Research Paper

Potential of Planting Guide, Rain Pattern and Double Cropping of Cowpea (SasaKawa), Jute and Spinach in a Planting Season: A Climate Change Mitigation Strategy for Federal College of Education (Technical) Bichi (FCETB) Old Site, Sudan Savanna Region of Nigeria.

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Abstract: *Climate change is a threat in peasant agricultural communities of Sudan Savanna and Northen Nigeria in general where FCETB old site is located. This study documents information on planting guide, rain pattern and potential of double cropping of cowpea (SasaKawa), Jute and Spinach in a planting season as a climate change mitigation strategy for Federal College of Education (Technical) Bichi Old Site, Sudan Savanna Region of Nigeria. The trials were carried out in 2023 and 2024 planting seasons, plot size was 8.0m x 7.0m each replicated twice and crops yields data collected were subjected to descriptive statistics mean analysis. Analyses of FCETB old site weather of 2023 and 2024 revealed high impact on cowpea, jute and spinach average yields. In both 2023 and 2024 planting seasons, the first set of cowpea, jute and spinach was planted in mid-June (16th) and harvested in August (19th-30th), while the second set of the crops was planted in early September (4^{h}) and harvested in early November (8th-20th). The cowpea gave total average grain yields of 2,939kg/ha (equivalent to \$4,055.8 or #67,597.0) in 2023 and 2,961kg/ha (equivalent to \$4,086.1 or #68,103.0) in 2024, total cowpea average fodder was 5,439kg/ha in 2023 and 5,441kg/ha in 2024, Jute produced total average fresh vegetables of 4,967kg/ha in 2023 and 4,761 in 2024, Spinach yielded total fresh vegetable of 5,139kg/ha (equivalent to \$4,625.1 or #77,085.0) in 2023 and 4,795kg/ha (equivalent to \$4,316.0 or #71,925.0) fresh vegetable in 2024. The study reveals that with adoption of the planting guide and rain pattern it is feasible for peasant farmers, agricultural education students, academic and non-teaching staff in Federal College of Education (Technical) Bichi old site to practice double cropping of cowpea (SasaKawa), Jute and Spinach in a planting season for income, revenue generation, job, food security and climate change mitigation strategy.*
Keywords: *climate change, double cropping, planting guide, mitigation strategy, food security, FCETB.*

I.   Introduction
1.1.   Rainfall and Temperature
Rainfall and temperature are the two most vital climatic elements for crop production in Federal College of Education (Technical) Bichi and Sudan savanna region of Nigeria in general, where rain-fed agriculture is mostly practiced. Incidences of meteorological and agricultural droughts, flooding and high variability in rainfall have been reported in some communities of Nigeria, particularly in Northern Nigeria where the FCETB and the Sudan Savanna are located. This is of great concern to Federal Government of Nigeria, agricultural education students and academics in department of agricultural education FCETB, peasant farmers, policy makers and water resources managers among others because of the adverse effects they have on crop and animal production. The Sudan Savanna of Nigeria is inhabited by people who are mostly peasant farmers. These farmers form a reasonable percentage of the farming population in Nigeria and the Sudan Savanna is the major source of grains (millet, wheat, maize, sorghum, sesame, rice etc.), legumes (cowpea, groundnut, soybean etc.), vegetables (jute leaves, spinach, tomatoes, lettuce, onion, pepper etc.) and livestock (cow, sheep, goat, camels etc.) in Nigeria (FME 2018, Bose et al 2015, Oguntoyinbo 2011).

1.2.   **Planting Guide**: Planting guide is a table for farmers, giving information about favourable date in a planting season to plant crops - cowpea, jute, spinach etc (table 1). **Rain Pattern** refers to date of the days of rain in the same rain season (table 1).

1.3   Double cropping
Double cropping means planting of two or more crops twice in the same land at different time and in the same crop year (same rain season), so that the same land is used to produce more crops in one year (one rain season).

1.4.   Sudan savanna
The Sudan savanna is a major savanna belt in northern Nigeria. Bauchi, Borno, Gombe, Kano, Kaduna, Katsina, Kebbi, Plateau, Sokoto and Zamfara are the states in the Sudan Savanna region of Nigeria, that is characterized by high rainfall variability (May to October), poor soil fertility and frequent droughts (Oguntoyinbo 2011).

