid regions (Desoky et al. 2023).

Droughts, floods, high temperature are the main external disturbance factors in crop growth and development (Gupta, Rico-Medina, and Cano-Delgado, 2020 ; Raza et al., 2019). Drought is a complicated phenomenon influenced by meteorological factors and related to soil moisture and surface conditions in the early stage. Agricultural water use and food production are seriously threatened by drought. Drought risk response is still a major research focus (Song et al., 2020 ; Webber et al., 2018).

Small-scale farmers are more vulnerable to drought than other categories of farmers (Savari and Zhooldideh, 2021). Under drought conditions, the incomes of small-scale farmers fall drastically because of their tendency to rain-fed agriculture with low yields (Salite and Poskitt, 2019).

This study conceptualizes the link between drought adaptation strategies

and maize yield of maize farmers as shown in maize production by smallholder farmers in Figure 1. Drought risks, including extreme weather events, involve the possibility of the occurrence of various natural hazards, such as erratic rainfall, intra-seasonal dry spells, frequent drought, high temperature, land degradation, and soil erosion. Such drought adversities can negatively affect maize production (Gebre and Rahut, 2021 ; IPCC, 2014 ; Ndiritu and Muricho, 2021). To mitigate the negative effects of drought risks on maize output, farmers implement various adaptation measures. (Ali and Erenstein, 2017 ; Aryal et al., 2018).

Farmers' adoption (choice) of different adaptation strategies against drought risks depends on multiple factors, including farmers' demographic (human capital), socioeconomic (social and financial capital) characteristics as well as other institutional and biophysical factors (physical and natural capital) (Aryal et al., 2018 ; Atube et al., 2021 ; Franklin et al., 2021 ; Gebre and Rahut, 2021). When the adaptation strategies are adequate and effective, it can increase the maize production of farm households, and vice versa. Income diversification adaptation strategy can also positively influence maize profitability levels by improving their financial capital base to purchase foods (Zakari et al. 2022).

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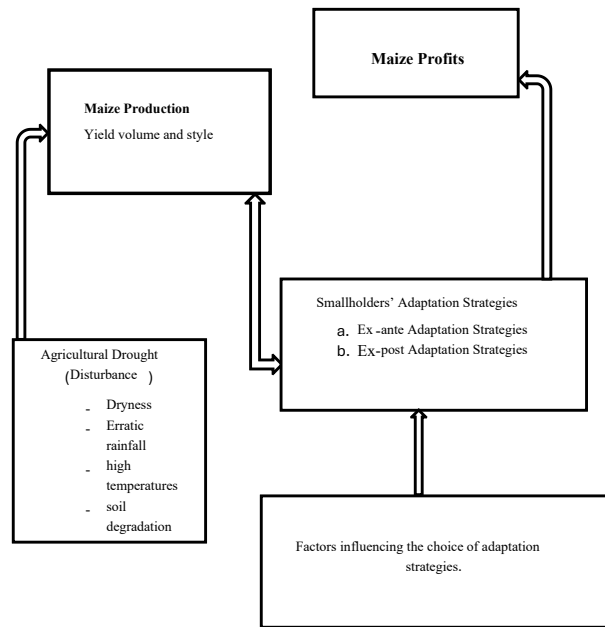


Figure 1: Conceptual Framework of the Study: Adapted from (Gabriel, Santiago, and Casimiro, 2021; Zenda, 2024).

The main objective of this work is to examine the drought adaptation strategies adopted by smallholder maize farmers and the profitability of maize in Sudan Savanah. Specific objectives are to:

- describe the socioeconomic characteristics of smallholder maize farmers in the Sudan Savanna
- examine the drought adaptation strategies adopted by smallholder maize farmers before and after drought in the Sudan Savanna
- estimate the profitability of maize production by smallholder maize

farmers in the Sudan Savana

2. METHODOLOGY

This study was carried out in Kano State with a temperature usually ranging between a maximum of 33°C and a minimum of 15.85°C although sometimes during the harmattan it falls to as low as 10°C, and annual rainfall ranges between 787 and 960mm (KNARDA, 2015). The study was conducted using primary data from 373 maize farmers in 12 communities from Tudun Wada, Bunkure and Bebeji.

