

Weed Species Composition and Profitability of Groundnut (*Arachis hypogaea* L.) Production as Affected by Variety and Intra-Row Spacing in Kano, Sudan Savannah, Nigeria

Kabir, M. M.; Bello, T. T.; and Shittu, E. A. 

Department of Agronomy, Bayero University, Kano, P.M.B 3011, Kano, Nigeria.

Corresponding author: seabraham.agr@buk.edu.ng

DOI: <https://doi.org/10.62154/ajasfr.2025.018.010615>

Abstract

This study examined how different types of groundnut plants and the space between them affect the types of weeds, yield, and economic benefits. It was conducted at the research farm of the Faculty of Agriculture at Bayero University Kano and the Institute of Agricultural Research farm in Minjibir, Kano, Nigeria, during the 2023 rainy season. The trials consisted of five varieties of groundnut and four improved varieties (SAMNUT-21, SAMNUT-23, SAMNUT-24, SAMNUT-27) and a local variety (Maibargo) with three intra-row spacings (20 cm, 30 cm, and 40 cm). The treatments were factorially combined and laid out in a randomized complete block design (RCBD) and replicated thrice. The results indicated that the SAMNUT-23 variety produced the highest pod yield (1013.7 kg ha⁻¹), kernel yield (599.7 kg ha⁻¹), and highest haulm yield (2012 kg ha⁻¹) when compared to other varieties at both locations. Closer intra-row spacing of 20 cm produced the highest pod yield (380.3 kg ha⁻¹), the highest kernel yield (222.8 kg ha⁻¹), and the highest haulm yield (2200 kg ha⁻¹) when compared to other intra-row spacings at BUK. The highest cost-benefit ratio was recorded from SAMNUT-23 with a corresponding intra-row spacing of 20 cm, 5.32, and 3.52 BUK and Minjibir, respectively. In comparison, SAMNUT 21 at 20 cm had the lowest BCR of 0.97 and 0.69 at both locations. The study also identified several dominant weed species, including *Oldenlandia corymbosa*, *Chochorus aestuans*, *Mitracarpus villosus*, and *Cyperus rotundus*, which can negatively impact crop productivity. The findings suggest that combining SAMNUT 23 and a 20 cm intra-row spacing can optimize groundnut production and economic returns.

Keywords: Profitability, Intra-Row Spacing, Variety, Yield, Weed Species Composition.

Introduction

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop of the semi-arid tropics (Sinare *et al.*, 2021) that ranks thirteenth (13th) in importance among world crops (Yila *et al.*, 2023). Groundnuts are grown on 26.4 million ha worldwide with a total production of 4,521,626.64 and 4,607,669.46 tonnes in 2020 and 2021, respectively, and an average yield of 10,977 kg ha⁻¹ and 10,786 kg ha⁻¹, respectively, in the same period (FAOSTAT, 2023). Developing countries account for 97 percent of the groundnut area and 94 percent of total production. Nigeria is one of the largest producers of groundnuts in 2019, with an annual production of 4.4 million tonnes, after China and India (FAO, 2021). It is estimated that 3.9

million hectares were planted in 2019 with groundnut in Nigeria. (FAO, 2021). According to Ajeigbe *et al.* (2014), groundnut is grown in all Northern Nigerian states. Traditional commercial groundnut-growing areas include Kano, Adamawa, Zamfara, Katsina, Jigawa, Yobe, Borno, Sokoto, Kaduna, Bauchi, Gombe, Taraba, Benue, Plateau, and Niger.

Between 1956 and 1967, groundnut was the country's most valuable single export crop, exemplified by the famous Kano groundnut pyramids (Ajeigbe *et al.*, 2014). It's an important source of edible oil (Tuei, 2023). It's a portion of excellent food in Nigeria and other developing countries where the crop is grown, and the seeds are reported to contain approximately 62% highly digestible protein, 22% carbohydrates, 6% minerals, and approximately 8% fat and high-quality edible oil (50%) (Udo *et al.*, 2021). The crop is a valuable source of vitamins E, K, and B; it is the richest plant source of thiamine (B₁) and is also rich in niacin, which is low in cereals. Groundnut cakes formed after the oil is extracted are a high-protein animal feed (Ghosh and Mandal, 2015; Singh *et al.*, 2022). Also, its hay (haulm) is used as livestock feed and is a valuable source of cash for small-scale farmers (Tsafiyo *et al.*, 2022). It is a staple food in several developing countries, much valued for its protein content, and as a source of income for smallholder farmers (Bekele *et al.*, 2023).

