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Climate Change and the Rice Farmers' Food Security in Kebbi State, Nigeria

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Abstract

Water supply planning and management in rice farming is addressing water supply challenge caused by climate change which could affect food security. Therefore, it is important to: assess the impact of water scarcity caused by climate change on the food security of the rice farmers in Kebbi state; investigate the efforts of the rice farmers to overcome the challenges of water scarcity during and after the rainy seasons; and examine the types of water supports the rice farmers received from government, NGOs and public in the study area to cushion the effect. Primary and secondary data were employed. The sample size of 300 was used and sampling methods included multi-stages and purposive samplings. Concepts of climate and water supply planning and management were reviewed. Findings revealed that due to shortage in water supply caused by climate change, 59.0% of the rice farmers practised rain-fed farming which may not guarantee food stability throughout the year; and the different ways water scarcity/inadequacy affected the rice farmers' livelihood and food security (access, availability, utilisation and stability) were also exposed. The paper concluded by recommending that there should be availability of data on the impact of climate change on: rice production per months, socio-economic characteristics of the rice farmers, their food availability and stability in every season of the year in Kebbi state; and the preparation of land use or/and regional plan/s in the state that consider rivers and their floodplains to be used by the rice farmers.

Keywords: Climate change, Food security, Impact, Kebbi state, Rice farmers.

Introduction

According to Heady and Ecker (2012), there are various definitions given to food security and its indicators but the worldwide accepted one was the one by FAO (1996), which states that there exists food security, when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious foods that meet their dietary needs and food preferences for an active and healthy life. This definition focuses on food access, availability, stability and utilization; and counted as the four dimensions of food security (Ike, Jacobs and Kelly, 2015). Going by statistics, it was confirmed that two billion people were living in moderate or severe food insecurity, as they didn't have regular access to food, not a necessary variety of nutritional value, or there was not enough food for the whole population available (Kralovec, 2020). FAO IFAD, UNICEF, WFP, WHO, (2020) establish that 820 Million of these two billion people facing food insecurity were living in hunger. The 2020 Global Report on Food Crisis (GRFC) (2020) avers that about 135 million people in 55 countries and territories are suffering from acute food insecurity while 73 million of this figure are from 36 countries in Africa (Otekunrin, Otekunrin, Sawicka and Ayinde, 2020).

World Data Lab (2020) establishes that Nigeria has an estimated population of 205,323,520 persons out of which 50% (102,407,327 people) are living in extreme poverty. Otekunrin et al. (2020) also

submit that Nigeria is the most populous nation in Africa and ranked number 7 globally with an estimated growth rate of 2.43 percent per annum. In another vein, Worldometer (2020) and World Data Lab (2020) equate the Nigeria's population to 2.64% of the total world population and was projected to 401million by 2050. Some years back, most especially during the oil boom, 50% of Nigeria population lived in extreme poverty within poverty threshold of $1.90 per day (World Data Lab, 2020). In recent time, the level of food insecurity in the country is at alarming rate that requires looking inward for urgent and immediate measures. One of these measures is rice production in large quantity to be able to take care of the present and future populations.

Seck et al. (2013) foresee that rice consumption in the Africa continent shall continue growing in the foreseeable future because of the continent's high population growth rate, rapid urbanization, and changes in employment patterns. In the same vein, Alexandratos and Bruinsma (2012) predict that the consumption of rice shall reach the saturation levels in an increasing number of countries by 2050. The percentage of Africa's population living in cities is expected to grow to 48% by 2030 and likely to face the threat of shortages in the supply of rice (UN-Economic Commission for Africa, 2015). The author stress that despite the rapid increase in local rice production after the 2007-2008 food crisis, the local rice production has never caught up with demand leading to importation of the food which is now restricted by the Federal Government. Therefore, as a staple food that more than 3 billion people rely on (Enriquez, Yadav, Evangelista, Villanueva, Burac, and Pede, 2021), enhancing rice production and supplying of water for its cultivation is essential to guaranteeing food security.

