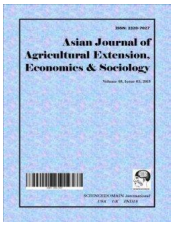

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Farmers' Knowledge of Inter Annual Rainfall Variability and Adaptation Strategies in Nasarawa State, Nigeria

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Authors' contributions

This work was carried out by active participation of all authors who gave inputs, read and approved the manuscript

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ABSTRACT

The study investigated farmers' knowledge of inter annual rainfall variability and adaptation methods used in Nasarawa State. The questionnaire was used to generate data on four sections bothering on the socio-economic background of farmers, farming practices, knowledge of inter annual rainfall variability and adaptation strategies. A Multistage random selection technique was used to distribute the questionnaire across the state. The study adopted the agricultural zones as used by Nasarawa Agricultural Development Program (N.A.D.P) which are South, West and North. The first stage of the picked two Local Government Areas from each of the agricultural zones, then the second stage was to divide each zone into three making a total of 18 units. Each of the zones was further divided into two extension units making a total of 36 units. Ten questionnaires were shared in the 36 units with the help of extension workers making a total of 360 units. The result

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shows that 53% of the farmers are not aware of inter annual rainfall variability while about 47% of the farmers are aware. Extension workers are the highest source of information amongst respondents with 55%. A large percentage of respondents (84%) noted that they have tried adaptation and it has led to higher yield. Changing in planting date is the most common adaptation used by the farmers (49%) while 55% of the farmers affirm that, lack of awareness is the greatest constraint to adaption.

Keywords: Adaptation; inter annual rainfall; variability and farmer knowledge.

1. INTRODUCTION

Inter annual rainfall variability is the change in the average rainfall characteristic of a place. The issue of inter annual rainfall variability is becoming a threat to the agriculture potentials of nations especially in the tropics. Rainfall variability occasioned by changes in onset, cessation dates and length of rainy season can have a devastating effect on the rain-fed farm system. Although inter annual rainfall variability is natural, farmers, on the other hand, have devised means to cope with its excesses. Adaptation is an act of coping with changes in a natural system which has a potential of negative impact. [1] reported that Adaptation has been viewed as an adjustment made to human, ecological or physical system in response to a perceived vulnerability. While, [2] also stated that, Adaptation is an integral part of managing the risks caused by climate change, therefore risk reduction activities should be embedded in an integrated approach to ensure sustainability. It was also reported that adaptation has the potential to reduce adverse impacts of climate change on farming activities with cost implication that may not prevent all the damages [3].

Several studies were carried out to investigate how inter annual rainfall variability affects crop yield, but neglecting to seek methods used by farmers to adapt or mitigate the negative effects. The ability of farmers to adapt to the problems of climate variability lies to a larger extent, on their knowledge and awareness of the risk and vulnerability. [1] observed that the awareness of climate risk and potential benefits of taking action is an important determinant of adoption of agricultural technologies. Knowing the fact, that climatic patterns are changing and pose a great deal of threat to farming, especially rain-fed farming, is a foundation of better adaptation. [4] stated that educated and experienced farmers have more knowledge and information about climate change and agronomic practices that they can adopt in response to consequences of climate change. Awareness of changing the climate and its effects on agriculture make farmers to be more ready to tame the effects.

It is on this note that this study sought to investigate the knowledge of inter annual rainfall variability amongst farmers in Nasarawa state and their adaptation strategies. To achieve that aim, questionnaires were distributed to farmers in the three Agricultural zones of the state namely: Northern, Western and Southern Zones.

2. MATERIALS AND METHODS

2.1 The Study Area

Nasarawa State is located in the central part of Nigeria otherwise known as the middle belt. The state lies between Latitude 7^0 $45^{/}$ and 9^0 $25^{/}$'N of the Equator and between Longitude 7^0 and 9^0 37'E of the Greenwich meridian as shown in Fig 1. It has a total landmass of about 27, 137.8 km^2. Nasarawa State has a total of 13 Local Government Areas which are; Akwanga, Awe, Obi, Karu, Nasarawa, Nasarawa Eggon, Keffi, Wamba, Doma, Lafia, Kokona, Toto and Keana. The State Shares boundary with Kaduna State to the North, Plateau State to the East, Benue State to the East and Kogi State and Federal Capital Territory (FCT) bounded the state to the West [5]).