A study by Ibrahim *et al.* (2021) found that an intra-row spacing of 15 cm significantly outperformed wider spacings (20 cm and 25 cm) in terms of pod number and weight, leading to higher yields. Similarly, Desmae *et al.* (2022) reported that a spacing of 40 cm × 10 cm yielded the highest dry pod yield during the rainy season, while 30 cm × 10 cm was optimal in the dry season, demonstrating the importance of adjusting spacing based on seasonal conditions. A study by Abdulsalam (2022) found a significant interaction between intra-row spacing and variety, with some doing better at particular spacings, underscoring the necessity for specialized methods in groundnut production. A study by Hussain *et al.* (2022) revealed that spacing significantly impacts growth development and yield, with closer spacing, which results in higher plant density, resulting in increased yield and weed control.

Weed species composition varies across different agricultural practices, and factors such as groundnut variety and intra-row spacing influence weed dynamics. The choice of variety affects canopy coverage and competitiveness against weeds, while intra-row spacing determines plant population density, influencing light interception, soil moisture retention, and overall crop-weed interactions. Poor weed management results in severe yield losses, increased labor demands, and a decline in farm profitability (Shittu *et al.*, 2023; Shittu and Lamarana, 2024).

This trial aims to assess the impact of variety selection and intra-row spacing on weed composition and economic returns of groundnut farming in Kano, Sudan, aiming to develop cost-effective weed management strategies to enhance productivity and profitability. Understanding these interactions is crucial for optimizing groundnut production.

Materials and Methods

Field trials were carried out during the 2023 rainy season at the Teaching and Research Farm of the Faculty of Agriculture, Bayero University Kano (Latitude 11°58' N and Longitude 8°41' E) and IAR Research Farm, Minjibir, Kano (Latitude 12°17' N and Longitude 8°55' E), to assess the impact of variety and intra-row spacing on weed composition and groundnut production profitability. The experiment included five varieties, comprising four improved varieties (SAMNUT-21, SAMNUT-23, SAMNUT-24, and SAMNUT-27) and a local variety (Maibargo) with three intra-row spacings (20, 30, and 40 cm).

The treatments were factorially combined and laid out in a randomized complete block design (RCBD), replicated three times. Each plot had a total of six ridges of 4.8 m long and a width of 4.5 m, making a gross plot size of 21.6 m², while the net plot size comprised four inner rows (14.4 m²). An alley of 0.5 m and 1.0 m was left to separate plots within and between replicates. Seeds were sown directly into the field at two seeds per hole at a depth of 2-3 cm by the dibbling method on a ridge of 75 cm, and the varied intra-row spacing was as per treatment required. Weeds were controlled manually hoeing at 3 and 6 weeks after sowing (WAS). Harvest was carried out when the crop attained physiological maturity. Plants within the net plots were harvested manually using a hoe; the pods were detached from the haulm and allowed to dry for several days under the sun. Data was collected on pod, kernel, and haulm yield. The costs of production (land preparation, weeding, cost of seed, sowing, cost of fertilizer, harvesting, and labor) were used for computation.

The gross revenue was computed based on the prevailing market price of groundnuts in Kano at the time of harvest (₦2000 per kg). Net return was calculated as gross revenue minus total cost, while the benefit-cost ratio = gross revenue divided by total cost to determine which of the varieties and a corresponding intra-row spacing gave the highest net return. The data obtained was subjected to a two-way analysis of variance (ANOVA) via GenStat statistical software. Means were compared using the Student Newman's Keuls Test (SNK) at the 5% level of probability.

Results and Discussion

Weed species composition

Table 1 shows the weed species composition associated with groundnut at BUK and Minjibir during the 2023 wet season. Results indicated that the total number of weeds was twenty-eight at BUK and twenty-three at Minjibir. There were twenty-three and sixteen broadleaf weed species and three, five grasses, and two sedges, respectively, at both BUK and Minjibir. The predominant broadleaf weed species were *Oldelandia crymbosa* (76-100%) followed by *Chochorus aestuans* (51-75%), *Mitracarpus villosus*, and *Oldenlandia blue* (26-50%) each at BUK, while at Minjibir the predominant broadleaf weeds were *Mitracarpus villosus* (76-100) followed *Oldenlandia blue* (51-75), *Alycarpus rustica*, and *Oldenlandia crymbosa* (26-50) each. Some broadleaf weeds, like *Acacia sayel* (whistling thorn), are only present at BUK. This could be due to differences in habitat suitability or management practices.

