Chapter 6
Citrus and Tomatoes Response to Climate Change: Survey of Farmers' Perception and Adaptation Strategies in Northern Nigeria

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Abstract Climate Change is a major challenge to agricultural development in Africa, Nigeria in particular and the world at large. Agriculture, as one of the most weather-dependent of all human activities, is highly vulnerable to climate change. The study was carried out to examine farmers' perception and adaptation strategies to citrus and tomatoes response to climate change in Northern Nigeria.

Multi-stage sampling procedure was used to select the study area. Purposely, North central and North-eastern zones were selected due to distinct comparative advantage in horticultural crop production. Benue (Central zone) and Gombe (North-east) agricultural zones were selected using random sampling technique, while Agricultural Development Programme (ADP) zones that are known for mass production of selected horticultural crops within the state were purposively selected. However, 271 farmers were proportionately sampled.

Secondary (weather data) as well as primary sources were used for data collection. Primary sources of data used include structured questionnaire and Focus Group Discussions (FGDs) which were subjected to both descriptive and inferential statistics. Result of analysis shows that majority of the respondents were between the ages of 35 and 45 years of age, married (89.7 %), and had formal education (84.5 %). Fifty-seven percent (57 %) were in high adaptation category, while 52.0 % were favorably disposed to the effect of climate change on production. Binomial logit regression shows that soil fertility, farmers' financial capacity and access to inputs to a large extent determine their choice of adaptation strategy. However, the inferential statistics result shows a significant difference in the adaptation strategies ($p = 0.000$, $t = -24.106$) and farmers' perception of citrus and tomatoes response to climate change ($p = 0.004$, $t = -182.269$).

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Intervention by relevant government and nongovernmental agencies toward adaptation strategies to mitigate the effect to this response will ultimately promote food security in Nigeria.

Keywords Climate change • Adaptation • Perception • Nigeria • Food security

Introduction

Changing climate had been accredited directly or indirectly to human activity that alters the composition of the global atmosphere and which led to the natural variability observed over comparable time periods. As implied from the definition therefore, the climate system can vary naturally, and when augmented, becomes a change (Adejuwon 2004).

Climate change is a major challenge to agricultural development in Africa and the world at large. Agriculture (being one of the most weather-dependent of all human activities) is highly vulnerable to climate change. Climate change threatens agriculture production through rising temperatures, changes in rainfall patterns or the increase of drought. This is directly linked to reduced soil productivity and to a higher incidence of pests and diseases (LEISA 2008). Horticultural crops such as mango, citrus, pepper and tomatoes are dependent on climatic factors for their growth. Thus, they are not left behind in the effect of climate change, simply because vegetables are very sensitive to water availability and minor stress of temperature outside the optimal range. Also flowering stage of fruit trees are susceptible to heavy rainfall. The fact that agricultural production in Nigeria is primarily rain–fed further reinforces the importance of climate to agriculture.

Some areas in the south western Nigeria that used to be termed rain forest are becoming derived savannah. Crops like water melon, cucumber and carrot that are usually grown in the savannah in those days are now being grown in the areas leading to the disappearance and extinction of tree crops which are supposed to be cash crops in these areas. Thus, the existence of such crops is being endangered. Farmers had to live with the realities of climate change to be able to manage the situation and to maintain their enterprise.

Odjugo (2009) reveals that the ways Nigerians are responding, perceiving and adapting to the changing climate have not been well investigated. Furthermore, while research efforts have focused on climate change at global scale, regional climatic patterns in Nigeria, have received limited attention. Worst still, the impact of climate change on agriculture especially horticulture has not received the desired attention (Nyelong 2004; Ati and Iguisi 2007).

The foregoing suggests the need for studies on the various ways farmers perceive the effect of climate change on horticultural crop production in Nigeria. This is in order to provide direction for the intervention that is currently emerging and to minimize the adverse effect of climate change on agricultural production at large.

Specific Objectives of the Study

1. Identify the socioeconomic characteristics of citrus and tomato farmers in the study area.
2. Assess the respondents' awareness of changes in major climate parameters.
3. Ascertain farmers' perception of the effect of climate change on citrus and tomato.
4. Determine the adaptation strategies of citrus and tomato farmers due to climate change and identify factors that influence the strategies used.

Research Hypotheses

Ho1: There is no significant difference in the perception of citrus and tomato farmers about climate change within the zones.
Ho2: There is no significant difference in the adaptation strategies used by citrus and tomato farmers within the zones.

