



## Factor Path of Constraints to Adaptive Capacity on Climate Change among IFAD-VCDP Farmers in North Central Nigeria

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### Authors' contributions

This work was carried out in collaboration among all authors. Author JNN designed the study. Author HS performed the statistical analysis and wrote the first draft of the manuscript. Authors AAC and USM managed the literature searches and edited the manuscript. All authors read and approved the final manuscript.

### Article Information

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### ABSTRACT

**Aim:** Adaptive capacity is the ability of the farmer to adjust his farm plans and programmes in the face of emerging risks, constraints and currently available information. In this study, the various constraints faced by International Fund for Agricultural Development-Value Chain Development Programme's farmers (IFAD-VCDP) in North Central Nigeria in adapting to climate change challenges were investigated.

**Study Design:** A multi-stage sampling technique was employed in the selection of respondents.

**Place and Duration of Study:** The study was conducted in Benue and Niger States of Nigeria in 2018.

**Methodology:** Data were collected from a total of 483 respondents using interview schedule and questionnaire. The data were analysed using exploratory (principal component analysis) and confirmatory (structural equation modelling) factor analysis.

**Results:** The results of the analysis revealed the significant constraints the farmers faced in order to improve their adaptive capacity to climate change which were institutional and technical

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(49.45%) and climate information (26.62%) constraints, although the factors differ slightly within the two states under study. In Benue State, institutional (31.26%), personal (14.63%), land and farm inputs (12.54%) and population (11.73%) while in Niger State, public and institutional (22.34%), land and farm inputs (14.78%), and personal (10.75) were the constraints to adaptive capacity.

**Conclusion:** These constraints make it harder to plan and implement adaptation actions by restricting the variety and effectiveness of options available to the farmers to improve their productivity and cope with the vagaries of climate change. It was therefore recommended that government and NGOs should intensify efforts on public, institutional, educational and climate policies, assist in increasing the adaptive capacity of the farmers in order to employ more adaptation measures, land governance systems should be strengthened in Nigeria to provide tenure security for all, financial institutions should help facilitate access to credit by farmers and assist in making reliable climate information accessible to all farmers.

*Keywords: Climate change; constraints; adaptive capacity; IFAD-VCDP; exploratory and confirmatory factor analysis; North Central Nigeria.*

## 1. INTRODUCTION

Adaptive capacity is the ability of the farmer to adjust his farm plans and programmes in the face of emerging risks, constraints and currently available information. The effects of climate change on human and the environment are so vital that it can hardly be ignored. Africa is one of the most vulnerable continents to environment and climate change because of multiple stress and low adaptive capacity [1]. According to Klein et al. [2] adaptive capacity is affected by actors' capacities to gain accessible open opportunities that facilitate the arranging and usage of adaptation just as imperatives that make adaptation forms increasingly hard for both human and natural systems. Constraints are unevenly disseminated among global regions, communities and species just as crosswise over various timespans. Improving the consciousness of individuals, associations and institutions about climate change vulnerability, effects and adjustment can help build individual and institutional capacity with respect to adaptation planning and implementation.

An adaptation constraint represents a factor or procedure that makes adaptation planning and execution progressively troublesome. This could incorporate decreases in the scope of adaptation alternatives that can be actualized, increments in the expenses of implementation or diminished viability of those choices with respect to accomplishing adaptation targets. The presence of a constraint alone does not imply that adaptation is unimaginable or that one's goals cannot be accomplished. Actors have different capacities to adapt to climate variability and change [3]. Literature on adaptive capacity advanced along two unique pathways. One

spotlights on the scope of chances that exist to encourage adaptation planning and execution. The other, which is likewise progressively broad, centres around portraying the constraints that restrain adaptation. Despite the fact that they are sometime treated in the literature as distinct, opportunities and requirements are corresponding in that adaptive capacity is affected mutually by the degree to which actors exploit accessible chances to seek after adaptation reactions and the degree to which the individuals, unmanaged systems experience limitations [4].

In the view of [5,6], there are significant knowledge gaps and obstructions to streams of information that can compel adaptation. Adaptation professionals and stakeholders in both developed and developing countries keep on recognizing knowledge deficits as an adaptation constraint. Regularly this interest for more information is connected to concerns with respect to decision making under uncertainty about the future [7]. As indicated by [8] population growth and economic development can prompt more noteworthy asset utilization and biological debasement which can compel adaptation in areas where livelihoods are firmly connected to environment merchandise and ventures.

Timely and requisite information is important to take adaptive measures for relieving the hazard caused by climate change and take advantage of it. The dispersal of climate information like precipitation conditions, credit information, improved varieties and the board practices will assume a significant role in adapting various strategies to change. Regardless of the smallholders' craving to set up useful shields

against the conceivably unfavourable effects of climate variability and change, a number of challenges stand in their way. These obstacles incorporate those exuding from both the downstream and upstream levels [9]. With an improved access to education, one is probably going to obtain more abilities helpful in unravelling life-related difficulties, both at individual and societal levels, thus widening their social and technical capital [10]. Furthermore, expanding more skills is probably going to empower individuals to access different livelihood streams. This at that point empowers them to assemble a more grounded financial and technical capital, resulting in lowering socioeconomic constraints related to their undertakings [11].

The Value Chain Development Programme (VCDP) is a six years development initiative of the Federal Government of Nigeria (FGN) and International Fund for Agricultural Development (IFAD) programme that focuses on supporting cassava and rice value chains for small farmers in the six states of Anambra, Benue, Ebonyi, Niger, Ogun and Taraba. Within each state, the programme is being implemented in five (5) Local Government Areas (LGAs) selected on the basis of objective criteria. VCDP is well anchored in Nigeria government's vision for agricultural transformation through commodity value chain approach, with emphasis on enhancing productivity and access to markets for rice and cassava smallholder farmers [12].

Various studies by [13,14,15] had identified Africa as one of the most exposed continents to suffer the devastating effects of climate change because of inadequate adaptive capacity. The enhancement of adaptive capacity is an effective means of facilitating adaptation to climate change and variability especially for vulnerable groups such as small-scale farmers in developing countries. Effective adaptation requires not only identifying adaptation alternatives but also constraints to adaptive capacity so as to explore available mechanisms for increasing the adaptive capacity of the farmers to climate change. According to the Forth Assessment Report, there are impressive ecological, financial, informational, social, attitudinal and conduct barriers to the usage of adaptation and availability of assets and building adaptive capacity are especially significant [16]. This study seeks to identify the constraints to adaptive capacity of the farmers in the light of the foregoing.