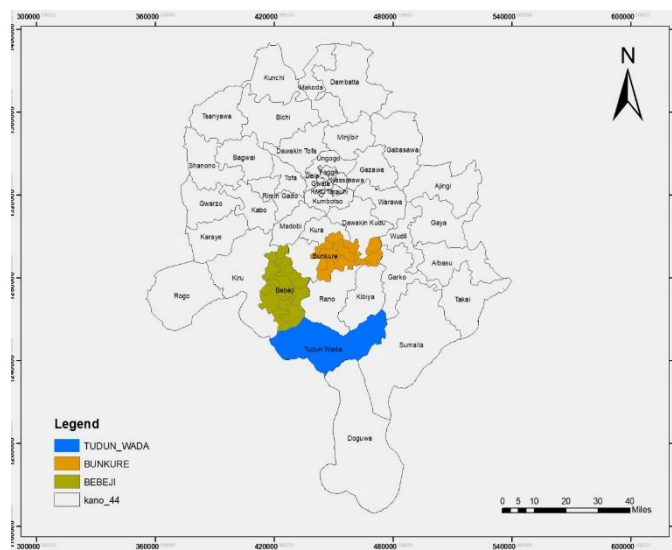


Figure 2: Map of Kano Showing the Study Area

Source: GIS Systems, Centre for Dryland Agriculture

Descriptive statistics and Gross Margin Analysis (GMA) were used in analysing the data using Stata statistical software. While descriptive statistics was used to describe socio-economic characteristics and drought adaptations strategies, GMA was used to determine the net revenue of smallholder farmers from maize production.

2.1 Descriptive Statistics

Descriptive statistics are concerned with scientific methods for summarizing, presenting and analysing data as well as drawing valid conclusion and making reasonable decisions on the basis of such analysis (Adamu and tinuke, 1997).

2.2 Gross Margin Analysis

$$GM = GFI - TVC \tag{1}$$

Where;

GM = Gross Margin

GFI = Gross Farm Income (N)

GFI = Total Value of Maize Output, expressed as follows

$$GFI = \text{Quantity of Maize Output (Q)} * \text{Unit Price of Maize Output (Py)}$$

$$GFI = Q * Py \tag{2}$$

TVC = Total Variable Cost of Maize Production (N)

TVC = Total Variable Cost of Maize Production, expressed as follows

$$TVC = V1X1 + V2X2 + V3X3 + V4X4$$

(3)

3. RESULTS AND DISCUSSION

3.1 Socio Economic Characteristics of Maize Farmers

Table 1: Distribution of Quantitative Socio-economic Variables (n=373)

Variable	Frequency	Percentage	Minimum	Maximum	Mean	SD
Age (years)						
21-29	43	11.53	21	75	43	9.42
31-39	88	23.59				
34-48	137	36.73				
49-57	79	21.18				
58-66	23	6.17				
67-75	3	0.80				
Household Size (persons)			1	25	11	6
1-5	84	22.52				
6-10	95	25.47				
11-15	120	32.17				
16-20	47	12.60				
21-25	27	7.24				
Farming Experience(years)			3	55	19	10
3-18	84	35.92				
19-34	57	35.12				
35-50	20	19.30				
51-66	1	9.11				
Land size (ha)						
0.4-1.32	158	42.36	0.4	5.0	1.66	0.944
1.33-2.24	154	41.29				
2.25-3.16	41	10.99				
3.17-4.08	16	4.9				
4.09-5.0	4	1.07				
Total Farm Income (NGN)			1	1,610,000	447,562	268,330
1-250,000	90	24.13				
250,001-500,000	149	39.95				
500,001-750,000	89	23.86				
750,001-1,000,000	36	9.65				
1,000,001-1,250,000	5	1.34				
1,250,001- 1,500,000	2	0.54				
1,500,001-1,750,000	2	0.54				

