CLIMATE SMART INTERCROPPING BETWEEN CASSAVA AND COWPEA: A PANACEA FOR FOOD SECURITY

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Abstract

Field trial was conducted at Adiabo, Odukpani, Cross River State to evaluate the yield of cassava varieties as affected by intercropped cowpea varieties during the 2024/2025 cropping season. Treatments comprised two varieties of cassava (TME 419 and Adiabo local) and two varieties of cowpea (Sampea 11 and Bida local). The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated thrice. The entire plot size used for the experiment was 49m x 22m (1078m^2) and each experimental plot measured 6m x 5m (30m^2). The result indicated that intercropping cassava with cowpea had no significant ($P \leq 0.05$) effect on all growth parameters of cowpea measured (plant height, number of leaves /plant, leaf area. Also, the number of pods per plant, number of seeds/pod were not significantly ($P \leq 0.05$) affected by cassava/cowpea intercropping system while seed weight per pod and total grain yield (t/ha) were significantly ($P \leq 0.05$) affected by cassava-cowpea mixtures. Furthermore, the result indicated that leaf area,1 and number of tubers/plants of cassava were not significantly ($P \leq 0.05$) affected by cassava/cowpea intercropping system while plant height, number of leaves /plant, fresh weight of root and total root yield of cassava were significantly ($P \leq 0.05$) affected by the intercropping system. The land equivalent ratios of all the intercropping plots were greater than 1, an indication of better land use efficiency of both crops. Therefore, the experiment showed that cassava is compatible with cowpea in an intercropping system and as such should be recommended to farmers subject to further trial arising from its yield advantage.

Keywords: *Climate smart; cropping system; arable crops; nutrient management; food security*

Introduction

Climate smart intercropping for food security in Nigeria has become the ultimate perspective for ensuring sustainability in cassava production. Surges in climatic variables is rapidly altering the physical environment in which agriculture operates. Increasing average global temperatures, changing precipitation patterns and amplifying the frequency and intensity of extreme weather events have become issues of global concern. In the past decades, research has shown that 2024 was the hottest year globally with mean surface temperatures reaching approximately 52.0 °C above the pre-industrial baseline (C3S, 2025; ESOTC, 2025). These climatic shifts are adversely affecting crop phenology, water availability and the dynamics of pests, diseases, and weed factors that collectively influence crop production and food security (Malhi *et al*., 2021; Msomba *et al*., 2024).

Repetitive monocropping of cassava dramatically increases soil erosion and reduces soil fertility. Intercropping, a key agroecological practice, effectively manages soil erosion by increasing soil cover, improving soil fertility and enhancing biodiversity. Cassava (*Manihot esculenta Crantz*), a major food crop of the people in most parts of Africa, plays an important role in terms of food security, employment and income generation for farm families in parts of the humid tropics. It derives its importance from its starchy tuberous root, which is a valuable source of cheap calories, especially in developing countries (Som, 2007). Apart from its use as food, it is also an important industrial raw material to produce starch, alcohol, pharmaceuticals, gums, confectioneries and livestock feed (Nnodu *et al.,* 2006). Presently, cassava has attained the status of an industrial crop in Nigeria. It is now being grown on large scale, repeatedly season after season on the same piece of land (Nguyen *et al.*, 2001). Cowpea, being a leguminous crop, could fix atmospheric nitrogen and improve soil quality making it a suitable companion crop for cassava. Cowpea, also known as black eyed pea or beans, adds nitrogen to the soil through its root nodules, enhancing soil fertility. When intercropped with cassava, cowpea can improve soil health, increase overall crop yield and provide additional economic benefits to farmers.