The Problem

Kebbi state has a rice-based developing economy. This made Lagos and Kebbi signed a MoU to invest in rice production in December 2016 in which they commenced distribution at the rate of N13, 000 per 50 kg bag. Kebbi state that is known as a rice producing state faces drought challenge which serves as a major constraint to her rice production and food security. According to Enriquez et al. (2021), for optimum growth and yield, rice requires about 1200 mm to 1600 mm of rainfall evenly distributed throughout its growing period. In addition, the UN-Water, WWAP (2012) establishes that producing 1 kilo of rice, for example, requires about 3,500 litres of water. This volume of rainfall/water evenly distributed is very rare in the whole Kebbi state. The few heavy rainfalls in the 2015 farming season destroyed 635, 000 hectares of low land rice in Kebbi and Jigawa alone (Awere, 2015) and in the 2018 farming season, over 2,000 rice farmlands were destroyed by flood in Kebbi State (Adebayo, 2018). With shortages of water during the rice farming season and flooding that pose threats to rice production and food security in the state and Nigeria at large; it is important to evaluate the effect of water supply planning on food security of the rice farmers in Kebbi state.

Objectives of the Study

The objectives include to:

1. assess the impact of water scarcity on the food security of the rice farmers in Kebbi state;
2. investigate the efforts of the rice farmers to overcome the challenges of water scarcity during and after the rainy seasons;
3. examine the types of water supports the rice farmers received from government, NGOs and public in the study area; and
4. proffer ways to use the available water resources to produce more rice which is essential for food security in the state.

Conceptual Framework

Climate Change

For better understanding of the concept of climate change, there is a need to differentiate between climate change and change in the weather. According to Mahato (2014), climate change is a change in the long-term weather patterns that characterize a region while the term "weather" can be referred to as the short-term (daily) changes in temperature, wind, and/or precipitation of a region. In line with this, Ojuederie and Ogunsola (2017) establish that climate change is a broad array of alterations in climatic and weather conditions which is characterised by shifts in average conditions and in the frequency and severity of extreme conditions. Therefore, it could be said that climate change is the transformation of climate which is usually characterised by the changes in the normal climate of a region in terms of temperature, precipitation, and wind. Mahata (2014) traced the cause of climate change to human activities such as industrialisation, urbanisation, deforestation, agriculture and change in land use pattern that lead to emission of greenhouse gases.

Mahata (2014) identifies three ways by which climate change may affect agriculture. These are: Firstly, increased atmospheric CO_2 concentrations which can have a direct effect on the growth rate of crop plants and weeds. Secondly, the induced CO_2 can influence plant and animal productivity as this may affect the levels of temperature, rainfall and sunshine required by the crop's growth and production. Thirdly, climate change may lead to rises in sea level, the consequences are loss of farmland by inundation and increasing salinity of groundwater in coastal areas. According to Ali, Liu, Ishaq, Shah, Abdullah, Ilyas and Din (2017), establish that the changes caused by climate change in agricultural production, could potentially cause food uncertainty for 9 billion people by 2050. Orifah, Sani, Murtala and Ibrahim (2020) corroborate this by stating that the consequences of climate change are severed for the developing countries like Nigeria where poverty, small farm holdings, and lack of finances to initiate mitigation strategy predominate. FAO (2015) identifies 4 direct effects of climate change on food security to include loss of rural livelihoods and income; loss of marine and coastal ecosystems, and livelihoods; loss of terrestrial and inland water ecosystems, and livelihoods; and food insecurity and breakdown of food systems. To cap it all, IPCC (2022) concludes that climate change has had already different negative impacts on human systems, including on water security and food production, health and well-being, and cities, settlements and infrastructure.

Concept of Water Supply Planning and Management

Water is very important when talking about agriculture in any nation that focuses on sustainable agricultural development and food security as a national policy. According to Chartzoulakisa and Bertaki (2015), more, in terms of food security and agricultural development can be achieved with less water through better planning and management. Planning and managing a surface water supply require extensive studies. These include measurement of stream /river/ runoff flow for a long period of time, ascertaining of flood and drought time and severity and size of the water resources intending to plan/manage. It is noteworthy that water supplies can be grouped into surface or subsurface though the two have their sources from rainfall/precipitation. Jones (2022) established that, little is known about subsurface supplies of water than about surface supplies. The foregoing limits the scope of this study to the surface water planning and management.