Source: Field Survey, 2022

3.2 Age of Farmer

Results in Table 1 showed that the mean age of the smallholder maize farmers is approximately 43 years, with a standard deviation of 9.42, indicating some variability in ages. Majority of respondents fall within the 31-48 age range, with the 40-48 age group being the largest at 36.73% of the sample followed by 31-39 age group with 23.59% of the respondents. It is noteworthy that there is representation across all age groups, including those in the 58-66 and 67-75 age categories, albeit with fewer

respondents of 6.17% and 0.8% of the maize farmers respectively. This is suggesting that majority of the farmers were within the economically active and productive age category (FAO, 2004). In support of this research finding, maize farmers within this age bracket (45years) are innovative and motivated individuals who can cope with challenges that may emanate from farming activities (Fakoya and Daramola, 2005). This result also aligned with the research outcomes of (Bello et al., 2020).

3.3 Household Size

Table 1 shows farmers have a wide range of household sizes, with an average of 11 people and a standard deviation of 6.00. The majority of farmers fall into the 6-15 household size category, with 11-15 households being the most prevalent at 32.17% and 6-10 at 25.47%. This falls within aggregable difference with results of a mean household size of 6 members reported by (Ebukiba et al., 2020).

3.4 Farming Experience

The study reveals a significant variation in farming experience among surveyed farmers, with the majority falling into the 3-23 years category, with 3-13 years being the largest and 14-23 years being the largest. This is similar to findings (Ebukiba et al., 2020). The maize farming community shows a significant presence of experienced farmers, with 19.3% and 9.11% of respondents aged 24-33 years, potentially impacting agricultural practices and new technologies.

3.5 Land Size

The distribution of land size among maize farmers is similar, with a mean of 1.66 ha and a significant portion cultivating on small landholdings, with the largest proportion falling within the 0.4 ha to 1.32 ha category. This land sizes confirm with the smallholder definition by international standards as reported by (Mgbenka, Mbah and Ezeano, 2016).

3.6 Farm Income (NGN)

Results for Farm Income (NGN) also showed in Table 1 that the range of income varies from NGN 0 to NGN 1,750,000. The mean income is NGN 447,562, with a standard deviation of NGN 268,330. This result is contrary to the findings from (Abdulaleem, Oluwatusin and Kolawole, 2017), which reported about twice the average farm revenue. Smallholder maize farmers (24.13%) in the study area reported minimal income, while 2.52% reported larger farm incomes over N 1,000,000, indicating low income levels.

Table 2: Distribution of Qualitative Socio-economic Variables

Variables	Frequency	Percentage
Sex		
Male	314	84.18
Female	59	15.82
Marital Status		
Married	366	98.12
Single	5	0.54
Widowed	2	0.804
Access to Credit		
Access	172	46.11
No access	201	53.89
Extension Agent Contact		
Extension contact	340	91.15
No Extension contact	33	8.85
Membership of Association		
Member	295	79.09
Non-Member	78	20.91
Sources of Farm Input		
Open market	275	73.73
Input dealers	29	7.77
Farmer Cooperatives	30	8.04
Input dealers + Family and Friends	21	5.63
KNARDA Extension Agents	17	4.56
Input dealers + Open Market	1	0.27
Period of maize cultivation		
Rainy Season	257	68.90
Both Rainy and Dry Season	116	31.10

Source: Field Survey, 2022

3.7 Sex

The survey reveals a gender imbalance in maize farming, with 84.18% of respondents being male farmers and 15.82% being female, highlighting the importance of sex in household socio-economic dynamics. This result is in line with the findings of (Girei et al., 2018) who reported majority of

maize farmers in their study.

3.8 Marital Status

Table 2 shows 98.12% of surveyed farmers are married, with 1.34% being single and 0.54% widowed, indicating a high household size and potential

food and income demand. This can positively increase family labour and enhance agricultural productivity of farming households. This result is in line with the findings of (Ebukiba et al., 2020).

