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Farmers' Perception on the Effect of Rainfall Variability on Rice Yield in Dadin-Kowa of Gombe, Gombe State

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Abstract: This work examines famers' perception on the effect of rainfall variability on rice yield in Dadin-kowa, Yamaltu Deba Local Government Area of Gombe State. Nigeria. Data for the study were collected via questionnaire survey of 60 respondents and it also covered and relates with daily rainfall data for a period of Seventeen (17) years, 2001 to 2017 from Upper Benue River Basin Dadin-kowa Meteorological Centre. Frequency table and percentages was used to access the In-depth knowledge and the perceived effects of climate change, rainfall variability to be précised, on rice production. While the analysis using Cumulative Rainfall Model clearly demonstrates delay in onset of rainy season, early cessation of rainy season and shortening of the length of hydrological growing season. The result further reveals 30th May as the onset mean date, the cessation mean date is 12th October and hydrological growing season is having a mean of 137 days. Farmers make sequential decision: Adjusting planting timing in response to delays in the onset of rainy season while changing crop variety responding to delay in the end of previous year's rainy season. The findings of the study show that the decrease in yield of rice is the immediate impacts of rainfall variability. Thus a study understanding farmers' perception on the effects of rainfall variability on rice yield can prove extremely valuable.

Keywords: Onset, Cessation, Hydrological Growing Season, Farmers Perception

1. Introduction

Variability in global climate and change are evident with enormous impacts, which vary across locations and socioeconomic features. Reports on empirical observations and climate models indicate that global climate have been changing over the past 100 years and will likely change more rapidly in the future [6]. The severities of impacts of climate change on our ecosystems are already evident and affect food security of humankind [7]. Agriculture, being central to livelihoods in Africa, is considerably vulnerable to variability in climate and change [8]. Global agriculture in the 21st century has significantly been affected by climate change and future impacts are projected to worsen as the temperature continues to rise and precipitation becomes more unreliable [9]. There was an increase in intensity and frequency of heavy precipitation events in the last 50 years and the spatial pattern of the rainfall is likely to change, with rise in number and intensity of extreme rainfall events which adversely impact the natural resources on which majority of the population is dependent [10]. Hence, there is need to recognize the enormous impacts of variability in global climate and change on agriculture. Impacts of variability in global climate and change on rainfall affect farmers in many regions, countries and developing countries including Africa. In India, the meteorological records indicate rise in the mean annual surface air temperature by 0.4°C with not much variations in absolute rainfall [10]. Developing countries especially in Africa are highly susceptible to the impacts [11-16] and the poor already struggle to cope [17]. The poor in Africa, particularly peasant farmers, are highly vulnerable to climatic and environmental hazards as their options for diversifying their resources and income sources are limited [9]. Thus, CVC affect agricultural production of farmers in Africa as well as Nigeria. Nigerian economy from past decades depends on the agricultural sector, which is reputed as the mainstay of the economy and the key driver for growth and development [18]. Yet, Nigeria is experiencing adverse climate conditions with negative impacts on welfare of millions of people, persistent droughts and flooding, off season rains and dry spells which have sent growing seasons out of track [19].

Agriculture will still remain the foreseeable future, the linchpin of the economy and the primary source of ensuring food security at local, national as well as global scale. Hence any threats to its optimal productivity need to be handled with all amount of seriousness [1]. In particular, the evidence as reflected in locally tailored solutions often provided by local farmers in mitigating agricultural challenges, it will be very true that cultural norms and values holds potential in raising or reducing the productivity of small-scale rice farmers and consequently improve or depreciate their livelihood respectively. Thus, The need to harmonized both climate change which constantly and continuously threatens agricultural productivity through the effects of higher temperature, more frequent droughts and flooding as well as rise in sea level that threatens rice production, And the Status quo of rice being a staple food capable of reducing hunger and for ensuring human health and nutritional food Security, rice productivity needs to be profitable while Farmers' Perception on Climate Change needs to be void of Dogmatic and Ancestral beliefs. The impact of global climatic change on agriculture, and especially precipitation and temperature variability (PTV), has recently become an issue of increasing importance. Rice production in Nigeria is dominated by smallholders' farmers who use traditional methods that are characterized with problems of low productivity [4]. However, relatively little is known about how cultural values and norms as reflected in local farmer's perception as well as in decision making will interact with climate change to sustain or erode agricultural productivity. [3] reported that local farmers are seriously concerned about rainfall variations because of the impact on food security, accessibility and utilization. Thus, it becomes imperative therefore, to investigate and know the in-depth knowledge of farmers on the impact of climate on rice production for ease of adaptation and to provide for further improvement in productivity.