Chartzoulakisa and Bertaki (2015) submit that better planning and management of water supply usually refers to improvement of water allocation and/or irrigation water efficiency. Therefore, sustainable water planning and management in agriculture aims at matching water availability and

water needs in quantity and quality, in space and time, at reasonable cost and with acceptable environmental impact (Chartzoulakisa and Bertaki, 2015). It can be deduced from the definition that sustainable water management can lead to water security, food security and environmental issues as presented in Figure 1. The World Economic Forum (2013) establishes that sustainable water management is one of the greatest twenty-first-century challenges and identifies water supply shortage as one of the gravest risks facing society. Within the same context, OECD (2012) posits that in the world, 1.6 billion people live in regions experiencing severe water stress and predicts that by 2050 this will increase to 3.9 billion people.

From Figure 1, water security is a part of sustainable water management. According to UN (2013), water (Blue or/green) security can be broadly defined as the capacity of a population to safeguard sustainable access to adequate water (in quantity and quality) for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability. This definition can be summarised as access to water in both quantity and quality for the various uses and people. Deficient water security will definitely affect food security because they are interconnected. Food security (Figure 1) is defined as the availability and access to sufficient, safe and nutritious (nutrition security) food to meet the dietary needs and food preferences for an active and healthy life (FAO, 2002). To this end, it can be said that food security encompasses edible agricultural crops, aquatic animals, wild foods/crops and livestock which needs water for their survival and production. Lastly, from Figure 1, soil management, irrigation and fertilizer application and disease and pest control are agricultural practices which are related to sustainable water management in agriculture and need to be controlled if the environment should be protected.

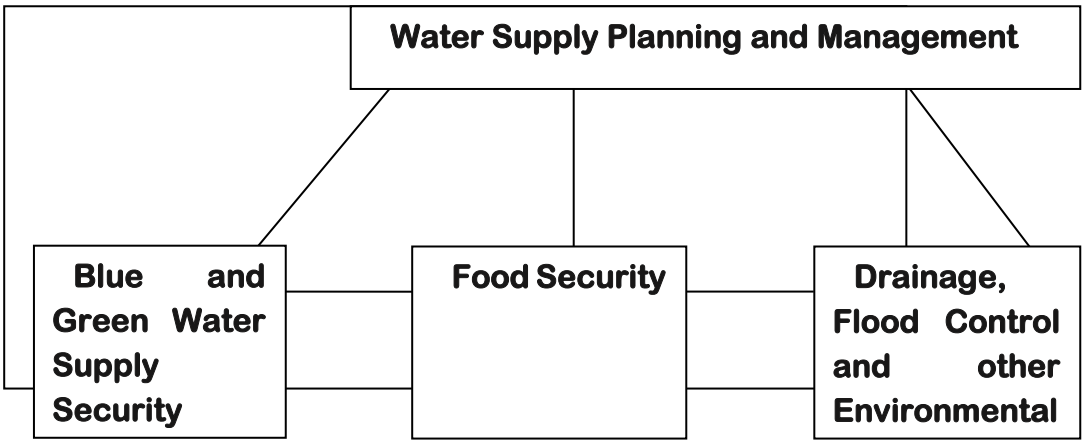

Figure 1: *Sustainable Water Supply Planning and Management Components*
Source: *Author's Construct, 2022*