Adaptive capacity constraints are factors that make it harder to plan and implement adaptation actions. Adaptive capacity constraints restrict the variety and effectiveness of options for actors to secure their existing objectives, or for a natural system to change in ways that maintain productivity or functioning. Adaptive capacity constraints confine the assortment and adequacy of alternatives for actors to verify their current goals, or for a natural system to change in manners that keep up profitability or functioning. Adaptive capacity at the level of the individual farm has been identified as critical for successful climate change adaptation [17]. This is because farmers are not responding sufficiently to recent climate changes [18]. Adaptive capacity is not a static attribute of the system [19], it can be improved over time, which makes it an important factor to be examined and discussed from both a research and a policy point of view. It is therefore important to account for the constraints to adaptive capacity in order to avoid incorrect assumptions about adaptation options available to the farmer. However, there is need to consider the constraints adaptive capacity in order to obtain a realistic picture of adaptation. The aim of this study is to investigate the constraints to adaptive capacity on climate change among IFAD-VCDP farmers in North Central Nigeria. The objectives are to utilise Principal Component Analysis (PCA) to retrieve the inherent factors in the constraints faced by the farmers in the study area, estimate the relationship within and between the retrieved factors using parallel factoring and regressions, and then established the inter-relationship between them using PATH diagram.

## **1.1 Theoretical Frame Work on Adaptation**

Climate change adaptation researchers traced their methodologies from agricultural technology adaptation because of the methodological similarities [20]. Agricultural technology adoption models are based on farmers' utility or profit maximizing behaviours. The assumption here is that farmers adopt a new technology only when the perceived utility or profit from using this new technology is significantly greater than the traditional or the old method. However, their capacity also constrained them to adopt new technologies. Maddison [21] noted that African farmers have been constrained by different factors to adopt climate change adaptation strategies. Adaptive capacity to climate change is the ability of a system or an individual to adjust to

climate change or climate variability so as to minimize the potential damages or cope with the consequences [22]. Therefore, adaptive capacity is the ability to plan and use adaptation measures to moderate the effect of climate change. Adaptive capacity varies from farmer to farmer based on certain factors that are peculiar to each farmer. It is assumed that farmers are rational and as such they adapt to climate change in order to reduce its consequences. Some farmers have higher ability to adjust to climate change than others. Measuring adaptive capacity is difficult, since adaptive capacity is essentially measuring the potential to respond to changes in climate or climate related disasters [23].

It was pointed by Deressa et al. [24] out that decision of farmers who perceived climate change to adopt or not to adopt a particular adaptation strategy depends on the utility associated with each decision. Therefore, adaptation strategy falls under theory of utility maximization. The decision of farmers to adopt or not to adopt any particular adaptation strategy (technology) to reduce the effects of climate change on agricultural production is characterized by certain socioeconomic factors, farm characteristics, changes in climatic factors. A farmer chooses an adaptation method by considering the weighted expected utility that he or she will derive from adopting that strategy. A farmer uses an adaptation strategy j if and only if he or she perceives that the utility or net benefit from using that adaptation strategy is significantly greater than the situation of not using it. The utility associated with such decisions are not directly observed. Meanwhile, the choices of adaptation measures of farmers are observed. The choices of farmers are unordered and hence their decisions on adaptation strategies are linked to random utility maximization. Assume that  $U_j$  is the expected utility that a farmer will gain from using adaptation strategy j whereas  $U_k$  is the expected utility for not choosing adaptation strategy j but rather k. The linear random utility model of adapting to climate change by choosing  $j^{th}$  adaptation strategy ( $U_j$ ) can be expressed as a function of explanatory variables  $X_i$  as shown below.

$$U_{ij} = \chi_i \beta'_j + \mu_j \quad (1)$$

Also, the linear random utility model for  $i^{th}$  farmer who does not use  $j^{th}$  adaptation strategy but rather  $k^{th}$  adaptation strategy is given by:

$$U_{ik} = \chi_i \beta'_k + \mu_k \quad (2)$$

Where  $\chi_i$  is a vector of explanatory variables (socioeconomic factors, farm characteristics, perception of farmers on changes in climatic factors),  $\beta'_j$  and  $\beta'_k$  are vectors of parameters for choosing  $j^{th}$  and  $k^{th}$  adaptation strategy respectively. Also,  $\mu_j$  and  $\mu_k$  are error terms for choosing  $j^{th}$  and  $k^{th}$  adaptation strategy respectively. The error terms in the above equations are assumed to be normally independently and identically distributed [25]. Following the commonly used adaptation strategies identified in the studies conducted by [26,27], and the preliminary survey by the researchers, the adaptation strategies mostly considered are changing crop varieties, changing planting dates, planting of trees, destocking, increase farm size, application of fertilizer, farming on fallowed land, diversification, mulching, changing farming practices, purchase of insurance, early warning systems, and incentives for relocation. If a farmer chooses to adopt  $j^{th}$  adaptation strategy to climate change, then the expected utility that the farmer gets is greater than the expected utility for not using that strategy. According to [28], a farmer chooses adaptation strategy j over adaptation strategy k if and only if the expected utility from adaptation strategy j is greater than that of k.

$$E(U_{\text{adopting } j^{\text{th}} \text{ strategy}}) > E(U_{\text{adopting } k^{\text{th}} \text{ strategy}}) \quad (3)$$

The actual inequality is expressed as:

$$U_{ij}(\chi_i \beta'_j + \mu_j) > U_{ik}(\chi_i \beta'_k + \mu_k) \quad (4)$$

Where  $j \neq k$ .

The CFA utilized in this research is Structural Equation Modelling (SEM), which is a state of art methodology and fulfills much of broader inference and causal analysis. SEM are models consisting of a combination of multivariate analysis, factor analysis and regression analysis, used to validate or reject one or more hypothesis about an existing relation between different variables. It estimates simultaneously dependency relations between variables (observed or latent) and estimate measurement error in model's variables. Holzinger and Swineford [29] proposed one of the most famous CFA models. In the model estimates,  $x_i, x_i$  are exogenous variables that record scores and  $y_i, y_i$  are latent (and endogenous) variables respectively, double-headed arrows represent an association between  $y_1 y_1, y_2 y_2,$  and  $y_3 y_3,$  single-

headed arrows represent direct effects, and  $\varepsilon_i$  represent error terms. It estimates *factor loading*, which is a measurable effect reflecting the incidence of an observed variable over another either observed or latent variable. Interpreting factor loadings is equivalent to interpreting direct effects in a linear econometric model. According to [30,31] CFA becomes a causal model if all latent variables are defined by observed variables.

## 2. MATERIALS AND METHODS

### 2.1 Study Area and Sampling

The IFAD-VCDP is currently being implemented in six states of Nigeria, viz Anambra, Benue, Ebonyi, Niger, Ogun, Taraba. This study was conducted in Niger and Benue States which are the participating states in North Central Nigeria (Fig. 1). Niger State is located between latitudes  $8^{\circ} 20'$  and  $11^{\circ} 30'$  North and longitudes  $3^{\circ} 30'$  and  $7^{\circ} 20'$  East. The state covers a total land area of 76,266,779 km<sup>2</sup> or about 8.3 million hectares which represent 8% of the total land area of Nigeria. About 85% of the land is arable and the vegetation consists mainly of short and scattered trees. The state experiences distinct dry and wet seasons with annual rainfall varying from 1,100 mm in the northern part to 1,600 mm in the southern parts. The temperature ranges from 23°C to 37°C and daylight duration is averagely 8.5 hours and it has a relative humidity of 40% [32]. The 2018 projected population based on the 2006 census at 2.5% growth is 5,312,642. The state has 25 Local Government Areas (LGAs) grouped into three agricultural Zones i.e. I, II and III, each having 8, 9 and 8 LGAs respectively. There are three major ethnic groups in the state, *Nupe*, *Gbagyi*, and *Hausa*. Other tribes are *Kadara*, *Koro*, *Dibo*, *Kambari*, *Kakanda*, *Dukkawa*, *Dakarkari*, *Gana-Gana*, *Kamuku*. The major economic activity is agriculture (farming, fishing and livestock rearing).

