
Profitability of Dry Season Farming of Jute Mallow (*Corchorus olitorius*) and Amaranth (*Amaranthus cruentus*) Inter and Sole Cropping Systems in Abeokuta, Nigeria.

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Abstract

The study determined the profitability of three different cropping systems. Data collected include cost of fixed assets, cost of variable inputs, yields and prices of outputs. Data were subjected to budgetary technique; analysis of variance and significant means were separated using Duncan's Multiple Range Test at 5% level of probability. Results of the gross margin analysis showed that both the intercropping and only sole Amaranth vegetable production were profitable. The intercrop production had a gross margin of ₦567,920/ha with a total revenue of ₦1,600,000/ha and having the highest output of 8000kg/ha while the sole Amaranth vegetable production had a gross margin of ₦179,920/ha with a total revenue of ₦1,200,000/ha and having an output of 6000kg/ha. Also, the intercrop vegetable production had a benefit cost ratio, rate of return and gross ratio of 1.51, 0.52 and 0.66, respectively while sole Amaranth production had a benefit cost ratio, rate of return and gross ratio of 1.15, 0.15 and 0.87, respectively. The result indicates that the two vegetable productions were profitable. Further analysis revealed that intercropping did not have significant ($p < 0.05$) effect on the

growth (plant height, number of leaves) of both vegetables. However, Jute yield was significantly ($p < 0.01$) affected by Amaranth-Jute intercropping. Both the intercrop and sole Amaranth enterprises were profitable, but there was a significant difference in the profitability of the intercrop cropping system practised as the Amaranth/Jute intercrop was more profitable. The intercrop is, therefore, recommended to farmers since it is more profitable and provides a variety of income generation for the farmer's thereby ensuring food and income security.

Keywords: Amaranth, Jute, vegetable, intercropping, sole cropping, profitability

Introduction

The cultivation of vegetable serves as a means of livelihood for thousands of household both in the rural and urban communities. Most vegetable farmers in the rural community grow vegetable for commercial purpose in other to generate income while some in the urban centre cultivate vegetable for the purpose of nutritional and medicinal value (Oladapo and Afolami, 2021).

There are various leafy vegetables grown in West Africa, Nigeria, inclusive among which are Amaranth– *Amaranthus cruentus* L.; bitter leaf – *Vernonia amygdalina* Del.; lettuce – *Lactuca sativa* L., spinach – *Basella alba* L., etc. Of these leafy vegetables, Amaranth is the most widely grown in Nigeria. It is a staple vegetable plant grown for its leafy material used in Nigerian dishes such as soup, stew, salad porridge and as garnish (Abdullahi et al., 2019). It is also considered as one of the most important green leafy vegetables of the tropics, because it provides minerals and vitamins (especially vitamin A) which are highly beneficial for the maintenance of good health and prevention of diseases.

Also, Jute mallow (*Corchorus olitorius*) is also another important vegetable generally cultivated in Africa. It belongs to the genus *Corchorus* and Tiliaceae family and is the second most important fibre crop after cotton in terms of global consumption.

Intercropping, which is also referred to as multi-cropping is a centuries-old agricultural practice that involves the growing of multiple crop species in close proximity such that they coexist for a significant part of their life cycle (Gitri et al., 2020). In tropical areas particularly in Africa, intercropping has been practiced for over a millennium, and it is still gaining popularity among the smallholder farmers (Gou et al., 2016; Gitari et al., 2018a; and 2019b; Nyawade et al., 2019a; and b).

Intercropping Jute/Amaranth is a farming practice gaining momentum among peasant farmers in Nigeria, with the choice being motivated by the economic objective of producing maximum output to earn a positive economic return (Akinkuoroye, 2019). The studies of (Shuaib et al, 2017), examined the profitability and production constraints in the sole vegetable production of dry season amaranth. Also, Akinkuoroye, (2019) worked on vegetable based intercropping systems of Celosia, Amaranth and Jute production. However, these studies did not reveal the economic viability particularly in Amaranth/Jute combination. There is, therefore, the need to examine the differences in profitability of *Jute/Amaranth* intercrop and sole crops while it also evaluates the effects of Amaranth-Jute intercropping on the

growth and yield of Amaranth and Jute vegetable productions respectively and also to determines the best cropping systems among sole Amaranth, sole Jute and Amaranth/Jute intercrop. Knowledge of this research will help farmers to obtain empirical information about their profitability in order to make a pre-informed farming decision on vegetable production.

Methodology

The research was carried out at the Farm of the Institute of Food Security, Environmental Resources and Agricultural Research, Federal University of Agriculture, Abeokuta (07° 15'N 03° 25'E) in the Forest-Savanna of South West Nigeria in 2020.