Based on the foregoing, UN Water (2006, p.4) defines water scarcity as "the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully". This definition mentions, "Meeting the demand by all sectors" which include the domestic, industrial and agricultural sectors. To this end, one can attribute the causes of water scarcity to the natural climatic condition, level of demand, quantity and quality of supply and bad

governance. To overcome those situations, CNN (2000) recommends a water management strategy, which is a plan or a specific project to meet a need for additional water by a discrete user group; this can mean increasing the total water supply or maximizing an existing supply. CNN (2000) expresses further that strategies can include development of new groundwater or surface water supplies; conservation; reuse; demand management; expansion of the use of existing supplies such as improved operations or conveying water from one location to another; or less conventional methods like weather modification, brush control, and desalination. It was concluded by CNN (2000) that factors such as the quantity of water the strategy could produce; capital and annual costs; potential impacts the strategy could have on the state's water quality, water supply, and agricultural and natural resources; and reliability of the strategy during time of drought should be considered in the water management strategy assessment process.

Literature Search

Water Management and Rice Production

Rice, maize and wheat are known as the main staple food sources for human, but rice becomes the most important with respect to human nutrition and caloric intake but maize is used for other purposes than human consumption ((Datta, Ullah and Ferdous, 2017). According to Akinbile, Abd El-Latif, Abdullah and Yusoff (2011), rice (*Oriza stiva* L.) is one of the most important staple foods for the world's population and ranks third after wheat and maize in terms of production. Rice is considered not only as a rich source of carbohydrate and proteins but also consists of vitamins, minerals and fibre. It is cultivated in the humid tropical and sub-tropical climate characterised by high temperature and high relative humidity (Kapoor, Arya, Siddiqui, Kumar and Amir, 2011). In a situation where the humidity is not high like Kebbi state, the available sources of water such as boreholes, rain and rivers should be managed to achieve food security in such an area. In addition, rice is the largest consumer of water in the agricultural sector (Thakur, Mohanty, Patil and Kumar, 2014) and most of the countries consume their own rice making its economic different from other export commodities (Datta et al., 2017).

Water is essential for rice cultivation and its supply in adequate quantity is one of the most important factors in rice production (Mondonedo, 2008; Akinbile, 2010). The challenge facing the sustainable rice production in any region or country is decrease in the amount of water used while maintaining or increasing grain yields to meet the demands of an ever-growing population (Yang and Zhang, 2010). However, increase in water demand by non-agricultural uses has created threat to food security through rice production, which requires a serious water management. In a situation where there is no sufficient water for rice irrigation, there is a pressing need for the betterment of water resource management so as to increase water productivity of agricultural sector. In this regard, Ricegrowers' Association of Australia (2012) suggested four guidelines for rice growers to be more water wise. These include: (1) rice can only be grown under strict regulations such as location, soil types and water availability; (2) shorter season rice varieties are the high choice so that rice is grown with less water; (3) plant crops require less water in the winter to utilize the remaining soil moisture from a preceding rice crop; and (4) implement actions conform to the plans set out by the state/national governments to minimize irrigation impact on environments.

In conclusion, this study focuses on the influence of water efficiency, availability and quality on rice farmers' food security in Kebbi state. This requires findings on improved water control, appropriate cultural techniques and avoidance of salinity through planning and management. This paper aims at

contributing to the literature by recommending how to maximise the existing sources of water and land for rice production in Kebbi state in a way to cater for the present generation and posterity.

Materials and Methods

Study area

Kebbi states is one of the states that are located in the extreme northwestern part of Nigeria. It covers approximately 18.591 Km^2. It is geographically located between latitudes 10° and 14° N and longitudes 3° and 7°E of the equator. As shown in Figure 2, Kebbi State shares international boundaries with Benin Republic and Niger in the west and bounded by Niger and Zamfara States of Nigeria in the South and East. The climate in the state is semi-arid coupled with severe water scarcity from October to May and water availability only in July to September with an annual average rainfall of less than 750mm. The mean monthly temperature ranges between 13° C in December through February, and 40°C in April and May. The relative humidity in Kebbi state varies from 10% in February to 90% in August. The main occupation of the people is farming and over 70% of the people practice one form of agriculture or the other (Ogungbenro and Morakinyo, 2014). According to Oyediran (2018), the landscape of Kebbi State is dominated by extensive flood plains. Rima River, Shella River, Yauri River (River Niger tributaries) have broad flood plains which favour the rice production. Within the same context, Oyediran (2018) submits that the highest solar radiation in Kebbi State is received in April and the lowest value occurs in December when the harmattan haze prevents the radiation from reaching the earth surface.