The two sedges linked to groundnut at both sites were *Cyperus rotundus* and *Kylinga* spp., both of which showed modest levels of occurrence (1–25%); however, *C. rotundus* was comparatively more abundant in Munjibir (26–50%) than at BUK. This suggests the necessity for prompt weed control efforts since it points to a significant weed problem that could have an adverse effect on groundnut yield and quality. The findings of Shittu and Bassey (2023) and Shittu (2023), who recognized *Cynodon dactylon* and *Cyperus* spp. as common noxious weeds in the Nigerian savanna, are supported by the spatial distribution of weed species. Lower crop yields, reduced quality from pests and disease, and higher production costs as a result of weed management methods can all be consequences of a heavy weed infestation. Crop competitiveness depends on an understanding of weed biology, as confirmed by Menalled *et al.* (2024). The significance of applying integrated weed management (IWM) techniques appropriate to the weed flora is underscored by this diversity.

Yield and yield characters

Table 2 shows the influence of groundnut varieties and intra-row spacing on pod yield, kernel yield, 100 seed weight, and shelling percentage at BUK and Minjibir. Results indicated that pod yield, kernel yield, and 100 seed weight were significantly influenced by variety at BUK, while kernel yield, pod yield, and shelling % were significantly influenced by variety at Minjibir. The SAMNUT 23 and *Maibargo* significantly ($P < 0.001$) produced higher pod yield at BUK, while SAMNUT 23 significantly produced higher kernel yield and 100 seed weight compared with the rest of the varieties at BUK. Similarly, SAMNUT 23 resulted in higher pod yield, kernel yield, and shelling percentage compared with other varieties. This suggests that genetic differences among varieties play a crucial role in these yield attributes. The ability of the SAMNUT 23 variety to outperform other varieties in both locations could be linked to the influence of favorable environmental conditions on the genetic makeup of producing more branches and canopy, which aids in producing a higher dry matter and yield. This aligns with the findings of Shittu *et al.* (2022) and Shittu *et al.* (2023), who reported variation in the yield of groundnut varieties due to the genetic makeup of the varieties and the prevailing environmental conditions. Hence, the choice of groundnut variety is critical for maximizing yield and quality. Breeders and farmers should carefully select varieties that are well-suited to their specific agro-ecological conditions and target traits.

However, only in BUK was there a discernible impact of intra-row spacing, as groundnuts spaced 20 cm apart from plants yielded more pods and kernels. The results indicate that the ideal intra-row spacing for groundnut plants in the BUK area is 20 cm. Plant competition for resources and individual plant growth are probably balanced by this spacing. Moreover, variations in soil characteristics, environmental circumstances, or other site-specific elements may be the reason for the importance of intra-row spacing at BUK. Plants' responses to varying spacing can be influenced by the availability of water, nutrients, and

sunlight. This indicates that the conditions in BUK are suitable, which might have made a 20 cm spacing ideal for yield maximization. This result supports the findings of Ibrahim *et al.* (2021) and Desmae *et al.* (2022), who found that groundnut growth and yield were enhanced by close spacing. However, it contradicts the findings of Xu *et al.* (2023), who reported an increase in stem development and secondary growth in *Nicotiana tabacum*.

The interaction between variety and intra-row spacing pod yield ha⁻¹ of groundnut revealed that the yield of SAMNUT 21, 24, 27, and Maibargo varieties significantly ($P < 0.001$) decreased with increasing spacing and was significantly higher at 20 cm than at 40 cm. However, the SAMNUT 23 spaced at 20 cm significantly produced the highest pod yield, which significantly decreased at 30 and 40 cm intra-row spacing. A similar pattern of result was equally obtained for kernel yield. This finding suggests that closer spacing can enhance plant competition, leading to increased pod yield. However, it's important to note that this effect can vary depending on the specific variety and environmental conditions. The study also highlights the superior performance of SAMNUT 23 at 20 cm spacing, indicating its potential for high pod yield under optimal conditions. This finding corroborates earlier reports of Shittu *et al.* (2022) and Shittu *et al.* (2023) on genetic x environmental interaction combined to favor SAMNUT 23 over other varieties.

Profitability of groundnut production

Tables 4 and 5 showed the effect of groundnut varieties and intra-row spacing on cost benefits and returns analysis on groundnut production at BUK and Munjibir during the 2023 rainy season. The SAMNUT-23 variety consistently showed the highest kernel yield and gross revenue across all spacing treatments, indicating its superior performance, while SAMNUT-21 generally had lower yields and lower net revenue, making it less profitable. The 20 cm spacing often resulted in higher yields and net revenue, especially for varieties SAMNUT 23 and *Maibargo*. However, it also led to higher production costs. The 40 cm spacing generally had lower yields and net revenue but also lower production costs. Thus, SAMNUT 23 at 20 cm had the highest benefit-cost ratio (BCR) of 5.32 and 3.52 at BUK and Minjibir, respectively, indicating the highest return on investment (RORI); this implies that for every one naira invested, ₦5.32k and ₦3.52k are returned as profit, respectively, while SAMNUT 21 at 20 cm had the lowest BCR of 0.97 and 0.69 at both locations, suggesting a marginal return or potential loss, implying that for every one naira invested, ₦0.97k and ₦0.69k are returned as profit, respectively. The higher net profit and cost-benefit ratio were observed with SAMNUT-23, with the varied intra-row spacing used in the experiment in both locations, which could be attributed to the higher yield produced by the variety as well as the varietal adaptation to the ecology. This outcome is consistent with that of Salma *et al.* (2023), who found that groundnuts with reduced intra-row spacing had the highest cost-benefit ratio. Similar results were found by Birhanu *et al.* (2018) and Iyorkaa *et al.* (2021), who reported that in soybeans and mung beans, respectively, narrow intra-row spacing maximized net benefit. Closer spacing improves light interception and crop yield as well as smothers the growth of weeds. Similar findings were reported by Daniya *et al.* (2018),