Benue state on the other hand is located between latitudes  $6^{\circ}25'$  and  $8^{\circ} 8'$  North and longitudes  $7^{\circ}47'$  and  $10^{\circ} 0'$  East, with total landmass of 34,059 km<sup>2</sup> with estimated population of 5,707,674 based on the 2006 census with growth rate of 2.8%. The State experiences two distinct seasons, the wet season and the dry season. The rainy season lasts from April to October with annual rainfall in the range of 1500-1800 mm and average

precipitation of 1500 mm. The dry season begins in November and ends in March. Temperatures fluctuate between 21°C to 37°C in a year, with mean temperature of 28°C. Benue State has of 23 LGAs divided into three Agricultural Development Project zones. It is inhabited predominantly by the *Tiv* and *Idoma* people. Other ethnic groups include *Igede*, *Etulo*, *Abakwa*, *Jukun*, *Hausa*, *Igbo*, *Akweya*, and *Nyifon*. Benue State has abundant human and material resources, most of the people in the State are farmers while inhabitants of the riverine areas engage in fishing as their primary or secondary occupations [33].

Multi-stage sampling technique was employed in sampling the location and the collection of primary data for this study. In the first stage, the two (2) participating States in North Central Nigeria under IFAD – VCDP that is, Niger and Benue States were selected purposively based on their participation in the IFAD-VCDP. In the second stage, all the five (5) participating Local Government Areas (LGAs) in each State were selected, given a total of ten (10) LGAs. In the third stage, sampling of farm households in each community was determined proportionately using [34] formula and adopted by [35]. The formula is presented in eqn. (5)

$$S = \frac{\chi^2 NP(1-P)}{d^2(N-1) + \chi^2 P(1-P)} \quad (5)$$

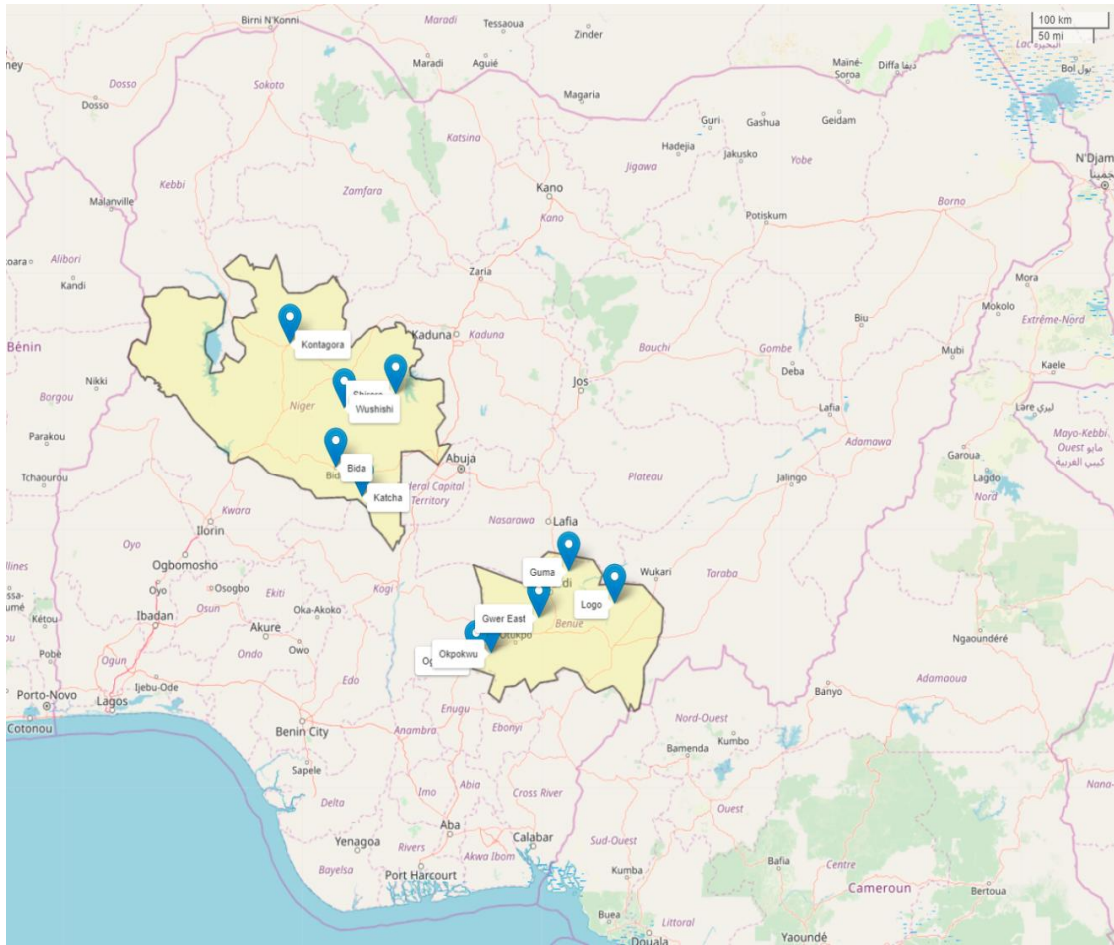
Where:

S = The required sample size,  
 $\chi^2$  = Table value of chi-square for 1 degree of freedom at the desired confidence level (1.96),  
 N = Population size,  
 P = Population proportion (assumed to be 0.80),  
 $d^2$  = Degree of accuracy squared expressed as a proportion (0.05) and  
 1= Constant.

A total of 500 questionnaires were distributed, however only 483 were completed and returned. As such the data analysis was based on 483 respondents fully interviewed. Data for this study were collected using interview schedules with the aid of trained enumerators.