Rice farmers have been witnessing heavy downpours due to intense rains as a result of variability in timing and amount of rainfall caused by climate change [23]. The degree and intensity which rains are experienced in recent times is far beyond what farmers are familiar and can grapple with in order to remain productive [23].

The focus of this study is centered on rainfall because rice production system in Nigeria is mainly rain-fed. Rain water supply is the limiting factor to the growth and production of rice in Nigeria as reflected by geographical distribution of rice-growing areas over region of heavy rainfall. Some of the major problems associated with rice production include drought, flooding, salt stress and extreme temperatures all of which are expected to worsen with climate change. [23]. Drastic changes in rainfall patterns and rise in temperatures will introduce unfavorable growing conditions into the cropping calendars. These changes modify growing seasons which subsequently reduce rice productivity [24].

2. Methodology

2.1. Study Area

The Dadin-Kowa is in Yamaltu Local Government area of Gombe State in the north east of Nigeria. Dadin-kowa town is located between Latitudes 10°19′19″N and 10.32194°N; Longitude 11°28′54″E and 11.48167°E [25]. It shares common boundary with Akko L. G. A in the South and West, Yamatu-Deda to the East and Kwami to the North. Dadin-kowa has an altitude of about 370 meters above sea level [25]. It is a residential and commercial area with such amenities as schools, Motor Park, market etc.

The study area is characterized by two distinct climates, the dry season (November–March) and the rainy season (April–October) with an average rainfall of 850 mm and the mean annual temperature is about 32°C, [26]. The dry season comes with the north eastern trade wind over the region originating from Sahara belt, the wind is dry and dust laden accompanied by low pressure system. The wet season comes with the south-westerly wind which is moisture laden ad originates from high pressure zone over the Atlantic Ocean to the low pressure zone over the Sahara.

2.1.1. Relief

The relief of the Dadin-kowa town ranges between 650m in the western part to 370m in the eastern parts [27]. The area in the eastern parts is dominated by flat terrain with hills of sandstones in the western part of the study area.

2.1.2. Soil

The soil of the study has a sandy clay loam texture, slightly acidic, low in major nutrients and moderate in available soil moisture content [26]. This is typical of savanna soils that are highly depleted with poor structure that requires close monitoring and adoption of best soil management practices to maintain its productivity [26].

2.2. Source of Data

The type of data required for this research include Annual daily rainfall data sourced from Upper Benue River Basin Development Authority Dadin-Kowa metrological station, similarly Perception of farmers toward rainfall variability and how it affect rice yield are sourced from administered questionnaire. Data for the research will be sourced from two main sources: primary source and secondary source.

2.2.1. Primary Data

The primary data for this study was obtained by administering questionnaire to 60 rice farmers in the study area.

2.2.2. Secondary Data

Daily rainfall data for seventeen years (2001 – 2017) was collected from the Upper Benue River Basin Development Authority office in Dadinkowa, Gombe State, other data and information on the research was obtained from books, dailies, dissertation, journals, thesis, websites and other public media relevant to the study. This help to provide facts for the research being undertaken.

2.3. Computational and Analytical Techniques

The rainfall onset and cessation dates, as well as the length of the rainy season were determined by adopting the percentage mean cumulative rainfall method. The method has the advantage of directly using the rainfall data or rainy days, rather than inferring the rainfall amount from other related parameters, making it appropriate for this study.

2.3.1. Plotting Rainfall Ogive

Firstly, the daily mean rainfall amount or rainy days from the entire data record (2001–2017) are calculated. For the determination of onset, cessation and length of the rainy season (LRS) or Hydrological Growing Season (HGS) in the study area five-day (pentad) were used to compute running sum for each year from 2001-20017. For example, the first five days are designated by “Z1” and the second

“Z2”, third “Z3” to the last “Z73”Where “Z73” = number of pentad in 365/5

365 = number of days in a year

5 = pentad

Pentad = P

P1 = Z1

P2 = (P1+Z2)

P3 = (P72+P73)