Haarhoff and Swanepoel (2022), and Akther *et al.* (2024) in groundnut and maize, respectively. According to the study, SAMNUT-23 produced greater groundnut gross profits and cost-benefit ratios when paired with a 20 cm intra-row spacing, indicating its potential for well-informed decision-making.

Studies in West African agronomy show that optimal plant density is crucial for maximizing groundnut yield and profitability. For instance, a study by ICRISAT in Mali found that planting 40 cm × 10 cm during the rainy season resulted in the highest dry pod yield and net benefit per hectare (Desmae *et al.*, 2022). In Ghana, a field experiment found that planting the Yenyawoso variety at a spacing of 30 cm × 40 cm produced the highest pods and pod yield (Iddrisu *et al.*, 2024). In Nigeria, an intra-row spacing of 25 cm yielded the highest yield characteristics (Ibrahim *et al.*, 2021).

Conclusion and Recommendation

The study found a diverse weed composition in groundnut production at BUK and Minjibir, with Broadleaf weeds being the most dominant. The presence of *Oldenlandia cymbosa*, *Chochorus aestuans*, *Mitracarpus villosus*, and *Cyperus rotundus*, in both locations, suggests the need for targeted weed management strategies. Groundnut variety and intra-row spacing significantly influenced yield and profitability. The SAMNUT 23 demonstrated superior performance, yielding the highest pod and kernel weight and maximizing profitability. The optimal intra-row spacing was 20 cm at BUK, promoting higher pod and kernel yields due to balanced resource competition. Thus, the combination of the SAMNUT 23 variety at 20 cm intra-row spacing provided the highest return on investment, making it the most economically viable option. Farmers should therefore prioritize high-yielding, adaptable varieties like SAMNUT 23 for maximum yield and economic returns using narrow spacing. However, it is of significant importance to note that closer spacing can increase production costs and potential challenges like disease pressure. The optimal spacing balances yield and input costs, tailored to specific environmental conditions.

Limitations of the Study

The study, conducted at BUK and Minjibir, may not apply to other agroecological zones with different environmental conditions. Its short duration and limited variety selection may limit its applicability to other zones. Additionally, seasonal variations and long-term effects on weed dynamics and groundnut productivity are not considered. The study tested various groundnut varieties but did not cover all commercial or landrace varieties that might perform differently under similar conditions. The cost-benefit analysis relied on a single season's data, potentially not reflecting long-term profitability due to fluctuating market prices and production costs, and lacked a detailed soil analysis to correlate yield performance with specific properties. Further research in the form of multi-location is needed to understand the long-term impacts of weed dynamics, intra-row spacing, and varietal performance on groundnut production under various agroecological conditions.

Table 1: Weed species composition associated with groundnut production at BUK and Minjibir in the 2023 rainy season.

