FINAL REPORT ON PERFORMANCE OF SESAME VARIETIES TESTED IN TWO (2) AGRO-ECOLOGICAL ZONES IN NAMIBIA

Sesame Seed Crop Varieties Adaptation Field Trial Research in Namibia

Season: 2022

NAMIBIAN AGRONOMIC BOARD

UNAM UNIVERSITY OF NAMIBIA

CONTENTS

1. INTRODUCTION

The sesame seed crop is one of the oldest oilseed crops, domesticated over 3000 years ago. The sesame crop is now widely cultivated; found in most of the tropical, subtropical, and southern temperate areas of the world and it is successfully grown in Africa. Sesame (*Sesamum indicum L.*) is one of the most drought-tolerant crops; it thrives in arid and tropical climates and can tolerate extreme heat up to 50°C. Its seed is rich in protein, vitamins, minerals, and antioxidants. The seed has numerous health and industrial benefits and is widely used for baking, medicine, cosmetics, and animal feeds. The global demand for sesame seeds is on the increase, and the market is expected to grow. Sesame seed contains 58% oil and 45% protein; therefore, it is a high-value cash crop (Eskandari *et al*., 2015; Pathak *et al*., 2014). Sesame is low-maintenance and therefore an economical crop to cultivate.

Sesame is among the most imported crop commodities into the Namibian market, whereby total national consumption tonnage of sesame and its products are imported from other countries at an average of 25 to 48 tonnes per annum, with a value ranging from N$457 000 to N$678 000 (NSA, 2019). Recently it was reported that the global market value of sesame was about USD 6.5 billion (N$97.5 billion) in 2018. Other estimates put the global sesame grain market worth at US$9 billion (N$156.2 billion) annually (FFoodSpectrum, 2019). It is further, expected that the global consumption of sesame seeds will grow at a rate of 2% per year in the next four years, which will increase the market size to 9.5 million tons in 2025 (Cision, 2019).

Achieving national food security and diversifying export earnings from agricultural commodities is one of the major objectives for the Namibian agronomic sector. The introduction of well-adapted and market-led sesame crop varieties into Namibia not only strives toward food security but also improves the socio-economic of local producers and traders. The nutritive content, low production inputs of the sesame crop, and high earning returns from the sale of sesame grains make sesame a suitable crop for the Namibian environment for both small-scale and large-scale commercial farmers.

The availability of locally adapted, quality sesame seeds in Namibia is limited. Therefore, introducing sesame seeds of suitable varieties (high yielding and adapted to the local climatic and field conditions) is considered an important step towards expanded local production. As a cash-crop option for Namibian farmers, it is logical to accelerate the development of highly yielded adapted varieties that feed into the mainstream seed production system. The University of Namibia (UNAM) and the

Namibian Agronomic Board (NAB) are implementing a 5-year MOU on Seed Research and Seed Production of selected agronomic and horticulture crops including sesame.

2. RESEARCH OBJECTIVES

Main objective

The main objective of the sesame trial is to assess the adaptability prospect of growing sesame crops using the rain-fed cropping system under Namibian soil and climatic conditions.

Specific objectives

The specific objectives of the study include:

a) Assess the yield performance of selected sesame seed varieties under rainfed conditions.
b) Establish the actual production cost per unit area or hectare.
c) Testing the domestic market for locally produced sesame.

3. RESEARCH METHODOLOGY

3.1 Research Protocol

- On the 11th of August 2021, UNAM/NAB identified four local farmers in two production zones - the Central and Karst areas. The names of the farms are Farm Ombanje, Farm Hoba, Farm Pfeffelbach, and Farm Rema.
- Four (4) improved sesame varieties for rainfed production (Foundation seed) were acquired by UNAM/NAB from National Cereals Research Institute (NCRI), Nigeria.
- The UNAM-NAB research team embarked on the research trial by planting at the **end of January 2022 and harvested in May/June 2022**.
- The 4 sesame varieties were planted in four (4) replications using Randomized Complete Block Design (RCBD) in plots measuring 10m x 12m. The total experimental total area per site was 56.5 m x 50 m = 2825m^2 (Figure 1).
- All production activities starting from planting, weeding, harvesting, threshing and winnowing were carried out manually.

3.2 Crop Management and Data Collection

The research trials were conducted under a rainfed production method on 4 farms. After land preparation, the plots were demarcated followed by manual planting. The farmers applied fertilizers as recommended in Table 1.

Farmers were given a data collection sheet to record agronomic parameters such as the number of tillers/plants, plant height, number of heads/plants, and yield per variety. These descriptive data on

agronomic parameters were then analysed in Microsoft Word and Excel and presented in tables and figures.