Methodology

Study Area

Northern Nigeria is predominantly occupied by Hausa, Fulani, Gwari, Borim, Kanuri, Tiv, Jukun and many other tribal groups. Nigeria is the most populous nation in West Africa, with a population of about 200 million. In northern Nigeria, there are two distinct seasons; wet season and prolonged dry season. Temperatures during the day remain constantly high while humidity is relatively low throughout the year, with little or no cloud cover. The mean monthly temperatures during the day exceed 36 °C while the mean monthly temperature at night falls below 22 °C.

Presently, Northern Nigeria is made up of the following 19 Nigerian states:

Adamawa, Bauchi, Benue, Borno, Gombe, Jigawa, Kaduna, Kano, Katsina, Kebbi, Kogi, Kwara, Nasarawa, Niger, Plateau, Sokoto, Taraba, Yobe and Zamfara (northernnigeriatourism 2009). Figure 6.1 shows the map of the study area.

Sampling Techniques

Multi-stage sampling procedure was used to draw sample for the study. Purposely, North central and North-eastern zones were selected due to distinct comparative advantage in horticultural crop production. Benue (North central zone) and Gombe

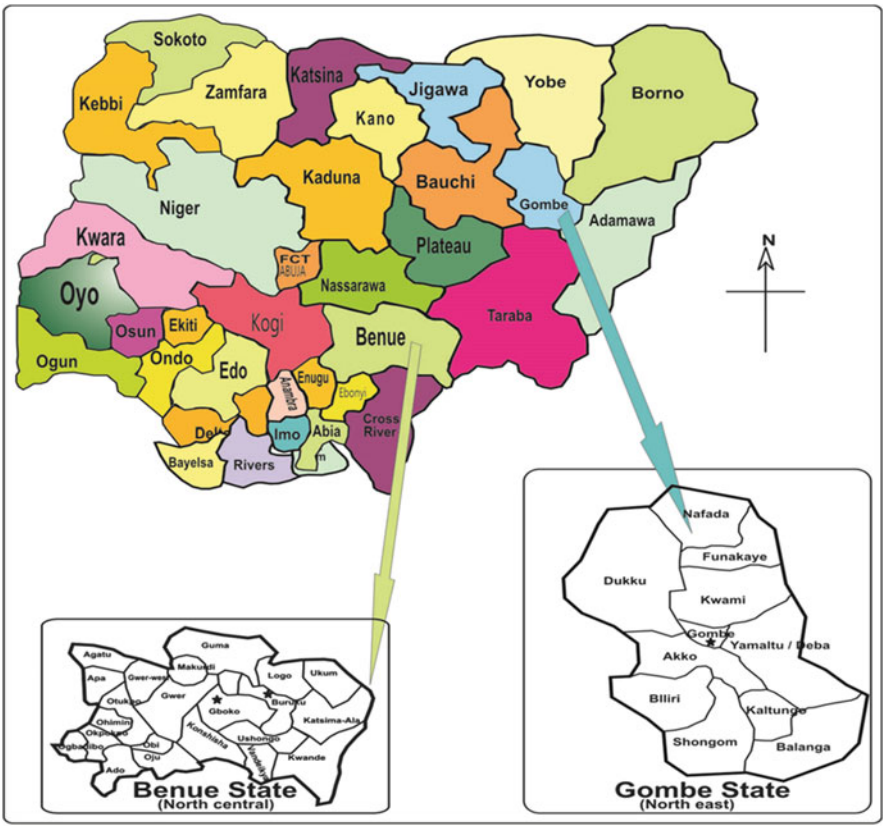

Fig. 6.1 Area of study (Gombe and Benue states). *Source*: 'Original', 2014

(North-east) agricultural zones were selected using random sampling technique, while Agricultural Development Programme (ADP) zones that are known for mass production of selected horticultural crops within the state were purposively selected. However 25 % of ADP blocks and 50 % of cells within the selected blocks and zones were randomly selected. Consequently, from the list of fruits and vegetable producers association, a proportionate sample of 271 farmers comprising of 157 and 114 Citrus and Tomatoes farmers respectively were selected.

Instrument for Data Collection

a. Qualitative method of data collection—Data was collected through the use of Focus Group Discussions (FGDs).
b. Quantitative method—Administration of validated interview schedule.

c. Secondary data: Rainfall and temperature data collected from the two major cities in each of the zones.

Limitation of the Study

The limitation of this study is that it focused only on rain-fed agriculture.