Weed Species	Common name	BUK	Minjibir
Broadleaf			
<i>Acacia sayel</i> Delile	Whistling thorn	*	-
<i>Acanthospermum hispidum</i> D.C	Bristly starbur	*	-
<i>Acmella indicus</i> Linn	Toothache plant	*	
<i>Ageratum conyzoides</i> (L.)	Billygoat-weed	*	*
<i>Alycarpus rustica</i> (L.)		-	***
<i>Amaranthus spinosus</i> (L.)	Spiny pigweed	-	*
<i>Aspelia spinosus</i> O. Hoffin. M		*	-
<i>Boerhavia diffusa</i> (L.)	Spreading hogweed	*	-
<i>Boerhavia erecta</i> (L.)	Erect spiderling	*	-
<i>Celosia argentea</i> (L.)	Quail grass	*	-
<i>Centratium punctatum</i> Cass	Brazilian bachelor's button	*	-
<i>Chochorus aestuans</i> (L.)	Jew's-mallow	***	*
<i>Cleome viscosa</i> (L.)	Tick weed	*	-
<i>Commelina bangalensis</i> (L.)	Tropical spiderwort	-	*
<i>Commelina diffusa</i> Burm.f	Day flowers	*	*
<i>Vigna unguiculata</i> L. Walp	Cowpea	*	*
<i>Ipomea triloba</i> L.	Aiea morning glory	-	*
<i>Ipomea vegarus</i> L.	Bind weed	*	-
<i>Leucas martinicensis</i> (Jacq.) R.Br.	White wort	*	-
<i>Leucas aspera</i> (Willd.) Link	Mosquito weed	*	-
<i>Metochia spp</i>		*	-
<i>Mitracarpus villosus</i> (Sw) DC	Tropical Girdle Pod	**	****
<i>Monechin chilantum</i>		*	-
<i>Nicotinica rustica</i> (L.)	Wild tobacco	*	*
<i>Oldenlandia blue</i> (L.)		**	****
<i>Oldenlandia cymbosa</i> (L.)	Diamond flower,	****	***
<i>Physalia angulata</i> (L.)	Goose berry	*	-
<i>Sigesbekia orientalis</i> (L.)	Common St.Paul's wort,	-	*
<i>Sporobolus indicus</i> (L) R. Br	Smut grass	-	*
<i>Synedrella nodiflora</i> (L.) Gaertn	Cinderella weed	-	*
<i>Trifolium angustifolium</i> (L.)	Narrow leaved clover	-	*
Grasses			
<i>Cynadon dactylon</i> (L.) Pers.	Couch grass	***	*
<i>Digitaria sanguinalis</i> (L.) Scop	Crab grass	-	*
<i>Eragrostis tenella</i> (L.) P.Beauv. ex Roem. & Schult	Feather love grass	*	-
<i>Eragrostis tremular</i> Hochst. ex Steud.	Bunch grass	*	*
<i>Sorghum helepense</i> (L.) Pers.	Johnson grass	-	*
<i>Tragus berterionasus</i> (L.)	Burr grass	-	*
Sedges			
<i>Cyperus rotundus</i> (L.)	Purple Nutsedge	*	*
<i>Kylinga spp.</i> Rottb	Spike sedges	*	**

Source: Fieldwork, 2023.

*= 1-25%, **= 26-50%, ***=51-75% and ****= 76-100%

Table 2: Effect of groundnut variety and intra-row spacing on pod yield, kernel yield, 100 seed weight, and shelling percentage at BUK and Minjibir in the 2023 rainy season

Treatment	BUK				Minjibir			
	Pod yield (kg ha ⁻¹)	Kernel yield (kg ha ⁻¹)	100-kernel weight (g)	Shelling %	Pod yield (kg ha ⁻¹)	Kernel yield (kg ha ⁻¹)	100-kernel weight (g)	Shelling %
Variety (V)								
SAMNUT -21	168.6d	94.05c	21.2c	54.2	130.0c	69.3c	20.3	54.3b
SAMNUT -24	271.8b	167.2b	24.1bc	61.1	177.1b	109.6b	23.2	55.5b
SAMNUT -23	1013.7a	599.7a	31.5a	66.4	639.6a	363.9a	31.9	61.8a
SAMNUT -27	237.9c	120.4c	25.5bc	50.8	262.3b	144.6b	25.7	56.2b
Maibargo	386.7b	291.4b	27.3b	63.0	306.1b	219.9b	26.8	43.7c
P of F	0.001	0.001	0.001	0.254	0.001	0.001	0.001	0.001
SE±	60.00	22.20	1.303	5.42	47.00	41.40	1.745	1.330
Intra-row spacing (S) (cm)								
20	570.4a	334.2a	27.2	58.0	303.0	138.0	26.6	55.1
30	316.9b	221.5b	25.0	66.8	286.5	185.0	25.3	52.7
40	270.0b	117.9c	25.6	52.6	229.5	124.5	25.0	55.0
P of F	0.001	0.001	0.281	0.071	0.621	0.560	0.648	0.199
SE±	46.50	17.25	1.009	4.20	54.60	32.10	1.351	1.030
Interaction								
V x S	**	**	NS	NS	NS	NS	NS	NS

Source: Fieldwork, 2023.

Means with the same letter(s) in the same column are not significantly different ($P \leq 0.05$) using Students-Neuman Keuls (SNK). **= significant at 1%, NS= Not significant

Table 3: Interaction between variety and intra-row spacing on pod and kernel yield of groundnut at BUK in the 2023 rainy season

	Intra row spacing (cm)		
	20	30	40
Variety (V)	Pod yield (Kg ha⁻¹)		
SAMNUT -21	247.9d	139.0d	118.95d
SAMNUT -24	382.0bd	260.4d	172.8d
SAMNUT -23	1566.7a	736.0bc	738.3b
SAMNUT -27	288.9d	239.7d	185.2d
Maibargo	366.3bd	209.4d	134.4d
SE±	103.8		
	Kernel yield (Kg ha⁻¹)		
SAMNUT -21	135.1c	80.55c	66.6
SAMNUT -24	242.7c	155.4c	103.5
SAMNUT -23	930.1a	609.9b	260.5
SAMNUT -27	152.1c	128.5c	80.5
Maibargo	210.4c	135.4c	78.4
SE±	38.55		

Source: Fieldwork, 2023.

