Harnessing the link between Climate change and Traditional Food Preservation Methods: Implications for Global Food Security and Public Health.

Abstract.

Climate change is a global issue, which impacts the different geographical zones in different levels. It is also linked to numerous human health issues, which are a concern to human health. This paper therefore assesses the effects of climate change on food security, traditional methods of food preservation and health status in Nigeria between. The research also reveals increased average annual temperatures and reduced rainfall as evidenced by data from NIMET and NEMA as the effects of climate change, which has led to disastrous impacts on agriculture, water resources and food security. The study shows that climate change has an adverse impact on food security through lowering crop productivity, raising post-harvest losses, and diminishing the efficacy of conventional preservation techniques like sun-drying and smoking because of high humidity and unpredictable weather patterns. This in turn leads to increased food wastage, malnutrition, hunger and food borne diseases especially in the rural areas. Moreover, the study establishes a correlation between climate change and food insecurity leading to poor nutrition among pregnant women and children, which has led to high under five mortality rates. The study also reveals that despite the fact that the rate of child mortality has been declining in Nigeria in the last one decade, climate change, poor nutrition, and inadequate food preservation methods remain critical threats to public health and food security. This study calls for climate smart preservation practices, improved access to healthy foods and improved health care delivery to reduce the effects of climate change on food security and health in Nigeria.

1.0 Introduction.

Climate change is now affecting ecosystems around the world in a way that has major implications for agriculture, food security, and health. Its impacts are being felt differently across different regions and it presents a major threat to the attainment of the UN Sustainable Development Goals (SDGs) especially those that are environmental and health related (Halim, S.A.; Dasgupta, P.; Hayward, B.; Kanninen, M., 2019).

One of the research gaps is the impact of climate change on indigenous food preservation methods. These traditional techniques are essential for food preservation especially in areas where the modern preservation technologies are not available. The disruption of these practices not only leads to food wastage and post-harvest losses but also has a direct impact on the health of the people. Climate change is a reality

and its effects on food systems and human welfare call for the need to come up with mitigation measures that incorporate both conventional and innovative preservation methods. Without these interventions, the achievement of the SDGs especially those related to hunger, health, and environment will be hard to realize.

Traditional food preservation methodsis a critical area of study in looking at the link between climate change. This has implications for both food security and public health. Climate change with increased global temperatures, unpredictable weather conditions and increased occurrence of events such as droughts and floods affects agricultural productivity and the conditions for storage, processing and food preservation. The traditional methods of food preservation are many. The popular ones are drying, fermenting, smoking, and salting .These have been used to make food available during periods of scarcity or non-growing seasons. According to Abegunde & Hoffman, (2022) tthese methods are crucial in the fight against post-harvest losses especially in the developing world. In these countries, access to modern preservation technologies is limited . However, new climate conditions are making these methods less effective and there is a need to understand their effectiveness in reducing food loss and their impact on public health.

A major threat to food security is basically, disruption which is associated to climate change. It has affected these traditional techniques of preservation and nutritional health of the world especially in the resource poor settings.These communities are associated with high dependence on such preservation methods. High temperatures, high humidity and extreme weather conditions reduce the efficiency of simple preservation methods like sun-drying and smoking and lead to high post-harvest losses (FAO, 2021). For instance, in tropical and subtropical areas, increasing humidity hastens the deterioration of dried grains, fruits, and fish, while unpredictable rainfall shortens the time available for drying and enhances the chances of mold formation and food spoilage (Sheahan & Barrett, 2017). The end result is increased vulnerability to malnutrition and food borne diseases which compounds the effects of existing food insecurity (Fang &Wakisaka, 2021).

Foods that are not stored properly in very hot or humid conditions become a host to pathogens and hence lead to diseases like botulism and mycotoxin contamination (Bai

et al., 2023). These food losses not only affect availability but also food security since most rural farmers engage in subsistence farming and food preservation. As climate induced food losses increase, households are unable to afford the food during the lean season hence increasing the risks of seasonal hunger and food insecurity (Khan & Johnson, 2022). Smallholder farmers, women, children and the elderly who use traditional preservation methods are most affected by these challenges.

Food losses are not only a matter of availability but also impact the nutritional quality of the food that is available for consumption. Those that occur after the harvest, due to climate change, impact on the consumption of various foods that are important in human nutrition and health. Households with poor access to adequately preserved foods are likely to consume low variety diets that are lacking in micronutrients, therefore, high incidences of malnutrition diseases such as vitamin A, iron and zinc deficiency are evident (Fraval et al., 2019).This has adverse effects on public health especially among children, pregnant women and the elderly because they are most vulnerable to malnutrition diseases such as anaemia, diarrhoea and respiratory diseases (UN These food losses not only reduce availability but also have an adverse effect on food security, especially in the rural areas where farming is the main source of food production and storage. With climate losses increasing, households are unable to provide food during the lean season thereby increasing the risk of seasonal hunger and food insecurity (Khan & Johnson, 2022). These challenges affect vulnerable groups of people, such as smallholder farmers, women, children, and the elderly who use traditional preservation techniques.

Food losses are not only a question of availability but also of the quality of the food that is available for consumption. The losses that occur after the harvest as a result of climate change impacts the kind of foods that are available for the people and this is very important for the health of the people. Households with limited access to properly processed food are likely to consume monotonous diets that lack micronutrients, which is one of the causes These food losses not only affect availability but also food security since most of the food is produced and preserved through subsistence farming in the rural areas. With climate-induced food losses, households are unable to have a steady food supply during the lean season and this increases the chances of seasonal hunger and food insecurity (Khan & Johnson, 2022).

The smallholder farmers, women, children, and the elderly who depend on traditional preservation methods are the most affected by these challenges.