Results and Discussion

Socioeconomic Characteristics of the Respondents

The result (Table 6.1) reveals that the respondents had mean age of 46.0 years ± 7.6. This is an indication that most of the respondents are still in their active years and they contribute significantly to agricultural production of the country. This finding is consistent with that of Yekinni (2010) and Salimonu (2007) who reported a mean age of 43.2 and 48.1 years for farmers in different studies carried out across agricultural zones of Nigeria. Distribution of respondents by sex shows that 84.9 % were male, while 15.1 % were female as shown in the Table. This finding corroborates Oyedele (2005) who reported that rural women in Nigeria do not have direct access to land ownership and inheritance. Results reveal that 10.3 % had no formal education, 19.2 % completed primary education, and 44.3 % had secondary education, while respondents with tertiary education were 21.0 %. This implies that majority of the respondents were literates. Discussants during the FGDs corroborated this when they stated that *"they can read and write"*. This is consistent with Oladeji (2011) who stated that farmers have one form of education or the other in a related study.

The result further reveals that 52.0 % of respondents had between 10 and 20 years in horticultural production. This implies that majority of the respondents had been into horticultural production for over a decade; meaning that they are highly knowledgeable and experienced in horticultural farming this will help them to discuss better on the effect of climate change on their production over the years and be better informed about its general effects on livelihood. On family size, the modal family size class was between 5 and 8 persons, while the mean family size was 6 ± 3.4. This depicts a fairly large family size in Nigeria. The implication of this finding is that if the family size is big, the family responsibilities for poor women become enormous in the time of natural disaster like flood or drought and thus women becomes more vulnerable. This big family size will in turn make the woman and girl child more prone to climate change fury (Aaditya 2011). Majority (59.8 %) of the horticultural farmers have between 1 and 3 ha, 24.1 % had <1 ha, 11.1 % had between 3.1 and 5.0 ha and 2.2 % (5.1–7.0 ha). This implies that farmers are smallholders and it is due to the fact that Spencer (1990) put the upper limit of

Table 6.1 Frequency distribution of socioeconomic characteristics of respondents

Variable description	Frequency	%	Parameters
Age (years)			
35–45	192	70.8	Mean = 46.0 ± 6.7
46–55	64	23.6	
56–65	10	3.7	
66–75	3	1.1	
>75	2	0.7	
Sex			
Male	230	84.9	Mode = male
Female	41	15.1	
Educational level attained			
No formal	28	10.3	
Primary education	52	19.2	Mode = secondary
Secondary education	120	44.3	
Tertiary education	57	21.0	
Others	14	5.2	
Number of years in horticultural production			
0.00	3	1.1	
<10	47	17.3	
10–20	141	52.0	
21–30	60	22.1	Mode = 10–20
31–40	8	3.0	
41–50	11	4.1	
>50	1	0.4	
Family size			
0.00	18	6.6	
1–4	59	21.8	
5–8	100	36.9	Mode = 5–8
9–12	73	26.9	
>12	21	7.7	
Income			
0.00	9	3.3	
<10,000	1	0.4	
10,000–30,000	27	10.0	Mode=> 90,000
31,000–50,000	55	20.3	
51,000–70,000	22	8.1	
71,000–90,000	15	5.5	
>90,000	142	52.4	
Farm size			
<1.0	67	24.7	
1.0–3.0	162	59.8	
3.1–5.0	30	11.1	Mode = 1.0–3.0
5.1–7.0	6	2.2	
7.1–9.0	4	1.5	
>9.0	2	0.7	

small scale farming at three hectares. This shows the dominance of small farm size holdings in the study area.

Respondents' Awareness of Changing Features of Climate Parameters

The result in Table 6.2 show that respondents were aware of the general decrease in yearly amount of rainfall ($\bar{x} = 0.92$), reduction in rainfall days ($\bar{x} = 0.81$), increase possibility of loss of soil nutrients ($\bar{x} = 0.70$), prolonged dry season ($\bar{x} = 0.67$), increased frequency of drought in recent decades ($\bar{x} = 0.69$) and increased intensity of drought in recent decades ($\bar{x} = 0.65$). The result implies that citrus and tomato farmers in Nigeria were aware of the changes that occur in climate parameters in recent years.

To corroborate these results, farmers in Gombe stated during the FGD that "we are aware that there has been less rainfall in the past 2 years when compared to 3–5 years ago when rainfall normally starts in June. Although it is less in terms of duration, the intensity has been high which then leads to flooding".