Means with the same letter(s) across rows and columns are not significantly different ($P \leq 0.05$) using Students-Neuman Keuls (SNK).

Table 4: Effect of groundnut varieties and spacing on cost benefits and returns analysis on groundnut production at BUK in 2023 Rainy Season.

Variety	Spacing (cm)	Kernel Yield (Kg ha ⁻¹)	Haulm yield (Kg ha ⁻¹)	Total Cost of Production (N)	Gross Revenue (N)	Net Revenue (N)	BenefitCost Ratio
V1	S1	135.1	1221	300,759	294,225	-6534	0.97
V1	S2	80.55	1090	253,177	202,575	-50602	0.80
V1	S3	66.6	878	204,400	165,750	-38650	0.81
V2	S1	242.7	2141	300,759	524,625	223,866	1.74
V2	S2	155.4	1277	253,177	328,875	75698	1.29
V2	S3	103.5	1235	204,400	247,875	43475	1.21
V3	S1	930.1	2743	300,759	1600875	1300116	5.32
V3	S2	609.9	1913	253,177	1058325	805,148	4.18
V3	S3	260.5	1381	204,400	494,325	289,925	2.41
V4	S1	152.1	2171	300,759	390,975	90216	1.29
V4	S2	128.5	1594	253,177	312,300	59123	1.23
V4	S3	80.5	977	204,400	194,025	-10375	0.94
V5	S1	210.4	2723	268,759	519,825	251,066	1.93
V5	S2	135.4	1677	237,977	328,875	90898	1.38
V5	S3	78.4	1441	176,400	225,675	49275	1.27

Source: Fieldwork, 2023.

The calculation of total revenue was based on the prevailing market price of N2000 per kg of groundnut at the time of harvest. N=Naira, V1= SAMNUT-21, V2= SAMNUT-24, V3=SAMNUT-23, V4=SAMNUT-27, V5=Maibargo, S1=20 cm, S2=30 cm, S3= 40 cm.

Table 5: Effect of groundnut varieties and spacing on cost benefits and returns analysis on groundnut production at Minjibir in the 2023 Rainy Season.

Variety	Spacing	Kernel Yield (Kg ha ⁻¹)	Haulm yield (Kg ha ⁻¹)	Total Cost of Production (N)	Gross Revenue (N)	Net Revenue (N)	Benefit Cost Ratio
V1	S1	127	1058	264,978	269,850	4,875	1.01
V1	S2	58.5	891	223,942	154,575	-69,367	0.69
V1	S3	67.5	875	184,424	166,875	-17,549	0.90
V2	S1	130.5	1169	264,978	283,425	18,447	1.06
V2	S2	99	1725	223,942	277,875	53,933	1.24
V2	S3	100.5	1109	184,424	233,925	49,501	1.26
V3	S1	457.5	1389	223,942	790,425	566,483	3.52
V3	S2	376.5	1421	264,978	671,325	406,347	2.53
V3	S3	258	1521	184,424	501,075	316,651	2.71
V4	S1	174	1975	264,978	409,125	144,147	1.54
V4	S2	123	1259	223,942	278,925	54,983	1.24
V4	S3	136.5	1289	184,424	301,425	117,001	1.63
V5	S1	94.5	1660	232,978	266,250	33,272	1.14
V5	S2	54	1153	198,742	167,475	-31,267	0.84
V5	S3	58.5	1569	156,424	205,425	49,001	1.31

Source: Fieldwork, 2023.

The calculation of total revenue was based on the prevailing price market price of N2000 per kg of groundnut at the time of harvest. N=Naira, V₁= SAMNUT-21, V₂= SAMNUT-24, V₃=SAMNUT-23, V₄=SAMNUT-27, V₅=Maibargo, S₁=20 cm, S₂=30 cm, S₃= 40 cm.