3.9 Access to Credit

Table 2 shows that 46.11% of surveyed maize farmers have access to credit, indicating that nearly half of them can potentially invest in inputs, technology, and expand farming operations, potentially improving productivity. This finding aligns with the assertion from (Osabohein et al., 2020) that majority of respondents did not have access to credit.

3.10 Extension Contact

The results of distribution of respondents by contact with extension agents/services as shown in Table 2 revealed that majority of the maize farmers (91.15%) had contacts with extension agents/services while 8.85% had no extension contacts. This implies that farmers in the study had access to information that is important in improving their knowledge of drought incidences and can also choosing adaptation strategies that can enhance maize production. This also suggests a good relationship that can increase productivity and better farming output. This result is contrary to the findings of (Abdullahi et al., 2021).

3.11 Membership of Association

Membership of association or cooperative is considered to enhance the sharing of information on adaptation strategies through interactions. Majority (79.09%) were members of farmers associations or other forms of cooperatives, while 20.91% do not belong to any farmers association.

This suggests the existence of adequate information sharing and assimilation for better adoption of good agricultural practices (GAPs), hence better profits. It also reveals group efforts in production of maize in the study area. This result is in agreement with findings by (Ibitola et al., 2019).

3.12 Sources of Inputs

The results also in Table 2 indicates that a significant majority of farmers (73.73%) source their inputs from the "Open market." This suggests that the open market is a primary and accessible source of agricultural inputs for most surveyed farmers. Other sources, such as "Input dealers" (7.77%), "Farmer Cooperatives" (8.04%), "KNARDA Extension Agents" (4.56%) and combinations of these sources, are mentioned as well but with lower percentages. The preference for the open market may be influenced by factors such as pricing, availability, and convenience. This result is in consonance with the research findings from (Nwoye et al., 2022).

3.13 Period of Maize Cultivation

Results from Table 2 showed that majority (69.90%) of the respondents cultivate maize in the rainy season and 31.10% cultivate it in both the rainy and dry season. This implies that maize cultivation in the study area is majorly rainfed. The reason for zero respondents engaging in dry season cultivation alone could be attributed to the cost associated with irrigation. This corroborates with the report from (Molla et al., 2023).

4. DROUGHT ADAPTATION STRATEGIES EMPLOYED BY MAIZE FARMERS

Table 3: Ex-Ante Drought Adaptation Strategies Adopted by Respondents

Adaptation Strategies	*Frequency	Percentage	Rank
Crop diversification	366	98.10	1 st
Income diversification	214	57.40	2 nd
Planting early maturing maize variety	92	24.70	3 rd
Changing crop variety	55	13.40	4 th
Planting high yield maize variety	48	12.90	5 th
Early planting	43	11.50	6 th
Mixed cropping/farming	42	11.30	7 th
Adjustment of cropping pattern	34	9.10	8 th
Soil and water management/conservation practices	24	7.00	9 th
Planting pest and disease resistant seeds	25	6.70	10 th
Crop ridging	24	6.40	11 th
Listening to information about drought/climate change	21	5.60	12 th
Intercropping	17	4.60	13 th
Changing weeding and fertilizer practices	17	4.60	13 th
Irrigation	3	0.80	15 th
Temporary migration	3	0.80	15 th
Buy insurance	2	0.50	17 th
Use of savings	2	0.50	17 th
Variety diversification	1	0.30	19 th

Source: Field Survey, 2022 *Multiple responses

The results in table 3 revealed that crop diversification was the most preferred (98.10%) ex-ante drought adaptation strategy by the maize farmers to reduce the effect of drought on their livelihood. Maize farmers in the study cultivated other crops such as groundnuts, beans, rice, and vegetables to cover losses during drought occurrence. This is in line with the findings by (Preeti, 2021).