The findings were consistent with Oyekale et al. (2009) who reported that 58.6 % of cocoa farmers in Nigeria were aware that there is low rainfall in recent years with other climatic parameters.

Figures 6.1 and 6.2 on rainfall and temperature distribution from secondary data also supported the findings that in using the lines of best fit there is general decrease in yearly amounts of rainfall and slight increase in temperature. Farmers are also

Table 6.2 Distribution of respondents' awareness of changing features of climate parameters

	NE		NC		Total			
Statement	F	%	F	%	F	%	WMS	SD
General decrease in yearly amounts of rainfall	91	33.6	158	58.3	249	91.9	0.92	0.27
Intense Harmattan period	90	33.2	55	20.3	145	53.5	0.53	0.49
Reduction in rainfall days	73	26.9	147	54.2	220	81.2	0.81	0.53
Increased possibility of loss of soil nutrients	63	23.2	128	47.2	191	70.5	0.70	0.45
Prolonged dry season	85	31.4	96	35.4	181	66.8	0.67	0.47
Incidence of sand dunes	60	22.1	47	17.3	107	39.4	0.39	0.49
Wind dryness	81	29.9	59	21.8	140	51.7	0.52	0.50
Increased rainfall intensity	62	22.9	86	31.7	148	54.6	0.55	0.50
High humidity	50	18.7	109	54.6	159	58.7	0.59	0.49
Increased frequency of drought in recent decades	62	22.9	126	46.5	188	69.4	0.69	0.46
Increased intensity of drought in recent decades	76	28.0	100	36.9	176	64.9	0.65	0.48

WMS weighted mean score; *SD* standard deviation

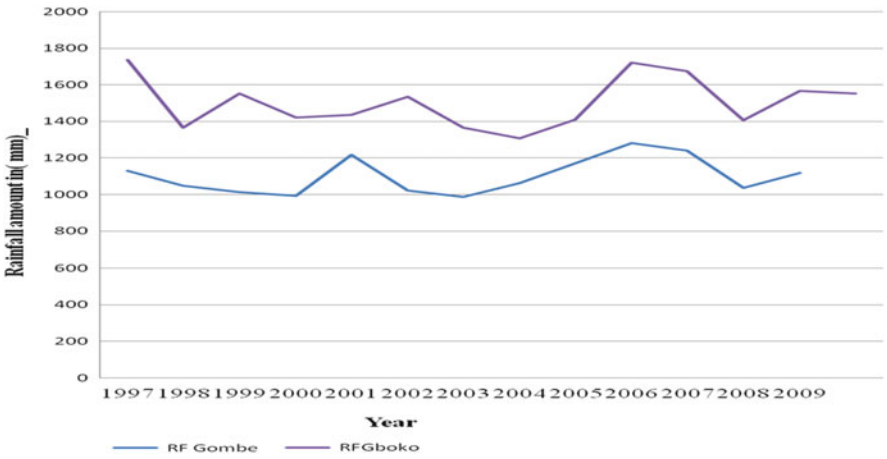

Fig. 6.2 Rainfall distribution pattern in Gombe and Gboko (Nigeria). *Source*: Stackhouse (2010)

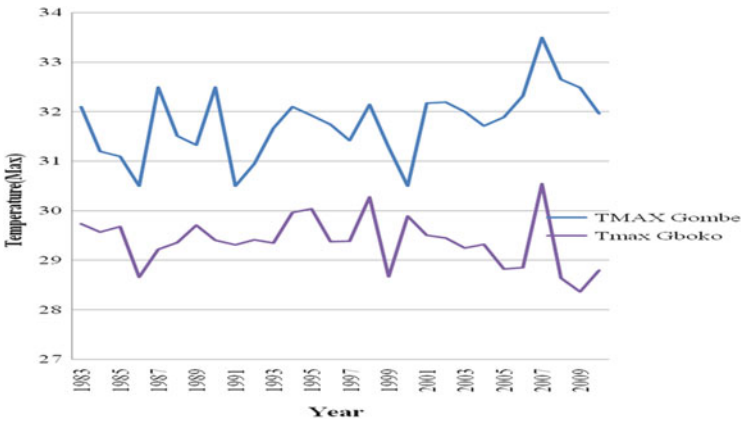

Fig. 6.3 Temperature distribution pattern in Gombe and Gboko (Nigeria). *Source*: Stackhouse (2010)

increasingly aware of climate change which could make them to be vulnerable (Fig. 6.3).

