IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 16, Issue 2 Ser. II (February. 2023), PP 25-30
www.iosrjournals.org

Sugarcane Intercropping Impact on Profitability, cane and Sugar Productivity

M.S. Bassey[1*], Audu S.A[2], EkaetteJ.E[3] and Ejieo O[4]
National Cereals Research Institute, P.M.B. 8, Bida - Nigeria
[1]Corresponding author email: mosessamuel36@yahoo.com

Abstract
The effects of sugarcane intercropping on profitability, cane and sugar productivity were investigated at Badeggi, Nigeria in 2016 and 2017. The results revealed that application of Sugarcane + Groundnut intercropping resulted in a comparable germination count, Tiller count, plant and stalk height to Soybean intercropping. Similarly, Sugarcane + Groundnut intercropping and Soybean intercropping produced comparable stalk height and brix content. Also, Sugarcane + Groundnut intercropping generated more millable canes and stools per plot. Application of Sugarcane + Groundnut intercropping proved equally effective as Soybean intercropping in contributing the highest cane yield. Highest net farm income was found in Sugarcane + Groundnut intercropping. In the same way, Sugarcane + Groundnut intercropping and Soybean intercropping produced comparable sucrose and glucose content. Taller plant and stalks, girth, brix content, millable cane, stools, sucrose, glucose content. and cane yield were observed in Sugarcane + Groundnut intercropping. In conclusion, application of Sugarcane + Groundnut intercropping or Soybean intercropping effectively increased plant and stalk height, girth, brix content, millable cane, stools and cane yield of sugarcane.

Keywords: *Intercropping, Plant crop, Sugarcane, Sugar quality, Profitability*

Date of Submission: 24-02-2023 Date of Acceptance: 05-03-2023

I. Introduction

Sugarcane (*Saccharum officinarum*) family Poaceae is widely grown crop in Nigeria. It provides employment to over a million people directly or indirectly besides contributing significantly to the national exchequer (FAOSTAT, 2019). It is a large tropical or subtropical grasses that is grown widely within the zone of 30^{O} on either side of the equator (Wada *et al.,* 2017; Martin-Guay *et al.,* 2018 and Bassey *et al.* (2019a and b). Raw sugarcane can be squeezed or chewed to extract the juice. In some countries, sugarcane is bottled for local distribution or sold fresh from juice bars, cafes and restaurants. Outside of commercial processing, artisanal processing of sugarcane occurs where sugarcane juice is boiled and cooled to make cakes of unrefined brown sugar, known as 'jaggery'('Mazarkwaila'), sweets ('Alewa') in Nigeria (Priyanka *et al*., 2019). In Nigeria, it is grown on an estimated land area of over 500, 000 hectares with a yield potential of over three million metric tons of sugarcane (Bassey *et al*., 2021).

Sugarcane is one of the world's economically viable cultivated crops. Daniel (2014) revealed the gross margin and net farm income of the farmers to be N83, 811.80 and N75, 292.34 $^{-1}$ respectively, in Adamawa state, Nigeria which showed that sugarcane production is a profitable venture. Aina *et al.* (2015) also examined the profitability and factors influencing Sugarcane production among farmers in Moro Local Government Area of Kwara State Nigeria. They showed that sugarcane production was profitable, as the farmers realized an average net farm income of ₦27,100.21 ha^{-1} with a return of ₦1.88 per every Naira invested.

One potential way to improve sugarcane production and profitability among small land holders and meet demand for sugar is by sugarcane intercropping. Sugarcane is a long duration and widely spaced crop in

comparison with other field crops; it offers a great scope for using its interspaces by growing short duration crops. In general, sugarcane has a juvenile period of 100-120 days, which can accommodate intercrops of arable crop and can be widely practiced (Rasool *et al*. 2011and Geetha *et al*. (2015).The wide space (1 – 1.5 m) available between two rows of sugarcane, long duration for sprouting (21–30 days), initially slow rate of growth and its ability to compensate for any loss of tillers due to intercropping, has helped successful intercropping of cereals, legumes, vegetables and spices in plant and ratoon crop (Priyanka *et al*., 2019).Sugarcane intercropping can be efficient and economically viable in increasing production per unit area and ensure judicious use of resources with increase in farmer's economy (Li *et al*. 2016). For example in Egypt, intercropping sugarcane with soybean significantly increase sugarcane yield and sugar quality (Morsy *et al*., 2017). In India, Singh *et al*. (2017) reported significant yield increase when Potatoes was intercropped with sugarcane. In Nigeria, intercropping sugarcane with arable crops has been recommended for optimum sugarcane production (Gana, 2013).