### 2.2 Data Analysis

The data were analysed using exploratory (EFA) and confirmatory (CFA) factor analysis. Factor analysis is a data reduction technique used to reduce a large number of variables to a smaller



**Fig. 1. Map of Nigeria showing the study areas**

set of underlying factors that summarize the essential information contained in the variables. The EFA utilised in this study is the Principal Component Analysis (PCA). PCA was used to group the constraints with the aid of principal factor method with varimax orthogonal rotation method developed by Kaiser [36]. The factor solution should explain at least half of each original variable's variance, so the communality value for each variable should be 0.30 or higher. The criterion of eigen value or characteristic root (Eigen value) greater than 1.0 was used for defining the number of the factors that were retained [37]. Model acceptance was based on three criteria: each variable, in order to be included in the variable cluster of a factor, must load to it more than 0.4, each factor must have more than two variables and variables that load in more than one constraint were discarded following [38,39]. The model is presented in eqn. (6):

$$\begin{aligned}
 Y_1 &= a_{11}X_1 + a_{12}X_2 + \dots + a_{1n}X_n \\
 Y_2 &= a_{21}X_1 + a_{22}X_2 + \dots + a_{2n}X_n \\
 Y_3 &= a_{31}X_1 + a_{32}X_2 + \dots + a_{3n}X_n
 \end{aligned}
 \tag{6}$$

$$\begin{aligned}
 & * & * \\
 & * & * \\
 Y_n &= a_{n1}X_1 + a_{n2}X_2 + \dots + a_{nm}X_n
 \end{aligned}$$

Where:

- $Y_1, Y_2, \dots, Y_n$  = Observed variables/ constraints to adaptive capacity;
- $a_1 - a_n$  = Constraint loading or correlation coefficients;
- $X_1, X_2, \dots, X_n$  = Unobserved underlying factors constraining the farmers to improve their adaptive capacity.

The model for CFA is of the form given in eq. (7)

Definition of latent variable

$$\begin{aligned}
 F1 &\sim x1 + x2 + x3 \\
 F2 &\sim y1 + a*y2 + b*y3 + c*y4 \\
 F3 &\sim y5 + a*y6 + b*y7 + c*y8 \\
 &\dots \\
 FK &\sim y_{i+k} + a*y_{i+k} + b*y_{i+k} + c*y_{i+k}
 \end{aligned}
 \tag{7}$$

The regressions

$$\begin{aligned}
 F1 &\sim F2 \\
 F2 &\sim F4 + F9 \\
 F5 &\sim F6 + F7 \\
 &\dots
 \end{aligned}
 \tag{8}$$

Residual correlations

$$\begin{aligned}
 y1 &\sim y5 \\
 y2 &\sim y4 + y6 \\
 y3 &\sim y7 \\
 y4 &\sim y8 \\
 y6 &\sim y8
 \end{aligned}
 \tag{9}$$

To judge the sampling adequacy and the factorability of the matrix as a whole, Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) were used. Bartlett's test of sphericity relates to the significance of the study and therefore shows the validity and suitability of the responses collected. If the KMO is greater than 0.8 (meritorious) then factorability is assumed. High values Kaiser-Meyer-Olkin (KMO) between 0.8 and 1.0 indicate factor analysis is appropriate [40].

**Factor extraction:** The communality which is the percentage of variance for the variable that is explained by the common factors for all the variables were above 0.30.

**Factor rotation and interpretation:** To make the structural factor more interpretable, the factors were rotated. For this study, varimax rotation was chosen in order to create more interpretable clusters of factors. The reason for this, is that varimax rotation attempts to maximize the distance between the factors orthogonally. Also, varimax is good for simple factor analysis since it is known to be a good general approach that simplifies the interpretation of factors.

The estimations and all the analysis were carried out in RStats [41] using lavaan [42], semPlot [43] and semTools [44] packages.

### 3. RESULTS AND DISCUSSION

Several well-recognized criteria for factor analysis were employed. The factor analysis in

this study consists of five parts. Firstly, the sample adequacy and factorability of the matrix as a whole was examined. Secondly, factors were extracted and presented. Thirdly, factors were rotated in order to see if any variables should not be included in the intended constructs. Fourthly, the reliability of the chosen constructs was tested using Cronbach's alpha test. In the end, a confirmatory analysis was conducted to validate the chosen constructs.

#### 3.1 Sample Adequacy and Factorability of the Data Matrix

Firstly, it was observed that all the 20 variables correlated at least 0.3 with at least one other variable which shows that the variables are correlated but not highly correlated, indicating that there is relationship between the variables and also uniquely contributing to explaining the data matrix of the variables scale, suggesting reasonable factorability. Secondly, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy for Benue State was 0.852 (meritorious), for Niger State was 0.801 (meritorious) and for the pooled data was 0.963 (marvellous) based on the KMO classification. The KMO provides an overall measure of the overlap or shared variance between pairs of variables. Since the study tried to identify variables that are related but yet provide unique information to the factors, higher values indicate overlap but not to the point of hindering the analysis due to multicollinearity. The Bartlett's test of sphericity for Benue State was significant ( $\chi^2 (240) = 3569.547 P < 0.001$ ), for Niger State was significant ( $\chi^2 (243) = 1956.465 P < 0.001$ ) and pooled data was also significant ( $\chi^2 (483) = 11357.558 P < 0.001$ ) which shows that the matrices are significantly different from zero (0). This indicated that there are sufficient inter-correlations to conduct the factor analysis based on the results presented in Table 1. Given all the above indicators, factor analysis was deemed to be suitable with all 20 variables in the two States and for the pooled data.

The results in Table 2 shows that the first combination of variables in the first factor explained 49.45% of the variance and the second factor explained 26.62% of the variance in the 20-variable scale. The two factors retained explained 76.07% of the variance in 20 constraining variables. After the varimax orthogonal rotation, only two factors were retained which were code-named Institutional and technical constraints; and climate information constraints. The findings are in line

with [45,46]. The findings also conform with [47,48] who noted that the absence of location specific climate forecasts followed by poor reliability and failure of the climate forecasts, coupled with poor extension service on climate prediction, forecasts in the media not answering operational needs and low conviction of climate prediction were the major constraints to adaptive capacity of the farmers. Farmers are known to practice different adaptive strategies to minimize the effect of climate change, although it takes time for farm households to recover from climatic events, but households with better access to diverse resources and a more balanced livelihood portfolio would be able to cope with vagaries of the climate.

On state specific findings, 70% of the variance in 20 constraining variables extracted four latent variables code-named, Institutional constraints, Personal constraints, land and farm inputs constraints; and population constraints for Benue State while 47.87% of the variance in 17 constraining variables extracted three factors code-named Public and institutional constraints, land and farm inputs constraints; and Personal constraints for Niger State. These results are supported by the study conducted by Centre for Environmental Economics and Policy in Africa

which opined that lack of access to credit is a major problem encountered by farmers in adapting to the effects of climate change [49]. The findings are also in line with [50-56]. The implications are that external and internal barriers to adaptation may be quantitative, such as population density or average income, or qualitative, representing factors such as the principal type of economic activity in a region, or people's perceptions of risk. Such elements constitute tangible and intangible barriers to adopt adaptation practices, generating adaptation lock-in which may lead to 'wait and see' or reactive approaches, low cognitive learning, misperception, and insufficient awareness of climate risks with inefficient individual response to face extreme events.