1.5.   Malnutrition
Malnutrition refers to deficiency or excess in nutrient intake, imbalance of essential nutrients or impaired nutrient utilization. The requirements for a healthy diet can be met from a variety of plant-based and animal-based foods (Melina 2016, Lean 2015).

1.6.   Unhealthy diet
An unhealthy diet is a major risk factor for a number of chronic diseases including: high blood pressure, high cholesterol, diabetes, abnormal blood lipids, overweight/obesity, cardiovascular diseases, and cancer. The World Health Organization has estimated that 2.7 million deaths each year are attributable to a diet low in fruit and vegetables (WHO 2004).

1.7.   Food Insecurity
Food Insecurity. A person is food insecure when he/she lacks access to enough, safe and nutritious food for growth, development and an active and healthy life. Abdulazeez (2024 and 2023) observed that the world citizens and Nigerians in particular are seriously facing a growing demand for food, income and employment. Food insecurity has many negative consequences, including:

i.   **Malnutrition**: Food insecurity can lead to malnutrition, which can impair physical and mental development. In 2020, around 2.6 million children under the age of five suffered from severe acute malnutrition.

ii.   **Health issues**: Chronic hunger can lead to wasting, susceptibility to other diseases, and even death.

iii.   **Social unrest**: People may become desperate for food, which can lead to social unrest.

iv.   **Poverty**: Food insecurity can lead to poverty (Hunger/FAO 2020, British Red Cross 2023).

1.8.   Poverty
Poverty is a state where a person or household lacks the financial resources to meet their basic needs or attain a quality of life beyond those needs. This can include a lack of access to food, clothing, shelter, education, medical care, and stable employment. Poverty can also be a broader social issue, affecting entire communities.

1.9.   Climate change
Climate change refers to long-term shifts in temperatures and weather patterns. Such shifts can be natural, due to changes in the sun's activity or large volcanic eruptions. Climate change can disrupt food availability, reduce access to food, and affect food quality. Increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability may all result in reduced agricultural productivity (Gopal, 1990). Climate change affects planting and harvesting periods. Due to this, there are occasional shifting seasonal rainfall patterns and severe precipitation events and flooding, delay planting and harvesting of plants. Climate change is causing declining crop yields due to rising temperatures, changing rainfall patterns, and more frequent extreme weather events. These changes disrupt growth cycles, increase water stress, and enable pests. Climate change is expected to lead to job losses in the agricultural sector. This could be due to changes in land use, where farmers may be forced to abandon some land or switch to crops that are more tolerant to climate change. Climate change could also lead to increased heat stress and other health problems for agricultural workers. (Climate Change, 2023)

1.10.   Climate change and food insecurity
For decades, the effects of climate change have contributed to decreased food production. This is a global problem, but it is more prevalent in developing countries, especially sub-Saharan Africa, which is among the most affected in the tropical world. The varieties of food crops cultivated in these regions are heavily impacted by changes in climate. Nigeria is among the countries that relies heavily on agriculture for its survival, while its productivity relies on weather patterns like rainfall. The country is very vulnerable to climate change and natural hazards such as rising temperatures, gully erosion, drought, and increased flooding. In 2022, Nigeria

was hit by devastating floods that killed more than 500 people, displaced more than 1.4 million, and destroyed about 90,000 homes. Analysis from the World Weather Attribution Group found that climate change was likely responsible for the heavy rains that caused the flooding. The floods destroyed thousands of hectares of farmland, worsening the already severe food insecurity in the country. Crops were destroyed, and the floods cost the agricultural sector about $2 billion in damages. In addition, the Sudan Savanna and arid regions of the northwest and northeastern parts of Nigeria are currently facing substantial challenges from drought and land degradation. Both issues have a significant impact on food security as they result in less water being available for crops (Climate Change 2023, Coldhubs.com, 2023, UNICEF, 2023).