Perceived Effect of Climate Change on Citrus and Tomato Farmers' Production

The summary of the response on the perceived effect of climate change on selected horticultural crops production is as shown on Table 6.3. The mean of total response was 3.3, therefore statements with mean score below 3.3 were considered to be of

Table 6.3 Frequency distributions of respondents according to their perceived effect of climate change

	Perception Statement	SD	D	UD	A	SA	Mean
1.	Irregular rainfall increases the prevalence of pest infestation on Citrus crops	7.4	2.6	1.1	25.5	63.5	4.4
2.	Irregular rainfall reduces disease infection on fruits and vegetables	20.7	18.1	5.9	35.4	19.9	3.2
3.	Drought results in early droppings of fruits of horticultural crops	4.8	6.6	8.5	30.3	49.8	4.1
4.	Harmattan causes plants to flourish	11.4	21.4	13.3	34.3	19.6	3.3
5.	Curling of leaves is a sign of climatic variability	4.4	4.8	7.0	45.0	38.7	4.1
6.	Increased temperature means climate has changed and thus leads to high yield of horticultural crops	38.4	18.8	13.7	18.5	10.7	2.4
7	Dropping of flowers which prevents further fruiting is an indicator of climatic change	17.0	8.9	12.5	24.0	37.6	3.6
8.	Weather has become hotter and drier resulting in yield increment	7.7	13.3	18.5	31.7	28.8	3.6
9.	Change in frequency of droughts has led to improve yield	11.4	14.4	18.8	28.8	26.6	3.4
10.	Incidence of flood leads to opportunities for growers	16.6	15.1	4.1	34.7	29.5	3.5
11.	Irregular temperature is an indication that climate has changed thus reduction in yield	7.7	5.9	10.0	27.3	49.1	4.0
12.	Longer dry season increases weed infestation	21.8	30.3	12.9	22.1	12.9	2.7
13.	Flooding is a threats to growers	11.1	7.7	7.4	23.2	50.6	3.9
14.	Less clearly defined seasons helps horticultural farmers to increase their rate production	20.7	25. 5	12.9	23.2	17.7	2.9
15.	Flooding generally encourage rapid horticultural production	19.6	14.0	8.9	32.1	25.5	3.3
16.	Cost associated with damaging weather events increases cost of production	14.0	21.4	20.7	28.0	15.9	3.1
17.	Change in timing of rains can affect production negatively	12.5	11.8	10.7	29.2	35.8	3.6
18.	High humidity reduces the quality of horticultural crops	16.6	28.0	16.6	15.9	22.9	3.0
19.	Taste and nutritional value of fruits and vegetables can be better off as a result of run-off	25.8	13.7	19.9	27.3	13.3	2.9
20.	Delayed rainfall alters production pattern of horticultural crops	9.6	15.5	14.0	25.8	35.1	3.6

negative effect while statements with mean and above were considered to be of positive effect. Respondents positively perceived that irregular rainfall increases the prevalence of pest infestation on Citrus crops ($\overline{x} = 4.4$). Also, drought results in early droppings of fruits of horticultural crops ($\overline{x} = 4.1$) and dropping of flowers which prevents further fruiting is an indicator of climatic change ($\overline{x} = 3.6$). Delayed

Table 6.4 Frequency distribution of perceived effect category of respondents

Perceived effect category	Frequency	Percentage
Negative perceived effect	130	48.0
Positive perceived effect	141	52.0
Total	271	100.0

rainfall alters production pattern of horticultural crops ($\bar{x} = 3.68$) and dry season (FADAMA) vegetable farming is encouraged as a result of drier season ($\bar{x} = 4.0$).

Perceived Effect Categories of Respondents in the Study Area

The result (Table 6.4) shows that 48.0 % of respondents were unfavourably disposed to the effect of climate change on production in the study area while 52.0 % were favourably disposed to the effect of climate change on production. This implies a positive impact on their production, indicating that climate change leads to low yield of the crops in question. In a related study carried out by Marhjan et al. (2011) in Nepal they found out that flooding at the time of harvesting swept out the consumable agricultural produces impacting huge agricultural loss. In the same vein there was a general agreement by the respondents on increase in temperature, drastic change in weather, and generally reduction in yield in a study on farmer's perception of the effects of climate change and coping strategies in the three ecological zones of Nigeria (Tologbonse et al. 2010).