Intercropping cassava with cowpea has gained attention as a sustainable agricultural practice that could potentially enhance land productivity and ensure food security. In Nigeria, cassava is grown extensively, especially in the southeastern region, where it is a major component of the diet and a significant source of livelihood for smallholder farmers. Cassava production is sensitive to climatic variations, with recent studies highlighting changes in cassava phenology, increased vulnerability to pests and pathogens and shifts in crop suitability zones due to climate change (Subedi *et al*., 2023). The productivity of cassava (*Manihot esculenta*) is often constrained by factors such as pest infestation, soil fertility depletion and inadequate agronomic practices. Soil degradation resulting from intensive cultivation and excessive use of synthetic fertilizers has unequivocally placed a tedious task on Agronomists (Elemi *et al., 2025*) One approach to address these challenges is through intercropping, which involves the simultaneous cultivation of two or more crops on the same piece of land. This strategy can enhance land use efficiency, increase crop yields, reduce pest prevalence and improve soil health. Intercropping can lead to better resources use compared to monoculture. However, the success of intercropping can vary depending on the crop varieties used, their growth habits and local environmental conditions.

Understanding the specific interactions between cassava (*Manihot esculenta*) varieties and cowpea (*Vigna unquiculata* L. walp) under the ecological conditions of Calabar is crucial for optimizing yield outcomes and guiding farmers in their cropping decisions. The current hunger and malnutrition in Nigeria and Sub-Saharan Africa in general are significant problems that need urgent government attention and requires sustainable agronomic strategies (Halberg and Muller, 2013). According to FAOSTAT (2015), more than 1 billion people (Ground one-sixth of the world's populations are undernourished with 98 % of them from developing countries including Nigeria.

Materials and Methods

A field study was conducted at a research and demonstration farm, Adiabo in Odukpani Local Government Area, Cross River State ($5^0$4`19``N and $8^0$15`7``E) during the 2024 – 2025 cropping season. Cross River State experiences a bimodal rainfall pattern, average about 3000mm per annum. Monthly precipitation ranges from 26.7mm in February to 459.1mm in July (Edet and Okereke, 2002). The ambient mean temperature of the area is 25.1 – 28^0c and a mean relative humidity of 80-89% (Unical/MET, 2023). Vegetation in the field consists of secondary bush, resulting from prolonged exploitation of the primary forest and intensive mixed cropping.

Based on USDA soil taxonomy, soils in the area are classified as Ultisols containing low amounts of nitrogen, but with a high carbon/nitrogen ratio. Basic cations (Ca^+, Mg^1, K^+)

are easily leached leaving mainly Al^{3+} and H^+ ions on the absorption complexes. As a result of their inherently adverse physical condition, high porosity, low nutrient reserve and high acidity, these soils would require strategy ecologically friendly agronomic practices such as intercropping with legumes to boost productivity. The total experimental land area was (1078 m^2) with each of the three replicate containing eight plots of 6 x 5 m (30 m^2).

Source of Planting Materials

The local variety of cassava was sourced locally from the villages in Adiabo community, and the second variety was sourced from National Root Crops Research Institute, Umudike, Abia State, Nigeria while cowpea varieties, Sampea 11 (CP_1) and Bida Local (CP_2) were sourced from International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria and National Cereals Research Institute (NCRI), Badeggi, Nigeria.

Treatments and Experimental Design

The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated thrice. Treatments were randomly assigned to plots in each block using random number tables. Each plot size was 6 x 5 m and separated from other 1 and 1-5 m between replications. Harvesting of cowpea was done at three months after planting while cassava on the other hand, was harvested 11 months after planting. Stems were cut with a machete at 1.5 m above ground level and then tuberous roots uprooted.