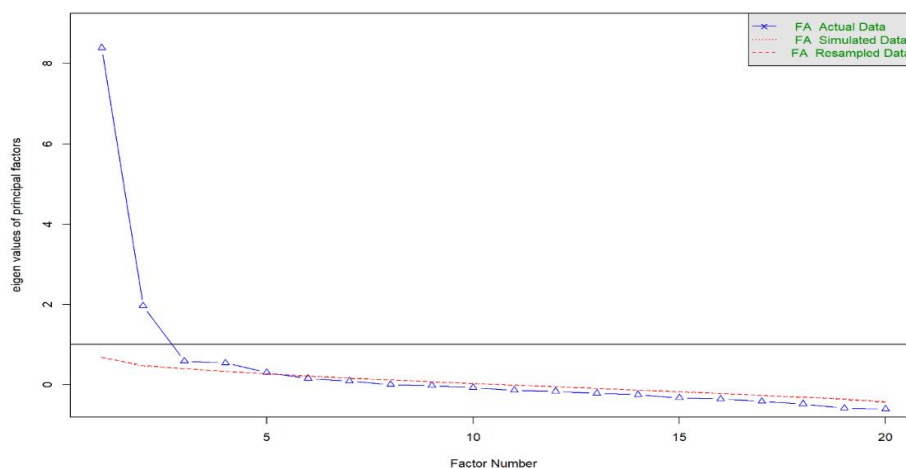
The scree plot in Fig. 2 confirmed the number of constraining factors retained in Benue State which is four, that is, the number of factors that are above the simulated data or where the rate of change on the slope is quite minimum.

The scree plot in Fig. 3 confirmed the number of constraining factors retained in Niger State which is three, that is, the number of factors that are above the simulated data or where the rate of change on the slope is quite minimum.

**Table 1. Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's test of sphericity**

Analysis	Benue State	Niger State	Pooled data
KMO	0.852	0.801	0.963
Bartlett test: Approx. Chi-square	3569.547	1956.465	11357.558
Degrees of freedom	190	190	190
Sig.	0.000	0.000	0.000

Source: Field survey, 2018



**Fig. 2. Scree plot of retained factors in Benue State**



**Table 2. Principal components of constraints to adaptive capacity in North Central Nigeria**

<b>State</b>	<b>Latent variable</b>	<b>Observed variables</b>	<b>Factor loadings</b>
Benue and Niger	Institutional and technical constraints	Poor access to credit	0.889
		Poor access to input supply	0.883
		High cost and ownership of land	0.872
		High cost of farm inputs	0.871
		High poverty status	0.869
		Poor access to extension service delivery	0.858
		Limited land availability	0.853
		Low educational status	0.828
		Lack of opportunities	0.827
		Low economic activities	0.784
		Poor technical know-how	0.747
		Shortage of labour	0.727
		Low cognitive learning	0.704
	Climate information constraints	Inadequate information on climate change	0.829
		Government irresponsiveness on climate change risk management	0.812
		Extensive subsistence agriculture	0.767
		Lack of policy support	0.756
		Population density	0.723
		Low migration	0.707
		Wide spread nomadism	0.705
Benue	Institutional constraints	Poor access to credit	0.867
		Poor access to input supplies	0.832
		Poor access to extension services	0.815
		Inadequate infrastructure	0.748
		Government irresponsiveness on climate change	0.731
		Lack of policy support	0.726
		Extensive subsistence agriculture	0.724
		Lack of opportunities	0.616
		Low economic activities	0.587
		Shortage of labour	0.576
	Wide spread nomadism	0.508	
	Personal constraints	High poverty status	0.879

State	Latent variable	Observed variables	Factor loadings
		Low educational status	0.869
		Poor technical know-how	0.723
	Land and farm inputs constraints	Low cognitive learning	0.63
		High cost and ownership of land	0.844
		Limited land availability	0.764
		High cost of farm inputs	0.606
	Population constraints	Population density	0.812
		Low migration	0.789
Niger	Public and institutional constraints	Inadequate information on climate change	0.851
		Government irresponsiveness on climate change risk management	0.801
		Poor access to input supply	0.783
		Extensive subsistence agriculture	0.76
		Poor access to extension service delivery	0.74
		Lack of policy support	0.723
		Population density	0.631
		Low migration	0.482
	Land and farm inputs constraints	High cost and ownership of land	0.658
		High cost of farm inputs	0.649
		Low educational status	0.633
		Low economic activities	0.577
		Limited land availability	0.446
	Personal constraints	Poor technical know-how	0.4
		High poverty status	0.789
		Poor access to credit	0.765
Wide spread nomadism		0.574	

Source: Computed from field survey data, 2018.  
Extraction method: Principal Component Analysis.  
Rotation method: varimax with Kaiser Normalization

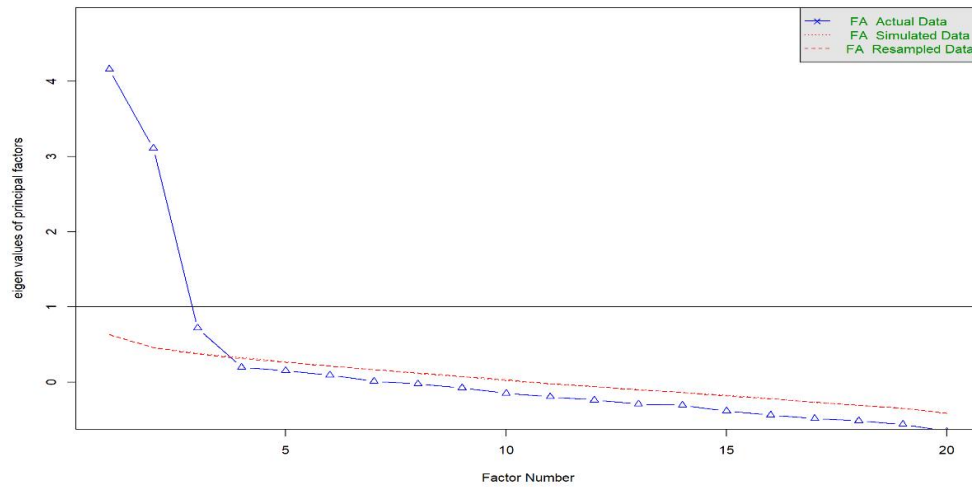


Fig. 3. Scree plot of retained factors in Niger State

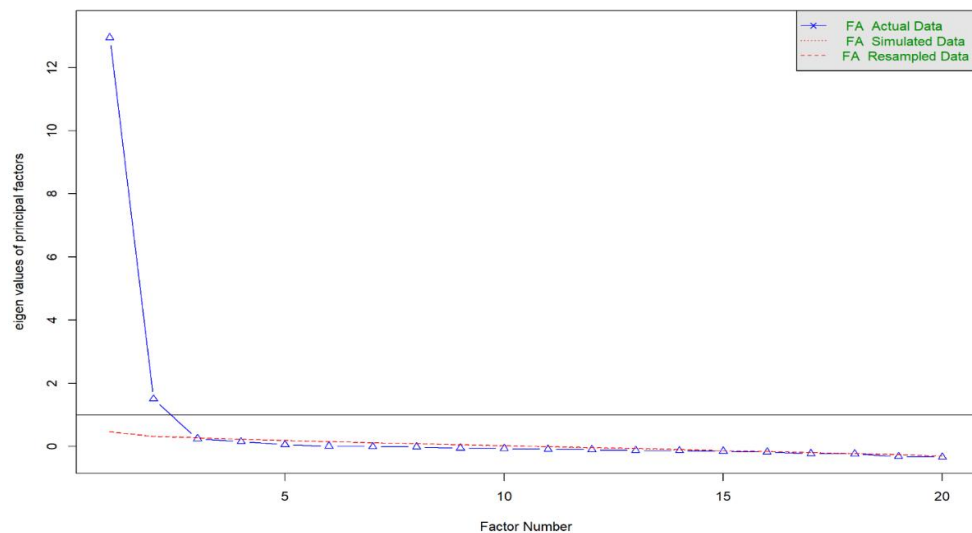


Fig. 4. Scree plot of retained factors in the pooled data

The scree plot in Fig. 4 confirmed the number of constraining factors retained in the pooled data which is two, that is, the number of factors that are above the simulated data or where the rate of change on the slope is quite minimum.

