NIGERIAN JOURNAL OF CROP SCIENCE
Volume 8 No 1 May 2022 pp 50 - 63
ISSN – 2350 – 2487

ACCEPTANCE OF CROP MANAGEMENT STRATEGIES ACROSS FOUR RAIN-FED AGRICULTURAL STATES IN NIGERIA

[1,2]Towolawi A.T., [2]Oguntoke O., [2]Bada B.S. and [3]Adejuwon J.O.

[1]Center for Excellence in Agricultural Development and Sustainable Environment (CEADESE),

Federal University of Agriculture, Abeokuta, PMB 2240, Ogun State, Nigeria.

[2]Department of Environmental Management and Toxicology, Federal University of Agriculture,

Abeokuta, PMB 2240, Ogun State, Nigeria.

Management and [3]Department of Water Resources Agrometeorology, Federal University of

Agriculture, Abeokuta, PMB 2240, Ogun State, Nigeria.

Corresponding author's email: taofiktowolawi@yahoo.com,

ABSTRACT
Threat of climate change is intense on rain-fed agriculture.This study investigated how farmer sare coping across four (Benue, Edo, Ondo and Niger) states in Nigeria using1600 copies of pretested questionnaire,which were descriptively (frequency and percentage) and inferentially (Chi-Square) analysed in SPSS v23.00.The results indicated that higher number of farmers significantly ($p < 0.05$) adapted scarce resources substitution (Niger>Benue>Ondo>Edo) except in Edo State. Majority of the farmers did not practise crop management (Edo>Benue>Niger>Ondo) and the reason was not significantly ($\chi = 8.620$, $p = 0.473 > 0.05$) different in Ondo State.There was no significant ($p < 0.05$) crop selection strategy mong the farmers (Niger>Benue>Edo>Ondo) in each State. The crop rotation strategy was adapted by the farmers (Benue>Edo>Niger>Ondo) with significant ($p < 0.05$) difference in Edo and Ondo States. Adaptation of mixed cropping systems followed Benue>Edo>Niger>Ondo with significant ($p < 0.05$) differenceamong farmers in Benue and Niger States.Building crop storage strategy (Niger>Benue>Ondo>Edo) was adapted ($p < 0.05$)in each State. The farmers practised seedling transplanting (Edo>Niger>Benue>Ondo) with significant ($p < 0.05$) difference except in Edo State ($\chi = 8.168$, $p = 0.086 > 0.05$), early planting (Benue>Niger>Ondo>Edo) in each State, and late planting (Niger>Benue>Edo>Ondo)with significant ($p < 0.05$) difference in Niger State. The same policy would not be effective for the farmers on crop selection, building crop storage and early planting strategy in each State, because their Chi-Square test indicated $p < 0.05$.

Keywords: Agricultural development programme, Agricultural policy, Chi-Square, Climate chang daptation, Sustainable environment

INTRODUCTION
Climate Change (CC) according to theIntergovernmental Panel on Climate Change is the unbalancing in the weather of Earth and changing in the normal climate of the planet indicating in temperature, precipitation, and wind fluctuations that are facilitated by human activities (IPCC, 2013). The CC is said to be a globally complex situation instigated by the released fuels from burning fossils, which increase heat-trapping gases to Earth's atmosphere (NASA, 2021). The CC is further simplified by the US Geological

Survey (USGS, 2021) as the rise in the measures (such as rainfall distribution, temperature, and wind patterns) of the climate over a long period of time. From another view, the CC is the Earth's rising surface temperature and the associated side effects of warming that are not limited to indications like melting glaciers, heavier rainstorms, or more frequent drought (Climate.Gov, 2021).

Threat of the CC on socioeconomy, environment and agriculture across the globe creates concern and requires craftingof multifaceted approach. The approach should outrun the lingering challenges and be sustainably beneficialto the concerned sectors. Agricultural sectors or systems feel pulse of the climate change because the climate properties (such as rainfall, relative humidity, temperature, solar radiation, and wind) dictate the fate of yields that the farmers would reap at the harvesting period. These properties singly or joinly affect every stage of agricultural activities from the pre-planting to the post-harvesting stages. The role of agricultural farming activities especially the crop production in the existence of human is inevitable (FAO-UN, 2021).

The beneficial derivable(food, feed and fibers) from crop production for the continuous living of human requires duty of care to agriculture. Factor that hinders achieving the maximum benefits currently go beyond human whose efforts seem not successful. The need forthe upsurge in crop production is putting pressure on the farmers, especially at the moment when population are growing and industrialization is also increasing. Solution to the situation is effective agriculture through crop production as it provides raw food for the former and raw materials for the latter. Source has pointed to the changing in climate as the driving force that causes lagging of and declination in the crop production (FAO-UN, 2016). There is a needfor a detailed analysis of the existing association between CC and some natural resources for agriculture to meet the demands. The association would be helpful to the world of agriculture. It will assist the farmers and relevant bodies to craft the best adaptation and stay unaffected as the climate is unstable these days. It will also create an avenue for justifiably responsive actions to the sustainable intensification and diversifying crop productions that are being advocated as one of the ways out. Adoption of either of the two advocated practices for farmer's sustainability to (1) adapt crop systems to the changing climate and (2) mitigate the associated effects can be keenly verified. The verification will substantiate the practice if it considers agro-ecological contribution. It is agreed that the practice of crop production relates to the CC adaptation, but the practice can specifically be dictated by the local agro-ecological endowments and the local knowledge of the farmers.

The CC indications (such as land degradation, compaction of the soil, soil fertility losses, dryness of water sources, shortness of rainfall distribution, extreme rise in temperature, immense solar radiation, abrupt fluctuation of relative humidity) in extreme dry-spell and over wetness in different agroecological zonesaffect viability of the environmental resources to supportcrop production. The above-mentioned indications affect the agricultural systems in entirety thereby instigating farmers to be proactive at tackling the persistent problems of CC so that the sustainable development goal (SDG) 1: zero hunger campaign of the UNDP (2020) would be realised by the farmers from their crop production activities. The possible solution that farmers need has to consider optimal management of crops to corroboratethe two practices (i.e., sustainable intensification and diversifying crop productions) that are being considered by the FAO-UN Climate Smart Agricultural Sourcebook (FAO-UN, 2021).Nearness to the farmers for heartrob discussion might assist to know what are specifically useful to farmers at various stages of crop production around which strategies could be crafted for sustainable agriculture. Thus, the objective of the current study was to verify perception of the farmers for their local knowledge about crop management which differs among the farmers and across the regions in this era of CC.

MATERIALS AND METHODS

Study Areas

Four rain-fed (Benue, Edo, Niger and Ondo) states were chosen because of theirremarkable yearly high crops produce. They are in the derived savannaagro-ecological zone of the countrywhere agricultural activities favourablyenjoy abundant rainfall distribution of at least 1000 mm/ year.The states just like every other states in Nigeria have two climatic seasons which are wet and dry. The former has 7 months (April to October) while the latter has 5 months (November to March).

The coordinate of Benue State is N7°19'59.99" and 8°45'0.00". Its southern parts is characterised by forest vegetation, yielding timber trees, and providingfavourable habitat for uncommon animal species and types. The coordinate of Edo State is Edo is N7°19'59.99" and E8°45'0.00". it is peculiar with the mangrove swamp vegetation**;** its northern part haas savannah vegetation, southern part has rain-forest, with secondary growth and elephant grass in most areas owing to deforestation activities of human. The soil types are clayey or porous red sand. Coordinate of the Ondo State is N7°10'0.01" and E5°04'59.99". The state is within themangrove-swamp forest close to the Benin's Gulf, tropical rain forest at the central part while wooded savanna in the northern part.Coordinate of the Niger State isN10°00'0.00" and E6°00'0.00". The state falls in the guinea savanna with moist and high grasses.