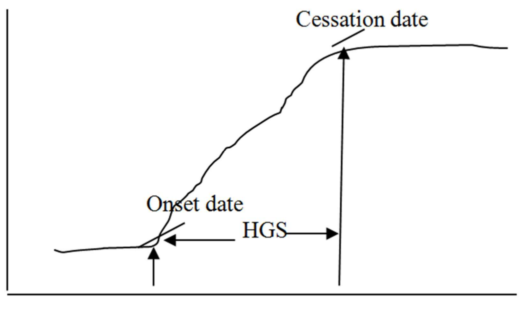

Figure 1. *Cumulative frequency graphs of onset, cessation and HGS.*

From the above computational procedure, cumulative ogive (cumulative frequencies of rainfall curves) for each of the years were plotted and cessation dates were deduced from the lower and upper points of inflexions as shown below. This procedure was adopted for each year throughout the 17 years period in order to derive the mean onset and cessation dates and the deduction of the length of rainy season (LRS) or the hydrological growing season (HGS).

2.3.2. Onset, Cessation and HGS Deviation Computation

OD = n-X

CD = n-X

HGS D = n-X

Where OD = Onset Deviation

CD = Cessation Deviation

HGS D = Hydrological Growing season Deviation

n = pentad value

X = Mean

2.4. Statistical Analysis of data Collected from Survey Questionnaire

Frequency distribution table is used to ascertain the frequency (f) and percentage (%) of the demographic characteristics of the respondents. This applies to Respondents awareness of changes in rainfall variation and perceived effect of rainfall variation on rice yield.

P = f x 100/n

Were P = percentage (%)

f = frequency

n = number of respondents

2.5. Sampling Design and Questionnaire

A multi-stage sampling technique is use to select respondents for the study. The first stage of selection entails purposive selection of 6 locations within the study area, in the second stage, the household will be chosen by random sampling technique. In order to fulfill the objectives of the intended study, a structured questionnaire survey is conducted, 60 respondents were sampled for the study. Data on respondent perception on the effect of rainfall were collected during the survey.

3. Results and Discussion

3.1. Relationship Between Rice Yield and Respondent on Onset, Cessation in Dadin Kowa

Result obtained from Table 1 reveals that, the onset of rainfall from 2001-2017 sway from 25-35 Pentade, resulting to 30th may as the onset mean date. This means that rain fall is reliable for crop germination within the given Pentade and the mean date 30th may, which is considered the onset of rainfall. The Pentade onset have a standard deviation of 3 (15) days, therefore implies that the onset of the rains can vary between 5th May ± 15 days on the lower limit to 24th June ± 15 days. The implication here is that any date of the onset of the rains that lie within these lower and upper limits of the onset is considered normal since it lies within the deviation of the onset. This also implies that crops planted above the deviation limit (± 15 days) are vulnerable to critical dry spell that may affect both plant germination and establishment. 2008 and 2014 have earlier rainfall onsets, with 4 and 5 onset deviation value respectively. This is considered normal. Similarly, 2002 have a negative deviation of-5, this is considered abnormal. The implication of this finding is that agricultural production and other rainfall dependent livelihood activities will be highly affected since onset of rainfall is highly unpredictable and late. Plant preparation and planting calendar, which are dependent on the dates of onset of rainfall, will be difficult to select by farmers [28, 29]. Predicted and confirmed shorter length of season that occurred in 2009. 12^{th} October as a findings of this work to be the cessation mean date justifies a very important outcome of this study were questionnaire results regarding the effects of the early cessation of rainy season on productivity growth of rice production are heterogeneous across farmers, depending on the financial capability and irrigation technology employed for those involved in both rain fed and irrigation agriculture.

3.2. Relationship Between Rice Yield and Respondent on Hydrological Growing Season

Judging by the computed Hydrological growing season (HGS) and days using cumulative rainfall model, the Hydrological growing season on average, extended over 6 months with a difference range of 10-55 days across the years. A shorter HGS of 110 days was observed in 2002 and 2013, while 2012 and 2014 were years with longer HGS of 165 days. It recorded a longer length of hydrological growing season for 2004, 2005, 2006, 2008, 2009, 2010, 2012 and 2014. Farmers identified these years for having met with crop unique optimum water requirement for proper crop germination and establishment consequently, higher yield. Respondents perceived effect of rainfall on rice yield. 95% respondents affirmed the occurrence of reduction and fluctuation in rainfall pattern and subsequently changes in the length of Hydrological growing season as shown in Table 1. The result however is in conformity with the findings of Egbe *et al* who reported that respondents are aware of alterations in climate parameters and the regularity in their manifestations [2],. The result reveals a favourable disposition by 25.0% of the respondents of rainfall variability effects on rice yield. This indicates a positive impact on rice yield while 75.0% of the respondents were unfavorably disposed to the effects of rainfall variability on rice yield, indicating a negative impact on rice yield.

