

# Evaluation of New Cassava Varieties for Compatibility with Maize and Cowpea under Intercropping

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**Abstract:** Intercropping is a production system that involves the growing of two or more crops simultaneously on the same piece of land. In intercropping, the component species are not necessarily sown at the same time and their harvest times may be different, but they are simultaneous for a significant part of their growing period. Past research at KALRO-Mtwapa developed cassava varieties that are high yielding and tolerant to cassava diseases. The varieties were developed and tested under sole cropping but farmers intercrop cassava with maize and cowpea. An experiment was therefore conducted at KALRO-Mtwapa to evaluate the new cassava varieties for their suitability for intercropping with maize and cowpea. Four cassava varieties: KME-08-05 (Karemba), KME-08-02 (Tajirika), KME-08-06 (Nzalaoka) and clone 2855 were used. The treatments comprised of the varieties and their intercrops with either maize or cowpea. The cassava number of root per plant was significantly ( $p \leq 0.05$ ) influenced by the presence of either maize or cowpea intercrop for all varieties except Karemba when intercropped with maize. Cowpea significantly ( $p \leq 0.05$ ) reduced the number of roots per plant for Karemba and Tajirika but its effect on clone 2855 and Nzalaoka was similar to that of maize for the same parameter. Among the crop treatments clone 2855 had significantly lower number of roots per plant than the other three clones. In terms of root yield Karemba recorded significantly ( $p \leq 0.05$ ) higher yield than Tajirika and clone 2855. However its root yield was significantly ( $p \leq 0.05$ ) reduced by both maize and cowpea intercrops. The yield reduction by cowpea was significantly ( $p \leq 0.05$ ) higher than that of maize. The root yield for the Nzalaoka and 2855 was significantly reduced by the presence of cowpea intercrop. Tajirika showed significantly ( $p \leq 0.05$ ) higher net income under cowpea intercrop than the other varieties. The yields of both maize and cowpea when intercropped with the four cassava varieties did not reveal any significant difference implying that cassava had no effect on the performance of the intercrops. Maize is therefore a better candidate for intercropping with cassava than cowpea and Tajirika is the most suitable variety for intercropping in coastal lowland Kenya.

**Key words:** Cassava, intercropping, roots, yield.

## 1. Introduction

Cassava (*Manihot esculenta* Crantz) is ideal for production in marginal and drought prone areas, which comprise over 80% of Kenya's land mass [1]. It is an important perennial crop whose roots serve as an important source of carbohydrates to over 800 million people in the world [2]. It can be used fresh or processed into a variety of products [3]. Compared to potato (*Solanum tuberosum*), sweet potato (*Ipomea batatas*), maize (*Zea mays* L.) and rice (*Oryza sativa* and *O. glaberrima*), cassava productivity per unit area is the highest [4] at 40%

more than rice and 25% more than maize [5]. The crop provides over 500 calories daily to over 70 million people [6]. It is the third most important source of carbohydrates in Africa and the second most important food crop after maize in the western and coastal regions of Kenya [7].

In Kenya, it is grown in diverse agro-ecological zones in western, eastern and central and coastal regions. Of the three regions, Western produces 60%, coastal 30%, and eastern and central regions 10% of the total production [8, 9]. Cassava has the potential for partial or complete replacement of maize as an energy source in the manufacture of animal feeds [10]. Cassava is one of the most efficient producers of carbohydrates and energy among all food crops. It

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can produce more than 250,000 calories per hectare per day, compared to 176,000 for rice, 110,000 for wheat and 200,000 for maize [11]. Despite its importance as a food, income generating and industrial crop, cassava productivity in coastal Kenya is estimated at 8 t/ha [12], which is below the estimated potential yield of 70.1 t/ha [13].

The low productivity is due to constraints such as inadequate planting materials, the low yielding potential of popular cultivated varieties, poor agronomic practices, unfavourable climatic conditions, pests and diseases [9]. Past research in coastal Kenya has addressed the constraints of low yields and diseases through development of improved varieties that are high yielding and tolerant to cassava diseases and pests [14]. The new varieties had not been integrated into existing cropping systems. These varieties were developed and tested under sole cropping, however, subsistence growers, or those with very limited areas of land, intercrop cassava with early maturing crops, such as maize, and/or various types of grain legumes, including cowpeas, green grams and groundnuts. Intercropping cassava with maize (*Zea mays* L.) and cowpea (*Vigna unguiculata* L.) has been shown to increase land productivity [15]. Similar findings in coastal lowland Kenya on intercropping cassava with maize and dolichos (*Lablab purpureus* L.) were also reported by Njunie [16].