Kebbi State has a total land mass of approximately 36,229 sq. km. According to Oladimeji, Ajao, Abdulrahman, Suleiman and Bolaji (2016), only an estimated 13,209 sq. km of the total land is being used for cultivation and fadama (wet) land covers about 200,000 ha of fertile land, mainly situated along the floodplain and mostly used in rice production. Orifah et al. (2020) establish that Kebbi State is a leading producer of rice in Northern Nigeria and recent reports had revealed imprints of aggravated climate change events in the State. This requires serious water supply planning and management to be able to cope with its effect on rice production in the state. Although, Sahabi-Augie (2021) establishes that the total rice output produced annually in the state has reached over four million tonnes. The United Nations World Water Development Report (2012), which states that producing 1 kilo of rice, requires about 3,500 litres of water. Therefore, to get the rough estimate of the amount of water used to produce 4,000,000 tonnes (4,000,000,000kg), 4,000,000,000kg was divided by 3,500 litres to arrive at 1,142,857.14 litres of water. Getting this large amount of water every year to produce 4 million tonnes of rice will require augumenting the existing water supply with reliable water sources that will help in ensuring food security for the rice farmers. In addition, planning and management should not be left behind.

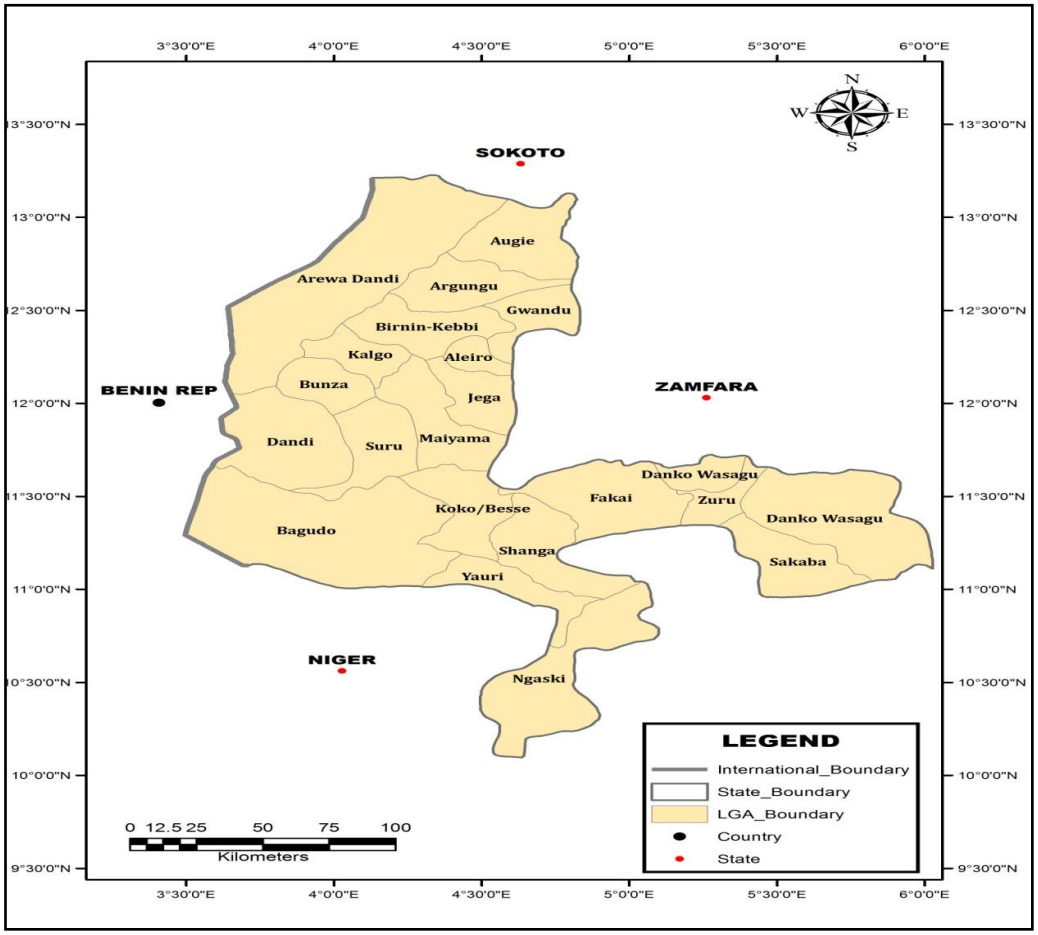

Figure 2: *Kebbi state and the various Local Government Areas (LGAs)*
Source: *https://www.gamers.com.ng/, 2018.*

Data and Sampling Method

Data used in this study were the primary and secondary data. Primary data were sourced using structured questionnaires, direct personal observations and oral interview with the rice farmers which was interpreted by one Hausa student. The secondary data that formed the introductory parts of this paper were sourced from journal articles, internet materials and government records on rice production and water management. Sample size of 300 was used and the sampling methods include multi-staged, systematic and purposive samplings. The selection of 300 sample size was guided by similar consideration by Ali et al. (2017) which was a related study. The first stage of sample selection was the selection of Kebbi North senatorial district, from the three districts that the state has as presented in Table 1. The selection was done through systematic sampling that requires selection of a sample after an interval of one. The selected Kebbi central senatorial district comprises Arewa, Argungu, Augie, Bagudo, Dandi and Suru Local Government Areas. The second stage of sample selection was the selection of settlements from each of the selected LGAs and lastly the selection of the 300 households that were interviewed mainly the rice farmers. The above-mentioned methods made the sampling methods to be multi-staged, systematic and purposive samplings. Descriptive statistics was used to analyse the collected data and presented in Tables.