Data Gathering and analysis

Assistance of the offices of the Agricultural Development Programmes (ADP) across the four states for field visitation was sorted via official letter duly stamped for the team of this research by the Center of Excellence in Agricultural Development and Sustainable Environment, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. Approval of the letter availed the team of the ADP indulgence to assign specialised field officers for easy communication of the contents of the pretested copies of the structured questionnaire with the farmers who assited to fill the questionnaire given to them. The study used the formula (with equations 1-3) of Cochran (1977) to get the sample size from the unknown number of farmers.The results indicated nearly 400 copies for each of the states, thereby making the team to administer 1600 copies of the questionnaire through the ADP specialised field officers across the four states using multi-stage sampling procedureused by Amujoyegbe (2010). Thus,10 % of the 1600(i.e. 160) copies of the questionnaire wasadministered among the final year students of Agriculture in Federal University of Agriculture, Abeokuta for the pretest validation. The students understood the project but were not parts of the farmers in any of the four states underthe study. The retrieved 160 copies of the questionnaire were validated and detected to have a Cronbach's ***α-value*** of 7.8indicating adequacy of the questionnaire contents for the objectives of the study.

$$N = Z^2P\ (1\text{-}P)/\ (D^2) \text{ ------ Equation 1}$$

$n = (1.96^2 * 0.50 * 0.50) / 0.05^2 = 384.16$---- Equation 2 A non-response rate of 10 $\%\ of\ 384 = (384 \text{ X } 10) / 100 = 38.4$----- Equation 3

where n = the required sample size, z = the survey'sconfidence limit at 95% (1.96), p = the respondents'(farmers') proportion, d= degree of accuracy which is the absolute deviation from true valueand it is 5%. The values deduced from the adopted equations were rounded off. Thought of the research was that effects of the climate change is global while its indicators are not the sameat the regional levels.Thus, this study investigated perception of the farmers on crop management across different regions in Nigeria. Chi-Square Analysis according to Kamat *et al.*(2010) was adopted by this research to verify similarity in the farmers' responses,for either the same crafted policy might effectively work in each state. The same agricultural policy would not be adopted if the Chi-Square testindicates significant ($p < 0.05$) difference.

RESULTS AND DISCUSSION

Resources Substitutions due to Scarce by the Respondents

All the respondents confirmed that they usually substitute scarce resources to stay productive and relevant in their chosen planting activities. It was observed that 254 out 394 showed resources substitution due to scarcity (RSS) engagement in Benue state with highest coming from the Benue East with 41.3 %, 184 out of 360 in Edo state with Edo North took the lead with 39.7 %, 303 out of 398 in the Niger state and highest (35) % from the Niger NE (i.e., Northeast), and 196 out of 293 in Ondo state where Okitipupa had the highest (32.1) %. Responses of the farmers on RSS had significant ($p < 0.05$) difference across the study States except Edo (χ= 11.579, $p > 0.05$)(Table 1).

The agricultural input reduction or supply to meet the demand in the era of climate change might necessitate resources substitution; as the environment warms some input lose potency and as population increases there is a need for the supply to meet demand. If the demand shortfalls the supply, aggravation of threats to farming activities from the scarce resources is possible (Calzadilla *et al.*, 2010; Liu *et al.*, 2016). The resources might be water shortage and soil fertility which in turn impose threats on farming activities. The shortage competes with other functions and places food security impacts on the populace thereby tasking/ allowing for a sector-specific endogenous adaptation to resources scarcity (Nechifor and Winning, 2018). The authors buttressed that the threat depends on the demands of the scarce resources by the other sectors in the farmland regions, amount and availability of the substitute required, and size of the farmland. If suggestion of the OECD (2015) "that it is better to prioritiseinterest of the scarce-resources users based on historical patterns" is considered, the number of farmers that are being threatened for such scarce-resources could then beeasilyhandled (Hejazi *et al.*, 2013; Shen *et al.*, 2014; Wada and Bierkens, 2014).The magnitude and extent of the threats of the scarce-resourcesdepend on the usefulness, and somepredictions assigned lowest priority to agriculture in favour of other sectors (Calzadilla *et al.*, 2010). Allocation of resources by the stakeholders may dictate the amount available and guarantee the quantity available to influence agricultural productivity (Barnett*et al.*, 2008). Where the resources are produced is also a dictating factor; imported resources may face inevitable and strict policy while local resources may face artificial scarcity to regularize the price or face the resources out. The RSS will therefore be a pressing issue.

Table 1: Scarce resources substitution by the farmers across the study areas

Scarce Resources Substitution		Benue N140	Benue C130	Benue E130	Total	Edo N130	Edo C100	Edo S170	Total
Yes	Count	94	55	105	254	73	46	65	184
	%	37.0%	21.7%	41.3%	100.0%	39.7%	25.0%	35.3%	100.0%
No	Count	32	63	26	121	46	23	59	128
	%	26.4%	52.1%	21.5%	100.0%	35.9%	18.0%	46.1%	100.0%
Total	Count	138	125	131	394	130	80	150	360
	%	35.0%	31.7%	33.2%	100.0%	36.1%	22.2%	41.7%	100.0%

Chi-Square Tests for Benue State / **Chi-Square Tests for Edo State**

	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	47.957[a]	2	0.000	11.579[a]	2	0.072
Likelihood Ratio	52.367	2	0.000	11.866	2	0.065
Linear-by-Linear Association	8.856	1	0.003	5.536	1	0.019

Scarce Resources Substitution		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	102	95	106	303	48	63	47	38	196
	%	33.7%	31.4%	35.0%	100.0%	24.5%	32.1%	24.0%	19.4%	100.0%
No	Count	16	57	14	87	12	23	36	26	97
	%	18.4%	65.5%	16.1%	100.0%	12.4%	23.7%	37.1%	26.8%	100.0%
Total	Count	119	159	120	398	60	86	83	64	293
	%	29.9%	39.9%	30.2%	100.0%	27.0%	26.5%	26.2%	20.3%	100.0%

Chi-Square Tests for Niger State / **Chi-Square Tests for Ondo State**

	Value	df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	40.931[a]	2	0.000	48.438[a]	6	0.000
Likelihood Ratio	42.161	2	0.000	53.810	6	0.000
Linear-by-Linear Association	.326	1	0.568	4.908	1	0.027

while local resources may face artificial scarcity to regularize the price or face the resources out. The RSS will therefore be a pressing issue.