In Nigeria, research information on industrial sugarcane when intercropped with arable crops is scarce. Hence, the objectives of this study were to evaluate the effects of industrial sugarcane intercropping on Profitability, cane and sugar productivity.

II. Materials and Methods

A field trial was conducted at the upland sugarcane experimental field of National Cereals Research Institute, Badeggi (Lat. 9^0 45' N, Long. 6^0 07' E and 89 m above sea level) in the southern Guinea savanna agro-ecological zone of Nigeria in 2016 and 2017 wet and dry season. The total rainfall during the experimental period was 1504.1 mm in 2016 and 1045.4 mm in 2017 while the mean air temperature was 35 to 38 ^oC in 2016 and 34 to 36 ^oC in 2017.

Before cultivation, the vegetative cover of the experimental site was manually cleared, ploughed and harrowed with a tractor. Thereafter, the land was marked out into plots with bunds at the edges for water retention. Gross plot size was 6 x 5 m (30 m^2) consisting of 5 sugarcane rows, and four rows of component crops, while net plot size was 5 x 3 m (15 m^2).Sugarcane was planted at 1.5 m inter – row spacing a month before the component species were planted in between at 0.75 m inter – row spacing. Tender healthy young stalks of six months old sugarcane were used as planting material. The stalks were cut into setts each containing three eye buds, planted continuously end-to-end without intra-row spacing in shallow sunken bed. The NPK fertilizer was applied at150 kg N, 60 kg P_2O_5 and 90 kg K_2 O in equal halves at planting and 10 WAP. Rainfall was supplemented with irrigation in May which was the establishment of the rainy season.

The treatments consisted of Short kaura, Beniseed, Soybean and Groundnut were intercropped with sugarcane along with sole sugarcane arranged in a randomized complete block design with three replications..

Sugarcane germination (%) was taken by counting the number of sprouted buds per plot at three weeks after planting and expressed as follows:

$$\text{Germination percentage} = \frac{Numberofsproutedbudspernetplot}{Totalnumberofbudsont\quad hesettsplantedpe\quad rplot} \text{ x } 100$$

Number of tillers per plot was taken by counting the number of axillary tillers per plot at two months after planting. Plant height was measured using meter rule from the base of the plant to the top of the uppermost leaf at 3 and 6 MAP and expressed in centimeters. Stalk height was measured using meter rule from the base of the plant to the uppermost node at 6, 9 and 12 MAP and expressed in centimeters. Stalk girth was measured using Vernier caliper from the middle of the plant at 8, 10 and 12 MAP and expressed in centimeters. Percent brix was measured using hand refractormeter from the base of the plant at 9 and 12 MAP to determine the level of soluble sugar. Number of sugarcane stools per plot was taken by counting the number of stools at 12 MAP or months after ratooning (MAR). Number of millable stalk per stool was taken by counting the number of stalks

at 12 MAP or months after ratooning (MAR). Stalk (Cane) yield at harvest was taken from the harvested stalks in the net plot, tied into bundles and weighed (tons ha^{-1}).

The economic assessment was determined by estimating the net farm income (NFI) of sugarcane production using the formula:

NFI = TR – TC ……. (1)

TC = TVC + TFC ……. (2)

Therefore,

NFI = TR – (TVC + TFC) ……..(3)

Where,

NFI = Net Farm Income

TR = Total Revenue

TVC = Total Variable Cost

TFC = Total Fixed Cost

The estimated Net Farm Income (NFI) gives an indication of the profitability or otherwise of the sugarcane production (Hamidu, 2005).

All data collected were subjected to analysis of variance (ANOVA). The means were separated using Duncan Multiple Range Test at 5% level of probability using SAS version 9.0 statistical package.

III. Results

Germination count (%) was significantly ($P < 0.05$) different between the sugarcane intercrops in both year of study (Table 1). Sugarcane + Groundnut intercropping had significantly higher germination percentage than the other intercrops in each year of study (Table 1). Furthermore, Sugarcane + Groundnut intercropping produced more tillers than the other intercrops in each year of study (Table 1). Taller sugarcane were obtained in Sugarcane + Groundnut intercropping than the other intercrops in each year of study (Table 1). Wider leaves were recorded in Sugarcane + Groundnut intercropping only in 2017 (Table 1). Stalk height and internode length were significantly ($P < 0.05$) different between the sugarcane intercrops in both year of study (Table 1). Sugarcane + Groundnut intercropping had consistently taller stalks and longer internodes than other intercrops in both years of study (Table 1).