These losses due to climate change affect the post-harvest foods, and this reduces the dietary diversity which is essential for human nutrition and health. Households with poor access to adequately preserved food are likely to rely on unvaried diets that lack micronutrients and thus lead to high incidences of malnutrition and deficiencies in vitamin A, iron, and zinc (Fraval et al., 2019).This has severe implications on public health especially among children, pregnant women and the elderly, who are most vulnerable to diseases associated with malnutrition including anemia, diarrhea and respiratory diseases (UNICEF, 2020).g proper nutrition and overall health. Households with limited access to adequately preserved food are more likely to resort to monotonous diets that lack essential micronutrients, contributing to increased rates of malnutrition and deficiencies in vitamin A, iron, and zinc (Fraval et al., 2019). This has grave public health consequences among children, pregnant women, and the elderly, who are more susceptible to malnutrition-related diseases, such as anaemia, diarrhoea, and respiratory infections (UNICEF, 2020). It is crucial to increase awareness of climate change in public health systems, especially inlow income countries where climate-related disorders worsen the already strained health systems. In SSA including Nigeria, issues such as weather risks and shifts in rainfall patterns are common climate change issues. Hence, knowledge of Nigeria's response to these challenges will assist other SSA countries to learn how to improve on their health care systems and cope with climate change. The measures that Nigeria has taken in its effort to reduce the gaps in healthcare can be used to persuade other such countries in the region to collaborate in addressing the issues that they encounter.

While there is a vast literature on climate change, food security, and public health, there is a dearth of research on the impact of climate change on traditional food preservation practices and the consequent nutritional and health outcomes in rural, resource-scarce settings. (Food Security and Climate Change,2023)This research seeks to fill this important gap.

This study is unique because it helps to fill the gap between climate change, traditional food systems, and health outcomes.Although there is a vast literature on the impact of climate change on agricultural production, this paper highlights a

critical but less explored area, which is food preservation. Its holistic approach correlates preservation techniques with food security and health issues and, therefore, is a significant contribution to the theoretical and practical literature. The research is expected to draw interest from scholars worldwide because of its unique approach and possible solutions to one of the biggest problems facing the world today.The results from this study will help to support several of the SDGs, including SDG 2, 3, and 13. This research is relevant to international goals of eradicating hunger and malnutrition and the effects of climate change on the most susceptible populace by concentrating on the relationship between food conservation, food security, and health.

It will also feed into sub continental architectures like the African Union's Comprehensive Africa Agriculture Development Programme (CAADP) .The study will enrich existing data towards policy advice for coherent approaches to address climate change impacts on food systems and health.

2.0 ConceptualFramework

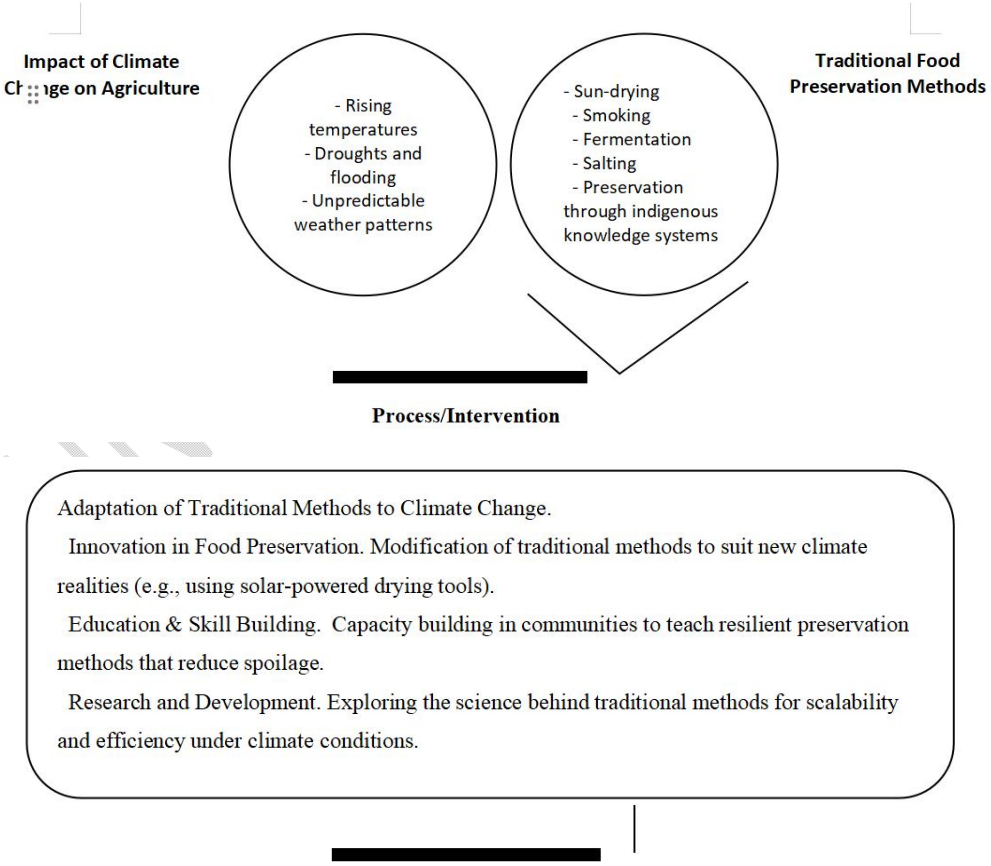


Figure 1. Author's compilation

This conceptual framework links climate change to traditional food preservation as the core process that affects food security and health . In this way, the framework shows how the improvement of traditional approaches through adaptation and innovation can lead to sustainability and resilience of food systems under climate conditions.

Climate change and malnutrition are two of the most pressing issues in the world today.Salas, R. N., Shultz, J. M., & Solomon, C. G. (2020).Addressing climate change and malnutrition shows a number of sectors and how they are related and how combating one has benefits to the otherand public health . Phalkey, R. K., Aranda-Jan, C., Marx, S., Höfle, B., &Sauerborn, R. (2015).By enhancing traditional methods through adaptation and innovation, the framework illustrates a pathway to achieving sustainability and resilience in food systems amidst climate pressures.