Table 2: Crop management practices by the respondents across the study areas

Crop Management Practice		Benue N140	Benue C130	Benue E130	Total	Edo N130	Edo C100	Edo S170	Total
Yes	Count	37	51	43	131	31	6	16	53
	%	28.2%	38.9%	32.8%	100.0%	58.5%	11.3%	30.2%	100.0%
No	Count	91	68	88	247	83	79	125	287
	%	36.8%	27.5%	35.6%	100.0%	28.9%	27.5%	43.6%	100.0%
Total	Count	128	119	131	378	114	85	141	340
	%	35.1%	31.8%	33.1%	100.0%	34.3%	25.5%	40.2%	100.0%

Chi-Square Tests for Benue State / **Chi-Square Tests for Edo State**

	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.336[a]	6	0.008	26.131[a]	6	0.000
Likelihood Ratio	22.210	6	0.001	27.728	6	0.000
Linear-by-Linear Association	6.364	1	0.012	2.348	1	0.125

Crop Management Practice		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	98	24	30	152	43	0	29	25	97
	%	64.5%	15.8%	19.7%	100.0%	44.3%	0.0%	29.9%	25.8%	100.0%
No	Count	19	132	89	240	46	1	58	45	150
	%	7.9%	55.0%	37.1%	100.0%	30.0%	0.7%	39.3%	30.0%	100.0%
Total	Count	117	155	119	392	89	1	88	70	247
	%	30.1%	39.8%	30.1%	100.0%	36.1%	0.4%	35.4%	28.1%	100.0%

Chi-Square Tests for Niger State / **Chi-Square Tests for Ondo State**

	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	145.186[a]	4	0.000	8.620[a]	9	0.473
Likelihood Ratio	152.456	4	0.000	8.945	9	0.442
Linear-by-Linear Association	67.952	1	0.000	1.455	1	0.228

Crop Management Practices by the Respondents

Respondents across the study areas indicated crop management practices (CMP). The responses of the farmers indicated a higher number of them not practisng crop management.Thus, 247 out of 378 hardly exercise CMP from Benue state with North having the highest (36.8 %), 287 out of 340 from Edo state withSouth having highest (43.6 %), 240 out of 378 from Niger state with North central having highest (55 %), and 150 out of 247 from Ondo state with Ikare zone having highest (36.1 %). Of all the four states, Ondo state had no significant (χ = 8.620, $p > 0.05$) difference in CMP (Table 2). The CMP has to do with the handling of soil nutrient management usingan innovative strategy to sustain productivity, increasing efficiency of input and protecting the natural resources and environment.

Managing soil organic matter for an instance improvescrop environment to function (Powlson *et al.*, 2011) and in turn influences crop germination and performance (Gerner *et al.,* 2011), asproduce from a farmland is dependent on the adequate CMP which requires continuous monitoring for sustainability. The concept of agricultural sustainability with the accompanied various strategies for soil and crop management are to augment crop yield under the current environmental conditions of climate change as agricultural practice determines level of food production for the supply to meet demand of the growing population (Tilman *et al.,* 2002). This sustainability has to be tailored with analytical tool for human-induced activities that might trigger ecological tremor (Xu *et al.*, 2014) and be long-term in application for general farming systems to abate health of the ecosystems to support continuous and adequate crop yield (Denyar 2000; Wu and Ma, 2018).

Ecosystem resilience from stresses to mitigate crop yield crises is necessary (Smith *et al.*, 2014). Provision of useful products which befit adequate CMP would be worthwhile when production cost is minimal and the profits made by the farmers are adequate (Uphoff *et al.,* 2006). Previous research (Tilman *et al.,* 2002) emphasise necessary efforts to enhance the potential yield of the main food crops and abate probable obstacle against agricultural sustainability. A breeding programme in conjunction with the CMP would mitigate food insecurity and current climate change concerns (Tester and Langridge, 2010). Crop species that has the potential to produce a better yield in the challenging environment ought to be considered in the CMP (Godfray *et al.,* 2010).

Crop Selection Strategies by the Respondents

Investigation on the adoption of crop selection strategies (CSS) by the respondents showed the number of respondents that declined to embark on CSS was 264 out of 374 in Benue State with Benue east (43.2 %) having a higher decline, 189 out of 358 in Edo state with Edo north (40.2 %) having a higher decline, 315 out of 377 in Niger state with Niger Northcentral (44.8 %) having a higher decline, unlike 112 out of 222 adopted CSS in Ondo state with Ikare zone (34.8 %) having higher adoption. Individual state adoption of the CSS was significantly ($p < 0.05$) different (Table 3).The respondents were made to realise that the idea of CSS is important to stabilise inconsistent crop yield and dwindling in the output of their farming efforts. The CSS is necessary to be considered alongside other various factors, which are not limited to soil types, types of nutrients and amount of additives, water quantity, growing stages and weather fluctuation (Spuhlerand Carle, 2020).Local condition is another factor if the CSS is to be adopted for crop choice in either hot or cool region.The CSS needs to combine crop planting because it plays a better role than single crop planting in ameliorating the imposed weather fluctuation effects.

However, agronomic research might produce a better cultivar in place of crop combination to ease out the climate change effects (Mendelsohn and Kurukulasuriya, 2008). Right decision in CSS for the starting of agricultural production is prevailing conditions ofthe location and site of the farmland,and for marketability of the produce and profitability from the sales (Bareja, 2019). The author also mentioned that prevailing farm conditions for any selected location should include soil biotic factors and weather conditions, resistance to pests and diseases, available technology, the farming system which is either farming alone or with livestock, availability of planting materials and labour cost. Alam *et al.* (2011) were of the view that CSS is a measure to tackle agricultural productivity and food security setbacks from the current influence of climate change. The measure is peculiar to every region as the nature, degree, rate and resultant effects differ temporally and spatially to a region. Unforeseen occurrences thrown into the human habitat by climate change effects are not limited to flood, drought, pest invasion and proliferation, disease outbreaks and crop cycle. Food insecurity and chronic malnutrition as the human population increases are the likely resultant effects (FAO, 2008), if measure like CSS is failed to be taken.

Table 3: Crop selection strategies by the respondents across the study areas

Crop Selection Strategies		Benue N140	Benue C130	Benue E130	Total	Edo N130	Edo C100	Edo S170	Total
Yes	Count	37	56	17	110	41	40	88	169
	%	33.6%	50.9%	15.5%	100.0%	24.3%	23.7%	52.1%	100.0%
No	Count	85	65	114	264	76	54	59	189
	%	32.2%	24.6%	43.2%	100.0%	40.2%	28.6%	31.2%	100.0%
Total	Count	122	121	131	374	127	94	147	358
	%	35.1%	31.6%	33.3%	100.0%	34.1%	25.6%	40.3%	100.0%

	Chi-Square Tests for Benue State			Chi-Square Tests for Edo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	60.060[a]	6	0.000	26.096[a]	6	0.000
Likelihood Ratio	65.248	6	0.000	26.942	6	0.000
Linear-by-Linear Association	.568	1	0.451	19.478	1	0.000

Crop Selection Strategies		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	28	10	24	62	39	0	35	38	112
	%	45.2%	16.1%	38.7%	100.0%	34.8%	0.0%	31.3%	33.9%	100.0%
No	Count	78	141	96	315	29	1	50	30	110
	%	24.8%	44.8%	30.5%	100.0%	26.4%	.9%	45.5%	27.3%	100.0%
Total	Count	106	151	120	377	68	1	85	68	222
	%	30.1%	39.8%	30.1%	100.0%	36.8%	.4%	34.6%	28.3%	100.0%

	Chi-Square Tests for Niger State			Chi-Square Tests for Ondo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	42.708[a]	6	0.000	28.164[a]	9	0.001
Likelihood Ratio	49.424	6	0.000	28.275	9	0.001
Linear-by-Linear Association	4.686	1	0.030	10.434	1	0.001

Table 4: Crop rotation strategies by the respondents across the study areas

Crop Rotation Strategies		Benue N140	Benue C130	Benue E130	Total	Edo N130	Edo C100	Edo S170	Total
Yes	Count	89	95	92	276	89	61	83	233
	%	32.2%	34.4%	33.3%	100.0%	38.2%	26.2%	35.6%	100.0%
No	Count	48	32	38	118	39	34	56	129
	%	40.7%	27.1%	32.2%	100.0%	30.2%	26.4%	43.4%	100.0%
Total	Count	137	127	131	394	128	95	139	362
	%	35.2%	31.9%	32.9%	100.0%	33.9%	26.2%	39.9%	100.0%