Moreover, 57.40% of the maize farmers acknowledged income

diversification was a preferred ex-ante drought adaptation strategy to minimize the risk of drought on their income, profitability, and food security status. Also, the result showed that 24.70% of maize farmers used planting early maturing maize variety as an adaptation strategy to deal with challenges of drought. It was realized that a reasonable proportion of farmers understood maize varieties and how to acquire them. Additionally, 13.4% and 12.9% of the respondents applied changing crop variety and the planting high yield maize variety as drought adaptation

strategies in the study area. This finding corroborates a study conducted by (FAO, 2004) in developing countries which revealed that planting different crop varieties enhances achievement of a sustainable agricultural growth for food security amidst climate change (McCarthy et al., 2018).

The results in Table 3 revealed that early planting, mixed

cropping/farming, adjustment of cropping pattern, soil, and water management/conservation practices, planting pest and disease resistant seeds, crop ridging, listening to information about drought/climate change, intercropping, changing weeding and fertilizer practices, irrigation, buy insurance, use of savings, and variety diversification are other ex-ante adaptation strategies that farmers adopted in the study area.

Table 4: Ex-Post Drought Adaptation Strategies Adopted by Maize Farmers

Adaptation Strategies	*Frequency	Percentage (%)	Rank
Crop diversification	366	98.10	1 st
Mixed Farming	42	11.30	2 nd
Irrigation	3	0.80	3 rd
Changing cropping pattern	3	0.80	3 rd
Seek off farm employment	2	0.50	5 th
Reduced number of livestock	2	0.50	5 th
Use of minor tillage	1	0.30	7 th
Maintaining flexibility in decision making	1	0.30	7 th

Source: Field Survey, 2022

*Multiple responses

The results in Table 4 revealed that crop diversification was the most preferred (98.1%) ex-post drought adaptation strategy by the respondent to reduce the effect of drought on their livelihood. Maize farmers in the study cultivated other crops such as groundnuts, beans, rice, and vegetables to cover losses during drought occurrence. This is in line with the findings by (Preeti, 2021).

Moreover, 11.3% of the maize farmers acknowledged mixed farming was the second preferred ex-post drought adaptation strategy to minimise the

risk of drought on their income, profitability, and food security status.

Finally, the results in Table 4 revealed that changing cropping pattern, irrigation, seek off farm employment, reduced number of livestock, use of minor tillage, and maintaining flexibility in decision making are other ex-post adaptation strategies that farmers adopted in the study area.

4.1 Smallholder Maize Profitability

Table 5: Average Costs and Return of Maize Production (n=373)

Variables	Price/Unit (NGN)	Quantity/Ha	Value in NGN/Ha	% of Average Total Cost
Variable Cost				
Seed (kg)	88.75	20	1,775.02	
Fertilizer (bags)	18,277.50	4	73,109.98	
Agrochemicals (L)	1,305.17	2	2,610.33	
Labour	1,922.69	14	26,917.67	25.78
Land preparation	1,662.78	4	6,651.11	6.37
Planting	636.92	2	1,273.84	1.22
Fertilizer Application	424.61	3	1,273.84	1.22
Wedding	5,109.28	3	15,327.83	14.68
Harvesting	1,195.53	2	2,391.06	2.29
Total Variable Cost			104,413	
Average Output (kg) per ha			1,811	
Average Price of 100kg (kg)			22,286	
Revenue(N)			368,484.19	
Gross Margin(N)			264,071.19	
Gross Ratio			71.7%	
Operating Ratio			28.3%	
Return on Investment			2.53	

Source: Field Survey, 2022.

Table 5 showed the profitability analysis of maize production. Maize

production is profitable, with an average output of 1,811 kg per hectare

and a revenue of NGN 368,484. The gross margin is NGN 264,071, with a return on investment (ROI) of 2.53, indicating that for every NGN 1 invested, farmers earned NGN 2.53. The GM value agrees with the GM value from research conducted by Bello *et al.* (2020) in their profitability estimation of small-scale maize farmers in Bichi. And ROI value of 2.40 recorded in a study conducted by (Girei *et al.*, 2018) in Nasarawa State.