Thicker sugarcane was recorded in Sugarcane + Groundnut intercropping compared with that in other intercrops in both years of study (Table 2). Furthermore, higher brix content was obtained in Sugarcane + Groundnut intercropping compared with that in other intercrops in both years of study (Table 2). Millable canes and Stools were significantly ($P < 0.05$) different between the sugarcane intercrops in both year of study (Table 2). Sugarcane + Groundnut intercropping consistently produced more millable canes and stools other intercrops in both years of study (Table 2). Cane yield of sugarcane was significantly higher in Sugarcane + Groundnut intercropping compared with the other intercrops in both years of study (Table 2). Similarly, Sugarcane + Groundnut intercropping consistently produced higher net farm income than the other intercrops in both year of study (Table 2). Net farm income was consistently higher in Sugarcane + Groundnut intercropping plot compared with the other intercrops in both years of study (Table 2).

Sugarcane moisture content was significantly ($P < 0.05$) different between the sugarcane intercrops in both year of study (Table 3). Sugarcane + Groundnut intercropping had significantly higher moisture content than the other intercrops in each year of study (Table 3).Sole sugarcane produced more fibre than the other intercrops in each year of study (Table 3). Higher sucrose content in sugarcane were obtained in Sugarcane + Groundnut intercropping compared with that in other intercrops in 2016 only (Table 5). Glucose content was significantly higher in Sugarcane + Groundnut intercropping compared with the other intercrops in both years of study (Table 3). The purest form of sugarcane was obtained in sole sugarcane and sugarcane + soybean intercrop in 2016 only (Table 3).

IV. Discussion

The high germination percentage, tiller count, plant and stalk height, leaf area and internode length obtained from sugarcane intercropped with legume may be attributed to the nitrogen supplied by the legume component crop (Groundnut) through nitrogen fixation and mineralization of the decomposed incorporated herbage. Gana (2013); Choudhary and Singh (2016) reported beneficial effects of legumes on sugarcane growth parameters (Germination count, tiller, stalk height and internode length) from incorporated legumes at Badeggi in Nigeria

The positive response (increase) observed in this study for stalk girth, brix content, millable canes, number of stools and cane yield due to sugarcane intercropped with groundnut could probably be attributed to incorporation of residues resulting in high SOC. Increase in soil organic matter level might have resulted in increase in soil microbial activity, soil fertility, nutrient supply, porosity, permeability and thus, soil productivity (Yusuf *et al*., 2009; Bassey *et al*., 2019c). The findings obtained are consistent with that of other workers in the same savanna agroecological zone of Nigeria (Afolabi *et al*., 2017). The high yield obtained in the study area might be attributed to adequate moisture and other optimum growth factors obtained in this study (Mohammed *et al*., 2017).

The production of Sugarcane + Groundnut intercropping was most profitable in this study. The reason for the higher net farm income in Sugarcane + Groundnut intercropping could be attributed to the superiority in cane yield of this intercrop over the other intercrops. Also, the relatively higher net farm income of Sugarcane + Groundnut intercropping suggests that it has the potential to increase sugarcane farmers' income. This finding is similar to the work of Daniel (2014) who found that, in 2006/2007 dry season, farmers made profit of ₦115,153.22 per hectare in Adamawa, Nigeria.

The variation in sugar quality for moisture, sucrose and glucose could be attributed to heavy tillering, quick canopy formation which were enhanced by incorporation of legume residues resulting in high SOC under the prevailing agro-ecological conditions. These results are in line with those of Rasool *et al*. (2011) and Geetha *et al*. (2015) who found significant variation in sugar quality for different legumes/ sugarcane intercropping. The observed increase in sucrose and glucose content might also be attributed to increased soil organic matter, improved physical and chemical properties and soil water regimes, which translates into better crop growth. This is in agreement with the work of Cheong and Teeluck (2015)and Gisele *et al.* (2017) who reported that variation in sugar quality in sugarcanes could be attributed to varied varietal morphology and better soil condition under the prevailing agro-ecological conditions.

The study has shown that the application of Groundnut or Soybean as intercrops for sugarcane effectively increased sugar quality, net farm income, growth and cane yield of sugarcane in this agroecology of Nigeria.

References

[1]. AfolabiS. G., Adeboye M. K. A., Lawal B. A., Bassey M. S. and Usman A. (2017). Cereal / legume rotation effects on soil carbon and nitrogen and grain yield of maize in the southern guinea savanna of Nigeria. Nigerian Journal of Soil Science, 27(7): 12-20.

[2]. Bassey M. S., Ibrahim P. A., Mohammed A. K., Musa I., Hadiza A. B. and Ngonadi E. N. (2019a). Maize/Jointvelch intercropping and N fertilization effects on Striga infestation and maize grain yield in theSouthern Guinea Savanna of Nigeria. International Journal of Environment, Agriculture and Biotechnology.**4**(4): 1-9.