	Chi-Square Tests for Benue State			Chi-Square Tests for Edo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.682[a]	8	0.220	16.043[a]	6	0.014
Likelihood Ratio	11.610	8	0.169	21.423	6	0.002
Linear-by-Linear Association	.180	1	0.671	8.914	1	0.003

Crop Rotation Strategies		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	60	90	60	210	32	69	50	45	196
	%	28.6%	42.9%	28.6%	100.0%	16.3%	35.2%	25.5%	23.0%	100.0%
No	Count	60	70	60	190	40	28	38	26	132
	%	31.6%	36.8%	31.6%	100.0%	30.3%	21.2%	28.8%	19.7%	100.0%
Total	Count	120	160	120	400	72	97	88	71	328
	%	30.0%	40.0%	30.0%	100.0%	26.6%	26.3%	25.8%	21.3%	100.0%

	Chi-Square Tests for Niger State			Chi-Square Tests for Ondo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.504[a]	2	0.471	45.983[a]	9	0.000
Likelihood Ratio	1.506	2	0.471	48.022	9	0.000
Linear-by-Linear Association	0.000	1	1.000	10.703	1	0.001

Crop rotation strategies by the respondents

Crop rotation strategy (CRS) was assessed across the study areas and found a high percentage of the famers pratising the strategy. All the respondents admitted to be practising CRS. Benue central had the highest (34.4) % among 276 out of 394 in Benue State, Edo north had the highest (38.2) % among 233 out of 362 in Edo State, Niger north central had the highest (42.9) % among 210 out of 400 in Niger State, and Okitipupa zone had the highest (35.2) % among 196 out of 328 in Ondo State. The Chi-square test showed that the CRS practice was significantly ($p < 0.05$) different in both Edo ($\chi = 16.043$) and Ondo ($\chi = 45.983$) state (Table 4).

This intentionally successional planting of different crops on the same farmland at different sessions is a vital checking tool for unexpected threats from disasters. The CRS involves removal of all previously planted plant matter, wetting and covering the soil, and allowing the soil to readjust for six to eight weeks before the introduction of new crops. Soil conditions are managed by the farmer via rotating crops not by adding chemicals (Layland, 2014). The benefits of practising CRS are not limited to improving biodiversity, regulating water availability within the ecosystems, efficient handling of disease outbreaks and their pathogens, and providing the required nutrients to the soil (Arcuri, 2019). The research conducted by Rinkesh (2020)also outlined the merits of CRS. The merits were linked to an increase in soil fertility and nutrients, crops yields, improve soil structure, minimise soil erosion,minimise pest infestation and disease outbreaks, reduce the stress of weeds on the growing crops to attain better performance, and reductionof pollution which accompanies too much fertilizer application. Features of the crops rotated such as shallow-rooted plants and deep-rooted plants would collectively exhibit different characteristics on the farmlands, thereby curbing the likely continuous effects of climatechange on the ecosystem (Cothren and Gryther, 2014). The authors also said that CRS could influence the rate of organic nitrogen to mineral nitrogen by modifying soil moisture, soil temperature, pH, plant residue, and tillage practices thereby serving as the best management practices to optimize the use of fertilizer N and reduce N loss to erosion.

Mixed Cropping Systems by the Respondents

Practice of growing different crops at the same times on the same piece of farmland indicated high adoption across the study areas. The result indicated that 353 out of 395 farmers in Benue State affirmed using mixed cropping systems (MCS) with the highest (35.7 %) from Benue east, 247 out of 357 in Edo State with the highest (42.9 %) from Edo south, 214 out of 399 in Niger State with the highest (44.9 %) from Niger north east, and 172 out of 273 in Ondo State with the highest (30.2 %) from Owo zone. Both Edo and Niger States had their MCS adoption significantly ($\chi = 14.095$, $p < 0.05$; $\chi = 125.623$, $p < 0.05$ respectively) different (Table 5).

There was an observation that the responding farmers have the knowledge of the unlimited advantage accrued in the strategy to have edge over the possibility of various crops reacting to the effects which climate change brings about. Engaging in mixed cropping which is also termed poly-culture, intercropping or co-cultivation gives the farmers an advantage to sow at least two plants concurrently on the same farmland so that they grow together. Mixed cropping checkmates not only total crop failure from abnormal weather conditions but competition for resources like sunlight, nutrients, water, root pattern and crop duration also. Success of fighting climate change with mixed cropping strategy is linked to seeding more than one crop to save space and explore a wealth of environmental benefits thereby sustaining a balance of input and exhausted soil nutrients; ripening of crops at different seasons; suppressing weed, disease and insect pest; resisting climate fluctuations; increasing in general productivity; managing scarce land resources to its optimal capacity (Hirst, 2019). The criteria for the MCS are not limited to the crop growth habit and duration, its root pattern, water and nutrient requirements.The advantages of following the aforementioned criteria include production of crop varieties, less risk of crop failure, improving soil fertility, controlling of weed and pest, and maintenance of symbiotic relationships between/ among crops (Reddy *et al.,* 2019). If the farmers realise unlimited merits of mixed cropping, they would realise that maximum utilisation of land, labour, machinery and growth resources would results in high total productivity (Ahmed *et al.,* 2006). Optimal utilisation of soil nutrients is peculiar to mixed cropping unlike mono-cropping (Santalla *et al.,* 2001) and the replenishment from appropriate chosen of planted crops is possible. However, optimising planting density with seedling rate of each crop on the mixture is needed for consideration (Talukder *et al.,* 2015).

Building Crop Storage by the Respondents

Availability of building crop storage (BCS) is a crucial integral part of farming activities.Theresults of the farmers within each State showed utilisationof BCS: 309 out of 390 in Benue State with Benue central had 36.2 %, 248 out of 361 in Edo State with Edo South had 48.8 %, 334 out of 399 in Niger with Northcentral had 45.5 %, and 299 out of 344 in Ondo with Okitipupa had 29.1 %. Building of the crop storage by the farmers within each state was significant ($p < 0.05$) different throughout (Table 6). The lower the BCS % the higher the impact of climate change; this indicated that the Edo State with the least general % of BCS might suffer the severe impact of unforeseen circumstances from the climate change impact. Such impacts include spoilage, quality reduction, cheap sales due to loss of perishability, and low profit making, and discouragement to the farmers.

The BCS is a holding area of agricultural produce before delivery: the home of final agricultural produce for maintaining the quality. It assists to have a practicable plan for harvesting and transportation. It prevents the spoilage of produce.Crop storage (such as warehouse, grains crib and silo, yam barns and shelf, pit storage, refrigerators) is considered a part of post-harvest technology, so the degree of impact on the harvested produce across the study areas depends on the standard of the required storage. Ojedele *et al.* (2018) presented the essence of storage to include provision of shelter with favourable environment for the preservation of quality and quantity of plants and crops, enhancement of the productivity of the farmers, and ascertaining of safety and good working condition of the farmland. Materials such as steel (the most expensive), timber, concrete and earth from which the storage are made determine the conditions provided for the produce kept in it. Scott (2018) mentioned probable eight factors to consider for viable stored crops; using an appropriate storing facility, storage of quality produce, drying to the right moisture contents, aeration management, temperature monitoring for the necessary adjustment, appropriate supervision for weather condition i.e. dry and wet season consideration, monitoring of the crop to avoid out-of-condition issues, and pest infestation and invasion handling.