Data Collection

Cassava growth parameters were measured at 4 and 6 months after planting (MAP) while that on cowpea were collected at 4 and 6 WAP. Four cassava plants from the net plot and six cowpea plants were sampled for the purpose of data collection. The following cowpea parameters were measured from a net plot of 1.0 m^2 at 4 and 6 WAP; Emergence percentage (%), Vine length (cm), number of leaves per plant, Number of pods per plant, Number of seeds per pod and total grain yield (kg/ha). Cassava growth and yield parameters measured were plant height, number of leaves, leaf area (cm^2), number tuberous roots per plant and total root yield (t/ha). Land Equivalent Ratio (LER) was calculated as:

$$\text{LER (a): } \frac{\text{Yield intercrop } CA_1}{\text{Yield of sole crop } CA_1} + \frac{\text{Yield intercrop } CP_1}{\text{Yield of sole crop } CP_1}$$

$$\text{(b) } \frac{\text{Yield intercrop } CA_2}{\text{Yield of sole crop } CA_2} + \frac{\text{Yield intercrop } CP_2}{\text{Yield of sole crop } CP_2}$$

Note: CA_1 = TME 419 variety of cassava
CA_2 = Adiabo local cassava (land race)
CP_1 = Sampea 11 variety of cowpea
CP_2 = Bida local cowpea (Land race)

Statistical Data Analysis

Data collected were subjected to statistical analysis of variance (ANOVA) according to Gomez and Gomez (1984) and significant means compared using Tukey Honest Significance Differences.

Results and Discussion

The impact of climate smart intercropping between cassava and cowpea on the vegetative components of cowpea is presented in Table 1. Results showed that both intercropped and sole cowpea did not have any significant ($p>0.05$) effect on plant height, number of leaves/plant as well as leaf area throughout the sampling period. Hence, the cropping systems adopted in the experiment were statistically ($P> 0.05$) at par in terms of plant height, number of leaves per plant and leaf area (cm^2) at 5 and 6 WAP, respectively. Although, Sampea II variety of cowpea in mixtures with TME 419 cassava variety produced longer vines, higher number of leaves and leaf area which were similar to all other cowpea treatments. This agrees with the findings of Njoku and Muoneke (2008) as well as Amoaka *et al* (2022) who posited that cassava/cowpea intercropping system did not have significant effect on plant height, number of seeds/pod and number of pods / plant of cowpea. This is in recognition of the fact that cassava is compatible with cowpea in an intercropping system.

Effects of climate smart intercropping between cassava and cowpea was not significant on leaf area index, number of pods per plant and number of seeds per plot (Table 2). Leaf area index, a measure of the photosynthetic efficiency of the crop was higher in mixtures of TME 419 and Bida Local Cowpea-C_1P_2 (109.81) and least at CA_2+CP_2 (89.40). Similarly, number of pods per plant and number of seeds per plot were higher at CA_1CP_2 (28.67) and sole Sampea II (CP_1) variety of cowpea (172.00), respectively. However, seed weight per pod (g) as well as total grain yield of cowpea were significantly ($p<0.05$) influenced by the intercrop. This may be due to the improved genetic yield potential of Sampea II compared to Bida local. This is an indication that the genetic potential of a variety determines its competing ability of the production capacity of the crop aside the cropping system. This position may be supported with the work of Sinaga *et al* (2024) and Adjebeng-Danqual *et al* (2023) who reported that the genetic response to mitigate the negative effect of harsh conditions in an ecology is the function of their physiological and morphological traits.

Findings revealed that , Adiabo local cassava and sampea II cowpea statistically produced higher seed weight per pod (19.50). Sole sampea II –(CP_1) grain yield (t/ha) was statistically ($p<0.05$) higher at CA_1+CP_2 ,respectively.

Effect of climate smart cassava-cowpea intercropping on plant height, no of leaves and leaf area of cassava is presented in Table 3. Plant height and number of leaves differed significantly ($P< 0.05$) with respect intercropping systems at 4 and 6 months after planting with taller plants observed in CA_1 + CP_1 (intercrop of TME 419 Cassava and Sampea II cowpea). TME 419 Cassava in mixtures of sampea II and Bida local varieties of cowpea produced similar plant heights which were statistically at par with one another. However, shorter cassava plants were recorded in CA_2 + CP_1 (Adiabo local cassava and sampea II cowpea).