1.11.   Justification of the trial
Climate change is threatening people's lives, families, health, crops, livestock and livelihoods in Sudan Savanna region of Nigeria. That could mean peasant agricultural communities in the Sudan Savanna region where FCETB is situated are facing food shortages, poverty and malnutrition. There is no Documented Information on Rain Pattern, Planting Guide and Double Cropping of Cowpea (SasaKawa), Jute and Spinach in a planting season as a climate change mitigation strategy in and outside Federal College of Education (Technical) Bichi Old Site. Hence, the need to document information on planting guide, rain pattern and potential of double cropping of cowpea (SasaKawa), Jute and Spinach in a planting season as a climate change mitigation strategy for Federal College of Education (Technical) Bichi Old Site, Sudan Savanna Region of Nigeria, since the Sudan savanna region is a major source of crops, livestock and livestock feed in Nigeria.

1.12.   Purpose of the trial
The purpose of this trial is to document information on planting guide, rain pattern and double cropping of cowpea (SasaKawa), Jute and Spinach in a planting season as a climate change mitigation strategy for Federal College of Education (Technical) Bichi Old Site, situated in the Sudan Savanna Region of Nigeria.

1.13.   The objectives of the trial
1.   To introduce Double cropping of Cowpea, Jute and Spinach in a planting season as a source of income, revenue, food, Job, Pre and Post Retirement Entrepreneurial Opportunities to agricultural education students, academic and non-teaching staff in Federal College of Education (Technical) Bichi.
2. To document information on planting guide, rain pattern and double cropping of cowpea (SasaKawa), Jute and Spinach in a planting season as a climate change mitigation strategy for Federal College of Education (Technical) Bichi Old Site and
3. To improve food security in Federal College of Education (Technical) Bichi and the Sudan Savanna region of Nigeria in general.

II.   Materials and Methods
2.1. Description of Trial site
The field trials were carried out between June and November 2023 and 2024 planting seasons at Federal College of Education (Technical) Bichi old site research farm, situated in the Sudan savanna region of Nigeria, latitude 8^0 14' – 12^0 14'E and longitude12^0 14' – 14^0 13'N, average temperature per annum 25^{oc} and average rainfall 80cm, Sudan savanna region of Nigeria. At the Federal College of Education (Technical) Bichi (FCETB) old site and the Sudan savanna region of Nigeria in general, rains typically start in May, stabilize in July with highest rains in August and end in October (Table 1). Federal College of Education (Technical) Bichi, Accredited Fully by National Commission for Colleges of Education (NCCE), is a Federal Tertiary Institution Established by Decree No. 4 of 14th March 1986, and reviewed by Decree No. 6 of January, 1993 by Federal Government of Nigeria with the sole aim of producing Specialist Teachers in Technical, Vocational, Business and Science Subjects for Basic Education in Nigeria. Land area of the college old site is 18.5 hectares, and area of the college new site covers expanse arable land of 640 hectares, a suitable vast land i, to cultivate food crops - cereals, roots, legumes, and vegetables – spinach, Senna obtusifolia -Tafasa (Abdulazeez, 2018) for the college community and National food security ii, to demonstrate the potential of Hadejia Jamaere River Basin Development Authority, Hope Restoration and Renewed Hope Initiatives of the Federal Government of Nigeria in cash crops production – groundnut, sesame, cowpea, Senna obtusifolia -Tafasa (Abdulazeez, 2018), potato, cassava, and cotton for improved foreign reserve and iii, an ideal location for Tertiary Education Trust Fund (TETfund), Individuals and Nigerian Politicians to establish centre of excellence in Crop Production, Out of School Child Program, Business, Entrepreneurship, Sciences, Vocational and Technical Education in the Sudan Savanna.

2.2. Documentation of Planting Guide and Rain Pattern of Trial site

Date of the days of rain in 2023 and 2024 at Federal College of Education (Technical) Bichi old site were monitored diligently from January to December and documented as planting guide and rain pattern (table 1).

2.3. Characterization of Soil at Trial Site

Prior to the establishment of the trials, four soil samples were taken from each site, the samples were thoroughly mixed and sub-samples taken to Department of Soil Science, Bayero University Kano for analyses. The soil was loamy sand in texture having pH 6.18 with 0.68% organic matter, N 0.14%, P 3.01mg/kg^{-1} and K 0.47cmol/kg^{-1}.