Table 5: Mixed cropping systems by the respondents across the study areas

Mixed Cropping Systems		Benue N140	Benue C130	Benue E130	Total	Edo N130	Edo C100	Edo S170	Total
Yes	Count	120	107	126	353	84	57	106	247
	%	34.0%	30.3%	35.7%	100.0%	34.0%	23.1%	42.9%	100.0%
No	Count	16	13	5	34	36	21	44	101
	%	47.1%	38.2%	14.7%	100.0%	35.6%	20.8%	43.6%	100.0%
Total	Count	139	125	131	395	128	78	151	357
	%	35.2%	31.6%	33.2%	100.0%	35.9%	21.8%	42.3%	100.0%

	Chi-Square Tests for Benue State			Chi-Square Tests for Edo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.095[a]	6	0.029	12.331[a]	6	0.055
Likelihood Ratio	16.493	6	0.011	14.154	6	0.028
Linear-by-Linear Association	6.526	1	0.011	3.889	1	0.049

Mixed Cropping Systems		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	87	31	96	214	51	0	69	52	172
	%	40.7%	14.5%	44.9%	100.0%	29.7%	0.0%	40.1%	30.2%	100.0%
No	Count	33	127	24	184	38	1	20	23	82
	%	17.9%	69.0%	13.0%	100.0%	46.3%	1.2%	24.4%	28.0%	100.0%
Total	Count	120	159	120	399	99	1	96	77	273
	%	30.1%	39.8%	30.1%	100.0%	36.3%	.4%	35.2%	28.2%	100.0%

	Chi-Square Tests for Niger State			Chi-Square Tests for Ondo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	125.632[a]	4	0.000	14.915[a]	9	0.093
Likelihood Ratio	133.619	4	0.000	15.920	9	0.069
Linear-by-Linear Association	1.326	1	0.250	7.111	1	0.008

eedling Transplanting Practices by the Respondents

Proper handling of seedlings from the start of planting to the harvesting period requires an extra attention which its importance is not only to increase plant survival and health but also optimise growing season while maximising space. Transplanting of seedlings onto the farm field reduces time consuming in monitoring and gives an assurance of which seed germinates. Seedling transplant practices (STP) across consideration of the farmers' response per state showed that 216 out 384 engaged in STP in Benue state with the highest (36.6) % in Benue north, 274 out of 378 in Edo with the highest (43.1) % in Edo south, 239 out of 386 in Niger state with the highest (39.7) % in Niger northsouth but 196 out 339 did not in Ondo state with the highest (28.1) % in Okitipupa. The Chi-square test showed tha the farmers' response was significiantly ($p < 0.05$) different in each state except in Edo state ($\chi = 8.168$, $p = 0.086 > 0.05$) (Table 7). The transplanting of crop seeds provides a place for crop to grow from controlled fertile soil and moisture contents as well as the right amount of heat and light. The crop has a high chance to flourish and mature within the growing season. Direct planting of seeds on the field exposes the crop to aftermath effects of climate change that are not limited to insect infestation, disease outbreaks, soil fertility reduction from excess dryness and erosion of soil (Murphy, 2017). The Editors (2019) stated the precautions to take in transplanting of seedlings to include (1) planning ahead to avert weather harsh conditions by monitoring the planting calendar and condition under which the crop grows best, (2) preparation of the garden for the plants using raised planting beds and ensuring penetration of the seedling roots, and (3) planting of the seedlings outdoors especially at the overcast and early in the morning to avoid harsh midday direct sun.

Early and late Planting Practices by the respondents

Comparison of early and late planting of crops showed that the respondents preferred early to late planting. The results indicated that 97 % in Benue and Niger states while 85 % in Edo and Ondo states of the study areas. The critical look on the positive (YES) response at the zone level showed that 369 out of 394 engaged in early planting practices (EPP) with the highest (36.9) % in Benue north, 288 out of 378 in Edo state with the highest (38.5) % in Edo south, 351 out of 399 in Niger state with the highest (43.6) % in Niger north central, and 315 out of 378 in Ondo state with the highest (29.2) % in Ikare zone. Responses of all the farmers that engaged in EPP were significantly ($p < 0.05$) different per state (Table 8).In contrast, the other side (late planting practice; LPP) was observed for farmers' response. The results indicated that 381 out of 394 engaged in LPP with the highest (35.2) % in Benue north, 321 out of 376 in Edo state with the highest (41.1) % in Edo south, 382 out of 394 in Niger state with the highest (40.8) % in Niger north central, and 315 out of 361 in Ondo state with the highest (27.3) % in Okitipupa zone.Responses of all the farmers that engaged in LPP were not significantly ($p > 0.05$) different per state except in the Niger state ($\chi = 8.669$, $p = 0.013 < 0.05$) (Table 9). The observations were that many of the farmers adapt the two (EPP and LPP) depending on the planting period and peculiarity of the crops to be planted. The farmers illustrated that "onion is observed to thrive with early planting while seedlings of eggplant, peppers, tomatoes and all cucumber family members become lanky and overgrown as they wait for warm weather if they are planted too early." These late planting seedlings require constant potting up to keep them from becoming root bound (Pleasant, 2014).Experience gathered from the previous practices assist in the current conditions of weather changes which at times make it difficult to predict when farmers will be on the farmland to start planting.Adjustment from the previous knowledge of behaviour of crops germination, performance and nutrient requisition guides the farmers to adapt EPP or LPP (i.e. plant early or late) to the usual time of planting. The idea is to ascertain and regulate soil internal factors (such as the edaphic, pH, moisture contents, soil mineralisation and sequestration) and external factors (temperature, precipitation, solar radiation) that influence the soil condition. Typical soil temperature varies temporally and spatially from the influence of the radiation reaching the soil surface. The soil compositions also determine the heat retaining capacity of the soil. The illustration is broadly affected by the climate change. Early seeded crop may avoid insect and disease problems;the crop would avert pest infestation and peak period.Such a crop will have highquality and matureearly for harvest (Weir, 2015).Improvements in seed genetic treatments make EPP less risk for their growing capabilities relative to a decade ago (Anderson, 2016).Increased rainfall has devastating effects on germinating and performance of crop from making the soil muddy with reduction in yield;this results from the soil compaction owing to drying of soil after heavy rainfall. Noticeable signs of compaction where plants stunted with leaves showing drought stress symptoms reflect on end rows, where equipment moves at right angles to rows thereby limiting the root penetration ability more than improving capillarity (UoI, 2019).Two reasons were pointed out to contribute to regulation of planting period (EPP and LPP); short commercial lifecycle of hybrids and increased climate variability.Its adoption would improve farmers' decision making(Dai *et al.,* 2015).

Delayed decision of when to switch to either of the two is a problem that farmers face when plantingbecause of a high precipitation (Nielsen *et al.*, 2002; Parker *et al.*, 2016). Also, other copies of research (Sindelar *et al.*, 2010; Abendroth *et al.*, 2017) illustrated that despite climate patterns, yield response to planting date (either EPP or LPP) have not changed and are likened to the more stable hybrids that have developed tolerance to weather unevenness.Late planting of maize has a remarkable impact on both the vegetative growth and grain-filling phase with a possible decrease yield, though vegetative biomass was not affected (Tsimba *et al.*, 2013).However, Baum *et al.* (2019) determined from their research that short and full-season hybrid comparative maturities had similar grain yields irrespective of when (EPP or LPP) they were planted as long as the crops reached maturity before harvesting. The highest frequency of optimum planting date was earlier (EPP) in the growing season (Long *et al.*, 2017).