Adaptation Strategies Used by Respondents

The result shows (Table 6.5) that considering farmers adaptation strategies to climate change under **Crop management**, (56.5)% of farmers always used altering input such as varietal/species followed by use of different planting days (48.7 %). Adaptation under **Soil fertility management** results shows that respondents always used barrier hedges along contour to the soil erosion 59.4 %, followed by soil protection through tree planting 53.5 %. In **water management technique used** respondents always use the adaptation strategies as follows: managing water to prevent water logging erosion and run off (51.3 %), wider use of technologies to harvest water (41.0 %). Adaptation under **insect and pest management** include: wider use of integrated pest and pathogen management, (46.9 %) and planting pest and diseases resistant varieties (34.7 %). **Diversification** as an adaptation strategy in the study reveals diversifying income through altering integration with other farming activities (61.1 %) as well as moving to different site (52.0 %). The result implies that farmers have been using one form of adaptation strategy or the other though at a minimal rate and this depends on location. During the FGD, discussants in *North-central stated that they alter planting dates and build barriers along*

Table 6.5 Frequency distribution of respondents' adaptation strategies to climate change

	Use		Frequency of use		
Adaptation strategies	Yes	No	Rarely	Occasionally	Always
Crop management					
Altering inputs such as varieties/species	56.5	43.5	8.5	20.3	27.7
Monitoring or improving quarantine capabilities	35.1	64.9	3.0	9.2	22.9
Use of varieties and species resistant to pest and diseases	41.7	58.3	4.4	17.0	20.3
Altering the timing or location of cropping activities	55.0	45.0	5.5	21.4	18.1
Different planting dates	48.7	51.3	7.0	17.0	24.7
Shorten length of growing period	33.9	66.1	5.9	18.1	10.0
Crop relocation	43.9	56.1	10.7	20.7	12.5
Planting drought resistant varieties	38.0	62.0	9.2	15.1	13.7
Soil fertility management					
Barriers hedges along contours to the soil erosion	59.4	40.6	8.4	25.5	25.5
Change amount of land	26.9	73.1	4.8	14.4	7.7
Soil protection through tree planting	53.5	46.5	10.3	21.0	22.1
Soil conservation	39.9	60.1	8.9	16.6	14.4
Water management					
Expansion of rainwater harvesting	32.5	67.5	4.4	11.4	16.6
Water storage and conservation technique	33.6	66.4	4.4	14.4	14.8
Water re-use	29.2	70.8	8.1	10.0	11.1
Desalination	25.8	74.2	10.0	6.3	9.5
Wider use of technologies to harvest water, conserve soil moisture	41.0	59.0	4.1	11.1	25.8
Managing water to prevent water logging, erosion and run-off	51.3	48.7	3.3	22.1	25.8
Increase irrigation	43.5	56.5	7.0	17.3	19.2
Planting flood resistant varieties	36.3	63.5	7.0	19.2	10.3
Increase water conservation	42.4	57.6	8.5	19.9	14.0
Pest and Insect management					
Planting pest and diseases resistant varieties	34.7	65.3	5.9	11.8	17.0
Wider use of integrated pest and pathogen management, development	46.9	53.1	12.2	16.6	18.1
Diversification					
Move to different site	52.0	48.0	13.7	22.1	16.2
Changes from crops to livestock	38.7	61.3	9.2	17.7	11.8
Farming to non-farming	33.6	66.4	4.4	14.0	15.1
Diversifying income through altering integration with other farming activities	61.6	38.4	7.0	18.5	36.2

(continued)

Table 6.5 (continued)

Adaptation strategies	Use		Frequency of use		
	Yes	No	Rarely	Occasionally	Always
Others					
Prayer	65.7	34.3	8.5	11.4	45.8
Change use of chemicals, fertilizers and pesticides	50.9	49.1	4.4	23.6	22.9
Use of weather insurance	29.5	70.5	4.1	15.9	9.6

Table 6.6 Frequency distribution of categorization of adaptation strategies

Adaptation categories	Frequency	Percentage
High adaptation (mean and above)	116	42.8
Low adaptation (Below the mean)	155	57.2
Total	271	100

SD = 16.6, Max = 71.0, Mean = 31.023, Min = 0.00

contour, while those in the North-east maintain the use of irrigation. Findings of Ayanwuyi et al. (2011) on farmers' perception of impact of climate change on food crop production corroborated this finding which indicated that increased water conservation, planting of different crops and change row orientation are common adaptation strategies employed by farmers.