3.3 Research Experiment Design, Planting Layout, and Fertilisation

Figure 1: Field layout of Sesame seed trial

Key: • VAR 1 = NCRIBEN 05E, VAR 2 = NCRIBEN 04E, VAR 3 = E8, VAR 4 = YANDEV 55 • The 4 varieties x 4 replications per site = **16 plots** • Plot size 12m wide x 10 m long = **120 m²** • Spacing = 40cm X 10 cm (drill then, thin to 40 cm x 10 cm at 15 days after sowing) • 30 rows of 10m each • Guard rows = 5 rows all round of 2m wide	• **Experimental area = 56.5 m x 50 m = 2825m² or 0.28ha** • Amount of seed per plot = 60 g (equivalent to 5 Kg/ha) • Data collection and harvesting area = 20 inner rows (leaving out 5 rows on each side) of 8 m each (leaving out 1 m from each end)

Table 1: Fertilizers applied per site

Fertilizer type	**Rate/ha (10,000 m²)**	**Rate/plot (120m²)**	**Fertilizer per site (2825m²) (**including guard rows)	**Fertilizer cost (N$)/ha**	**Fertilizer cost (N$)/site**
1. 4:3:4 (33)	200 Kg	2.4 Kg	56.5 Kg	**1365**	**386**
2. MAP	50 Kg	600 g	14.1 Kg	**513**	**145**
3. Urea	65 Kg (as top dress)	780 g	18.4 Kg	**783**	**221**

4. Mg Sulphate	5 Kg	60 g	1.4 Kg	**683**	**193**
5. Zn sulphate	5 Kg	60 g	1.4 Kg	**521**	**147**
TOTAL COST				**N$3 865.00**	**N$1 092.00**

4. RESULTS

4.1 Germination and Growth

The crop germinated well in all 4 trial sites and the crop growth was excellent (Photo 1).

Photo 1: Young sesame plants

However, there was insect damage on the pods (Photo 2) and the crop was prone to shattering (Photo 3). When sesame pods ripen, the tops of the pods open up and they shatter easily, dispersing the valuable seeds. Another challenge encountered included manual weeding and manual threshing (Photo 4).

Photo 2: Damage symptoms on capsules of sesame due to larval feeding of Antigastra catalaunali

Photo 3: Shattering potential of sesame is caused by opening up of pods when they ripen

Photo 4: Manual threshing of sesame

The data from flowering, and maturity to harvesting were only available in Farm Rema and Farm Ombanje since the harvest of different varieties received from Farm Hoba were mixed, variety cross-contamination making it impossible for comparison analysis and harvest from Farm Pfeffelbach was not planted in replications making it impossible to undertake statistical means analysis. Furthermore, Farm Pfeffelbach gave the same score (value) for all plots for Plant height at 50% flowering (58 cm) and the same score (value) for the number of branches per plant at 50% (4 branches), and this compromised the quality of the data. Farm Rema had the same problem of scoring these two parameters mentioned above with the same value across all plots (85 cm and 4 branches, respectively). Therefore, the results in this report are based on data from two production sites, that is Farm Rema and Farm Ombanje.

4.2 Flowering and Maturity

Table 2 below shows the average plant height at 50% flowering, the number of capsules per plant at 50% maturity, and the number of seeds per capsule at maturity NCRIBEN 04E has the highest plant height of 81 cm, number of capsules per plant, 47.7 capsules and higher number of seeds per capsule than other varieties, 41 seeds.

NCRIBEN 05E scored second highest after NCRIBEN 04E on plant height with 80 cm while E8 scored second on the number of capsules with 45.7 capsules per plant and then YANDEV 55 scored second on the number of seeds per capsule with 40 seeds per capsule.

Table 2: Flowering and yield components of Sesame varieties

ENTRY	Plant height (cm) at 50% flowering	Number of capsules per plant at 50% maturity	Number of seeds per capsule at maturity
YANDEV 55	78	39.3	40
NCRIBEN 05E	80	41.9	24
E8	79	45.6	33
NCRIBEN 04E	81	47.7	41

4.3. Grain Yield

Table 3 shows the mean grain yield attained in kilograms per hectare of the two production sites in comparison to the potential yield in the country of origin. Farm Rema produced higher sesame grain yields compared to Farm Ombanje across all four sesame varieties.

The variety NCRIBEN 04E attained the highest yield of 601.25 kg/ha at Rema farm in the Central production area, followed by NCRIBEN 05E with 501.38 kg/ha (Table 3). In Farm Ombanje, YANDEV

55 attained the highest yield of 166.63 kg/ha followed by NCRIBEN 04E with 156.50kg/ha. The average yield of **499kg/ha** at **Rema Farm** is close to the average yield of **885kg/ha in Nigeria**.