5. CONCLUSION

The study concludes that smallholder maize farming is profitable in Kano despite frequent droughts. Farmers commonly use drought adaptation strategies like crop diversification and mixed farming. The profitability of maize farming is positively influenced by these adaptive measures.

RECOMMENDATIONS

Given that 46% of farmers lack access to credit, which limits their capacity to invest in adaptive strategies, financial institutions and government programs should create more accessible and affordable credit options for smallholder farmers aimed at improving drought resilience in maize farming. Additionally, the adoption of drought-tolerant and high-yield maize varieties should be encouraged through government agricultural programs and NGOs working in the region. Collaborations with research institutions could help make these varieties more accessible and affordable, especially for resource-poor farmers. Finally, owing to the prevalence of income diversification as an adaptation strategy, programs that provide additional income-generating activities, such as livestock rearing or small-scale agro-processing, can support farmers' income stability during drought periods.

REFERENCES

- Abdullahi, A., Tafida, I., Kamilu, F. and Asma'u, M. K., 2021. Effects Of Socio-Economic Features of Maize Farmers On The Adoption Of Maize (Bundled Services) In Kano State, Nigeria. *Journal of Agripreneurship and Sustainable Development (JASD)* 4(4) ISSN (Print): 2651-6144; ISSN (Online): Pp. 2651-6365.
- Aryal, J.P., Rahut, D.B., Maharjan, S., Erenstein, O., 2018. Factors affecting the adoption of multiple climate-smart agricultural practices in the Indo-Gangetic Plains of India. *Nat. Resource Forum* 42, Pp. 141–158.
- Atube, F., Malinga, G.M. and Nyeko, M., 2021. Determinants of smallholder farmers' adaptation strategies to the effects of climate change: Evidence from northern Uganda. *Agric and Food Secur* 10, 6.
- Bello, N.A., Nazeer, A., Frederick, K.Y. and Ibrahim, U.M., 2020. Profitability of Small-Scale Maize Production in Nigeria: A Case Study of Bichi Local Government, Kano State-Nigeria. *European Journal of Agriculture and Food Sciences*. Vol. 2, No. 5, September 2020.
- Desoky E.S.M, Alharbi. K, Rady M.M, Elnahal A.S.M, Selem. E, Arnaout S.M.A.I, Mansour E., 2023. Physiological, Biochemical, Anatomical, and Agronomic Responses of Sesame to Exogenously Applied Polyamines under Different Irrigation Regimes. *Agronomy*. 13 2023 875, doi:10.3390/agronomy13030875.
- Ebukiba, E. S., Anthony, L., and Adamu, S. M., 2020. Economics and Technical Efficiency of Maize Production Among Small Scale Farmers in Abuja, Nigeria: Stochastic Frontier Model Approach. *European Journal of Agriculture and Food Sciences*, 2(6).
- Fakoya, E. O. and Daramola, B. G., 2005. Socio Economic Factors Influencing Farmers Participation in Integrated Fish Farming. *Rural Sociology Journal*. P. 2.
- FAO. 2004. The State of Food Insecurity in the World 2004. Monitoring progress towards the World Food Summit and Millennium Development Goals. ISBN: 92-5-105178-X.
- Franklin, S.M., Collins, M.M., Milka, N.K., Joseph, M.M., Onemus, K.N., Chris, A.S., Jeremiah, M.O., Daniel, N.M., Elizabeth, A.O. and Felix, K.N., 2021. Determinants of farmers' perceptions of climate variability, mitigation, and adaptation strategies in the central highlands of Kenya. *Weather and Climate Extremes* 34, 100374.