CONCLUSION

Farmers hardly practise crop management (Edo>Benue>Niger>Ondo) and the reason was not significantly ($\chi = 8.620$, $p = 0.473 > 0.05$) different in Ondo state, and hardly adapted crop selection (Niger>Benue>Edo>Ondo) with significant ($p < 0.05$) difference in each state. Higher number of farmers adapted scarce resources substitution (Niger>Benue>Ondo>Edo) significantly ($p < 0.05$) except in Edo State, crop rotation strategy (Benue>Edo>Niger>Ondo) and significantly ($p < 0.05$) in Edo and Ondo states, mixed cropping systems (Benue>Edo>Niger>Ondo) with significant ($p < 0.05$) difference among farmers in Benue and Niger states. Building crop storage strategy (Niger>Benue>Ondo>Edo) and early planting (Benue>Niger>Ondo>Edo) were significantly ($p < 0.05$) adapted in each state. The farmers practised seedling transplanting (Edo>Niger>Benue>Ondo) with significant ($p < 0.05$) difference except in Edo state ($\chi = 8.168$, $p = 0.086 > 0.05$) and late planting (Niger>Benue>Edo>Ondo) with significant ($p < 0.05$) difference in Niger state.Thus, the same policy would not be effective (Chi-Square had $p < 0.05$) for the farmers on crop selection, building crop storage and early planting strategy in each state.

Table 6: Building crop storage by the respondents across the study areas

Building Crop Storage		Benue N140	Benue C130	Benue E130	Total	Edo N130	Edo C100	Edo S170	Total
Yes	Count	103	112	94	309	68	59	121	248
	%	33.3%	36.2%	30.4%	100.0%	27.4%	23.8%	48.8%	100.0%
No	Count	31	13	37	81	52	36	25	113
	%	38.3%	16.0%	45.7%	100.0%	46.0%	31.9%	22.1%	100.0%
Total	Count	134	125	131	390	120	95	146	361
	%	34.8%	32.2%	33.0%	100.0%	33.9%	26.1%	39.9%	100.0%

	Chi-Square Tests for Benue State: Value	Df	Asymp. Sig. (2-sided)	Chi-Square Tests for Edo State: Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.191[a]	6	0.001	26.081[a]	6	0.000
Likelihood Ratio	24.433	6	0.000	27.071	6	0.000
Linear-by-Linear Association	0.001	1	0.971	15.361	1	0.000

Building Crop Storage		Niger N-S 120	Niger N-C 160	Niger N-E 120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	116	152	66	334	67	87	81	64	299
	%	34.7%	45.5%	19.8%	100.0%	22.4%	29.1%	27.1%	21.4%	100.0%
No	Count	4	7	54	65	11	10	15	9	45
	%	6.2%	10.8%	83.1%	100.0%	24.4%	22.2%	33.3%	20.0%	100.0%
Total	Count	120	159	120	399	78	97	96	73	344
	%	30.0%	40.0%	30.0%	100.0%	26.4%	26.1%	26.1%	21.4%	100.0%

	Chi-Square Tests for Niger State: Value	Df	Asymp. Sig. (2-sided)	Chi-Square Tests for Ondo State: Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	105.442[a]	4	0.000	32.621[a]	9	0.000
Likelihood Ratio	98.878	4	0.000	32.869	9	0.000
Linear-by-Linear Association	71.935	1	0.000	5.580	1	0.018

Table 7: Seedling transplanting practices by the respondents across the study areas

Seedling Transplanting Practices		Benue N140	Benue C130	Benue E130	Total	Edo N130	Edo C100	Edo S170	Total
Yes	Count	79	59	78	216	92	64	118	274
	%	36.6%	27.3%	36.1%	100.0%	33.6%	23.4%	43.1%	100.0%
No	Count	48	67	53	168	38	34	32	104
	%	28.6%	39.9%	31.5%	100.0%	36.5%	32.7%	30.8%	100.0%
Total	Count	127	126	131	384	130	98	150	378
	%	34.8%	32.2%	33.0%	100.0%	33.9%	26.1%	39.9%	100.0%

	Chi-Square Tests for Benue State Value	Df	Asymp. Sig. (2-sided)	**Chi-Square Tests for Edo State** Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.946[a]	6	0.001	8.168[a]	4	0.086
Likelihood Ratio	24.893	6	0.000	9.814	4	0.044
Linear-by-Linear Association	2.587	1	0.108	0.706	1	0.401

Seedling Transplanting Practices		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	95	69	75	239	18	50	37	38	143
	%	39.7%	28.9%	31.4%	100.0%	12.6%	35.0%	25.9%	26.6%	100.0%
No	Count	19	84	44	147	52	47	55	42	196
	%	12.9%	57.1%	29.9%	100.0%	26.5%	24.0%	28.1%	21.4%	100.0%
Total	Count	114	153	119	386	70	97	92	80	339
	%	30.0%	40.0%	30.0%	100.0%	26.6%	26.1%	25.5%	21.8%	100.0%

	Chi-Square Tests for Niger State Value	Df	Asymp. Sig. (2-sided)	**Chi-Square Tests for Ondo State** Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	45.634[a]	6	0.000	74.312[a]	9	0.000
Likelihood Ratio	49.273	6	0.000	70.712	9	0.000
Linear-by-Linear Association	2.496	1	0.114	30.463	1	0.000

Table 8: Early planting practices by the respondents across the study areas

Early Planting Practices		Benue N140	Benue C130	Benue E130	Total	Edo N130	Edo C100	Edo S170	Total
Yes	Count	136	108	125	369	109	68	111	288
	%	36.9%	29.3%	33.9%	100.0%	37.8%	23.6%	38.5%	100.0%
No	Count	2	17	6	25	20	30	40	90
	%	8.0%	68.0%	24.0%	100.0%	22.2%	33.3%	44.4%	100.0%
Total	Count	138	125	131	394	129	98	151	378
	%	34.9%	31.9%	33.2%	100.0%	34.1%	25.9%	39.9%	100.0%

	Chi-Square Tests for Benue State Value	Df	Asymp. Sig. (2-sided)	**Chi-Square Tests for Edo State** Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.420[a]	4	0.001	8.004[a]	2	0.018
Likelihood Ratio	19.505	4	0.001	8.339	2	0.015
Linear-by-Linear Association	1.082	1	0.298	4.298	1	0.038

Early Planting Practices		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	81	153	117	351	92	69	87	67	315
	%	23.1%	43.6%	33.3%	100.0%	29.2%	21.9%	27.6%	21.3%	100.0%
No	Count	39	6	3	48	8	29	8	8	53
	%	81.3%	12.5%	6.3%	100.0%	15.1%	54.7%	15.1%	15.1%	100.0%
Total	Count	120	159	120	399	100	99	95	75	378
	%	30.1%	39.8%	30.1%	100.0%	26.7%	26.7%	26.2%	20.3%	100.0%

	Chi-Square Tests for Niger State Value	Df	Asymp. Sig. (2-sided)	**Chi-Square Tests for Ondo State** Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	68.053[a]	2	0.000	28.301[a]	6	0.000
Likelihood Ratio	62.790	2	0.000	27.171	6	0.000
Linear-by-Linear Association	50.898	1	0.000	.000	1	0.994

Table 9: Late planting practices by the respondents across the study areas

Late Planting Practices		Benue N140	Benue C130	Benue E130	Total	Edo N130	Edo C100	Edo S170	Total
Yes	Count	134	118	129	381	113	76	132	321
	%	35.2%	31.0%	33.9%	100.0%	35.2%	23.7%	41.1%	100.0%
No	Count	4	7	2	13	16	21	18	55
	%	30.8%	53.8%	15.4%	100.0%	29.1%	38.2%	32.7%	100.0%
Total	Count	138	125	131	394	129	97	150	376
	%	35.1%	31.8%	33.1%	100.0%	34.4%	25.9%	39.7%	100.0%