Table 1: The Senatorial Districts and the Local Government Areas (LGAs) Composition in Kebbi State

Senatorial District	LGA Composition	No. of LGAs
Kebbi Central	Aleiro/Birnin Kebbi/Bunza/Jega/Gwandu/Kalgo/Koko-Besse/ Maiyama	8
Kebbi North	Arewa/Argungu/Augie/Bagudo/ Dandi/Suru	6
Kebbi South	Fakai/Ngaski/Sakaba/Shanga/ Zuru/ Wasagu-Danko/Yauri	7

Source: *INEC, 2018*

Findings and Discussion

The socio-economic characteristics of the respondents depict factors that relate to the social and economic factors. As regards to this study, the relevant ones were sex, literacy level, income level, size of the farm, types of farming and period of farming. Table 2 revealed that large number (70.3%) of the rice farmers interviewed were male unlike other areas such as the eastern part of Nigeria where majority of the farmers are females. In addition, 64.3% of the respondents could neither write nor read while 35.7% were literates (see Table 2). It could be deduced from this revelation that rice farming in Kebbi state is for both literates and illiterates. The interview conducted in the field showed that many of the rice farms were owned by civil servants and high ranked politicians. The presence of the illiterates among the farmers will make the adoption of new varieties and technologies easier. In terms of income level, high percentage of the respondent realised between ₦61,000 and ₦80,000 in a season, followed by those that earned between ₦41,000 and ₦60,000 while the least went to those that submitted, they realised less than ₦20,000 in a season. This may be associated to the water efficiency and amount invested on irrigation. Regarding the size of farm, most (47.7%) of the respondents farmed on land less than an acre (see Plate 1). It could be deduced from this that the small farm land sizes was due to the fact that there was high demand for land near the river for irrigation rice farms. This made most of the rice farmers in Kebbi state subsistent ones. In addition, Table 2 depicts that 59.0% of the respondents were rainfed rice farmers. This is in consonance with Rockström, Hatibu, Oweis, Wani, Barron, Bruggeman, Farahani, Karlsberg and Qing's (2007) prediction that rainfed agriculture will remain the major source of food production in the coming decades and every plan should be directed toward improving water management in rainfed lands.