The effect of intercropping on cassava number of leaves followed a similar behavioural pattern as higher number of leaves were recorded in CA_1 + CP_1 which were statistically at par with either cassava varieties grown solely in all sampling periods, least number of leaves were recorded in Adiabo local cassava intercropped with sampea II cowpea. Contrary, leaf area of cassava plants were all statistically the same ($P>0.05$), irrespective of the cropping system. However, larger leaf area were recorded in local cassava variety intercropped with Bida local cowpea. This is an indication of the compatibility of TME 419 variety of cassava with cowpea. This is in support of the position of Sinaga *et al* (2024) who opined that intercropping cassava and cowpea significantly influenced casava morphology during the cowpea growth phase, affecting plant height, stem girth and number of leaves.

Table 1: Effect of climate smart cassava-cowpea intercropping on plant height (cm), number of leaves per plant and leaf area (cm^2) of cowpea.

Plant height		Number of leaves/plant		Leaf area		
Treatment	5 WAP plant	6 WAP height	5 WAP number of leaves / plant	6 WAP	5 WAP	6WAP leaf area
CP_1	19.95[a]	22.56[a]	6.94a	9.00[a]	54.72[a]	63.50[a]
CP_2	18.83[a]	21.28[a]	6.39a	8.66[a]	51.99[a]	59.79[a]
$CA_1 + CP_1$	16.94[a]	19.67[a]	5.94a	8.44[a]	43.68[a]	47.26[a]
$CA_1 + CP_2$	21.39[a]	24.67[a]	6.89a	10.18[a]	54.40[a]	63.65[a]
$CA_2 + CP_1$	15.78[a]	18.89[a]	6.61a	10.72[a]	47.61[a]	56.90[a]
$CA_2 + CP_2$	17.78[a]	21.06[a]	4.77a	10.22[a]	44.70[a]	53.42[a]
SEM ±	1.92	2.66	1.09	1.11	7.39	8.39
COV (%)	18.1	15.2	30.1	20.1	25.90	25.3

Means in the column followed by similar letter(s) are not significantly different according to Tukey Honest Significance Difference ($P \leq 0.05$)

Note:

CP_1 = Sampea 11 variety of cowpea
CP_2 = Bida local cowpea (Land race)
$CA_1 + CP_1$ = Intercrop of TME 419 cassava and Sampea 11 cowpea
$CA_1 + CP_2$ = Intercrop of TME 419 and Bida Local cowpea
$CA_2 + CP_1$ = Intercrop of Adiabo local cassava and Sampea 11 cowpea
$CA_2 + CP_2$ = Intercrop of Adiabo local cassava and Bida brown eye
SEM=Standard error of means; COV= Coefficient of variability

Table 2: Effect of climate smart cassava-cowpea intercropping on the leaf area index, number of pods per plant, number of seeds per plot and total grain yield(t/ha)

Treatment	**Leaf area index**		**No. of pods per plants**	**No of seeds per pod**	**Seed weight per pod (g)**	**Total grain yield (t/ha)**
	5WAP	6WAP				
CP_1	109.45[a]	127.00[a]	25.33[a]	12.00[a]	11.27[ab]	3.60[a]
CP_2	103.97[a]	119.60[a]	24.00[a]	13.70[a]	6.97[b]	1.01[b]
$CA_1 + CP_1$	87.37[a]	94.50[a]	21.00[a]	13.70[a]	18.33[ab]	2.76[ab]
$CA_1 + CP_2$	109.81[a]	127.30[a]	28.67[a]	14.30[a]	13.03[ab]	1.25[b]
$CA_2 + CP_1$	95.59[a]	113.80[a]	24.67[a]	14.70[a]	19.50[a]	3.50[a]
$CA_2 + CP_2$	89.40[a]	106.80[a]	28.33[a]	13.70[a]	9.07[ab]	1.56[ab]
SEM ±	14.81	16.78	04.31	11.80	3.36	0.65
COV (%)	25.90	25.30	29.05	22.50	44.70	49.50