	Chi-Square Tests for Benue State			Chi-Square Tests for Edo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.435[a]	4	0.350	6.544[a]	4	0.162
Likelihood Ratio	5.017	4	0.286	6.899	4	0.141
Linear-by-Linear Association	.966	1	0.326	.382	1	0.536

Late Planting Practices		Niger N-S120	Niger N-C160	Niger N-E120	Total	Ikare 100	Okitipupa 100	Ondo 100	Owo 100	Total
Yes	Count	107	156	119	382	92	86	76	61	315
	%	28.0%	40.8%	31.2%	100.0%	29.2%	27.3%	24.1%	19.4%	100.0%
No	Count	8	3	1	12	8	13	17	8	46
	%	66.7%	25.0%	8.3%	100.0%	17.4%	28.3%	37.0%	17.4%	100.0%
Total	Count	115	159	120	394	100	99	93	69	361
	%	29.2%	40.4%	30.5%	100.0%	27.0%	27.0%	26.5%	19.5%	100.0%

	Chi-Square Tests for Niger State			Chi-Square Tests for Ondo State		
	Value	Df	Asymp. Sig. (2-sided)	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.669[a]	2	0.013	12.290[a]	9	0.197
Likelihood Ratio	8.016	2	0.018	14.634	9	0.101
Linear-by-Linear Association	7.355	1	0.007	6.443	1	0.011

ACKNOWLEDGEMENTS

I am gratefully thanking World Bank for the grant approved for my research as a 3rd Cohort and PhD Student(Adeleke Taofik TOWOLAWI,with the Matriculation Number: PG 09/ 0181) in Environmental Systems & Climate Change programme. The Director (Prof. O. D. Akinyemi) of the Centre of Agricultural Development and Sustainable Environment (CEADESE),Federal University of Agriculture Abeokuta (FUNAAB) andmy Programme Leader (Prof. O. S. Awokola) are passionately appreciated. Lastly, my gratitude goes to Olaide Khadijat, Qanita Rooreromi and Yasir Ooreoluwa for their assistance in my data coding and analyses.

FUNDING:

This research was financially supported by the World Bank at CEADESE, FUNAAB.

REFERENCES

Abendroth, L.J., Woli, K.P., Myers, A.J.W. and Elmore, R.W. (2017) Yield-based corn planting date recommendation windows for Iowa. Crop Forage Turfgrass Management 3. DOI:10.2134/cftm2017.02 .0 015.

Ahmed, F., Rahman, M.A., Jaahn, M.A.H.S., Ahmed, M. and Khayer, M.A. (2006) Effect of different planting system in maize/spinach-red amaranth intercropping. Bangladesh Journal of Agriculture and Environment 2 (2): 69-79.

Alam, M.M., Siwar, C., Murad, M.W. and Mohd Ekhwan, T. (2011) Impacts of climate change on agriculture and food security issues in Malaysia: An empirical study on farm level assessment.World Applied Sciences Journal 14(3): 431-442.

Amujoyegbe, B.J. (2012) Farming system analysis of two agro ecological zones of Southwestern Nigeria. Agricultural Science Research Journal 2(1): 13 – 19.

Anderson, K. (2016), Benefits to early planting. Brownfield, AG News for America. https://brownfieldagnews.com/2016/04/benefits-early-planting/accessed on 14 February 2020.

Arcuri, L. (2019),Cover crops and their benefits. The spruce. https://www.thespruce.com/definition-of-cover-crop-3016953. Accessed on 11 February, 2020.

Bareja, B.G. (2019), Proper crop selection is an important factor in successful crop farming. Towards a sculpted contour in agriculture. Cropsreview. https://www.cropsreview.com/crop-selection.html. Written on Oct. 2011 and edited Apr. 5, 2019accessed on 10 February 2020.

Barnett, B.J., Barrett, C.B. and Skees, J.R. (2008) Poverty traps and index-based risk transfer products. World Development 36: 1766–1785.

Baum, M.E., Archontoulis, S.V. and Licht, M.A. (2019) Planting date, hybrid maturity, and weather effects on maize yield and crop stage. Crop economics, production, and management. Agronomy Journal 111 (1): 303-313.

Calzadilla, A., Rehdanz, K. and Tol, R.S. (2010) The economic impact of more sustainable water use in agriculture: A computable general equilibrium analysis. Journal of Hydrology 384: 292–305.

Climate.Gov (2021),https://www.climate.gov/news-features/climate-qa/whats-difference-between-global-warming-and-climate-change accessed on 15 August 2021

Cochran, W.G. (1977), Sampling techniques,3rd ed. John Wiley Sons, New York, USA.

Cothren, J. and Gryder, J. (2014)Advantages of crop rotation.North Carolina State University. https://wilkes.ces.ncsu.edu/2014/12/advantages-of-crop-rotation/ accessed on 11 February 2020.

Dai, S., Shulski, M.D., Hubbard, K.G. and Takle, E.S. (2015) A spatio-temporal analysis of Midwest US temperature and precipitation trends during the growing season from 1980–2013. International Journal Climatology 36: 517–525.

Denyar, R. (2000) Integrated crop management. Pest Management Science 56: 945–946.

FAO (Food and Agriculture Organization) (2008), High-level conference on world food security: The challenges of climate change and bioenergy. Soaring food prices: Facts, perspectives, impacts and actions required. FAO, Rome. HLC/08/INF/1: 50 pp. http://www.fao.org/fileadmin/user_upload/foodclimate/HLCdocs/HLC08-inf-1-E.pdf accessed on 11 February 2020.

FAO-UN (Food and Agriculture Organization of the United Nations)(2016) The State of Food and Agriculture. Climate Change, Agriculture and Food Security. Pp. 194. The Publishing Group in FAO's Office for Corporate Communication, Rome, Italy. ISBN 978-92-5-109374-0.

FAO-UN (Food and Agriculture Organization of the United Nations)(2021) http://www.fao.org/climate-smart-agriculture-sourcebook/production-resources/module-b1-crops/chapter-b1-1/en/ accessed on 15 August 2021.

Germer, J., Sauerborn, J., Asch, F., de Boer, J., Schreiber, J., Weber, G. and Müller, J. (2011) Skyfarming an ecological innovation to enhance global food security. Journal of Consumer Protection and Food Safety 6: 237–251.

Godfray, H., Beddington, J., Crute, I., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S. and Toulmin, C. (2010) Food security: The challenge of feeding 9 billion people. Science 327: 812–818.

Hejazi, M., Edmonds, J., Chaturvedi, V., Davies, E. and Eom, J. (2013) Scenarios of global municipal water-use demand projections over the 21st century. Hydrology Science Journal 58: 519–538.

Hirst, K.K. (2019),Mixed cropping. The co-cultivation of two or more crops. ThoughtCo. https://www.thoughtco.com/mixed-cropping-history-171201accessed 24 February 2020.

IPCC (Intergovernmental Panel on Climate Change)(2013), Summary for policymakers. *In:* Stocker, T.F., Qin, D., Plattner, G.K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V. and Midgley, P.M. (Eds.), Climate Change (2013), The physical science basis. Working group I contribution to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK. Pp. 222.