Intercropping is a production system that involves planting of two or more crops in a field during a growing season [17]. It is a way to increase diversity in an agricultural ecosystem. Intercropping is the most common production system used in subsistence tropical agriculture. In intercropping, the component species are not necessarily sown at the same time and their harvest times may be different, but they occupy the land simultaneously for a significant part of their growth period. Intercropping has many benefits—it protects the soil from the direct impact of rain, reduces soil erosion from runoff, and limits weed

growth during the early stages of cassava development. Intercropping also produces crops that can be harvested at different times during the year, increases total net income per unit area of land, and reduces the risk of total crop failure. Since the crops in an intercrop have different pest and disease complexes and growth requirements, one crop may survive even if the other fails. Cassava is less risky crop and if the associate crop succeeds, provides a bonus [18]. The work presented here was carried out to address the following objectives:

- (1) To determine the effect of inclusion of maize or cowpea on the yield of four cassava varieties;
- (2) To determine the economics of cassava-maize or cassava-cowpea intercropping.

## **2. Materials and Methods**

The study presented here was conducted at the Kenya Agricultural and Livestock Organization's Centre, Mtwapa from 2013 to 2015. The site lies in latitude: 03°56'11" S and longitude: 039°44'11" E from 2013 to 2015. The altitude for the study site is 15 m above sea level. The agro-ecological zone for the sites as described by Jaetzold and Schmidt [19] is coastal lowland zone 3. The site had sandy soils with a pH of 6.9. The soils are deficient in essential macro-nutrients, especially nitrogen and phosphorus [20], and have low organic matter content and cation exchange capacity [20]. The mean annual rainfall for the site is 1,200 mm, with most of it falling during the long rain months of April to August. The mean monthly minimum and maximum temperatures are about 22 °C and 30 °C, respectively.

The experiment comprised of four cassava varieties which were evaluated as sole crop and under intercropping with either maize or cowpea. The four varieties were KME-08-05 (Karembo), KME-08-02 (Tajirika), KME-08-06 (Nzalaoka) and clone 2855. Cassava was planted at a spacing of 1 m × 1 m. In the cassava-maize intercrop, one row of maize was planted in between two rows of cassava

at a spacing of 50 cm with three seeds planted per hill and later thinned to two. Two rows of cowpea were sown between two cassava rows at a spacing of 30 cm, with three seeds planted per hill and thinned to two later. Randomized complete block design [21] was used. The treatments were replicated three times.

Land preparation and planting were carried out during the month of April 2013, May 2014 and May 2015. Stem cuttings, 20 cm long were planted at 45° angle in respective plots. Plots consisted of six rows of cassava and the net plots comprised of four rows. The row length was 6 m. Weeding was carried out three times during the whole crop growth period. Di-ammonium phosphate (DAP) and calcium ammonium nitrate (CAN) were applied to maize crop to provide the necessary phosphorus and nitrogen. The rate of application was 46 kg/ha P<sub>2</sub>O<sub>5</sub> and 60 kg/ha N, respectively. Phosphatic fertilizer was applied at planting alongside the first split of 18 t/ha nitrogen. Additional nitrogen fertilizer was applied as top-dress at a rate of 42 t/ha four weeks after planting.

Cyclone (chloropyriphos 10% + cypermethrin 35%) was sprayed to control maize stalk borer and

pod borers for maize and cowpea, respectively. Thirty milliliters (30 mL) were used in 20 L knapsack sprayer translating to 1 L of the chemical per hectare. Harvesting for cassava and cowpea was done by uprooting the whole plant for all the plants from the net plot. Maize was harvested by removing the ears from the stalk. Data for cassava were recorded: number of roots per plant, total number of roots, number of marketable roots per plot, percent marketable roots and marketable root yield per hectare. Maize and cowpea yield were also recorded. Agronomic data were subjected to analysis of variance using the linear model:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \varepsilon_{ij}$$

where,  $\mu$ : constant, overall mean;  $\alpha_i$ : constant for  $i$ th treatment group;  $\beta_j$ : constant for the  $j$ th deviation from mean  $j$ ;  $\varepsilon_{ij}$ : random deviation associated with each observation.