Categorization of Respondents According to Adaptation Strategies

The study went further to compute adaptation scores for the area under study; findings revealed that 57.2 % of respondents in the study area have low adaptation strategy score while 42.8 % (Table 6.6) have high adaptation strategy score. It therefore implies that generally farmers have low adaptation strategies. This is in line with Salau et al. (2012), in his study who stated that farmers have low adaptive capacity to climate change.

Result of Binomial Logit Regression Showing Factors that Affect Respondents' Choice of Adaptation Strategies

The result in Table 6.7 reveals that soil fertility negatively and significantly ($t = -3.790$; $p = 0.002$) influenced respondents choice of adaptation; implying that the fertile the soil, the less the choice of adaptation strategies being used. The table also reveals that finance at the same time significantly ($t = 2.610$;

Table 6.7 Binomial logit regression showing factors that affect respondents' choice of adaptation strategies

Factors	Coefficient (β)	t value	p value	Decision
Tenure right	0.373	1.540	0.124	Not significant
Household size	0.108	0.432	0.666	Not significant
Soil fertility	−1.161	−3.790	0.002	Significant
Off farm activities	−0.127	−0.529	0.597	Not significant
Access to inputs	1.385	4.836	0.000	Significant
Access to fertiliser	0.169	0.635	0.525	Not significant
Wealth	0.615	2.610	0.009	Significant
Access to extension	0.411	1.805	0.071	Not significant
Access to credit	0.100	0.426	0.670	Not significant

Table 6.8 T-test difference in the adaptation strategies between the North-east and North-central zones of Nigeria

Adaptation strategies	F-value	t-value	df	Mean difference	P-value	Decision
Assumed	0.795	24.106	270	27.974	0.000	Significant
						Level of sig 0.05

$p = 0.009$) influenced respondents choice of adaptation strategies; implying that finance is a major factor that affect farmers' choice of adaptation strategies. Finally, the table shows that access to inputs significantly influenced ($t = 4.836$; $p = 0.000$) farmers' choice of adaptation strategies; implying that the more access to inputs the more the choice of adaptation strategies used by respondents. This is an indication that level of soil fertility, farmers' financial capacity and access to inputs greatly determine their choice of adaptation strategy.

Hypotheses Testing 1

Adaptation Strategies Between the North-East and North-Central Zones of Nigeria

The result shows (Table 6.8) a significant difference in the adaptation strategies in the two zones under study ($P = 0.000$, $t = -24.106$). This result implies that in the two zones considered in this study the rate at which both zones make use of adaptation strategies is quite different, which may be as a result of the difference in time at which they started noticing change in climate or as a result of the differences in the intensity of change and impact.

Table 6.9 T-test difference in the perceived effect strategies between the North-east and North-central zones of Nigeria

Perceived effect	F-value	t-value	df	Mean difference	P-value	Decision
Assumed	0.177	182.269	270	134.5978	0.004	Significant
						Level of sig 0.05

Hypotheses 2

Perceived Effect Strategies Between the North-East and North-Central Zones of Nigeria

The result (Table 6.9) shows a significant difference in the perceived effect of citrus and tomato farmers about climate change in the two zones under study ($P = 0.004$, $t = -182.269$). The implication of this is that in the two zones under study, farmers perceived the effect of climate change on the production of tomato and citrus differently, this may still be due to the period they started noticing change in climate.

Conclusions

Arising from the study, respondents are aware of change in climate parameters such as rainfall, temperature and wind. The adaptation strategies of respondents to climate change are still a little above average despite their high level of awareness and knowledge. The adaptation strategies across the North central and North-east are significantly different. It suffices therefore that, any type of adaptation strategy introduced is likely to be adopted to improve on their present form of adaptation strategies.

In the same vein, the perceived effect of climate change on production across the zones are also different, while it was found out that farmers had favourable perception to the effect of climate change, in this wise climate change has a lot of negative impact on their production. Finally adaptation choice by farmers is mainly determined by soil fertility, wealth and input availability.

Recommendations

The following recommendations are put forward based on the findings of this study for the development of horticulture industry in Nigeria.

- Bulletins on awareness creation on climate change, preferably in local languages should be made available to farmers so as to further create more awareness.