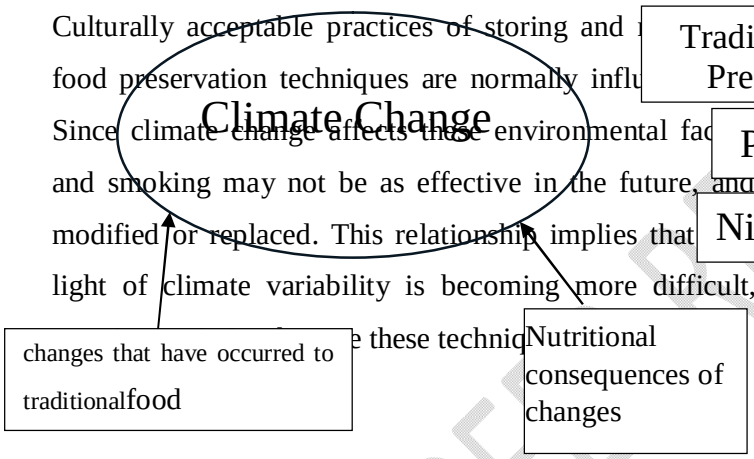
Climate change and malnutrition are two of the biggest challenges facing humanity today. Responding to climate change and malnutrition reveals a range of areas where the two interact and how addressing one can have positive impacts on the other. (FAO,2024)

Traditionally, food preservation techniques have been used to minimize post harvest losses especially in the rural areas where access to modern preservation methods such as refrigeration and cold chain are limited. These techniques are not only important for sustaining food stocks but also for retaining the quality of the foods. For example, fermentation, which is a common preservation technique, enhances nutrient absorption and decreases the number of pathogenic micro-organisms. However, as climate change affects food systems across the world, these preservation methods are becoming less effective. These techniques are influenced by changes in humidity, temperature, and rainfall, which lead to higher spoilage and food borne illnesses, according to Zenda (2024).

The application of traditional preservation methods in the light of climate change may therefore lead to more severe adverse effects on the public health. Some of these methods are sensitive to environmental changes and since climate changes are now more frequent, these techniques are less accurate. For example, drying, which is one

of the most widespread methods of preservation, requires sunny weather, but it can rain at any time, and then foodstuffs will be covered with mold and other unwanted additions. This in turn threatens food safety and quality, and a decrease in the availability of safe and healthy foods especially in the developing countries where access to modern preservation techniques is a challenge (Liu et al., 2023).

Global warming, which is defined by the rise in temperature, fluctuating weather conditions, and natural disasters, has an impact on food production and perishability. Culturally acceptable practices of storing and n traditional food preservation techniques are normally influ the region. Since climate change affects these environmental fac mentation, and smoking may not be as effective in the future, and therefore, may need to be modified or replaced. This relationship implies that ood in the light of climate variability is becoming more difficult, particularly for rural and e these techniq



3.0 Methodology.

Picture 1 :Conceptual Framework

Carrying out case studies in selected areas can help in understanding the correlation between traditional food preservation techniques, health status, and climate change.Nigeria was chosen as the case study.The following set questions were used to assess the research interest properly.

>>>The changes that have occurred to traditional food preservation in Nigeria due to climate change

>>>>>The nutritional consequences of changes with climate?

>>>>>> Policy measures can be taken to encourage sustainable food preservation in Nigeria?

For this study,we used the following proxies for climate change,Traditional Food Preservation,food security and Nutritional Health Outcomes:

Climate Change:

1.Rising average annual temperature

2.Fluctuations in the annual rainfall (mm)

3.Droughts, floods, or extreme weather events occurring with a certain frequency

Traditional Food Preservation:

1.Number of days taken to sun-dry foods under normal and changing climate regimes

2.Smoking efficiency (for example, the spoilage rate) under conditions of increased humidity

Food Security:

1.Undernourishment in the population as a percentage of the total population

2.The GFSI score for Nigeria

Nutritional Health Outcomes:

1.Proportion of children under five years of age who are stunted, wasted, or underweight

2.Micronutrient malnutrition (for example vitamin A, iron, zinc)

3.Prevalence of diseases associated with diet (for example anaemia, immune suppression)

4 Findings

In Nigeria,available data on some of the key proxies for climate change are presented below.

Category	Proxy	Data Source	Value (2013)	Value (2014)	Value (2015)	Value (2016)	Value (2017)	Value (2018)	Value (2019)	Value (2020)	Value (2021)	Value (2022)	Value (2023)
Climate Change	Average annual temperature increases (°C)	Nigerian Meteorological Agency (NIMET)	0.3°C	0.4°C	0.5°C	0.6°C	0.7°C	0.8°C	0.9°C	1.0°C	1.1°C	1.2°C	1.3°C

Table 1. Source: Nigerian Meteorological Agency (NIMET)

This table has details on climate change in Nigeria.The measure of climate change is the change in average annual temperature (°C). Temperature rise is one of the most employed indicators to measure the climate change effects over time, especially the mean annual temperature change between 2013 and 2023. The information used in this research was obtained from the Nigerian Meteorological Agency (NIMET) which is responsible for the observation of weather and climate in Nigeria.The table above shows that Nigeria's average annual temperatures are gradually rising each year. The temperature increase starts from 0.3°C in 2013 and increases by 0.1°C per year and becomes 1.3°C in 2023. This gradual rise is an indication of the constant rise in temperature due to climate change in Nigeria. Average temperature rise has various impacts including heat waves, change in rainfall patterns and impact on agriculture and food production. These temperature increases are significant because a degree change in temperature can cause a drastic change in climate, ecosystems, and health of the people.The increase in temperature is also cumulative, which means that there is gradual warming in Nigeria over the decade as a result of climate change.