The treatments were Amaranth and Jute grown sole or in intercropping with each other. The size of each plot was 3 m × 2 m with a border of 0.5m between plots. The experiment was laid out in randomized complete block design (RCBD) consisting of three treatments and replicated four times. Incorporation of manure was done prior to sowing of seeds after tilling on the 6th of November, 2020. Manual weeding was carried out regularly to disallow effects of weeds on the cultivated crops. Data collected were cost of fixed assets, cost of variable inputs, yields and prices of outputs. Also five plants were measured per plot for plant height; number of leaves, and leaf yield/plot was measured from 3m x 2m (6m²).

The data were analysed using budgetary techniques, analysis of variance (ANOVA) and where the means are significant, they were separated using Duncan's Multiple Range Test (DMRT).

Budgetary technique: It enables the estimation of the total costs as well as total revenue accrued to an enterprise, gross margin, farm net profit and profitability of an enterprise within a specific production period.

The gross margin is calculated as follows:

$$GM=GR-TVC \text{ -----(i)}$$

Where GM =gross margin; GR =gross revenue or gross income; and TVC =total variable cost.

$$TVC=TOC+TLC \text{ -----(ii)}$$

Where TOC =total operating cost; and TLC =total labour cost.

The total cost of production (TC) is defined as:

$$TC=TVC+TFC=TOC+TLC+TFC \text{ -----(iii)}$$

Where TFC =total fixed cost; and TVC , TOC and TLC are as previously defined.

The Benefit Cost Ratio (BCR), Rate of Return and Gross Ratio used as a measure of profitability are calculated as:

$$BCR= TR/TC \text{ -----(iv)}$$

$$ROR = NR/TC \text{ -----}(v)$$

$$GR = TC/TR \text{ -----}(vi)$$

Land Equivalent ratio (LER): This is used to evaluate the intercrop's performance and was calculated as follows:

$$LER = \frac{X_{yi}}{X_{ys}} + \frac{Y_{yi}}{Y_{ys}}$$

Where, X_y and Y_y refer to X (maize) and Y (soybean) yields, respectively. The subscript "i", refers to the intercrop and the subscript "s" the sole crop.

Results and Discussion

Production Cost of *Corchorus olitorius*-*Amaranthus cruentus* Intercrop and Sole Crops

Table 1 shows the total cost of fixed assets and variable inputs for each production during the period of the experiment. The Amaranth-Jute intercrop had the highest total variable cost compared to the sole Amaranth and Jute respectively. This is because a large proportion of the variable costs for the intercrop were attributable to the labor input, which accounted for more than 50%. This identifies labor as the single most costly input in operating an irrigated dry season farms. This situation is not unexpected, since all farm operations including land clearing, planting, weeding, watering, spraying, manuring and harvesting were accomplished through manual labor. In other words, there is reduced efficiency in planting, weeding and harvesting in intercropping which may add to the labour costs of these operations. This finding is synonymous with the findings of (Ka Ming Fung et al., 2019), who reported that intercropping is a labor-intensive practise and requires higher cost of maintenance, in particular, weeding, which may have to be done by hand.

Table 1: Production cost per hectare of *Amaranth-Jute mallow* inter and sole cropping systems

	Amaranth/Jute intercrop	sole Amaranth	sole Jute
Fixed Costs	Amount (N/ha)	Amount (N/ha)	Amount (N/ha)
Land Purchase	120,000	120,000	120,000
Bowl	500	500	500
Pan	1,000	1,000	1,000
Weighing Scale (20kg)	6,000	6,000	6,000
Hoe	1,500	1,500	1,500
Overhead Tank 500 Ltr	18,000	18,000	18,000
Pumping machine 0.75hp	25,000	25,000	25,000
Well	140,000	140,000	140,000
Generator 2.5kva	80,000	80,000	80,000
Total Fixed Cost	393,500	393,500	393,500
Variable Items			
Land clearing, Seed bed preparation, manuring and planting	224,000	224,000	224,000
Watering, Weeding and Spraying	520,000	514,000	514,000
Cost of Bio pesticide (1) & (2)	67,000	67,000	67,000
Cost of Fuel (petrol)	81,008	81,008	810,008
Cost of Manure with Transportation	26,000	26,000	26,000
Cost of Seeds	24,000	24,000	24,000
Cost of Harvesting	90,000	84,000	84,000
Total Variable Cost	1,032,080	1,020,080	1,020,080

Source: Field Experiment, 2020**Gross Returns Per Hectare of Jute Mallow-Amaranth Intercrop and Sole Cropping Systems**

Table 2, reveals that on per hectare basis, the intercrop combination of Jute-Amaranth had the highest revenue of ₦1,600,000/ha compared to the revenue both

from sole Jute and sole Amaranth which was ₦520,000/ha and ₦1,200,000/ha respectively. This implies that of the three vegetable production systems, the intercrop had the highest return during the period of experiment. Studies in other developed countries reveal that intercropping systems can also increase net income, compared with sole cropping systems in northwest China (Yang et al., 2018).