**Reliability test:** Based on the results of the reliability consistency presented in Table 3 revealed that the internal consistency reliability for the overall scale and factor 1 in Benue State were 0.928 and 0.934 respectively which are excellent. The coefficient alpha for factor 2 and 4 were 0.838 and 0.810 respectively which are very good. The coefficient alpha for factor 3 is

0.790 which is good based on Cronbach's alpha classification. This indicated that the responses were consistent and reliable. This implies that the most severe constraint to adaptive capacity to climate change in Benue State is institutional constraint, followed by personal constraint, then land and farm inputs constraint and the least constraint is population constraint. In Niger State, the internal consistency reliability for the overall scale and factor 1 were very good with values of 0.815 and 0.880 respectively. Coefficient alpha for factor 2 and 3 were good with values of 0.737 and 0.736 respectively. This indicated that the responses were consistent and reliable. The result implies that the most severe constraint to

adaptive capacity in Niger State is public and institutional constraint, followed by land and farm inputs constraint and the least constraint is personal constraint. The internal consistency reliability for the overall scale, factor 1 and factor 2 in the pooled data were excellent with values of 0.972, 0.976 and 0.928 respectively. This indicated that the responses were consistent and reliable. This also implies that the most severe constraint to adaptive capacity in the pooled data is institutional and technical constraints. Followed by climate information constraints. These constraints makes it harder to plan and implement adaptation actions by restricting the variety and effectiveness of options available to the farmers to maintained or improve their productivity and cope with the vagaries of climate change.

### 3.2 Confirmatory Factor Analysis of Constraints to Adaptive Capacity

The results of the confirmatory factor analysis of extracted factors on constraints to adaptive capacity to climate change for the two States and pooled data are presented in Tables 4, 5 and 6, and Figs. 5, 6 and 7 respectively. The results indicated that the hypothesized (four for Benue State, three for Niger State and two for the pooled data) factor models fit the data well for all the 20 variable items. Based on the diagnostics statistics, model fit test statistic was (885.481) for Benue State, (436.584) for Niger State and (1162.521) for the pooled data. The Chi square statistics were significant at 1% probability level for the two States and pooled data, with Comparative Fit Index of 0.794 for Benue State, 0.774 for Niger State and 0.911 for the pooled data. Tucker-Lewis Index was 0.756 for Benue State, 0.729 for Niger State and 0.900 for pooled data. The Root Mean Square Error of approximation was 0.013 for Benue State, 0.011 for Niger State and pooled data. This indicated that the models are of good fit. The results

further indicate that all the variables constraints included in the model are significantly related to the factors measured. The standardized loading shows the correlation between the variables and the factors. The variable item with the highest standardized value is the best indicator of the factor, which usually have the least error variance left over. In Benue State, variable X19 has the highest loading of 0.886 in factor 1, for the factor 2 variable X2 load highest with 0.878, for factor 3 variable X17 load highest with 0.873 and for factor 4 variable X5 load highest with 0.846. In Niger State, for factor 1 variable X4 load highest with 0.885, for factor 2 variable X17 load highest with 0.721 and for factor 3 variable X11 load highest with 0.822. For the pooled data, variable X2 has the highest loading of 0.929 in factor 1 and for factor 2 variable X4 load highest with 0.879.

Confirmatory factor analysis is the analysis of covariance, in other words it is the analysis of correlation and directional path. Covariance estimates how the constructs are correlated since they are on the same constructs, it implies that they might be related to each other. The results of the covariances in Tables 4, 5 and 6 and Figs. 5, 6 and 7 indicated that in Benue State, factor 2, 3 and 4 are significantly correlated with factor 1. Factor 4 is significantly correlated with factor 2 and 3. In Niger State, Factor 1 and 2 are significantly correlated with factor 3. In the pooled data, Factor 1 is significantly correlated with factor 2. Usually, all measurements are made with error (random and / or systematic). The confirmatory factor analysis tends to isolate "true score" component of measurement by decomposing the variable item into true score and error variance. The error variance is the left over variation in that variable not accounted for by the model. The estimates of the error variance for all the variables are presented in Table 6.

**Table 3. Cronbach's alpha analysis for the scale and factors retained**

Construct	Coefficients alpha		
	Benue State	Niger State	Pooled
Overall scale	0.928	0.815	0.972
Factor 1	0.934	0.880	0.976
Factor 2	0.838	0.737	0.928
Factor 3	0.790	0.736	
Factor 4	0.810		

Source: Field survey, 2018

Table 4. Extracted factors of constraints to adaptive capacity in Benue State

Latent Variables	Estimate	z-value	P(> z )	Standardize all
<b>MR1 =~</b>				
X8	1			0.6
X10	1.038	9.026	0	0.705
X11	1.372	10.204	0	0.845
X12	1.389	10.162	0	0.839
X13	1.169	8.91	0	0.692
X14	1.341	9.821	0	0.796
X16	1.135	8.422	0	0.63
X18	1.261	9.823	0	0.797
X19	1.329	10.511	0	0.886
X20	1.239	9.721	0	0.74
X7	0.373	2.771	0.006	0.232
X9	0.83	7.31	0	0.536
<b>MR2 =~</b>				
X1	1			0.68
X2	1.318	11.23	0	0.878
X3	1.202	10.295	0	0.763
X4	1.015	9.668	0	0.709
<b>MR3 =~</b>				
X16	1			0.249
X20	0.908	3.813	0	0.243
X15	3.002	4.483	0	0.783
X17	3.301	4.441	0	0.873
<b>MR4 =~</b>				
X5	1			0.846
X6	0.808	9.286	0	0.646
X7	0.776	5.95	0	0.606
<b>Covariances</b>				
MR1 ~~				
MR2	0.056	4.964	0	0.463
MR3	0.023	3.485	0	0.455
MR4	0.095	6.289	0	0.666
MR2 ~~				
MR4	0.067	4.979	0	0.446
MR3 ~~				
MR4	0.016	2.546	0.011	0.251
<b>Variances</b>				
X8	0.203	10.64	0	0.64
X10	0.124	10.402	0	0.503
X11	0.086	9.555	0	0.287
X12	0.092	9.615	0	0.296
X13	0.169	10.439	0	0.521
X14	0.118	9.981	0	0.366
X16	0.147	10.131	0	0.398
X18	0.104	9.98	0	0.365
X19	0.055	8.9	0	0.215
X20	0.073	9.189	0	0.23
X7	0.114	7.879	0	0.39
X9	0.195	10.73	0	0.713
X1	0.148	9.532	0	0.537
X2	0.065	5.436	0	0.228