2.4. Field preparation and crop husbandry

The trial fields were ploughed and harrowed to a depth of 15cm. The unit plot size for cowpea, jute and spinach was 8.0m x 7.0m each, replicated twice. In 2023 and 2024 planting seasons, the first planting of the crops was on 16th June and the second planting took place on 4th September (Table 1). Cowpea was sown at a spacing of 50cm between rows and 30cm between stands, while jute and spinach seeds were sown in drills at 20cm between drills on flat unit plots, then covered with soil and thinned to 20cm between stands at three weeks after emergence. The cowpea, jute and spinach seeds were purchased from Bichi Emirate Market.

Table 1. 2023 and 2024 Planting Guide and Rain Pattern of FCETB old site, Sudan Savanna region of Nigeria.

Month ↓	Year →	2023 Rain Pattern ↓	2024 Rain Pattern ↓
January		----------------------------------	--
February		----------------------------------	---
March		-------------------------------------	---
April		----------------------------------	---
May		6th ,8th and16th	7th ,10th and 28th
June		2nd ,4th .11th ,15th **16th***,17th ,22nd and 25th	1st ,4th ,10th ,11th ,15th ,**16th***,20th and 24th
July		1st ,7th ,11th ,12th ,13th ,20th ,21st ,27th and 31st .	5th ,10th ,14th ,15th ,22nd ,24th ,25th ,26th and 27th .
August		2nd ,5th ,9th ,10th ,13th ,16th ,17th **19th**,23rd ,27th and 30th	2nd ,3rd ,6th ,9th ,11th ,12th ,16th ,**19th***,22nd ,23rd ,26th and 30th
September		1st ,**4th****,9th ,14th ,18th ,28th and 30th	**4th****, 5th , 6th ,10th ,17th ,18th ,20th ,23rd and 30th
October		2nd, 6th and 13th	4th ,6th ,9th ,12th and 22nd
November **8th**		----------------------------------	--
December		----------------------------------	--

Key: First Planting/Cropping **16th*** June to **19th*** August
Second Planting/Cropping **4th**** September to **8th** November
No rain: --

2.5. Sheep manure (organic fertilizer) application.

300g of sheep manure was applied once to each stand of cowpea at two weeks after emergence, in the jute and spinach, 2 tonnes/ha each of sheep manure was spread on the unit plot a week before planting.

2.6. Weeding

First weeding for the three crops was carried out manually at third week after emergence and the second at fourth week after the first weeding.

2.7. Harvesting

Cowpea was harvested at tenth week, cowpea pods were sun dried, threshed and grains weighed. Fresh vegetables of jute and spinach were also harvested at tenth week and weighed (Table 2). All the three crop yields were extrapolated to yield per hectare.

III. Results

Table 2. Average yield (kg/ha, 1kg/$ and 1kg/#) of cowpea, jute and spinach for first and second planting/cropping in 2023 and 2024 planting seasons.

Crop	2023 season Average yield (Kg/ha)	2024 season Average yield (Kg/ha)	USA DOLLARS ($/kg)	NIGERIA NAIRA (#/kg)
Cowpea: Grains: 1st cropping----------------------	1,593	1,607	Grains 1kg = $ 1.380.00	Grains 1kg = #2,300.0
2nd cropping-------------------------------	1,346 (2,939)	1,354 (2,961)		
Fodder: - 1st cropping--------------------	2,793	2,787	Fodder 1kg = $ 1.800.00	Fodder 1kg = #3,000.0
2nd cropping-----------------------------	2,646 (5,439)	2,654 (5,441)		

Jute: Fresh vegetable: 1ˢᵗ cropping------------ 　　　　　　　2ⁿᵈ cropping--------------------	2,506 2,461 (4,967)	2,407 2,354 (4,761)	Vegetables 1kg = $ 0. 900.0	Vegetables 1kg = #1,500.0
Spinach: Fresh vegetable: 1ˢᵗ cropping------------ 　　　　　　　2ⁿᵈ cropping-----------------	2,598 2,541 (5,139)	2,437 2,358 (4,795)	Vegetables 1kg = $ 0.900.0	Vegetables 1kg = #1,500.0

Tuesday, 26ᵗʰ November, 2024. Exchange rate: 1USD = #1,665.99NGN. Source: Central Bank of Nigeria (CBN) 2024.