Table 2: Gross returns per hectare of Jute Mallow-Amaranth intercrop and sole cropping systems

Cropping systems	Output (kg/ha)	Average price (₦/kg)	market	Total Revenue(₦)
Jute (intercrop)	2,800	200		56,0000
Amaranth (intercrop)	5,200	200		1,040,000
Sub Total	8,000	200		1,600,000
Jute (sole)	2,600	200		520,000
Amaranth (sole)	6,000	200		1,200,000

Source: Field Experiment, 2020

Cost and Returns Per Hectare of Jute Mallow-Amaranth Intercrop and Sole Cropping Systems

Table 3 presents summary of the costs and returns to dry season vegetable production for each enterprise in ₦/ha. The gross margin, benefit cost ratio, rate of returns and gross ratios were computed for each vegetable enterprise expressed in ₦/ha. The result revealed that both the intercropping system and sole Amaranth vegetable production was profitable in the study area with the intercropping systems having the highest gross margin of ₦567,920k/ha followed by Amaranth (sole) which also had a gross margin of ₦179,920/ha. This means that the intercropping system was the most profitable vegetable production. However, the profitability of this vegetable production was due to its high yield of 8000kg/ha compared with the output from sole Amaranth yielding 6000kg/ha. A similar study by (Shuaibu et al., 2017) reported that Amaranth producers realized a Net Farm Income of ₦213,965 per hectare per year implying that production of the crop was profitable. Also, Shuaibu and Mohammed (2018), worked on the profitability of Amaranth and Lettuce production revealed that Amaranth and Lettuce producers realized a net farm income of ₦213,965 and ₦294,287 per hectare per year for the production of the two crops respectively. This implies that Amaranth and Lettuce have positive net farm income and therefore production of the two crops was profitable.

The benefit cost ratio (BCR) for the intercrop and sole Amaranth was 1.51 and 1.15 respectively as shown in the table of analysis below. As a rule of thumb, project with benefit cost ratio greater than one, equal to one or less than one indicate profit, break-even or loss respectively. Since the ratios were greater than one, it showed profit and indicated that the enterprises were profitable and worth venturing into in

dry season. This was compared with the sole Jute whose BCR was (0.49). Since this production system shows a negative BCR, this indicates loss in profit. However, this loss could be as a result of weed infestation during the course of production. These weeds competed with the sole Jute most especially which in turn affected its productivity.

The rate of return (ROR) provides a measure of financial performance of the enterprise employed expressed in percentage (%) (i.e. profit/ ₦ invested). Results of the analysis revealed that the rate of returns for the intercropping system was the highest with a ROR of 0.52 which implies that for every ₦1.00 invested in this production, the enterprise yields ₦52.00 as gain. Also for the sole Amaranth production, the ROR was 0.15. This also implies that for every ₦1.00 invested, ₦15.00 was gained by the farmer. However, the ROR for sole Jute was (0.50). This means that for every ₦1.00 invested, ₦50.00 was lost by the vegetable farmer.

The gross ratio of the Amaranth/Jute intercrop and sole Amaranth vegetable production were 0.66 and 0.87 respectively. The ratios with respect to the vegetable crops were all less than unity. A less than one ratio is preferred for any farm business. Impliedly, Amaranth/Jute intercrop recorded lower gross ratio than sole Amaranth indicating that intercropping was more profitable than the sole Amaranth. This finding is similar to the findings of Shuaibu and Mohammed (2018) that Amaranth had a gross ratio of 0.58 implying that Amaranth was also profitable.