Latent Variables	Estimate	z-value	P(> z )	Standardize all
X3	0.132	8.554	0	0.418
X4	0.13	9.273	0	0.498
X15	0.131	6.608	0	0.388
X17	0.078	3.862	0	0.238
X5	0.071	4.562	0	0.284
X6	0.163	9.254	0	0.582
Model Fit Test Statistics	885.481			
Degrees of freedom	161			
P-value (Chi-square)	0			
Comparative Fit Index (CFI)	0.794			
Tucker-Lewis Index (TLI)	0.756			
Akaike (AIC)	5059.876			
Root Mean Square Error of Approximation (RMSEA)	0.014			
P-value RMSEA (0.05)	0			

Source: Field survey, 2018

Table 5. Extracted factors of constraints to adaptive capacity in Niger State

Latent Variables	Estimate	z-value	P(> z )	Standardize all
<b>MR1 =~</b>				
X3	1			0.728
X4	1.472	13.304	0	0.885
X7	0.934	10.834	0	0.718
X9	0.991	9.388	0	0.624
X12	1.325	11.315	0	0.749
X18	0.957	8.937	0	0.595
X20	0.981	10.528	0	0.702
X13	0.688	7.567	0	0.506
<b>MR2 =~</b>				
X1	1			0.424
X20	0.024	0.153	0.878	0.009
X5	1.232	5.041	0	0.574
X15	1.067	4.33	0	0.422
X16	1.138	5.038	0	0.573
X17	1.56	5.381	0	0.721
<b>MR3 =~</b>				
X8	1			0.432
X11	2.087	5.657	0	0.822
X19	2.156	5.716	0	0.699
<b>Covariances</b>				
MR1 ~~				
MR3	0.051	1.971	0.049	0.162
MR2 ~~				
MR3	0.093	3.667	0	0.587
<b>Variances</b>				
X3	0.602	9.695	0	0.469
X4	0.408	6.782	0	0.216
X7	0.558	9.774	0	0.484
X9	1.045	10.28	0	0.61
X12	0.935	9.515	0	0.439
X18	1.136	10.387	0	0.646

Latent Variables	Estimate	z-value	P(> z )	Standardize all
X20	0.67	9.877	0	0.505
X13	0.938	10.627	0	0.744
X1	0.782	10.164	0	0.82
X5	0.529	9.049	0	0.67
X15	0.9	10.173	0	0.822
X16	0.453	9.06	0	0.672
X17	0.386	6.716	0	0.481
X8	0.641	10.274	0	0.813
X11	0.308	4.011	0	0.324
X19	0.718	7.073	0	0.512
Model Fit Test Statistics	436.584			
Degrees of freedom	100			
P-value (Chi-square)	0			
Comparative Fit Index (CFI)	0.774			
Tucker-Lewis Index (TLI)	0.729			
Akaike (AIC)	10571.4			
Root Mean Square Error of Approximation (RMSEA)	0.011			
P-value RMSEA (0.05)	0			

Source: Field survey, 2018

**Table 6. Extracted factors of constraints to adaptive capacity in the pooled data**

Latent Variables	Estimate	z-value	P(> z )	Standardize all
<b>MR1 =~</b>				
X1	1			0.851
X2	1.223	29.508	0	0.929
X5	1.073	28.418	0	0.912
X6	1.046	27.365	0	0.895
X8	1.058	27.153	0	0.892
X10	0.936	24.544	0	0.845
X11	0.999	26.058	0	0.873
X13	0.904	22.644	0	0.806
X14	1.134	28.921	0	0.92
X15	0.758	19.906	0	0.743
X16	1.141	28.633	0	0.916
X17	0.913	25.021	0	0.854
X19	1	23.766	0	0.829
<b>MR2 =~</b>				
X3	1			0.862
X4	0.987	26.341	0	0.879
X7	0.879	25.351	0	0.861
X9	0.958	23.545	0	0.827
X12	0.923	22.825	0	0.812
X18	0.541	14.172	0	0.586
X20	0.841	23.81	0	0.832
<b>Covariances</b>				
MR1 ~~				
MR2	1.02	11.767	0	0.774
<b>Variiances</b>				
X1	0.504	14.679	0	0.276
X2	0.314	13.471	0	0.137
X5	0.307	13.908	0	0.168

Latent Variables	Estimate	z-value	P(> z )	Standardize all
X6	0.358	14.212	0	0.199
X8	0.381	14.264	0	0.205
X10	0.464	14.722	0	0.286
X11	0.412	14.489	0	0.238
X13	0.581	14.931	0	0.35
X14	0.308	13.726	0	0.154
X15	0.614	15.135	0	0.448
X16	0.332	13.834	0	0.162
X17	0.409	14.656	0	0.271
X19	0.599	14.816	0	0.312
X3	0.453	12.918	0	0.256
X4	0.378	12.473	0	0.228
X7	0.354	12.947	0	0.258
X9	0.559	13.593	0	0.316
X12	0.579	13.796	0	0.34
X18	0.737	15.074	0	0.657
X20	0.414	13.512	0	0.307
Model Fit Test Statistics		1161.521		
Degrees of freedom		169		
P-value (Chi-square)		0		
Comparative Fit Index (CFI)		0.911		
Tucker-Lewis Index (TLI)		0.9		
Akaike (AIC)		22366		
Root Mean Square Error of Approximation (RMSEA)		0.011		
P-value RMSEA (0.05)		0		

Source: Field survey, 2018

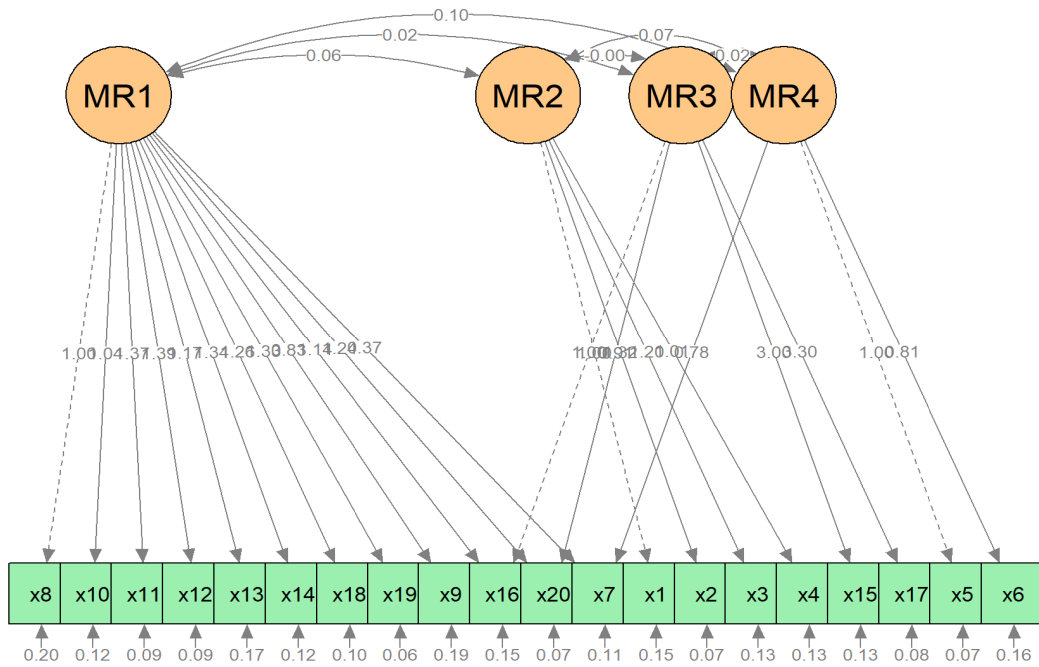


Fig. 5. Confirmatory factor analysis of the extracted factors from the exploratory factor analysis in Benue State