2.2 Rainfall

Precipitation in Nasarawa State like elsewhere in the tropics consists entirely of rainfall; it is the most variable element of tropical climate. The mean annual rainfall across the state is between 1400 mm and 1500 mm, with the highest in August about 1560 mm and the lowest in October about 328 mm. The rapid decrease in the monthly rainfall is attributed to the rapid retreating of the Inter- Tropical Discontinuity (ITD) at a speed of 320 km per month as against 160 km for the South-North movement [6]. The onset of rain varies within the State; some Northern parts of the State witness rain early around 29th March then the Southern part around 1st April while the

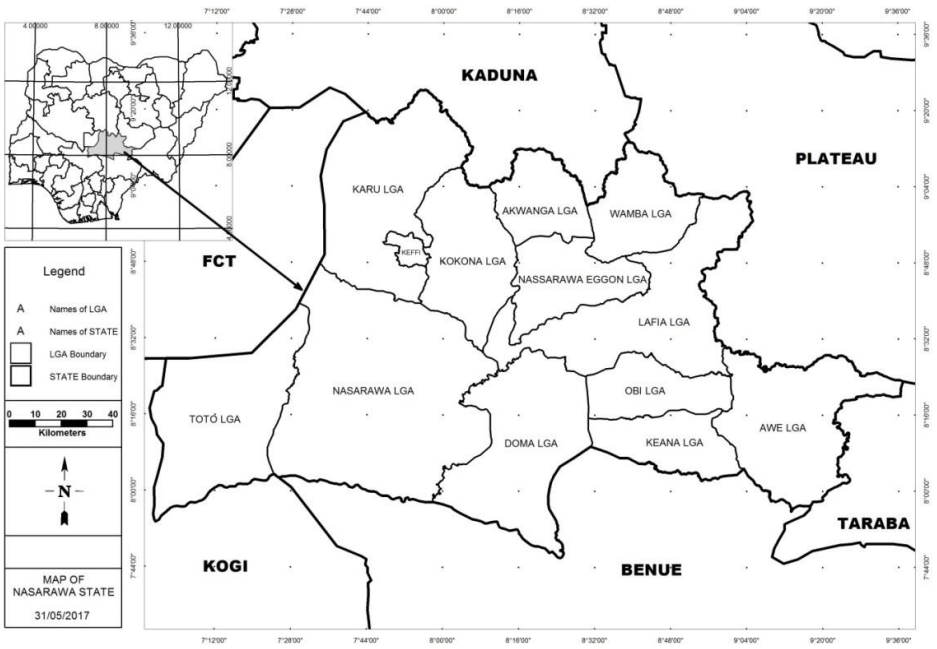

Fig. 1. Map of Nasarawa state showing study areas
(Source NAGIS)

Western and Eastern parts is between 4th and 5th April. The mean cessation dates of rains in the State are usually 24th October. Nasarawa State has a tropical sub-humid climate, with two distinct seasons which are wet season and dry season. The wet season lasts for seven months which is between April and October, while the dry season is between November and March [7].

2.3 Temperature

Temperatures are generally very high during the day, particularly in March and April. Nasarawa State records average maximum and minimum daily temperatures of 35°C and 21°C in rainy season and 37°C and 16°C in dry season respectively [7]. A maximum is reached in March when temperature can be as high as 39°C. The minimum temperature on the other hand in the State can drop to as low as 17°C in December and January [8]. There is a spatial variation in temperature distribution over the state; mean monthly temperature ranges between 26.8°C in the southern part to about 27.9° in the northern part of the state [9]. The temperature in Nasarawa State is generally high, partly because of its location in the tropical sub-humid climatic belt and the high radiation income in this part of the globe, which is evenly distributed throughout the year, [8].

2.4 Data Collection

For the purpose of this study, multistage sampling technique was adopted due to the complexity of the population distribution of the respondents which required more than a single sampling technique to select the required samples. Firstly, six (6) out of the thirteen (13) LGAs were purposively selected and are known for crop production. Two LGAs each from each Agricultural Zones of the State (West, Central and South) were selected.

Secondly, each LGA was further divided into three (3) extension blocks, making a total of 18 extension blocks.

Thirdly, two (2) farming villages/ communities were randomly selected from each extension blocks making a total of thirty six (36) villages/communities. Lastly, in each community/farming village, with the assistance of the NADP local extension personnel, a list of crop farmers households were compiled and then ten (10) crop farmers were randomly selected, making a sample size of three hundred and sixty (360) food crop farmers, 120 from each zone and 60 from each LGA.

The structural and validated questionnaire was used to generate data. Information gathered

includes socio-economic characteristics of the respondents, knowledge of inter annual rainfall variability and adaptation strategies. The data was collected with the help of extension workers from N.A.D.P.