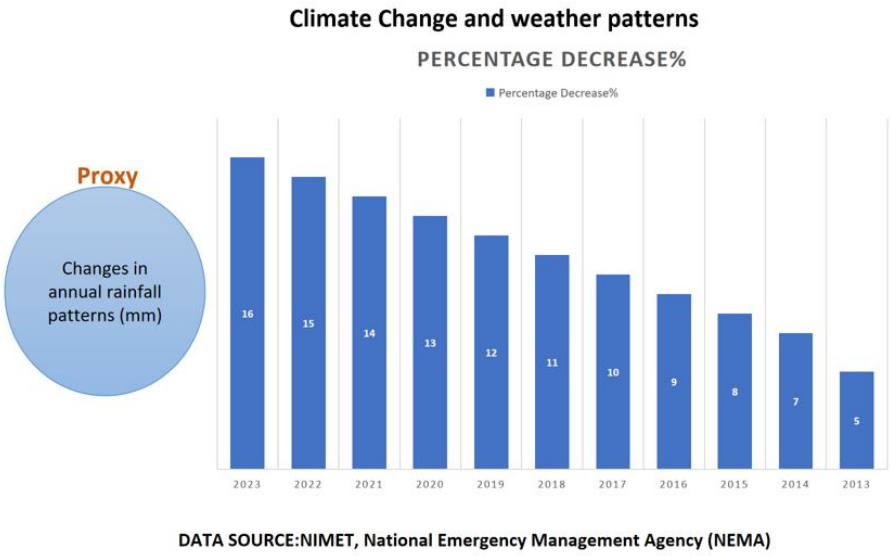


Figure 2 .Author's compilation.

The figure above shows how the annual rainfall in Nigeria has been reducing over the years from 2013 to 2023. The graph illustrates that the annual rainfall has been gradually decreasing year by year. Starting with 5% in 2013, the reduction is achieved

by about 1-2% annually and is 16% by 2023. This is a cumulative reduction in rainfall that has serious consequences for agriculture, water resources and the balance of ecosystems in Nigeria. This has resulted in decreased water supply for crops hence decreased agricultural yields particularly in the rain fed agriculture. Reduced rainfall also implies a reduction in the rate at which water sources like the rivers and lakes are replenished, which may cause water scarcity for human consumption, agricultural and industrial uses.The progressive reduction in rainfall may result in conditions of drought, soil degradation and desertification especially in the northern part of Nigeria. These changes may lead to rural people moving to other areas and there may be more competition for the limited resources.

This is in line with climate change predictions whereby an increase in temperature affects the hydrological cycle and results in changes in the weather patterns and rainfall in particular, which in this case has been on the decline.Climate Change and its impact on Food Security .Nigeria's annual rainfall patterns over a period from 2013 to 2023, highlighting a consistent decrease in rainfall across the years. The data shows a steady decline in annual rainfall over time. Beginning with a 5% decrease in 2013, the reduction continues by approximately 1-2% each year, reaching a 16% decrease by 2023. This is a significant cumulative reduction in rainfall, which can have severe implications for agriculture, water resources, and overall ecosystem balance in Nigeria. This reduction in rainfall means less water available for crops, leading to lower agricultural productivity, especially in rain-fed farming areas. Decreased rainfall also affects the replenishment of water bodies such as rivers and lakes, potentially leading to water shortages for drinking, irrigation, and industrial use. The ongoing decrease in rainfall can lead to drought conditions, land degradation, and desertification, particularly in northern Nigeria. These changes may force rural populations to migrate and could increase conflicts over diminishing natural resources.

The continuous decline in rainfall aligns with climate change predictions, where rising temperatures alter the hydrological cycle, leading to more erratic and extreme weather patterns, including decreased precipitation in certain regions.

2.2:Climate Change affecting Food Security.

Climate change impacts food security through decreased yields, changes in seasons and increased post harvest losses due to natural disasters. However, when these

traditional food preservation methods do not help in reducing these losses, the chances of food insecurity increases. This is especially the case in areas where there are few technological developments in food preservation. Further, areas that are vulnerable to more severe climate change effects are likely to face lower food supply, higher food prices, and lower nutritional quality.

The figure below shows the records of major floods and severe droughts in Nigeria from 2013 to 2023 obtained from NIMET and NEMA.).

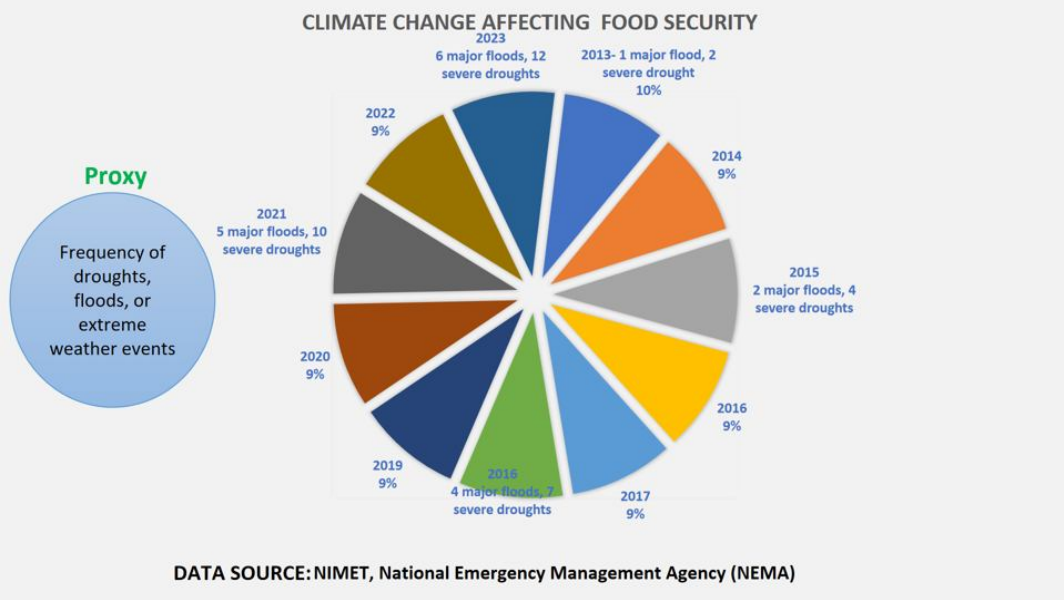


Figure 3:Author's compilation

The analysis of the data shows that there is an upward trend in the frequency of both major floods and severe droughts in the region.This increasing frequency may be due to either a deterioration of climate conditions or an increase in the susceptibility of the region to extreme weather events.The effects of extreme weather events are social-economic and include agriculture, livelihoods and health.The trends in the data are useful for policy makers and stakeholders to understand in order to plan for interventions to address the effects of major floods and severe droughts in Nigeria from 2013 to 2023, using data sourced from the). The frequency of both major floods and severe droughts has been increasing in the recent past.This rising trend may be

attributed to either worsening climate conditions or increased susceptibility of the region to climate change related disasters.The effects of climate change are felt in various sectors such as agriculture, livelihoods, and health.The analysis of these trends is important for policy makers and other stakeholders to develop and implement appropriate measures to address the impacts of climate change.