Table 1. *Computed Onset, Cessation and Hydrological Growing Season (HGS) Pentadee, their Date and Deviation from 2001-2017.*

Year	Pentade Onset	Onset Deviation	Onset Date	Pentadee Cessation	Cessation Deviation	Cessation Date	Pentadee HGS	HGS Deviation	HGS in Days
2001	28	2	20^{th} /5	55	2	2^{nd} /10	27	1	135
2002	35	-5	24^{th} /6	57	0	12^{th} /10	22	6	110
2003	32	-2	9^{th} /6	58	-1	$17^{th/}$10	26	2	130
2004	29	1	25^{th} /5	57	0	12^{th} /10	28	0	140
2005	28	2	20^{th}/5	57	0	12^{th} /10	29	-1	145
2006	27	3	15^{th}/5	57	0	12^{th} /10	30	-2	150
2007	30	0	30^{th} /5	54	3	27^{th} /9	24	4	120
2008	26	4	10^{th}/5	58	-1	17^{th} /10	32	-4	160
2009	30	0	30^{th} /5	61	-4	1^{st} /11	29	-1	145
2010	28	2	20^{th} /5	57	0	12^{th}/10	29	-1	145
2011	33	-3	14^{th} /6	57	0	12^{th} /10	24	4	120
2012	27	3	15^{th}/5	60	-3	27^{th} /10	33	-5	165
2013	33	-3	14^{th} /5	55	2	2^{nd} /10	22	6	110
2014	25	5	5^{th}/5	58	-1	17^{th} /10	33	-5	165
2015	30	0	30^{th} /5	57	0	12^{th} /10	27	1	135
2016	31	-1	4^{th} /6	57	0	12^{th} /10	26	2	130
2017	30	0	30^{th} /5	56	1	7^{th} /10	26	2	130
MEAN	30		30^{th} /5	57		12^{th} /10	28		137
SD	3			2			3		17

Source: Authors Field Data 2018.

3.3. Demographic Characteristics of the Respondent in Dadin Kowa

Demographic factors such as Sex, Age, Marital status, Educational level, Farming experience among others had been found to relate either negatively or positively with rice production in different context by researchers [20]. It is therefore a matter of concern to understand how demographic variables affect rice production.

3.3.1. Gender

Gender is a socio-cultural concept used to differentiate male and female. Gender plays a significance role in the agricultural sector where both men and women are involved in the agricultural value chain activities that complement each other [21]. The federal ministry of agriculture and rural development (FAMARD) reported that women account for 75% of the farming population, in Nigeria [22]. They are largely involve in the production, processing and trading of such as sorghum, maize, rice, cassava, pepper, vegetable, yam and oil. Men carry out tedious task such as land clearing and felling down of trees, gathering and burning of bush. A survey on gender involvement in crop production by Federal Ministry of Agriculture and Rural Development showed that male involvement in crop production declined while female involvement was on increase [22]. This has been associated with the increase in male out-migration to urban areas.

However, the findings of this research work reveal that male constitute 85% while female constitute 15%, this implies that rice production in the study area is not balanced between the gender. This supports the findings of [30] where he pointed out that in West Africa, women's involvement in rice farming varies from region to region, and even with regions. The predominance of male farming in the study area may not be unconnected with socio-cultural and religious values, in the study area. Recognition of gender roles and the specific needs of both men and women are key to effective and productive rice farming.

3.3.2. Age Bracket

The respondent within the age bracket of 26 to 35 years were 28.3% and 38.3% were within the age bracket of 36 to 45 years which is similar to Adam *et al* who reported majority of rice farmers to be within the age category of 31 to 50 years [31]. Federal Ministry of Agriculture and Rural Development reported that farmers in the age bracket of 40 years were still energetic and have a lot of positive implication for the production of rice as a crop [22]. shows that majority of the respondents are young, energetic and enterprising.

Majority of the respondents are stable and could command societal respect as majority of the respondent are married. Being married could mean that the respondents are responsible.

Priority knowledge that farms in Nigeria are largely small scaled and generally less than 5 hectares. These farms are usually small sized fragmented and scattered and not continuous land holdings and posses a great challenge to the much desire agricultural mechanization / Commercialization in Nigeria [33]. With regard to farm size hold by rice farmers in the study area, 36.7% of farmers had <1 hectare, 50.0% had < 2 hectare, and 13.3% had ≥2 hectares. This justify the findings stated above were only 13.3% had ≥2 hectares.