Kamat, G.V., Metgud, S.C., Pattanshetti, V.M. and Godhi, A.S. (2010) A cross-sectional study to detect the prevalence of hyperhomocysteinemia in cases of deep vein thrombosis. The Indian Journal of Surgery72(4): 323–326.

Layland, D. (2014). Soil: essence of life. UC master gardener of Napa county weekly column. https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=14267 accessed on 11 February 2020.

Liu, J., Hertel, T. and Taheripour, F. (2016) Analyzing future water scarcity in computable general equilibrium models. Water Econ. Policy 2: 1650006.

Long, N.V., Assefa, Y., Schwalbert, R. and Ciampitti, I.A. (2017) Maize yield and planting date relationship: Asynthesis-analysis for US high-yielding contest winner and field research data. Frontiers in Plant Science, 8 (Article 2106).Pp. 9. doi:10.3389/fpls.2017.02106.

Mendelsohn, R. and Kurukulasuriya, P. (2008),The impact of climate change on primary crops in Africa: Examining the choices farmers make crop switching as a strategy for adapting to climate change. African Association of Agricultural Economists (AAAE). https://www.eldis.org/document/A37588 accessed on 08 February 2020.

Murphy, E. (2017), Transplanting seedlings vs. direct sowing seeds. Grow what you love. Passthepistill.com: https://passthepistil.com/transplanting-seedlings-vs-direct-sowing-seeds/ accessed on 17 February 2020.

NASA(2021),https://climate.nasa.gov/resources/global-warming-vs-climate-change/ accessed on 15 August 2021.

Nechifor, V. and Winning, M. (2018) Global economic and food security impacts of demand-driven water scarcity-alternative water management options for a thirsty world. Water 10: 1442 (20pp). DOI: 10.3390/w10101442.

Nielsen, R.L., Thomison, P.R., Brown, G.A., Halter, A.L., Wells, J. and Wuethrich, K.L. (2002) Delayed planting effects on flowering and grain maturation of dent corn. Agronomy Journal 94: 549–558.

OECD (Organization for Economic Co-operation and Development) (2015) Water resources allocation; organization for economic co-operation and development (OECD): Paris, France. *In*: Nechifor, V. and Winning, M. (2018) Global economic and food security impacts of demand-driven water scarcity-alternative water management options for a thirsty world. Water, 10: 1442.Pp. 20. DOI: 10.3390/w10101442.

Ojedele, O.S., Ezejiofor, N.R., Ehiomogue, P.O. and Orji, F.N. (2018) The necessity of farm structures in Nigeria. American Journal of Engineering Research (AJER) 7 (6): 283-291.

Parker, P.S., Shonkwiler, J.S. and Aurbacher, J. (2016) Cause and consequence in maize planting dates in Germany. Journal of Agronomy and Crop Science 203: 1–14.

Pleasant, B. (2014), Which vegetables are best for early planting? GrowVeg. https://www.growveg.com/guides/which-vegetables-are-best-for-early-planting/accessed on 14 February 2020.

Powlson, D.S., Gregory, P.J., Whalley, W.R., Quinton, J.N., Hopkins, D.W., Whitmore, A.P., Hirsch, P.R. and Goulding, K.W.T. (2011) Soil management in relation to sustainable agriculture and ecosystem services. Food Policy 36: 72–87.

Reddy, S. (2020),What is mixed cropping and what are its benefits? Learn natural farming. Farming chemical free. https://www.learnnaturalfarming.com/what-is-mixed-cropping-and-what-are-its-benefits/ accessed 24 February 2020.

Rinkesh (2020), Conserve future energy, be green stay green. https://www.conserve-energy-future.com/advantages-disadvantages-crop-rotation.phpaccessed on 11 February 2020.

Santalla, M., Rodino, A.P., Casquero, P.A. and De Ron, A.M. (2001). Interactions of bush bean intercropped with field and sweet maize. European Journal of Agronomy 15: 185-196.

Scott, J. (2018), Eight (8) tips for long-term grain storage. Successful farming. https://www.agriculture.com/machinery/grain-handling-and-equipment/grain-bins/8-tips-f-longterm-grain-stage_214-ar45622accessed on 13 February 2020.

Shen, Y., Oki, T., Kanae, S., Hanasaki, N., Utsumi, N. and Kiguchi, M. (2014) Projection of future world water resourcesunder SRES scenarios: An integrated assessment. Hydrology Science Journal 59: 1775–1793.

Sindelar, A.J., Roozeboom, K.L., Gordon, W.B. and Heer, W.F. (2010) Corn response to delayed planting in the central Great Plains. Agronomy Journal 102: 530–536.

Smith, J.C., Levy, M.C. and Gleick, P.H. (2014) Maladaptation to drought: A case report from California, USA. Sustain. Sci. 10: 491–501.

Spuhler, D and Carle, N. (2020), Crop selection factsheet. Technologies and solutions to overcome shortages and pressure on resources. https://sswm.info/sswm-solutions-bop-markets/improving-water-and-sanitation-services-provided-public-institutions-0/crop-selection accessed on 08 February 2020.

Talukder, A.H.M.M.R., Rahman, J., Nahar, L., Rahman, M.M. and Kaisar, N. (2015) Mixed cropping onion with different plant population of sweet gourd. IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) 8 (5): 45 - 50.

Tester, M. and Langridge, P. (2010) Breeding technologies to increase crop production in a changing world. Science 327: 818–822.

The Editors (2019), Tips for transplanting seedlings. How and when to transplant to the garden. The old farmer’s almanac. https://www.almanac.com/content/tips-transplanting-seedlings accessed on 17 February 2020.

Tilman, D., Cassman, K.G., Matson, P.A., Naylor, R. and Polasky, S. (2002) Agricultural sustainability and intensive production systems. Nature 418: 671–677.

Tsimba, R., Edmeades, G.O., Millner, J.P. and Kemp, P.D. (2013) The effect of planting date on maize grain yields and yield components. Field Crops Research 150: 135–144.

UNDP (United Nations Development Programme),(2020), https://www.undp.org/content/ dam/undp/library/corporate/brochure/SDGs_Booklet_Web_En.pdf accessed on 23 January 2020.

UoI (University of Illinois) (2019),How to deal with very late planting. The rules of planting change once we enter June. Successful farming. https://www.agriculture.com/crops/how-to-deal-with-very-late-planting-1accessed on 14 February 2020.

Uphoff, N., Ball, A., Fernandes, E.C.M., Herren, H., Husson, O., Laing, M., Palm, C.A., Pretty, J., Sanchez, P.A., Sanginga, N. and Thies, J.E. (2006) Understanding the functioning and management of soil systems. DOI: 10.1201/9781420017113.ch1. *In* Biological approaches to sustainable soil systems. CRC Press: Boca Raton, FL, USA.Pp. 1–6.

USGS (2021),https://www.usgs.gov/faqs/what-difference-between-global-warming-and-climate-change-1?qt-news_science_products=0#qt-news_science_products accessed on 15 August 2021.

Wada, Y. and Bierkens, M.F. (2014) Sustainability of global water use: Past reconstruction and future projections. Environmental Resources Letter 9: 104003.

Weir, T. (2015), The risks and benefits of early seeding. Glacier farm media. The western producer. https://www.producer.com/daily/the-risks-and-benefits-of-early-seeding/ accessed on 14 February 2020.

Wu, W. and Ma, B.L. (2018) Assessment of canola crop lodging under elevated temperatures for adaptation to climate change. Agric. For. Meteorol. 248: 329–338.

Xu, L., Marinova, D. and Guo, X. (2014) Resilience thinking: A renewed system approach for sustainability science. Sustain. Sci. 10: 123–138.