2.3 On Traditional food preservation

Food preservation is an important aspect of food security because it helps in reducing post-harvest losses and also serves as a buffer against food shortage especially in regions where access to modern preservation methods like refrigeration is not easily available. The specific method being tracked is sun-drying, which is one of the traditional techniques of preserving food especially in the rural areas of Nigeria. The table below reveals the time taken in this process under normal climate conditions and under changing climate conditions over the years.

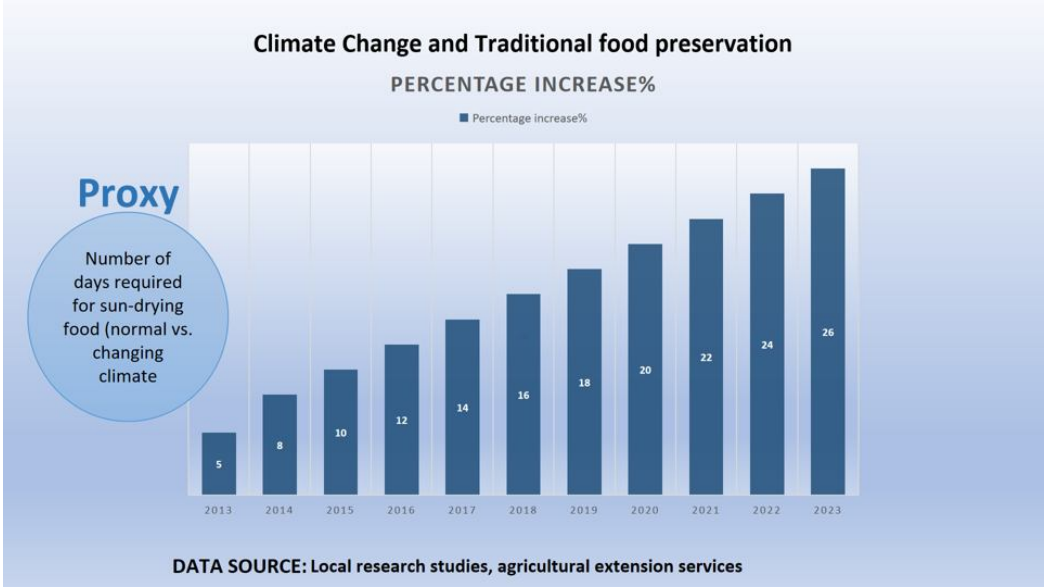


Figure 4:Source;Author's compilation.

The figure reveals that climate change is gradually encroaching on traditional food preservation in Nigeria, therefore, the need for climate change adaptation to improve food security and public health in vulnerable rural areas. The values are the

percentage changes in the time taken for sun-drying food due to climate change over the years as shown below. The findings show a progressive increase in the number of days taken to sun-dry foods because of climate change. This implies that new weather conditions like less sun, high humidity and changes in weather are impacting on sun-drying food preservation in Nigeria.

The longer it takes to dry, the less effective traditional preservation methods are, which may result in even more food loss, especially for perishable crops such as fruits, vegetables, and fish, which are sun-dried in rural Nigeria. These areas are more vulnerable to food losses since sun-drying is still prevalent in the rural areas because of the unavailability of modern preservation structures. This could lead to increased hunger, malnutrition and other health complications that affect the normal functioning of the body and economic problems particularly in developing countries that depend on agriculture. As food preservation becomes more difficult, the chances of getting food borne diseases could rise because the food is likely to be contaminated. such as reduced sunlight, higher humidity, and increased unpredictability of weather conditions, are affecting traditional food preservation methods in Nigeria.

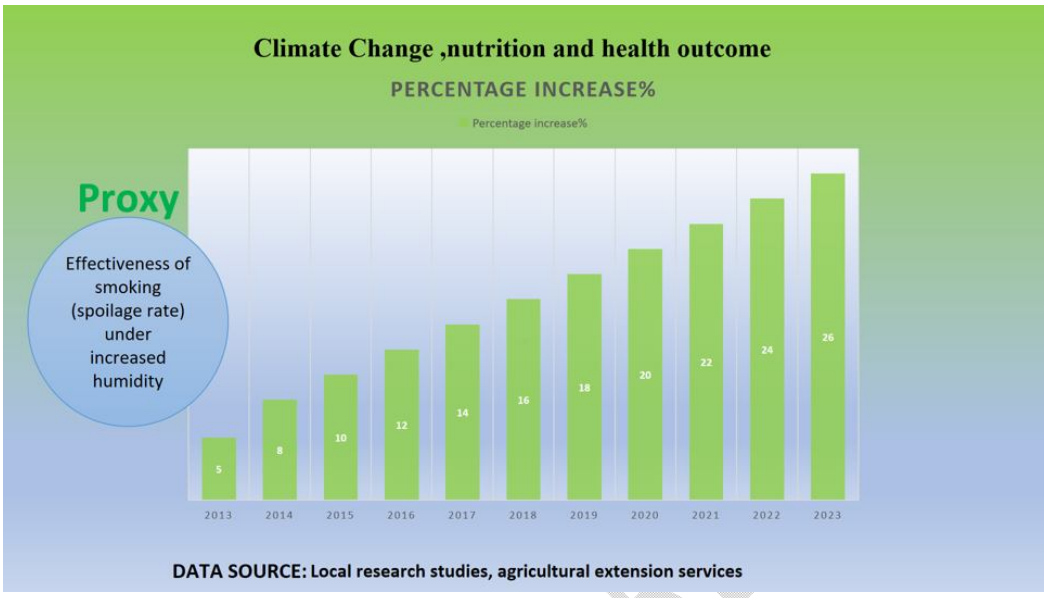
As drying time increases, conventional preservation techniques are less effective; this could result in higher food losses especially for perishable crops such as fruits, vegetables and fish, which are sun-dried in rural Nigeria. This is because rural areas where sun-drying is still common due to inadequate modern preservation structures lose more food. This could worsen hunger, malnutrition and economic shocks particularly in the developing world where many depend on agriculture for food.