Plate 1: Land Allocated to Rice Farmers at Arugungu

Source: *Field work, 2021*

Table 2: Farmers Characteristics

Variable	Frequency	Percentage
Sex		
Male	211	70.3
Female	89	29.7
Total	**300**	**100.0**
Literacy Level		
Illiterate	193	64.3
Literate	107	35.7
Total	**300**	**100.0**
Income in ₦/Season		
Less than 20,000	17	5.6
21,000 – 40,000	59	19.7
41,000 – 60,000	71	23.7
61,000 – 80,000	105	35.0
Above 81,000	48	16.0
Total	**300**	**100.0**
Size of the farm in Acre		
Below 1 acre	143	47.7
1 – 5	16	5.3
6 – 10	23	7.7
11 – 15	21	7.0
16 and above	97	32.3
Total	**300**	**100.0**
Period of farming		
Raining season only	177	59.0
Dry season only	95	31.7
During both dry and raining seasons	28	9.3
Total	**300**	**100.0**

Source: *Field work, 2021*

Assessment of the Impact of Water Scarcity on Food Security of the Rice Farmers

Water scarcity in this regard is a situation when water supply is insufficient to meet the needed water. Kumari, Kumari and Sharma (2021) identify the critical stage of water requirement in rice farming as: (1) active tilling (2) panicle initiation (3) booting (4) heading and (5) flowering. This submission depicted that it's only during rice harvesting that water is not needed. According to the revelation in Table 3, 33.6% of the respondents established that water scarcity affected their household food security in the areas of loss of income (food access), intensified of risks to food security (food availability) and increase in malnutrition (Utilisation). This was followed by those (32.7%) that focused on just food availability while the least percentage went to those that picked 1 and 2 option. A respondent (Alhaji Umaru) submitted that:

Water scarcity causes changes in rice production which caused food uncertainty to us as rice is our major food here in the north. It affects us as there is no money to buy other foods even rice production and access to food.

It could be deduced that water scarcity affected rice farming in several ways such as quantity and quality of crops in terms of productivity, growth rates and moisture availability which directly affect the pillars of food security (access, availability, utilisation and stability).

Table 3: Impact of Water Scarcity on the Food Security of the Rice Farmers

Variable	Frequency	Percentage
Loss of rural income (food access)	62	20.7
Intensification of risks to food security (availability)	98	32.7
Increase malnutrition (utilisation)	23	7.7
All of the above (Stabilisation)	101	33.6
1 and 2	16	5.3
Total	**300**	**100.0**

Source: Field work, 2021

The Efforts of the Rice Farmers to Overcome the Challenges of Water Scarcity

It is a good idea to try one's effort to overcome a challenge. Table 4 presented the efforts taken by the rice farmers to overcome water scarcity problem as a result of climate change. Large number (33.3%) of the respondents adopted digging of deep wells in their farms for irrigation (Plate 2), this was followed by those that adopted tapping water from the existing river through pipes to their farms and 11.0% dammed the existing river/s (Plate 3). It could be inferred from these results that efforts were made based on farmers' financial capacity, location of the farms and size of the farms.

Plate 2: *Hand Dug Well covered with a Tyre and the little Pumping Machine*

Plate 3: *Tapping water from an existing River through a Pipe to the Farms*

Plate 4: *Damming of an existing river for Rice Farm Irrigation at Jega*

Source: *Field work, 2021*

Regarding the efficiency of the method/efforts adopted, Table also depicts that 40.0% of the respondents submitted that their efforts were marginally efficient. According to these people, the reason was that the methods/efforts were meeting their present needs for now. Those that disclosed that their method was very efficient were those that had laid pipes and practised an advanced irrigation. It could be deduced that water efficiency is relative. So, what is efficient by a farmer may not be efficient to the other. What really matters is meeting one's demands, expectations and objectives.