2.5 Data Analysis

Data collected were subjected to descriptive statistics such as mean, frequency, percentages, and tables.

3. RESULTS AND DISCUSSION

The results of socio-economic characteristics of farmers are shown in Table 1. The socio-economic background has shown to have an influence on farmers' success.

3.1 Section One: Socio-economic Background of Respondents

The age distribution of farmers shows that more than 70% of them are between the age of 35 years and 65 years. This shows that farming activities are being carried out by people in their active age. This is perhaps an outcome of government deliberate policy to have everyone actively engaged in agriculture.

92% of the total respondents are married, 6.70%, are single, 0.27% are Divorced and widow made up 0.83%. Married people dominant in this sector maybe because of more responsibility and also the need to have an alternative source of income.

The sex distribution reveals that 79% of the respondents are male while females are 20% of the respondents. This finding agrees with the result of [10] which noted that men are 74.17% and women 25.83% of crop farmers in savannah region of Nigeria. This dominance of male in this regard may not be unconnected to the traditional role of men as bread-winners of their homes, especially in Africa.

37.20% the respondent said they have about 6-10 workers on their farms which is the highest.

This can be deduced that most of the workforce are family members either children or relatives. 4.41% of respondents which represent the least percentage have about 16-25 workers. This result reveals that most of the farmers are subsistent farmers who use mainly family members than hired labourers.

Table 1. Socioeconomic characteristics

Variable	Frequency	Percentage
Age		
5--20	12	3.30%
21-35	68	18.80%
35-50	188	52.20%
51-65	84	23.30%
66 And Above	8	2.22%
Marital status		
Married	331	**92%**
Single	24	6.70%
Divorce	1	0.27%
Widow	3	0.83%
Sex		
Male	282	79.20%
Female	74	20.80%
Workforce		
0-5	51	**14.20%**
6--10	134	37.20%
11--15	92	25.60%
16--20	49	13.60%
21--25	18	5%
26--30	16	4.41%
Distance		
0-1k M	176	**48.90%**
2-3km	111	30.83%
4-5km	30	8.33%
6-7km	10	2.80%
8-9km	1	0.27%
>10 Km	32	8.88%
Acess to credit facility		
Yes	7	**1.94%**
No	253	98.10%
Other source of income		
Yes	105	**29.20%**
No	255	70.83%
Acess to extension workers		
Yes	221	**61.40%**
No	139	38.60%
Number of ext workers visit in a year		
0-5	43	**13%**
6--10	9	2.74
11--15	12	3.70%
16--20	126	38.40%
21--25	24	7.32%
Nil	114	34.76%
Level of education		
Tertiary	66	**18.33%**
Secondary	93	25.83%
Primary	91	25.30%
Nil	110	30.56%

More than 70% of respondents have their distance to farm from 0-3 km, this shows that they are not far from their farms and have an opportunity for better care of the farms. By protecting their crops from pests or giving quick attention to any form of abnormality noticed. About 10% of respondents have a distance between 8 km to above 10 km, which is quite far

from home and might need some form of transportation to get to the farms.

98.1% of respondents don't have access to credit facility in any form. While a paltry 1.94% do have access to credit facilities. Financial institutions give credits facilities only to clubs or cooperative societies of which many farmers have not joined yet. The stringent and cumbersome process and conditions of getting credit facilities is another factor that might have influenced the high number of respondents in Nasarawa State not having access to the credit facility.

70% of farmers in the study areas have no any other source of income other than farming. While 29.20% engaged in other activities other than farming. The high dependence on rain-fed farming by the respondents is a great risk to the economy. This is because any negative consequence of climate will render a lot jobless.

61.40% of respondents have access to extension workers while 38.60% said they have no access to extension workers. The high access to extension workers is a good omen of great things because extension workers were trained and sent to further disseminate information and demonstrate the use of seed hybrid and improve farming techniques to farmers.

38.40% of respondent have 11 and 20 numbers of visits in a year while 34.76% have no visit at all. The percentage difference of visits by extension workers and no visit is not wide, which indicate that quite a good number of farmers are still not met.

The result shows that 30% of the respondents have no formal education while 70% of the respondents have attained at least primary, secondary or tertiary education. This finding also agreed with [10] which finds out that 74% of farmers in Savana region of Nigeria have formal education. Since most of the respondent are literate it will be easier to understand the concept of inter annual rainfall variability and also adaptation to excesses of climate variability.