References

- Abdussalam, M. S. (2023). Productivity of Groundnut (*Arachis hypogaea* L.) as Influenced by Variety and Spacing in Ningi LGA, Bauchi State, Nigeria. *Journal of Agripreneurship and Sustainable Development*, 6 (1), 65–72. DOI: <https://doi.org/10.59331/jasd.v6i1.393>.
- Ajeigbe, H.A., Waliyar, F., Echekwu, C.A., Ayuba, K., Motagi, B.N., Eniayeju, D., & Inuwa, A. (2014). A Farmer's Guide to Groundnut Production in Nigeria. Patancheru 502 324, Telangana, India: International Crops Research Institute for the Semi-Arid Tropics. 36 pp.
- Akther, S., Hasan, A., Kader, A., Bell, R., Hossen, M., & Mainuddin, M. (2024). Effect Of Plant Spacing and Variety on Growth, Yield, and Quality of Maize in Southern Coastal Region in Bangladesh. *SAARC Journal of Agriculture*, 22(1), 191–202. <https://doi.org/10.3329/sja.v22i1.72864>
- Bekele, G., Birhanu, T., & Terefe, F. (2023). Growth, yield, yield components, and grain qualities of groundnut (*Arachis hypogaea* L.) as affected by liming and phosphorus rates in southwest Ethiopia. *Oil Crop Science*, 8 (3), 165-173. <https://doi.org/10.1016/j.ocsci.2023.07.001>.
- Birhanu, A., Tadesse, T., & Tadesse, D. (2018). Effect of inter- and intra-row spacing on yield and yield components of mung bean (*Vigna radiata* L.) under rain-fed conditions at Metema District, northwestern Ethiopia. *Agriculture & Food Security*, 7, 84. <https://doi.org/10.1186/s40066-018-0234-9>
- Daniya, E., Yusuf, M.A., Onimisi, O.J., & Mohammed, A.B. (2018). Weeding Regime Effect on Weed Growth and Yield of Groundnut (*Arachis hypogaea* L.) Varieties in a Moist Savanna of Nigeria. *Nigerian Journal of Crop Science*, 5, 52-57.
- Desmae, H., Sako, D., & Konate, D. (2022). Optimum Plant Density for Increased Groundnut Pod Yield and Economic Benefits in the Semi-Arid Tropics of West Africa. *Agronomy*, 12(6), 1474. <https://doi.org/10.3390/agronomy12061474>
- FAO. (2021). World Food and Agriculture - Statistical Yearbook 2021. Rome. <https://doi.org/10.4060/cb4477en>
- FAOSTAT (2023) Agricultural Production, Crop Primary Database. Food and Agriculture Organization of the United Nations, Rome. <http://www.fao.org/faostat/en/#data/QC/>
- Ghosh, K., & Mandal, S. (2015). Nutritional evaluation of groundnut oil cake in formulated diets for rohu, Labeo rohita (Hamilton) fingerlings after solid state fermentation with a tannase producing yeast, *Pichia kudriavzevii* (GU939629) isolated from fish gut. *Aquaculture Reports*, 2, 82-90. <https://doi.org/10.1016/j.aqrep.2015.08.006>.
- Haarhoff, S. J., & Swanepoel, P. A. (2022). Plant Population and Row Spacing Affects Growth and Yield of Rainfed Maize in Semi-arid Environments. *Frontiers in Plant Science*, 13 <https://doi.org/10.3389/fpls.2022.761121>
- Hussain, M., Abbas, M. H., Majeed, A., Minhas, W. A., Farooq, S., & Jabran, K. (2022). The Influence of Different Row Spacing and Weed Control Intervals on Weed Infestation and Yield-Related Traits of American (*Gossypium hirsutum* L.) and Desi (*Gossypium arboreum*) Cotton. *Sustainability*, 14(16), 9867. <https://doi.org/10.3390/su14169867>
- Ibrahim, A.M., Sanusi, J., A., & Adesoji, G. (2021). Influence of variety, intra-row spacing and irrigation interval on growth and yield of groundnut (*Arachis hypogaea* L.) at Sudan savannah zone of Nigeria. *Fudma Journal of Sciences*, 5(1), 395-403. <https://doi.org/10.33003/fjs-2021-0501-583>.
- Ibrahim, Iro I., Umar, U. M., Adeniyi, T.O., Adegoke, I. B., & Nabage, O. H. A. (2021). Efficacy of intra-row spacing on the growth and yield of groundnut (*Arachis hypogaea* (L.)) cultivars on the Jos Plateau