The differences among treatment means were compared using Fischer's protected least significant difference (LSD) test at  $p \leq 0.05$ .

### 3. Results and Discussion

Combined results for the three years' data are summarized in Table 1. The number of roots per plant

**Table 1** Performance of cassava varieties across years as influenced by maize and cowpea intercrops.

Treatment combination	Parameters measured				
	Number of roots per plant	Marketable roots per plot	Percent marketable roots	Root yield (t/ha)	Yield reduction (%)
Karembo sole	10.8	136.6	62.0	40.1	0
Tajirika sole	9.7	113.2	69.5	31.5	0
Nzalaoka sole	8.2	90.0	58.5	26.5	0
Clone 2855 sole	7.4	99.1	66.1	30.4	0
Karembo with maize	8.9	108.0	62.7	28.3	29.4
Tajirika with maize	7.1	92.7	74.1	33.4	-6.0
Nzalaoka with maize	6.0	87.6	72.4	29.3	-10.6
Clone 2855 with maize	6.9	76.2	72.3	27.8	8.6
Karembo with cowpea	6.8	78.1	64.3	17.8	55.6
Tajirika with cowpea	4.9	80.0	68.6	24.9	21.0
Nzalaoka with cowpea	5.0	57.1	68.9	16.2	38.9
Clone 2855 with cowpea	5.0	60.0	68.3	19.7	35.2
CV	28.8	27.9	16.8	34.8	
LSD	1.95	23.54	10.65	8.88	

ranged from 4.9 for Tajirika with cowpea to 10.8 for sole Karembo. Sole Karembo recorded significantly ( $p \leq 0.05$ ) higher number of roots per plant than both sole Nzalauka and clone 2855. This was expected because the number of roots per plant is one of the major yield components and Karembo has a higher yield potential than the other test varieties [13]. Significant ( $p \leq 0.05$ ) difference was also observed between Tajirika and clone 2855 for the same parameter. Maize intercrop significantly ( $p \leq 0.05$ ) reduced number of roots per plant for Tajirika and Nzalauka and this might be due to shading effect. Cowpea intercrop reduced the number of roots per plant in all cassava varieties. This was as a result of early shading which covered all the cassava plants completely for most of cowpea growing period of two months. The highest reduction by cowpea in the number of roots per plant was recorded for Tajirika whereas the lowest was that for clone 2855.

Sole Nzalauka and clone 2855 recorded significantly ( $p \leq 0.05$ ) lower number marketable roots per plot than sole Karembo. Apart from Karembo, the other three cassava varieties did not show any significant ( $p \leq 0.05$ ) differences in marketable roots per plot under intercropping with maize. Cowpea significantly ( $p \leq 0.05$ ) reduced the number of marketable roots per plot for all the cassava varieties and the highest reduction was that for clone 2855. As regards percent marketable roots, Tajirika had significantly ( $p \leq 0.05$ ) higher proportion of marketable roots than Nzalauka. Nzalauka/maize intercrop had significantly ( $p \leq 0.05$ ) higher proportion of marketable roots than sole Nzalauka.

Root yield ranged from 16.2 t/ha for Nzalauka with cowpea to 40.1 t/ha for sole Karembo. Sole Karembo gave significantly ( $p \leq 0.05$ ) higher root

yield than sole crops of Nzalauka and clone 2855. This was expected because of contribution of higher number of roots per plant with a big proportion of marketable roots. Cowpea intercrop caused significant ( $p \leq 0.05$ ) reduction in root yield for all cassava varieties except Tajirika. Tajirika stems are tall and straight without branches and tended to penetrate above the cowpea canopy whereas the other varieties were completely covered by cowpea and this led to insignificant yield reduction. Shading was the major contributor to yield reduction due to cowpea intercrop. There was no significant ( $p \leq 0.05$ ) yield reduction in any of the cassava varieties under intercropping with maize. This implies that cassava compensates for shading if the companion crop does not provide complete cover over the cassava. For Nzalauka and Tajirika, the yield increased under maize intercropping and this might be attributed to residual fertilizer applied to maize finding its way to cassava.