[3]. Bassey M. S., Adeboye M. K. A. and Kolo M. G. M. (2019b). Effects of fallowing and nitrogen application on Striga infestation, soil fertility and maize performance. International Journal of Plant and Soil.**27**(3): 1-10. https://doi.org/10.9734/ijpss/2019/v27i330076

[4]. Bassey M. S., Olaniyan O. B., Onotugoma E., Sheriff A. B. & Onwuegba M. C. (2019c). Effects of fallowing and nitrogen application on Striga infestation and maize performance. International Journal of Applied Research and Technology. **8**(4): 9-16.

[5]. Bassey M.S, Kolo M.G.M, Daniya E & Odofin A.J. (2021). Trash Mulch and Weed Management Practice Impact on Some Soil Properties, Weed Dynamics and Sugarcane (Saccharum officinarum L.) Genotypes Plant Crop Productivity. Sugar Technology, 23(2), 395-406

[6]. Cheong, L.R., & M. Teeluck. (2015). The practice of green cane trash blanketing in the irrigated zone of Mauritius: effects on soil moisture and water use efficiency of sugarcane. Sugar Technology. doi: 10.1007/s12355-015-0374-1.

[7]. Choudhary H.R & Singh R.K (2016). Effect of sequential application of herbicides on weeds and production of spring planted sugarcane (Saccharum officinarum L.). International Journal of Life Sciences, 11(1), 687-690

[8]. Daniel, J.D. (2014). Estimation of profit potentials for sugarcane production among rural farmers in Nigeria: Empirical evidence from Madagali local government area, Adamawa state, Nigeria. Journal of Agriculture and Veterinary Sciences, 6(1), 2-4

[9]. Food and Agricultural Organisation Statistics, FAOSTAT (2019). Available online : http://www.fao.org/faostat/en/data/QC (Accessed on 21 August 2019), 9-12

[10]. Gana, A.K (2013). Intercropping sugarcane (Saccharum officinarum L.) with annual food crops at Badeggi, Southern Guinea Savannah of Nigeria. Journal of Applied Agricultural Research, 5(2):185 – 192
[11]. Geetha P., Sivaraman K., Tayade A.S. and Dhanapal R. (2015): Sugarcane based intercropping system and its effect on cane yield. Journal of Sugarcane Research, 5 (2): 1 - 10
[12]. Gisele Silva de Aquino, Cristiane de Conti Medina, Dairi Cortez da Costa, Muhammad Shahab, and Antonio Dias Santiogo (2017). Sugarcane straw management and its impact on production and development of rations. Industrial Crop and Products, 102 (2017), 58-64
[13]. Hamidu B.M. (2005). Comparative Analysis of Farm Labour Utilization in sole and mixed cropping in Bauchi State. Unpublished M.Sc. Thesis, Abubarkar Tafawa Balewa University, Bauchi, Nigeria; 100
[14]. Li q. S., Wu l. K., Chen J., Khan M. A., Luo X. M. & Lin W. X. (2016). Biochemical and microbial properties of rhizospheres under maize/peanut intercropping. Journal of Integrative Agriculture**,** 15(1): 101-110. https://doi.org/10.1016/S2095-3119(15)61089-9
[15]. Martin-Guay M. O., Paquette A., Dupras J. & Rivest D. (2018). The new Green Revolution: sustainable intensification of agriculture by intercropping. Science of the TotalEnvironment.615: 767-772. https://doi.org/10.1016/j.scitotenv.2017.10.024
[16]. Mohammed A., Dikko, A.U., Audu, M. and Mohammed, B.S. (2017). Effects of cowpea residue incorporation and fertilizer nitrogen rates on nitrogen use efficiency and yields of millet in an Entisol of Sokoto Sudan Savanna zone of Nigeria. Nigerian Journal of Soil Science, 27:137 – 149
[17]. Morsy, A.S.M., Elwan A.M. and Nadla M.A.E.(2017). Studies on Intercropping Soybean with Sugar cane under Different Nitrogen Levels. Egypt. Journal of .Agronomy, 39(.2):.221-237
[18]. Singh S.N, Pathak A.D. and Sharma A.K. (2017) Introducing technology of intercropping winter vegetables with autumn planted sugarcane (Saccharum sp. Hybrid) for enhanced productivity and profitability in real farming situations of north-central India. Proc DSTA 66:37–40
[19]. Priyanka S., Singh S. N.,Ajay K. T., Sanjeev K. P., Anil K. S., Sangeeta S. and Narendra M. (2019). Integration of sugarcane production technologies for enhanced cane and sugar productivity targeting to increase farmers' income: strategies and prospects**.** 3 Biotech (2019) 9, 1-15
[20]. Rasool AM, Farooq A, Zubair M, Jamil M, Ahmad S, Afghan S (2011) Prospects of intercropping rabi crops in autumn planted sugarcane. Pakistan Sugar Journal 26 (2): 2-5
[21]. Wada, A. C., Abo-Elwafa, A., Salaudeen M. T., Bello L. Y. & Kwon-Ndung E. H. (2017). Sugar cane production problems in Nigeria and some Northern African countries, International Standard Journal, (3), 141-161
[22]. Yusuf A. A., Abaidoo R. C., Iwuafor E. N. O., Olufajo O. O. & Sanginga N. (2009). Rotation effects of grain legumes and fallow on maize yield, microbial biomass and chemical properties of an Alfisol in the Nigerian savanna. Agriculture, Ecosystem and Environment. 129 (1-3): 325-331. https://doi.org/10.1016/j.agee.2008.10.007