Table 3: Cost and returns per hectare of Jute Mallow-Amaranth intercrop and sole cropping systems

Items (₦/ha)	Amaranth- Chochorus (₦/ha)	Amaranth sole (₦/ha)	Jute sole (₦/ha)
Gross returns	1,600,000	1,200,000	520,000
Total variable cost	1,032,080	1,020,080	1,020,080
Gross margin	567,920	179,920	(500,080)
Benefit cost ratio	1.51	1.15	(0.49)
Rate of return	0.52	0.15	(0.50)
Gross ratio	0.66	0.87	(2.01)

Source: Field Experiment, 2020

Effect of Intercropping on Amaranth Yields and Growth Parameters

Intercropping of Amaranth and Jute did not have significant ($p < 0.05$) effect on the plant height and number of leaves of Amaranth. (Table 4). Non-significant effect of this intercropping on the growth of Amaranth disagrees with findings of Akinkuoroye (2019) who reported that intercropping can lead to reduction in growth rate of one or more component crops due to adverse competitive effects. This present result hence

indicates the compatibility of these two test crops for intercropping. There was negligible effect of competition for available resources during this growth stage. Amaranth yield was not significantly ($p \leq 0.05$) affected by Amaranth-Jute intercropping (Table 4).

Table 4: Effect of intercropping on Amaranth yields and growth parameters

Treatments	Plant (cm)			Height Number of leaves			Yield/plot (kg)	Yield (t/ha)
	3	4	5	3	4	5		
WAP								
Sole Amaranth	13.9	20.9	30.8	10	11	22	3.6	6.0
Amaranth-Mallow	12.8	18.1	26.4	9	11	20	1.6	5.2
S.E \pm	0.4	1.3	2.2	0.3	0.9	3.8	0.6	1.0
F test	Ns	ns	Ns	Ns	Ns	Ns	Ns	Ns

WAP = Weeks after planting. ns = not significant. * = Significant at 5% level of probability. ** = Significant at 1% level of probability.

***Field Experiment, 2020

Effect of Intercropping on Jute Yields and Growth Parameters

Table 5 shows the result of the effect of intercropped Amaranth and Jute on Jute yields and growth parameters. The effect of intercropping was not significant ($p < 0.05$) on the plant height and number of leaves of Jute. The compatibility of these two crops is further exemplified by this result. Jute yield was significantly ($p < 0.01$) affected by Amaranth-Jute intercropping. The intercrop treatment recorded higher yield/plot than the sole crop. This could be attributed to the fact that the intercrop component offer better opportunities to the components to utilize available resources. Intercropping assures efficient utilization of the resources and more yield than sole cropping. According to Gitari et al., (2019), yield advantage pronounces due to better use of growth resources such as light, water, and nutrients by the intercrop over time and space.

Table 5: Effect of intercropping on Jute yields and growth parameters

Treatments	Plant (cm)			Height Number of leaves			Yield/plot (kg)	Yield (t/ha)
	3	4	5	3	4	5		
WAP								
Sole Jute	9.3	13.9	24.8	5	8	22	0.8	2.6
Amaranth-Jute	9.4	12.9	23.0	6	9	16	1.6	2.8
S.E \pm	0.4	1.2	1.3	0.3	1.2	3.3	0.2	0.3
F test	Ns	Ns	Ns	Ns	Ns	Ns	**	Ns

WAP = Weeks after planting. ns = not significant. * = Significant at 5% level of probability. ** = Significant at 1% level of probability.

*** Field Experiment, 2020

Effect of Amaranth-Jute Intercropping on Land Equivalent Ratio (LER) of Amaranth and Jute

The partial LERs values were significantly ($p < 0.05$) affected by the intercropping. The total LER values showed greater yield advantage of 89 percent of intercropping of Amaranth and Jute over component sole crops (Table 6). Probably the greater LER of intercrops was mainly due to a greater resource use and resource complementarity than when the crops were grown separately. This agrees with the findings of (Yang et al., 2018) who observed that intercropping systems can also increase LER and net income, compared with sole cropping systems.

Table 6: Effect of Amaranth-Jute intercropping on land equivalent ratio of Amaranth and Jute

Treatments	Partial LER		Total LER
	Amaranth	Jute	
Sole Amaranth	1.00	...	1.00
Sole Cochorus	...	1.00	1.00
Amaranth-Jute	0.86	1.03	1.89
S.E \pm			0.1
F test			**

* = Significant at 5% level of probability. ** = Significant at 1% level of probability.

*** **Field Experiment, 2020**

Conclusions and Recommendations

Both the intercrop and sole Amaranth enterprises were profitable but there was a notable difference in the profitability of the intercropping system practised as the Amaranth/Jute intercrop was more profitable than the sole cropping. Vegetable farmers should go more into Amaranth/Jute intercrop as it gives higher yield and higher profit than sole cropping. Farmers should adopt Amaranth/Jute intercrop as both vegetables are complementary species for intercropping systems.

To ensuring food and income security, the intercrop is, therefore, recommended for the farmers since it is more profitable than the sole Amaranth production.

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