As food preservation becomes more difficult, the risk of food-borne illnesses could increase, as improperly preserved food is more susceptible to contamination. This is a clear threat to human health particularly in the developing world where access to refrigerator and other modern means of food preservation is rare.

2.4 Conventional Techniques of Food Preservation and Health Issues

Appropriate traditional preservation techniques can help minimize the incidence of foodborne diseases and malnutrition through preservation of the nutritional value of foods and minimizing spoilage. However, the old or less effective techniques may bring in contaminants that are unhealthy for the public. With the increase in the

effects of climate change, the importance of preserving food safely to avoid food borne diseases and promote health increases.



Source:Author's compilation.

Figure 5.climate change, nutrition and health outcome

The figure is centered on the efficiency of smoking as a traditional way of preserving foods in Nigeria with special reference to spoilage rates under conditions of raised humidity from 2013 to 2023 and increased unpredictability of weather conditions, are affecting traditional food preservation methods in Nigeria.

With longer drying times, traditional methods of food preservation become less efficient, which could lead to greater food spoilage, particularly for perishable crops like fruits, vegetables, and fish, commonly preserved using sun-drying in rural Nigeria. Rural areas, where sun-drying is still widely practiced due to a lack of modern preservation infrastructure, are more vulnerable to food losses. This could exacerbate hunger, malnutrition, and economic instability, especially in regions that rely heavily on subsistence farming.

If food preservation is a problem, then the incidence of food poisoning could rise because spoiled food is more likely to be contaminated. This is a direct threat to public health, especially in areas where people cannot afford to store their food in refrigerators and other modern methods of food preservation.

2.4 Traditional Food Preservation Methods and Public Health

Appropriate traditional preservation techniques can minimize the likelihood of contracting foodborne illnesses and malnutrition since it preserves the nutrient content of food and minimizes spoilage. However, the traditional or less efficient techniques can bring in contaminants that are not good for the health of the people. With the increase in the effects of climate change, the preservation of food safely is even more important to avoid the outbreak of food borne diseases.The table is concerned with the role of smoking as a traditional technique of food preservation in Nigeria and relative to the spoilage level under the condition of raised humidity in the period 2013-2023.pted methods can introduce contaminants, which negatively impact public health. As climate change worsens, the need for preserving food safely becomes more critical to prevent foodborne diseases and maintain public health.

The table focuses on the effectiveness of smoking as a traditional food preservation method in Nigeria, particularly in relation to spoilage rates under conditions of increased humidity from 2013 to 2023. Smoking is one of the most common methods used in Nigeria particularly in the rural areas to preserve perishable foods including fish, meat and other protein foods.The data used in this research is derived from local research and agricultural extension services on the effects of changing environmental conditions on food preservation in Nigeria.

The data shows that spoilage rates for smoked foods are gradually increasing due to high humidity, which may be attributed to climate change.ge. This is especially so when the environment is humid such as during the rainy season or when the climate is tropical as in the case of Nigeria where smoking cannot effectively prevent the growth of mold, bacteria and other spoilage organisms.

The increasing spoilage rate is a potential danger to food security, especially among the rural population that uses smoking as one of the most available and effective ways to preserve food. Lack of proper food preservation methods results in high wastage of food, high expenses, and food scarcity especially during the periods when there is no harvest. Smoking is a very important process in preservation of fish and meat and

areas that rely on this method are the most affected. If spoilage increases, it means that the income of the small scale farmers and fishers will be affected and this will lead to more economic difficulties.This is due to the fact that the spoilage rates are directly proportional to the humidity levels that are resulting from the effects of climate change.Since weather conditions are changing, traditional preservation techniques that require dry and stable weather conditions are not as effective as they used to be, hence the need for climate smart preservation techniques.The consumption of spoiled food leads to food borne diseases, which puts a lot of pressure on the health facilities, especially in rural Nigeria where health care is scarce

The rising spoilage rate threatens food security, particularly in rural communities where smoking is one of the most accessible and affordable food preservation methods. The inability to effectively preserve food can lead to increased food waste, higher costs, and food shortages, especially during off-harvest seasons. This is especially so for rural and coastal populations who rely on smoking fish and meat respectively for preservation. If spoilage rises, it can decrease the income of small scale farmers and fishers, thereby worsening poverty.High spoilage rates are directly associated with higher levels of humidity resulting from climate change.Traditional preservation techniques that work well in dry conditions are no longer as useful as the climate changes, and this makes climate adaptation important.The consumption of spoiled food is dangerous because it leads to food borne diseases that put a lot of pressure on the health facilities, especially in rural Nigeria where access to health care is already a challenge.s shift, traditional preservation methods that rely on stable, dry conditions are becoming less effective, underscoring the need for climate-adaptive strategies.The consumption of spoiled food poses a risk of foodborne illnesses, which can strain healthcare systems, especially in rural Nigeria where access to healthcare is already limited.

The table above shows the issues that relate to high humidity on the conventional ways of preserving food in Nigeria. With spoilage rates rising because of climate change, food security, health, and economic risks for rural and vulnerable populations are also on the rise.It is now high time that measures like climate change friendly preservation methods are employed to counter the situation.itions are affecting food preservation methods in Nigeria.The data shows that spoilage rates for smoked foods are on the rise due to high humidity, which is believed to be caused by climate change.