Table 1: Sugarcane intercropping effects on some growth parameters of sugarcane

Treatments	Germination count (%)		Tiller count/ plot		Plant height (cm)		Leaf area index		Stalk height (cm)		Internode length (cm)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Sugarcane + Sole	53.8	66.7	36.5	49.3	150.4	176.4	311.3	331.3	119.9	150.2	7.0	9.8
Sugarcane + Short kaura	50.5	67.0	35.8	47.7	144.8	184.5	313.4	331.0	118.6	155.3	6.0	10.3
Sugarcane + Beniseed	50.9	70.3	36.3	58.7	141.7	176.1	308.1	304.3	119.5	160.2	7.1	10.6
Sugarcane + Soybean	54.0	72.0	39.3	64.7	154.2	190.6	311.3	309.3	127.4	166.9	6.8	10.9
Sugarcane + Groundnut	59.0	83.3	43.2	67.0	164.8	198.3	340.0	345.3	136.3	175.5	8.9	11.7
LSD (0.05)	5.8	5.2	6.5	3.9	15.0	4.4	40.7	32.7	14.8	3.4	1.4	0.2

LSD – Least significant difference

Table 2: Sugarcane intercropping effects on some yield parameters of sugarcane

Treatments	Stalk girth (cm)		Brix (%)		Millable cane/ Plot		Stools/Plot		Cane yield (t ha^{-1})		Net farm income (Naira ha^{-1})	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Sugarcane + Sole	3.1	2.7	14.9	18.1	73.9	94.7	15.9	14.3	66.1	59.9	2577	3204.7
Sugarcane + Short kaura	2.9	2.7	14.5	18.2	71.5	94.9	17.6	15.3	71.7	66.4	5493	5750.0
Sugarcane + Beniseed	3.2	2.8	15.5	19.2	80.0	98.7	16.7	17.0	72.1	74.2	4220	8462.0
Sugarcane + Soybean	3.1	2.9	15.8	20.4	83.7	100.0	17.2	16.6	81.3	77.2	9280	9758.1
Sugarcane + Groundnut	3.5	3.5	18.9	21.0	90.5	119.1	19.7	20.0	87.6	85.8	16347	13261.3
LSD (0.05)	0.3	0.2	1.2	0.4	2.5	2.4	3.5	1.8	12.8	0.9	6401.8	1269.7

LSD – Least significant difference

Table 3: Sugarcane intercropping effects on sugar quality of sugarcane

Treatments	Moisture		Fibre		Sucrose		Glucose		Polarity		Purity	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Sugarcane + Sole	62.1	52.0	13.6	12.7	18.9	21.7	23.7	23.5	21.0	20.2	86.9	12.0
Sugarcane + Short kaura	65.2	54.7	12.5	11.7	20.2	19.7	25.3	25.0	18.5	18.6	82.2	11.2
Sugarcane + Beniseed	66.2	55.7	11.9	10.7	20.2	20.0	25.2	25.2	18.5	19.3	84.5	11.3
Sugarcane + Soybean	63.9	53.7	13.4	12.3	21.6	20.3	27.0	26.6	19.7	23.3	86.9	11.9
Sugarcane + Groundnut	69.4	59.0	8.8	9.3	22.8	18.7	28.5	27.7	17.5	18.2	79.8	11.1
LSD (0.05)	4.7	5.2	4.2	2.4	4.1	1.5	4.2	4.3	3.4	3.9	10.9	1.8

LSD – Least significant difference