Means in the column followed by similar letter(s) are not significantly different according to Tukey Honest Significance Difference ($P \leq 0.05$)

Note:

CP_1 = Sampea 11 variety of cowpea
CP_2 = Bida local cowpea (Land race)
$CA_1 + CP_1$ = Intercrop of TME 419 cassava and Sampea 11 cowpea
$CA_1 + CP_2$ = Intercrop of TME 419 and Bida Local cowpea
$CA_2 + CP_1$ = Intercrop of Adiabo local cassava and Sampea 11 cowpea
$CA_2 + CP_2$ = Intercrop of Adiabo local cassava and Bida brown eye
SEM= Standard error of means; COV= Coefficient of variability

Table 3: Effect of climate smart cassava/cowpea intercropping system on plant height(c^2), number of leaves and leaf area (cm^2) of cassava at 4 and 6 months after planting (MAP)

Treatment	Plant height		No of leaves per plant		Leaf area	
	4MAP	**6MAP**	**4MAP**	**6MAP**	**4MAP**	**6MAP**
CP_1	74.58^a	153.30^{ab}	20.17^{ab}	38.42^a	10.75^a	37.96^a
CP_2	78.50^a	170.80^a	13.58^{ab}	23.50^b	13.28^a	47.42^a
$CA_1 + CP_1$	80.17^a	164.30^{ab}	22.36^a	37.75^a	12.83	50.29^a
$CA_1 + CP_2$	67.25^{ab}	106.60^b	15.75^{ab}	30.42^{ab}	10.54^a	42.76^a
$CA_2 + CP_1$	53.67^b	132.80^{ab}	12.83^b	24.92^b	10.78^a	42.12^a
$CA_2 + CP_2$	55.67^b	116.60^{ab}	14.58^{ab}	27.42^{ab}	17.73^a	57.35^a
SEM $\pm$	5.19	17.65	2.61	3.30	2.42	5.39
COV (%)	13.20	21.70	27.40	18.80	33.10	20.60

Means in the column followed by similar letter(s) are not significantly different according to Tukey Honest Significance Difference ($P \leq 0.05$)

Note:

CP_1 = Sampea 11 variety of cowpea
CP_2 = Bida local cowpea (Land race)
$CA_1 + CP_1$ = Intercrop of TME 419 cassava and Sampea 11 cowpea
$CA_1 + CP_2$ = Intercrop of TME 419 and Bida Local cowpea
$CA_2 + CP_1$ = Intercrop of Adiabo local cassava and Sampea 11 cowpea
$CA_2 + CP_2$ = Intercrop of Adiabo local cassava and Bida brown eye

The effect of climate smart cassava/cowpea intercropping system on number of tuberous roots per plant, fresh root weight per plot, total root yield as well as land equivalent ratio is presented in Table 4. Number of tuberous roots /plant was not significantly ($P>0.05$) affected by cassava cowpea intercrop. Findings showed that sole TME 419 variety of cassava (CA_1) produced higher number of root tubers which were statistically similar with intercropped cassava. Fresh tuber weight per plot and total root tuber yield (t/ha) were significantly ($P<0.05$) affected by intercropping. TME 419 variety of cassava planted solely gave higher tuber yield (58.00) than other cassava varieties as well as their intercrop. This result is in conformity with that of Sinaga *et al*. (2024), who stated that cassava grown under monoculture produced higher tuber weight and number of tuber roots than its intercrop with cowpea. Similarly, Mansang *et al*. (2022) posited that cassava grown as sole crop produced higher tuber yield than that intercropped with cowpea. This is also corroborated with the findings of Njoku and Muoneke (2008), who reported higher yields in sole cassava cropping system due to reduction in competition for growth resources, especially nitrogen.