- Gebre, G.G. and Rahut, D.B., 2021. Prevalence of Household Food Insecurity In East Africa: Linking Food Access With Climate Vulnerability. *Climate Risk Management*. 33 <https://doi.org/10.1016/j.crm.2021.100333>.
- Girei, A. A., Saingbe, N. D., Ohen, S. B and Umar, K. O., 2018. Economics of Small-scale Maize Production in Toto Local Government Area, Nasarawa State, Nigeria *Agrosearch* (2018) 18 No. 1: Pp. 90 – 104.
- Gupta, A., Rico-Medina, A., Cano-Delgado, A.I., 2020. The Physiology of Plant Responses to Drought. *Science* 368, Pp. 266–269.
- Ibitola, O.R.; Fasakin, I.J.; Popoola, O.O., Olajide, O.O., 2019. Productivity Among Smallholder Farmers in Oyo State, Nigeria. *Greener Journal of Agricultural Sciences*, vol. 9, no. 2, pp.189-198, 2019.
- KNARDA 2015. Village listing survey bulletin. Kano State Agricultural and Rural Development Agency.
- McCarthy, N., Lipper, L., and Zilberman, D., 2018. Economics of climate smart agriculture: An overview. In *Climate Smart Agriculture 2018*. Pp. 31–47. Springer, Cham.
- Mgbenka, R.N Mbah E.N. and Ezeano C.I., 2015. A Review of Small holder Farming in Nigeria: Need for Transformation. *Agricultural Engineering Research Journal* 5(2): Pp. 19-26, 2015. ISSN 2218-3906.
- Molla, M.S.H., Kumdee, O., Wongkaew, A., Khongchui, P., Worathongchai, N., Alam, M.R., Mahmud, A.-A., Nakasathien, S., 2023. Potentiality of Sustainable Maize Production Under Rainfed Conditions in the Tropics by Triggering Agro-Physio-Biochemical Traits Ascertained from a Greenhouse. *Plants* 2023.
- Ndiritu, S.W., and Muricho, G., 2021. Impact of Climate Change Adaptation on Food Security: Evidence from Semi-Arid Lands, Kenya. *Climate Change* vol: 167(24).
- Preeti, Y., 2021. Crop Diversification As a Boom Adaptation Strategy to Climate Change: An Empirical Evidence. Vol. Issue-5, January 2021.
- Raza, A., Razzaq, A., Mehmood, S.S., Zou, X., Zhang, X., Lv, Y. and Xu, J., 2019. Impact of climate change on crops adaptation and strategies to tackle its outcome: a review. *Plants* 8.
- Salite, D., Poskitt, S., 2019. Managing The Impacts Of Drought: The Role Of Cultural Beliefs In Small-Scale Farmers' Responses To Drought In Gaza Province, Southern Mozambique, *International Journal Disaster Risk Reduction*. 41 2019 101298.
- Savari, M., Zhoolideh, M., 2021. The role of climate change adaptation of small-scale farmers on the household's food security level in the west of Iran, *Dev. Pract.* 2021. Pp. 1–15.
- Song, Y., Tian, J., Linderholm, H.W., Wang, C., Ou, Z. and Chen, D., 2020. The contributions of climate change and production area expansion to drought risk for maize in China over the last four decades. *Int. J. Climatology*. 41.
- Webber, H., Ewert, F., Olesen, J.E., Muller, C., Fronzek, S., Ruane, A.C., Bourgault, M., Martre, P., Ababaei, B., Bindi, M., Ferrise, R., Finger, R., Fodor, N., GabaldonLeal, C., Gaiser, T., Jabloun, M., Kersebaum, K.C., Lizaso, J.I., Lorite, I.J., Manceau, L., Moriondo, M., Nendel, C., Rodriguez, A., Ruiz-Ramos, M., Semenov, M. A., Siebert, S., Stella, T., Stratonovitch, P., Trombi, G. and Wallach, D., 2018. Diverging Importance of Drought Stress for Maize and Winter Wheat In Europe. *Natural Communication*. 9, 4249.
- Zakari, S., Ibro, G., Moussa, B. and Abdoulaye, T., 2022. Adaptation Strategies to Climate Change and Impacts On Household Income And Food Security: Evidence From Sahelian Region Of Niger. *Sustainability* 14, 2847.