Significant ( $p \leq 0.05$ ) cost differences were observed between cassava intercropped with maize and either sole cassava and cassava with cowpea for all cassava varieties (Fig. 1). This was attributed to extra costs associated with fertilizer application on maize. For all the cases, monoculture cassava yields were better than those of the cassava/cowpea intercropping system and production costs were almost the same. However, the high commercial value of the cowpea produced resulted in a total net income higher than that of the cassava monoculture. Tajirika showed significantly ( $p \leq 0.05$ ) higher net income under cowpea intercrop than the other varieties. While cassava cowpea intercropping system produces generally lower root yields, compared with monocropping, it is found to increase land use efficiency and results in higher economic returns [22].

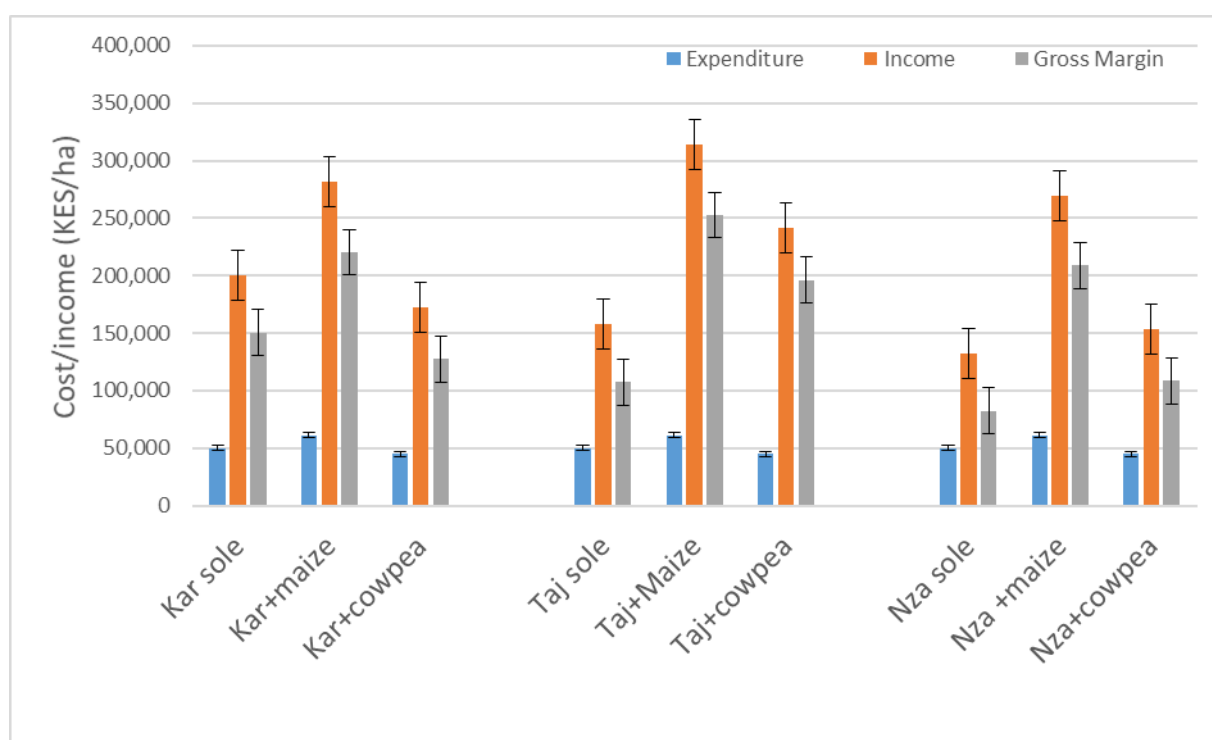


Fig. 1 Production costs, gross and net income of three cassava varieties under intercropping.

## 4. Conclusions

Tajirika is the most suitable variety for intercropping in coastal lowland Kenya. Compared to cowpea, maize is a better choice for intercropping with cassava. It is more paying to intercrop cassava with maize than cassava sole cropping.

## 5. Recommendation

For higher returns to land investment, farmers in coastal lowlands Kenya should intercrop cassava especially Tajirika variety with maize

## Acknowledgment

The author is grateful to the Centre Director, KARLOI-Mtwapa for provision of facilities. Thanks also go to Dau Mwakina for trial management and data collection.

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