Land equivalent ratio at all intercropping mixtures were greater than 1 implying better utilization of available land resources for enhanced productivity of both cassava and cowpea. The highest LER was recorded in $CA_2 + CP_2$ (2.26) and the least was observed in $CA_1 + CP_1$ (1.18). In addition, the land equivalent ratio of all the intercropping systems had yield advantages over monoculture as it had 18 % - 126 % land saving under the intercropping. The intercropping of TME 419 with Bida local had 73 % land saving value while the intercrop of Adiabo local with Bida local had 126% land saving. This result may be possible because of the nitrogen fixation in the soil aided by the cowpea, protection of the soil from erosion, the abundance of natural enemies that help in protecting the crops against insect pests and abundance of beneficial bacteria/fungi. This position is supported with the work of Trung *et al* (2021), Li, *et al* (2017); Mansary *et al*. (2022); Kando and Bitane (2023); Sinaga *et al*. (2024); Abirami *et al* (2025). The results therefore suggest that the intercropping of TME 419 cassava with Bida local and that of Adiabo local with Bida local were more complementary and efficient among the cropping systems.

Table 4: Effects of climate smart cassava/cowpea intercropping system on number of tuberous roots, fresh root weight, total root yield of cassava (t/ha) and land equivalent ratio (LER)

Treatment	No of tuberous roots / plant	Fresh root weight (kg/plot)	Total root yield (t/ha)	Land equivalent ratio
CA_1	5.00[a]	5.80[a]	58.00[a]	
CA_2	4.67[a]	5.67[a]	56.67[a]	
$CA_1 + CP_1$	3.75[a]	3.27[b]	23.67[b]	1.18
$CA_1 + CP_2$	3.58[a]	2.83[b]	28.33[b]	1.73
$CA_2 + CP_1$	4.00[a]	2.57[b]	25.67[b]	1.43
$CA_2 + CP_2$	4.25[a]	4.07[ab]	40.67[ab]	2.26
SEM$\pm$	0.46	0.69	8.08	
COV (%)	19.10	29.8	36.00	

Means in the column followed by similar letter(s) are not significantly different according to Tukey Honest Significance Difference ($P \leq 0.05$)

Note:

CA_1 = TME 419 variety of cassava
CA_2 = Adiabo local cassava (land race)
$CA_1 + CP_1$ = Intercrop of TME 419 cassava and Sampea 11 cowpea
$CA_1 + CP_2$ = Intercrop of TME 419 and Bida Local cowpea
$CA_2 + CP_1$ = Intercrop of Adiabo local cassava and Sampea 11 cowpea
$CA_2 + CP_2$ = Intercrop of Adiabo local cassava and Bida local cowpea

Findings showed that intercropping of cowpea with cassava has a significant impact on the growth parameters and yield outcomes of cassava. The intercropping system can enhance soil fertility, optimize land use, and improve overall productivity due to the complementary growth habits of the two species. Cassava, a staple food with high carbohydrate content, benefits from the nitrogen-fixing ability of cowpea, which contributes to improved soil health and nutrient availability. The study revealed that intercropped cassava plants exhibited better growth and yield characteristics compared to those grown as monocrops. The synergy between cassava and cowpea allows for a more efficient use of resources such as light, water, and nutrients, thus leading to improved yield. The synergistic relationship between cassava and cowpea in intercropped systems has been shown to optimize growth conditions for both species, resulting in improved outcomes compared to mono-cropping practices. Therefore, farmers in the region should consider adopting intercropping strategies to maximize the benefits of cassava cultivation while promoting environmental sustainability.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Promote Intercropping Systems: Farmers should be encouraged to adopt the intercropping system of cassava and cowpea, especially the TME 419 variety and Bida local variety of cowpea to optimize land use and enhance the productivity of both crops.
2. Cultural methods of soil management be adopted by farmers to boost productivity of crops.

3. Further Research: Additional studies should be conducted to explore the economic viability and market potential of intercropped cassava and cowpea, including the effects of different environmental conditions on their growth.

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