Another disadvantage of smoking is that it is not effective in the tropical climate of Nigeria especially during the rainy season because high humidity is a good breeding ground for mold, bacteria and other spoilage organisms.

The increased spoilage rate is a major concern for food security, especially in rural areas where smoking is one of the most readily available and inexpensive techniques of food preservation. Lack of proper food preservation methods results in increased food wastage, high costs, and food scarcity during seasons other than the harvest seasons. Smoking is a common method of preserving fish and meat in many countries and rural areas and coastal regions are the most affected. If spoilage rises, it will lower the income of small-scale farmers and fishers, compounding poverty.

weather patterns shift, traditional preservation methods that rely on stable, dry conditions are becoming less effective, underscoring the need for climate-adaptive strategies.The consumption of spoiled food poses a risk of foodborne illnesses, which can strain healthcare systems, especially in rural Nigeria where access to healthcare is already limited.

The figure presented underscores the challenges posed by increased humidity on traditional food preservation methods in Nigeria. As spoilage rates continue to rise due to climate change, rural and vulnerable communities face heightened risks to food security, public health, and economic stability. There is an urgent need for interventions, such as climate-resilient preservation techniques, to adapt to the changing environment.

2.5 Climate change,poor nutrition and their impact on health outcome.

following figure presents the trends of infant mortality rate and under-five mortality rate in Nigeria from 2014 to 2022 in deaths per 1,000 live births.r 1,000 live births) in Nigeria from 2014 to 2022. Both of these

rates have been declining over the years, but at a slower pace, which shows some improvement in child mortality rate over the years.However, the high mortality rates in Nigeria have remained high due to various factors such as climate change and poor diet especially among pregnant women and children. in Nigeria from 2014 to 2022. There is a gradual decline in both rates, indicating some progress in reducing child mortality over the years. However, the persistent high mortality rates in Nigeria can be linked to a variety of factors, including climate change and poor nutrition, particularly for pregnant women and children.

Nigeria	Year	Mortality rate, under-5 (per 1,000 live births)
	2004	160
	2005	154.6
	2006	149.7
	2007	145.2
	2008	141.3
	2009	138
	2010	135.3
	2011	132.9
	2012	130.9
	2013	129.1
	2014	127.7
	2015	126.2
	2016	124.5
	2017	122.4
	2018	119.9
	2019	116.9
	2020	113.9
	2021	110.6
	2022	107.2

Source :World development Indicator

Table 2.Mortality rate, under-5 (per 1,000 live births)

The under five mortality rate also reduced from 87 deaths per 1,000 live births in 2014 to 72 in 2022.The under five mortality rate has reduced from 127.7 per 1000 live

births in 2014 to 107.2 in 2022.to 68.5 in 2022. The under-5 mortality rate dropped from 127.7 per 1,000 live births in 2014 to 107.2 in 2022

Droughts, floods and high temperatures are some of the adverse effects of climate change that reduce food production, hence food availability and quality.This directly affects the food intake of pregnant women and children, the most affected by malnutrition, because crop failure due to climate change affects food production, especially in rural areas where most people depend on agriculture. and rising temperatures negatively affect food production, leading to reduced food availability and quality. This directly impacts the nutrition of pregnant women and children, who are most vulnerable to malnutrition. due to climate-induced crop failures increases malnutrition rates, especially in rural areas where agriculture is the main source of livelihood. Malnutrition compromises immune systems and therefore children are more prone to diseases such as diarrhoea, pneumonia and malaria which are some of the major causes of child mortality in Nigeria.Pregnancy related anaemia is associated with preterm births, low birth weight and developmental complications in infants.r-5 mortality rate dropped from 127.7 per 1,000 live births in 2014 to 107.2 in 2022

Extreme weather events such as droughts, floods, and rising temperatures negatively affect food production, leading to reduced food availability and quality. This directly impacts the nutrition of pregnant women and children, who are most vulnerable to malnutrition. due to climate-induced crop failures increases malnutrition rates, especially in rural areas where agriculture is the main source of livelihood. Poor nutrition weakens immune systems, making children more susceptible to diseases like diarrhoea, pneumonia, and malaria, which are leading causes of child mortality in Nigeria.

Malnutrition in pregnancy increases the risk of preterm births, low birth weight, and developmental issues in infants. Babies born under these conditions are more likely to die because they are more susceptible to infections and other related complications.Global warming leads to food scarcity and poor quality food which in turn increases the prevalence of malnutrition among pregnant women.This can cause infant and under 5 mortality because it impacts on the general wellbeing of children from the time they are in the womb.High mortality is as a result of child

malnutrition.,000 live births in 2014 to 68.5 in 2022. The under-5 mortality rate dropped from 127.7 per 1,000 live births in 2014 to 107.2 in 2022

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Malnutrition in pregnancy increases the risk of preterm births, low birth weight, and developmental issues in infants. Babies born under these conditions have higher mortality risks, as they are more vulnerable to infections and other health complications. Climate change exacerbates food shortages and makes nutritious food less accessible, leading to higher rates of malnutrition in expectant mothers. This can contribute to both infant and under-5 mortality by affecting the overall health and development of children from the womb.

Child malnutrition is a major contributor to high mortality rates. Stunting, wasting, and underweight conditions compromise the children's immune system, which makes them more vulnerable to fatal diseases. As climate change affects food production and poverty deepens, it becomes difficult to feed adequately leading to a cycle of malnutrition and high child mortality among the under fives.The decline in the infant and under 5 mortality rates suggest some progress in healthcare and perhaps better strategies that seek to prevent child deaths.live births in 2014 to 107.2 in 2022

The gradual reduction in infant and under-5 mortality rates indicates some improvements in healthcare and possibly better interventions aimed at reducing child deaths. Nevertheless, the high rates still portray the system's problems in the various organizations.The two leading causes of child mortality are climate change and poor nutrition because they cause malnutrition, which makes children susceptible to diseases.

Although there has been an improvement in the proportion of under five mortality in Nigeria, the high figures call for more efforts. Climate smart agriculture, better access to healthy foods, and appropriate and timely health care for pregnant women and children are critical in reducing the effects of climate change and malnutrition on child mortality.