The results of Agricultural system and crop yields amongst farmers are shown in Table 2 which involve the types of crop grown and yields over time

3.2 Section Two: Agricultural Practices and Systems

The distribution of farming practice by the farmers in the study area reveals that 99.40% of farmers are rain fed farmers, which means they depend on rainfall for their farming activities while 0.56% are irrigation farmers. The result portrays a bleak future for farming in the state owing to the fact that climate change is obvious and thus depending on rainfall solely for farming can be detrimental.

37% of the farmers are engaged in Maize farming, 32% are into Yam while 30% are into rice farming. The almost uniform distributions of the percentage of types of crop grown were because of a suitable condition for the growth of the crops in all the agricultural zones of the state. Maize has a higher percentage because it has a short growing period and suitable in all the soil across the state. While Rice has the least because it is usually confined along swampy areas and it's highly water dependent.

3.61% of the respondents are involved in mixed farming which is the rearing of animals and crop farming at the same time. 45.03% are purely crop farmers while 0.56% are pastoralist. The result reveals that crop farmers are gearing up with the understanding of not only relying on crops but having animal to support in the difficult crop season.

Enquired if there is any noticeable change in crop yield 63.06% of respondent affirm that there are increases in crop yields, 11.11% said there are no changes in crop yield while 25.83% said there is decreased in crop yields. This result is an outcome of a higher percentage of farmers being a literate and high number of extension workers among farmers in the state. 33.08% of respondents said the change in crop yield is as results of the use of improved crop varieties. This represents the highest of the percentage amongst the respondents. 2.31% which is the least choice by respondents said the farmers-herders crises are responsible for changes in crop yields. Improved seed variety is the most common improvement to farm yield to the farmers thus they see it as the reason behind the high yields.

3.3 Section Three: Farmers' Knowledge on Climate Change

The results on the farmers' knowledge of climate variability and change are shown in Table 3.

75% do not belong to any farmers club while 25% belong to at least a single farmers club.

With high percentage of respondent not belonging to any farming club, the implication is that a large number of them may not have access to credit facility because banks give loans only to farming clubs and or cooperative societies. Club is also a veritable way of information dissemination and easy sharing of ideas.

53.3% of respondents don't have knowledge of inter annual rainfall variability while 46.70% have knowledge. The high number of respondent not having knowledge on inter annual rainfall variability may not be unconnected to the fact That most of the respondents do not belong to any farming club and hence have the tendency of not having the knowledge or information.

Table 2. Agricultural system and crop yields

Variable	Frequency	Percentage
Type of farming		
Rainfed	358	**99.40%**
Irrigation	2	0.56%
Crops grown		
Yam	179	**32.02%**
Maize	211	37.75%
Rice	169	30.02%
Farming practice		
Crop Farming	165	**45.03%**
Pastorial	2	0.56
Mixed Farming	193	53.61%
Nomadic	0%	0%
Nomadic	0%	0%
Others		
Farming system practice		
Multiple	276	**76.66%**
Irrigation	3	0.83%
Monoculture	45	12.50%
Others	36	10.00%
Total harvest of yam per anum		
100-500 Tubers	187	51.94%
600-100 Tubers	115	31.94%
1000-5000 Tubers	35	9.72%
6000 And Above	23	6.39%
Total harvest of maize per annum		
10-20 Bags	190	52.78%
30-50 Bags	89	24.72%
60-100 Bags	37	10.28%
110 And Above	44	12.22%
Total harvest of rice per anum		
10-20 Bags	149	41.39%
30-50 Bags	99	27.50%
60-100 Bags	79	21.94%
110 And Above	17	4.72%
Less Than 10 Bags	16	4.44%
Any change in crop yield in the past?		
Increased	227	63.06%
Decreased	93	25.83%
No Change	40	11.11%
What is responsible for the change?		
Increase In Farm Size	32	12.30%
Fulani Crisis	6	2.31%
Early Planting	24	9.23%
Used Of Fertilizer/Pesticides	50	19.23%
Climate Change	13	5%
Rain Pattern	25	9.62%
Uses Of New Crop Specie	86	33.08%
Use Of Improve Technology	13	5%
Lack Of Fund	11	4.23%