Table 5: Methods/Efforts to Overcome Water Scarcity and Level of Efficiency

Efforts to Overcome Water Scarcity Challenge			
Irrigation		92	30.7
Damming of the existing River/s		33	11.0
Digging of deep wells	100		33.3
Channelising a nearby river/stream to the farm	75		25.0
Total	300		100.0
Efficiency of the method			
Very Efficient	28		9.33
Efficient	67		22.33
Moderately Efficient	82		27.33
Marginally Efficient	120		40.00
Not Efficient	3		1.00
Total	**300**		**100.0**

Source: *Field work, 2021.*

Water Supports the Rice Farmers Received from Government and/or NGOs

The rice farmers in Kebbi State were receiving supports from both the state and federal government. According to the Chairman, Rice Farmers Association of Nigeria (RIFAN) in Kebbi, Alhaji Muhammed Sahabi-Augie (2021):

All the farmers were given inputs such as fertiliser, water pumps, agro chemical and seeds, as well as fuel for their water pumping machines. In addition, rice farmers also benefitted from the Anchor Borrower Programme (ABP) that helped in boosting our production.

From the words of the RIFAN Chairman, governments provided pumping machines and water pumps for the rice farmers in the state without consultation with them to know what exactly they were in need of or preference. What about efforts to make water available and efficient every season (dry and wet)?

Conclusion

This paper is about the effect of water supply planning and management on rice farmers' household food security which is a title that has received little attention in the food security literature and this may be the reason Kebbi state government was silent about it in its provisions. In addition, the paper has also evaluated the relationship that exists between water supply planning and management and food security at the household level. It has demonstrated that one way of enhancing rice farmers' (small farm holders) food security in the aspect of achieving improved yields is to ensure water efficiency, availability and quality for the rice farmers in Kebbi state. Findings revealed that: 1. Due

to shortage in water supply, many rice farmers practiced rain-fed farming which may not guarantee food stability throughout the year; 2. Many of these rice farmers most especially the low income ones needed money to tap from the existing water resources and buy irrigation equipment which will enhance their productivity; 3. Water scarcity/inadequacy is affecting rice farming in Kebbi state in several ways such as quantity and quality of crops in terms of productivity, growth rates and moisture availability which directly affect the pillars of food security (access, availability, utilisation and stability); 4. The rice farmers' efforts were marginally efficient because the financial and technical resources that will expose them how to plan and manage the existing water resources were not there: 5. The supports received from the state and federal government were inadequate as there was no support on water planning and management. This study has established the fact that water scarcity/inadequacy poses threats to livelihoods as well as food security of the rice farmers in Kebbi state; therefore, urgent water supply planning and management are needed to make water resources in the state more efficient and available. To achieve this, the following recommendations were made:

Recommendations

1. Data is very important in water supply planning and management. Therefore, there should be availability of data on the impact of climate change on: rice production per months, socio-economic characteristics of the rice farmers, their food availability and stability in every season of the year in Kebbi state.
2. In water supply planning and management to overcome climate change impact, the service radius of every water source using for irrigation purposes should be defined. This deals with the area the water source can serve at a particular time and season.
3. Furthermore, the population of the users of a water resource at every season should be known. This will reveal the bearing capacity of the source for a season. Therefore, if the volume of the water source was reduced, the population of the users should be also reduced.
4. There should be availability of timely and adequate other complementary support services such as loan, agricultural training on how to plan and manage water resources, drought tolerant/improved rice seeds, and market support for smallholder rice irrigation farmers to succeed in reducing household food insecurity.
5. Public participation in every water supply planning from inception to completion by rice farmers is very important. This will help in prioritising what water supply planning and management practices need most. Thus, participatory water resources planning processes is a must.
6. In preparing land use or/and regional plan/s in the state, rivers and their floodplains must be considered. This should involve considering the variations in surface water flows and aquifer storage volumes over space, season and time.
7. The Kebbi State Ministry of Agriculture should employ river basin and estuarine managers that will see to the planning and management of water resources effectively and efficiently, meeting the demands or expectations of all rice farmers and other users, and reconciling divergent needs.

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