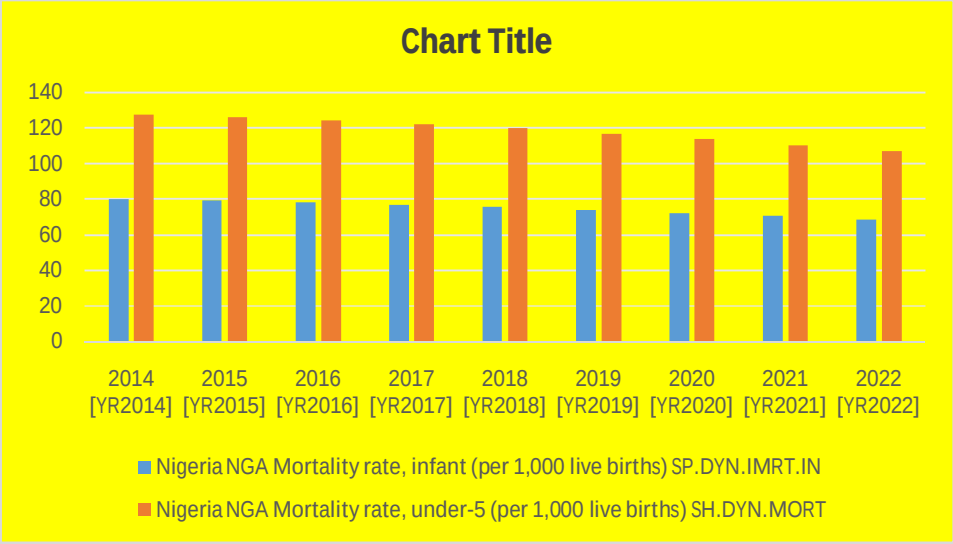

Fig 6 :Decline in the infant and under 5 mortality rates in Nigeria

4.0 Conclusion

Harnessing the link between Climate change and Traditional Food Preservation Methods is an important study towards appreciating the key gaps in post-harvest losses, and their impacts on food security and public health,

Though analysis was done using variables from Nigeria,findings offer valuable regional insights that can be applied across Sub-Saharan Africa. In this study ,we explored adaptive strategies needed to mitigate climate change.Emphasise was contribute towards global and regional policies aimed at achieving sustainable food security and improved health outcomes. This therefore become essential to the international discourse on climate change, food security, and public health.

By negatively influencing food systems,Climate change has far-reaching effects on human health.What more can be more demanding than emphasising the preparedness of policy-makers to respond to the health challenges associated with climate-induced changes in food preservation methods. This research output therefore,contributed immensely towards providing insights into climate change's impact on traditional preservation techniques.Furthermore, the urgent need toward policy actions towards food-related diseases and public health risks in Nigeria were highlighted.

Besides, the study looks at the possible policy measures and adaptation measures to address the impacts of climate change on traditional food preservation. With climate variability on the rise, it is imperative that efforts are made to improve the stability of food systems where the use of modern preservation techniques is either impossible or unaffordable. This may involve the creation of climate smart preservation methods, encouragement of better hardy crop varieties, and education to enhance traditional preservation methods in the face of climate change (FAO, 2021).

The combination of conventional approaches with the contemporary technologies offers a chance to address these issues. Technological advancements like modified atmosphere storage and smart cold chain that is a combination of traditional and modern technology in food preservation can help in the fight against climate change (Zenda, 2024). Such systems help to reduce some of the negative impacts of climate variability on food safety and public health in communities.

Finally, climate change, traditional food preservation, and public health are the three critical areas that require adaptive approaches. Since climate conditions are constantly changing, the sustainability of traditional food systems will be under pressure, which will affect food security and health on a global level. For the welfare of the vulnerable, there is a need to innovate—integrating conventional and advanced approaches will preserve both the amount and quality of food (Fang &Wakisaka, 2021).
This study, therefore, fills this gap by providing a step in understanding the challenges and opportunities in addressing climate-induced food insecurity and health risks, building food system resilience and advancing sustainable global food security and public health.

Policy Implication and recommendation.

Policy interventions should also address the wider population health consequences of climate change and food insecurity and malnutrition. To tackle these challenges, it is necessary to improve healthcare systems to tackle malnutrition, support nutrition-sensitive agriculture, and make sure that food security initiatives take climate change into account (Fraval et al., 2019). Further, measures to minimize post-harvest losses can go a long way in enhancing the supply of healthy foods and thus help to address the problem of malnutrition among the needy groups.

With the climate changing and becoming warmer, and climate variability increasing, food systems have to change as well. The need to have safe, nutritious, and preserved food in the future in the context of climate change is a challenge that needs to be addressed at the local, national, and global levels. Thus, by analyzing these problems in the international context, this work will help to enrich the discussion on climate vulnerability, food safety, and health. The results will be useful for policy

makers, health care providers, and international organizations that are facing the problems of climate change, food preservation, and nutrition.

The impact of climate change on food preservation shows that there is a direct correlation between the ability to preserve food and the level of technology. In Nigeria, the slow advancement in the modernization of traditional food processing and preservation methods is one of the reasons for food and nutrition insecurity in the region. Drought and flooding data show the necessity of improving the disaster management and climate risk reduction measures. Improving on the traditional techniques of food preservation is crucial in minimizing food insecurity risks, particularly under the current climatic conditions, by minimizing food losses.The data also indicates the need for new adaptation measures, including the use of solar dryers, which can reduce drying time by focusing solar radiation and shielding against unfavourable weather conditions. For instance, the conventional smoking techniques are not as efficient as before due to the changing climatic conditions. This calls for the use of better preservation methods like the modern smoking methods, solar drying or refrigeration to minimize on food wastage and enhance food security.

Combating climate change and enhancing food security as well as maternal and child nutrition is important in the reduction of infant and under-5 mortality in Nigeria. Our findings show this relationship, underlining the need for policy actions, technological solutions, and resilience measures to protect food and nutritional security under shifting climate regimes.

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