Table 3. Farmers knowledge on climate variability and change

Variable	Frequency	Percentage
Belong to any farming club?		
Yes	90	25%
No	270	75%
Are you aware of IARV?		
Yes	168	46.70%
No	192	53.33%
Source of your information		
School	8	2.22%
Television	47	13.05%
Extension Workers	198	55%
None	107	29.72%
How does IARV manifest in your case?		
Increased Rainfall	72	**24.08%**
Decreased Rainfall	115	38.46%
Changes In Onset/Cessation Dates	50	16.72%
Low Rainfall Frequency	37	12.37%
Short Growing Season	25	8.36%
Which variable affect yield the most for you		
Extreme Temperature	34	9.44%
Changes In Onset/Cessation Dates	163	45.30%
Variation In Rainfall Distribution	113	31.39%
Early Season	50	13.89%

55% of respondents relied on extension workers for their source of information and knowledge on inter annual rainfall variability, while 2.22% got their information in school. This shows the importance of extension workers in better-informing farmers on new techniques of farming and impending dangers. With a paltry 8% of respondents getting to know about inter annual rainfall variability in school goes to show that our education system is not living up to the reality of the society. Such need to be taught in schools which will help in turning the fortunes of agriculture in the state.

38.46% indicated that inter annual rainfall manifests as decreased in rainfall while 24% noted that it is manifested through an increase in rainfall. This concurs with the fact that climate change does not give uniform consequence; some places will have drought while others will have flood. The least percentage of manifestation goes to short growing season which has 8.36.

3.4 Section Four: Adaptation Strategies

The results of farmer's adaptation strategies and constraints are presented in Table 4.

84.14% of respondents have tried adaptation method to counter the consequence of inter annual rainfall variability while 15.83% have never tried adapting. Adaptation is an inherent process for farmers; the years put into farming activities give the farmers edge in adaptation. As noted by [11] that indigenous traditional knowledge has over time played a significant role in solving problems that are related to climate change and variability.

Most of the respondents 49.20% relied on change in planting dates as adaptation strategies; others about 32.50% used improved crop variety as strategy for adaptation. The least strategy used is insurance which accounts for 0.56%.

83.60% of respondents acknowledge that the strategies they used in adaptation paid off because the yield of crops increased. While 16.40% said the strategies did not lead to increase in crop yields. This goes to show that adaptation strategies by farmers using their traditional knowledge and others have a great way of dealing with the negative consequences of climate variability on crop yields.

55.6% noted that the major constraint to adaptation is limited knowledge of the causes and effects of inter annual rainfall variability; this represents the highest factor chosen by the respondents. While 0.13% said lack of government support is the main constraint to adaptation.

Table 4. Adaptation

Variable	Frequency	Percentage
Have you try adapting to iarv?		
Yes	303	**84.14%**
No	57	15.83%
What are the adaptation strategies used?		
Changes In Planting Date	177	**49.20%**
Used Of Improved Crop Varieties	117	32.50%
Switch From Crop To Livestock Farming	3	0.83%
Insurance	2	0.56%
Move To New Farm Site	7	1.94%
Increased Water Management	5	1.39%
Increased In Farm Size	19	5.28%
Used Of Fertilizer And Insecticides	5	8%
Has your strategies increased yield?		
Yes	301	**83.60%**
No	59	16.40%
What are the constraints you have to adaptation		
Poverty	59	**16.40%**
Lack Of Labourers	7	1.94%
Low Level Of Technological Know How	36	10%
Poor Soil	14	3.38%
Lack Of Water	8	2.22%
Shortage Of Land	31	8.61%
Limited Awareness	200	55.60%
Lack Of Government Support	5	0.13%
Other adaptation options recommended		
Use Of Improved Crops Varieties	72	**20%**
More Advocacy On IARV	136	37.70%
Changes In Planting Dates	17	4.72%
Use Of Fertilizers And Pesticides	64	17.80%
Increase In Farm Size	14	4%
Government	39	10.83
Insurance	3	0.83%

When asked to suggest best adaptation methods; 37.70% suggested the use of mass media to create more awareness. The least option advocated is insurance with 0.83%.

4. RECOMMENDATIONS

- The government should intensify efforts toward irrigation farming in order to curtail the uncertainty attached to rain-fed agriculture.
- Annual sensitization workshop and seminar should be encouraged for farmers, to create awareness among them on the working of climate and its potential impact on crop yields.
- More extension workers should be deployed in the state owing to their importance to rural farmers.
- Farmer's adaptation measures to climate variability in the state should be harnessed for proper result.

5. CONCLUSION

This study which covers Nasarawa State revealed that majority of farmers are aware of inter annual rainfall variability, which is a major threat to high crop yields across the state. It is also an index of climate change. Farmers across the state have to brace up to the challenge of inter annual rainfall variability by adapting various methods of mitigating its consequences. The role of extension workers to the understanding of climate variability and adaptation options was obvious in the study area.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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