- Nigeria. *Journal of Agricultural Science and Practice*, 6(3), 105-110. <https://doi.org/10.31248/JASP2021.284>
- Iddrisu, A., Adjei, E., Asomaning, S., Santo, K., Isaac, A. & Danson-Anokye, A. (2024) Effect of Variety and Plant Spacing on Growth and Yield of Groundnuts (*Arachis hypogaea* L.). *Agricultural Sciences*, 15, 54-70. doi: [10.4236/as.2024.151004](https://doi.org/10.4236/as.2024.151004).
- Iyorkaa, N., Omoigui, L., Ugbaa, M.S., Ekeuro, G.C & Odo, P.E. (2021). Effects of inter-row spacing on growth, seed yield and yield components of soybean (*Glycine max*) in Makurdi, Benue State-Nigeria. *International Journal of Agricultural Sciences and Veterinary Medicine*, 9(2), 18-24.
- Menalled, U.D., Ann Bybee-Finley, K., Smith, R. G., DiTommaso, A., Darby, H.M., Pethybridge, S.J & Ryan, M.R. (2024). Legacy effects of crop diversity on weed-crop competition in maize production. *npj Sustainable Agriculture*, 2, 28. <https://doi.org/10.1038/s44264-024-00036-y>
- Salma Chilakala, Victor Debbarma & Pavani Reddy P. (2023). Effect of Spacing and Varieties on Growth, Yield and Economics of Summer Groundnut (*Arachis hypogaea* L.). *Biological Forum – An International Journal*, 15(3), 605-609.
- Shittu, E.A., & Bassey, M.S. (2023). Weed persistence, crop resistance and herbicide phytotoxic effects in cowpea (*Vigna unguiculata* [L] Walp) under various weed control treatments in Kano, Nigeria. *World News of Natural Science*, WNOFNS 48, 60-69.
- Shittu, E. A. & Lamarana, L. B. (2024). Analysis of effectiveness and profitability of selected weed control methods for cowpea [*Vigna unguiculata* (L.) Walp] production in the Sudan savanna ecology of Nigeria. *Journal of Agricultural Economics, Environment and Social Science*, 10 (2), 1-12.
- Shittu, E.A., Fagam, A.S., Garba, A.A., Sabo, M.U., & Gworgwor, N.A. (2022). Weed Control Efficiency, Nodulation and Yield Response of Groundnut as Affected by Weed Control, Variety, and Season in Bauchi, Nigeria. National Innovation and Research Academia. *International Journal of Agribusiness and Agricultural Sciences*, 7 (1), 1-17.
- Shittu, E. A., Bassey, M.S., & Babayola. (2023). Physiological Growth Indices and Yield Attributes of Groundnut (*Arachis Hypogaea* L) Varieties as Affected by Weed Control Methods and Season in Northern Guinea Savanna Ecology of Nigeria. *International Academy Journal of Agribusiness and Agricultural Science Annals*, 6(2), 29-48, DOI: 272142522721623.
- Sinare, B., Miningou, A., Nebié, B., Eleblu, J., Kwadwo, O., Traoré, A., Zagre, B., & Desmae, H. (2021). Participatory analysis of groundnut (*Arachis hypogaea* L.) cropping system and production constraints in Burkina Faso. *Journal Ethnobiology and Ethnomedicine*, 17, 2. <https://doi.org/10.1186/s13002-020-00429-6>
- Singh, R., Langyan, S., Sangwan, S., Rohtagi, B., Khandelwal, A., & Shrivastava, M. (2022). Protein for Human Consumption from Oilseed Cakes: A Review. *Frontiers in Sustainable Food Systems*, 6. <https://doi.org/10.3389/fsufs.2022.856401>.
- Tsafiyo, B., Zewdie, B., Yirga, H., & Teshome, D. (2022) Effect of Groundnut (*Arachis hypogaea* L.) Haulm and Maize Bran Mixture Supplementation on Growth and Carcass Characteristics Performance of Local Sheep Fed Pasture Hay Basal Diet. *Open Journal of Animal Sciences*, 12, 36-57. doi: [10.4236/ojas.2022.121003](https://doi.org/10.4236/ojas.2022.121003).
- Tuei, V.C. (2023) Availability of Vegetable Edible Oils and Potential Health Implications in Kenya. *Open Access Library Journal*, 10, 1-9. doi: [10.4236/oalib.1109756](https://doi.org/10.4236/oalib.1109756)
- Udo, N. N., Effiong, O. O., George, U. E., & Okon, E. J. (2021). Effects of processing on the mineral content and proximate composition of Groundnut (*Arachis hypogaea* L.) seeds. *World Journal of Advanced Research and Reviews*, 12(1), 387-395. <https://doi.org/10.30574/wjarr.2021.12.1.0379>.
- Xu, N., Meng, L., Tang, F., Du, S., Xu, Y., Kuang, S., Lv, Y., Song, W., Li, Y., Qi, W., & Zhang, Y. (2023). Plant Spacing Effects on Stem Development and Secondary Growth in *Nicotiana tabacum*. *Agronomy*, 13(8), 2142. <https://doi.org/10.3390/agronomy13082142>.

Yila, J.O., Martey, E., Etwire, P.M. *et al.* (2023) Exploring gender differences in trait preferences among groundnut value chain actors in northern Ghana. *Agriculture & Food Security*, 12, 24. <https://doi.org/10.1186/s40066-023-00430-8>