- Varieties of horticultural crops that are resistant to drought and certain pests and diseases that are as a result of climate change can be introduced to farmers in the study area by the research Institute.
- Several projects like shelter belt project, afforestation projects climate change programmes should be funded by the government of each zones and states.
- Efforts on mitigation and adaptation strategies should be based on religious and gender bias. In this wise farmer should be made to realize that though God is all in all, but they are responsible and at the same time liable to some of the actions they partake in for example when they cut trees and refuse to re-plant. It is therefore pertinent to introduce mitigating and adaptation strategies that will safe guard livelihood of the respondents and salvage them from poverty and other problems like harsh or extreme weather conditions on agricultural produce particularly tomatoes and other horticultural crops that are classified as crops that are highly sensitive to weather conditions. The resultant effect was described as low quality and poor quantity of the produce which make them to attract low market price.

References

Aaditya S (2011) Climate change, developing country, development, family planning fertility, overpopulation, population growth, poverty, women. 12 August 2011. Posted in Wikinut > News > Environment. http://nut.bz/1u3rs_iy/. Downloaded Sept 2011

Adejuwon SA (2004) Impacts of climate variability and climate change on crop yield in Nigeria. Being the lead paper presented at the stakeholders' workshop on assessment of impacts and adaptation to climate change (AIACC), Conference Centres Obafemi Awolowo University, Ile-Ife, 20–21 September, p 14

Ati OF, Iguisi OE (2007) Recent trends in the duration of rainy season in some station north of latitude 9^{0N} of Nigeria. Paper presented at the 49th annual conference of the association of Nigerian geographers held at University of Abuja, Abuja—Nigeria, 16–18 October 2007

Ayanwuyi E, Kuponiyi F, Ogunlade A, Oyetoro JO (2011) Farmers' perception of impact of climate change on food crop production in Ogbomosho Agricultural zone of Oyo state Nigeria. Glob J Hum Soc Sci 10(7):34–39

LEISA Magazine (2008) Living soils desertification. Posted on September 23, 2008, LEISA Magazine 24:2. wordpress.com/2008/09/23/leisa-magazine

Maharjan K, Sigdel ER, Sthapit BR, Regmi BR (2011) Tharu community's perception on climate changes and their adaptive initiations to withstand its impacts. West Terai Nepal Int NGO J 6(2):035–042

northernnigeriatourism (2009) REF—Northern Nigeria tourism and trade copyright @2009 NNT. www.northernnigeriatourism.com/nnt/about-northern-nigeria.html. Retrieved 22 Jan 2015

Nyelong PN (2004) Global warming and global waters. J Energy Environ 17(1):79–90

Odjugo PAO (2009) Shift in crop production as a means of adaptation to climate change in semi-arid region of Nigeria. Paper presented at the international conference of Nigeria meteorological society, Osun State University, 6–11 December 2009, p 211

Oladeji JO (2011) Farmers' perception of agricultural advertisements in Nigerian newspapers in Ibadan municipality, Oyo State. Niger J Media Commun Stud 3(3):97–101

Oyedele OO (2005) Information and training needs for improved technique of citrus production among farmers in Southwestern Nigeria. An unpublished PhD Thesis submitted to the department of Agricultural Extension and Rural Development University of Ibadan, p 211

Oyekale AS, Bolaji MB, Olowa OW (2009) The effect of climate change on cocoa production and vulnerability assessment in Nigeria. Medwell Agric J 4(2):77–85

Salau ES, Onuk EG, Ibrahim A (2012) Knowledge, perception and adaptation strategies to climate change among farmers in Southern Agricultural Zone in Nasarawa State. Niger J Agric Ext 16 (2):199

Salimonu KK (2007) Attitude to risk in resource allocation among food crop farmers in Osun State, Nigeria. PhD Thesis submitted to Agricultural Economics Department, University of Ibadan, Ibadan

Spencer DSC (1990) Research priorities for sustainable agriculture in sub-Saharan African. In: Lawani SM, Odemwingie TE (eds) Communication for sustainable agriculture. IITA, Ibadan

Stackhouse PW (2010) NASA climatology resource for agro climatology daily average data (evaluation version). National Aeronautics and space. Administration available at http://power.larc.nasa.gov

Tologbonse EB, Auta SJ, Bidoli TD, Jaliya MM, Onu RO (2010) Farmers perception of the effects of climate change and coping strategies in three agro-ecological zones of Nigeria. Paper presented at the agricultural extension society of Nigeria annual conference held in Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria, between 10 and 14 May, 2010

Yekinni OT (2010) Determinants of utilization of information of information communication technologies for agricultural extension delivery in Nigeria. A PhD Thesis submitted to Agricultural Extension and Rural Development Department, University of Ibadan, Ibadan, p 226