Well experienced farmers have some positive implications for increased production [34]. The positive relationship between farming experience and farmers productivity suggests that farmers with a higher farming experience tends to have higher productivity than those with no or less farming experience. Similarly, Educational gives farmers the ability to perceive, interpret and respond to new information faster than their counterpart without education.

Table 2 shows the distribution of respondents' socio-demographic characteristics. As the results indicate, the distribution of rice farmers according to age categories shows that 28.3% of the respondent were within the age bracket of 26 to 35 years and 38.3% were within the age bracket of 36 to 45 years which is similar to [31] who reported majority of rice farmers to be within the age category of 31 to 50 years. As further shown in (Table 2), 85% were male and 65% married. Findings also show that 28.3% of the respondents attended primary school, 38.3% had secondary education and 13.3% were graduates of tertiary Institutions. The low tertiary education could be an impediment to perception as education has been found to be a determinant of perception [32]. With regard to farm size, 36.7% of farmers had <1 hectare, 50.0% had < 2 hectare, and 13.3% had ≥2 hectares. Farmers with farming experience of more than 15 years had 10%, 10 to 15 years had 31.7%, 6 to 10 years had 41.7%, and those with less than 6 years had 16.7%.

Table 2. *Demographic Characteristics of the Respondents in Dadin-Kowa.*

Variable description	Frequency (f)	Percentage (%)
Gender		
Male	51	85.0
Female	9	15.0
Age (Years)		
15-25	9	15.0
26-35	17	28.3
36-45	23	38.3
>46	11	18.3
Marital Status		
Single	14	23.3
Married	39	65.0
Divorced	5	5.0
Separated	4	6.7
Educational Level		
Informal	12	20.0
Primary education	17	28.3
Secondary	23	38.3
Tertiary	8	13.3
Farm Size (In Hectare)		
0 – 0.5	22	36.7
0.6 – 1	30	50.0
2 and above	8	13.3
Years of Experience		
0 – 5	10	16.7
6 – 10	25	41.7
10 – 15	19	31.7
15 and above	6	10.0

Source: Field Work, 2018. shows respondents' perceived effect of rainfall on rice yield. 95% respondents affirmed the occurrence of reduction and fluctuation in rainfall pattern and subsequently changes in the length of Hydrological growing season. The result however is in conformity with the findings of Egbe *et al* who reported that respondents are aware of alterations in climate parameters and the regularity in their manifestations [2]. The result reveals a favourable disposition by 25.0% of the respondents of rainfall variability effects on rice yield. This indicates a positive impact on rice yield while 75.0% of the respondents were unfavorably disposed to the effects of rainfall variability on rice yield, indicating a negative impact on rice yield.

Among the key findings of the Questionnaire survey are the following:

1. That the population of youths engaged in rice farming is low which could be attributed to rural-urban migration prevalence and implies loss of labour for rice production.
2. Farmers are aware of the reduction and fluctuation in rainfall pattern strongly influenced by Spirituality and personal experiences.
3. Findings also reveals that majority of the farmers are having 6 to 15 years of rice farming experience which suggests their ability to ascertain significant changes in rainfall variability.

4. Conclusion

This study has tried to relate the trend of mean annual rainfall records that covered a daily rainfall data for a period of seventeen (17) years with the perception of the farmers at local scale. (Dadin-kowa). The result has shown prevalence of rainfall variability as was confirmed by a majority of the farmers during survey whom having 6-15 years of rice farming experience, suggest their ability to ascertain significant changes in rainfall variability. In the case of rice production, result reveals that rainfall variability had adverse effect on the yield of rice in the study area. The adverse effect, though insignificant during the period of study, is a warning signal to rice stakeholders to take some precautionary measure against unfavorable effects of rain variability on rice yield.

5. Recommendations

A study understanding farmers' perceptions on the effect of rainfall variability on rice yield can prove extremely valuable. Furthermore, the findings and results presented here reveal some important insights and are also great sources of information for policy makers and extension workers alike. These insights lead to several important policy implications. First, a strong initiative by policy makers for planned adaptation is important. An effective climate information services can increase the success rate of adaptation and efficiency of resource use for rice production. Similarly, Future policy options needs to prioritize Sex, Age, Education and Family planning settings with Climate adaptation options.

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