3.1. Yields Results

3.2. Grain and vegetable yields

The grains, fodder and vegetable average yields of cowpea, jute and spinach respectively for 2023 and 2024 planting seasons are shown in Table 2. All the yields for the cowpea, jute and spinach were extrapolated to average yield in kilogram per hectare. In 2023 cowpea average grain yields from first planting was 1593kg/ha and second planting recorded 1346kg/ha. In 2024 planting season, first cowpea planting gave average grains yield of 1607kg/ha and second planting produced 1354kg/ha of grains. In 2023 cowpea dry fodder average yield for first planting was 2793kg/ha and second planting recorded 2646kg/ha. In 2024 planting season, first cowpea planting gave dry fodder yield of 2787kg/ha and second planting produced 2654kg/ha of dry fodder. In 2023 jute fresh vegetable average yield for first planting was 2506kg/ha and second planting recorded 2461kg/ha. In 2024 planting season, first jute planting gave fresh vegetable yield of 2407kg/ha and second planting produced 2354kg/ha. In 2023 planting season spinach fresh vegetable average yield for first planting was 2598kg/ha and second planting recorded 2541kg/ha. In 2024 planting season, first spinach planting gave fresh vegetable yield of 2437kg/ha and second planting produced 2358kg/ha of fresh vegetable. Gopal (1990), reported that growth, productivity and profitability of plants depend on the available water to the plants.

IV.　　Discussion

4.1 Discussion

The 2023 and 2024 FCETB old site planting guide and rain pattern (table 1) and the cowpea, jute and spinach average yield results (table 2 and 3.1) clearly demonstrated that double cropping of cowpea, jute and spinach in a planting season can be successfully practised as a climate change mitigation strategy in the Federal College of Education (Technical) Bichi old site, Sudan Savanna region of Nigeria. The yields (table 2 and 3.1) of cowpea (fig. 1), jute (fig. 2) and spinach (fig. 3) will not only secure healthy food for the communities of FCETB, the Sudan savanna and Nigeria in general, but will also provide employment, income, revenue, nutritious grains for humans and fodder for livestock, in addition, the crops will provide essential fibre, minerals and vitamins for human growth, development and strengthen immune system to combat diseases in Nigeria. The Planting Guide and Rain Pattern provide favourable dates to plant crops, thus prevent crops failure and poor yield. Academic, health and economic benefits of cowpea, jute and spinach are presented in table 3.

Table 3. Academic, Health and Economic characteristics/benefits of cowpea, jute and spinach crops

Scientific name	English name	Hausa name	Igbo name	Yoruba name	Health/Economic benefits
Vigna unguiculata	Cowpea	Wanke	Agwa	Ewa	extremely rich in minerals – iron, zinc, potassium, phosphorous, fiber, energy food, and protein. Prevent weak bone, cancer, anemia, it provides local and international income. contains vitamin C and vitamin B6, which bolster a robust immune system. Regular consumption can help your body prevent constipation and defend against infections and illnesses.
Corchorus olitorius	Jute leaves	Lalo	Achingbara	Ewedu	As a vegetable, jute leaf is full of fiber that prevent constipation, full of antioxidants that have been linked to protection against several medical illnesses as well as chronic diseases like cancer, diabetes, heart disease, and hypertension. It provides local and international income
Amaranthus spinosus	Spinach	Alaiyaho	---------	Efo	Amaranth leaves are a storehouse of essential nutrients. They are loaded with vitamins A, C, K, and folate, vital for supporting a robust immune system, promoting healthy vision, and aiding in cell growth and repair. Consuming amaranth leaves benefit heart. The leaves are full of fiber that prevent constipation. It provides local and international income

4.2. **Conclusion**

        Climate change, that is increases in temperatures, changes in rainfall patterns, changes in extreme weather events, strong winds, reductions in water availability and flooding affect crops planting and harvesting periods and reduce crops productivity. Not only does this study address the existing gab (the study documented information on planting guide, rain pattern and double cropping in a planting season), but it also demonstrates the potential of planting guide, rain pattern and double cropping of cowpea (SasaKawa), jute and spinach in a planting season as climate change mitigation strategy, viable for the college food security and national economic growth, profitable to earn both Dollars and Naira and also, employable for Nigerian youths, academic and non-teaching staff of Federal College of Education (Technical) Bichi old site, Sudan savanna region of Nigeria.

Fig. 1. Cowpea.

Fig. 2. Jute.

Fig. 3. Spinach.

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