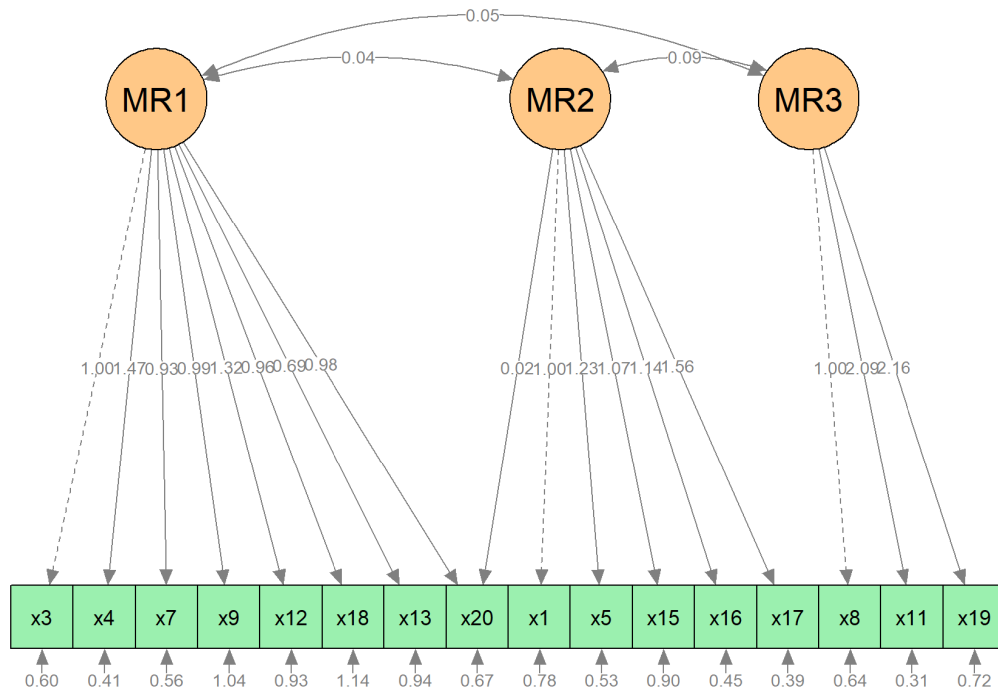


Fig. 6. Confirmatory factor analysis of the extracted factors from the exploratory factor analysis in Niger State

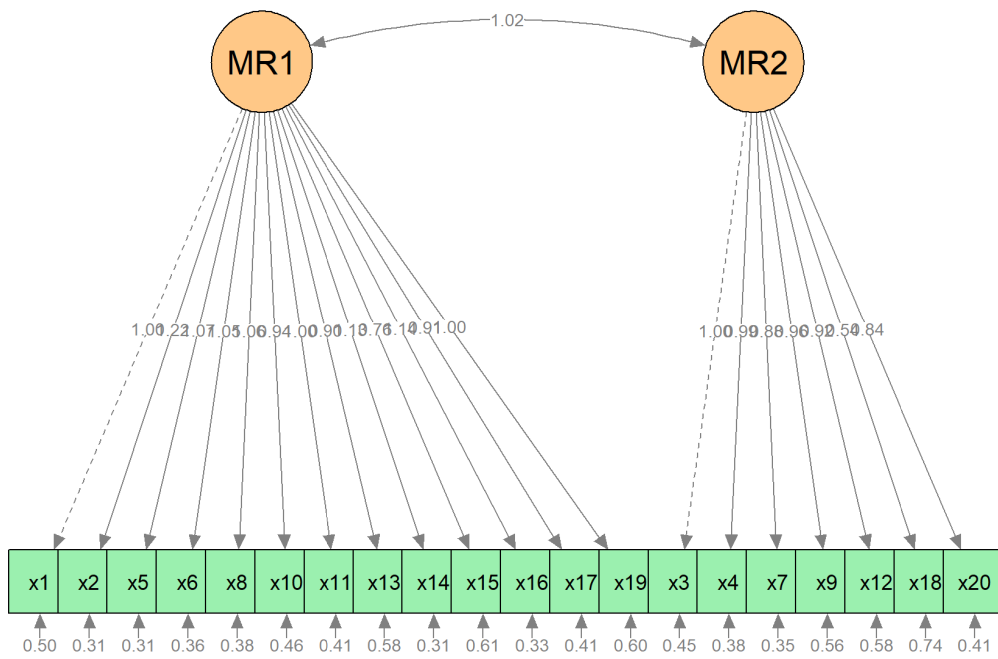


Fig. 7. Confirmatory factor analysis of the extracted factors from the exploratory factor analysis in pooled data

#### 4. CONCLUSION

In conclusion this study has validated empirical findings of many studies by revealing the principal constraints that the farmer faced in order to improve their adaptive capacity to climate change, asserting that constraints are unevenly disseminated among the various communities as well as individuals in the study area. It was revealed that the significant constraints faced by the beneficiaries of IFAD-VCDP farmers in North Central Nigeria were institutional, personal, land and farm inputs, and population constraints in Benue State; and public and institutional, land and farm inputs, and personal constraints in Niger State. The constraints among the combined farmers are institutional and technical as well as climate information constraints. These constraints make it harder to plan and implement adaptation actions by restricting the variety and effectiveness of options available to the farmers to maintained or improve their productivity.

Arising from this, the study recommended that government and non-government organizations should intensify efforts on weather and climate services including policies that would enhance the attainment of the twin objectives of increasing agricultural production and effectively adapting to the effects of climate change. Access to timely weather and climate information is key to adequately preparing adaptive and adaptation plans and actions thus increasing the adaptive capacity of the farmers in order to employ more adaptation measures. Public and private institutions should conduct educational campaign and training on climate change and adaptation techniques while land governance systems and access should be strengthened in Nigeria to provide tenure security for all to adapt to a variety of livelihood options and enhance negotiation position and planning. There is need to increase capacity for low cost land survey and registration as a safeguard against corruption in land administration. Financial institutions should help facilitate access to credit by farmers so as to stimulate the adoption of climate smart practices and access to extension services in the States.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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