Table 3: Grain yield (kg per ha) of sesame varieties

Site	**Variety name**	**Mean grain yield (Kg/ha)**	**Potential yield in Nigeria, the country of origin (Kg/ha)**
Ombanje karst farm	E8 (Early maturing)	100.88	1,000
	NCRIBEN 04E (Early maturing)	156.50	1,300
	NCRIBEN 05E (Early maturing)	125.13	1,200
	YANDEV 55 (Late maturing)	166.63	600
Site mean (Kg/ha)		***137.28***	
Rema 219 Hochfeld farm	E8 (Early maturing)	456.50	1,000
	NCRIBEN 04E (Early maturing)	601.25	1,300
	NCRIBEN 05E (Early maturing)	501.38	1,200
	YANDEV 55 (Late maturing)	437.00	600
Site Mean (Kg/ha)		***499.03***	
Grand Mean (Kg/ha)	**Mean of 2 sites**	**318.16**	**1,025.00**
Average yields in Nigeria (Kg/ha) - 2021		**885**	
Average global yield		**471**	

The trendline in Figure 2 shows that the yield of **499kg/ha at Farm Rema** is higher than the **average global yield of 471kg/ha**, though lower than the yield potential, it is close to the average yields of sesame in **Nigeria of 885kg/ ha** and not too far from the varieties' potential yields at the National Cereals Research Institute (NCRI), Nigeria.

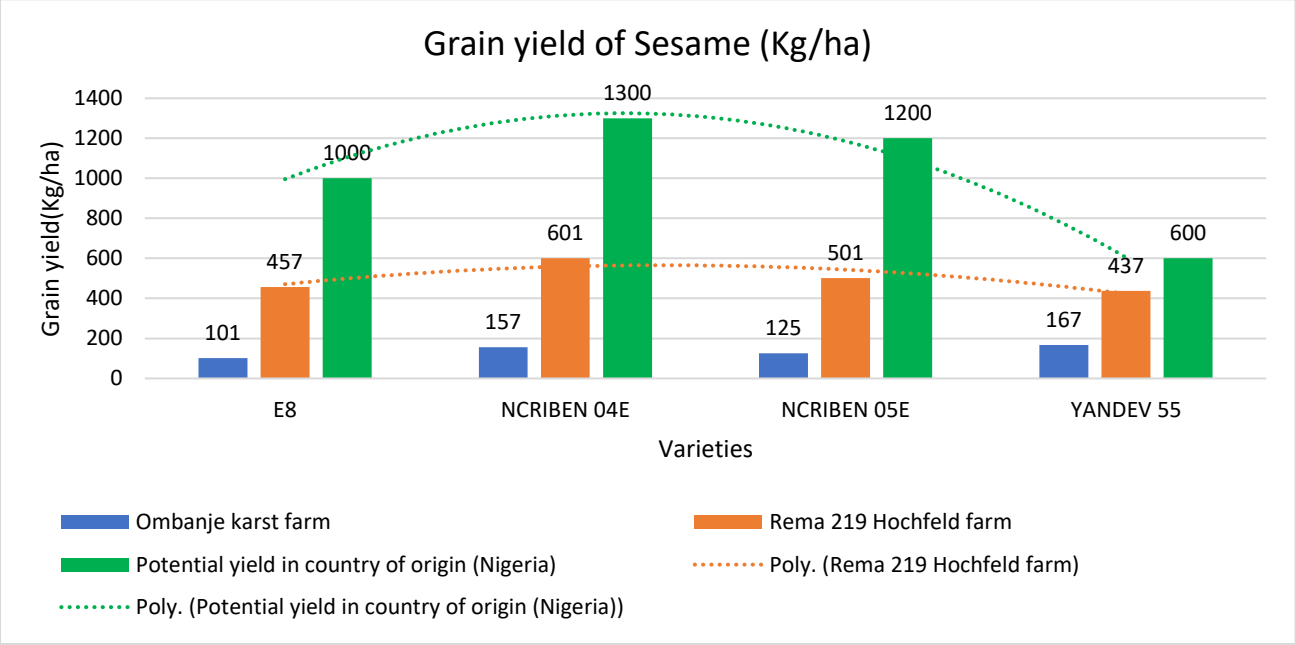

Figure 2: Comparative grain yield of Sesame varieties in Farm Rema, Ombanje, and at NCRI, Nigeria

4.4 Grain Properties

The seeds of all sesame varieties are white (Photo 5).

Photo 5: Colours of sesame seeds

Note on maturing: Early – 90 to 100 days | Intermediate – 100 to 110 days | Late – 110 to 125 days

4.5 Grain Shattering

Sesame is prone to grain shattering because the capsules/pods easily break as soon as the crops reach maturity (Photo 3). NCRIBEN 04E experienced more shuttering than the rest of the 3 varieties with a worse score of 4 while NCRIBEN 05E showed the least shattering among other varieties scoring only 2.5 (Figure 3).

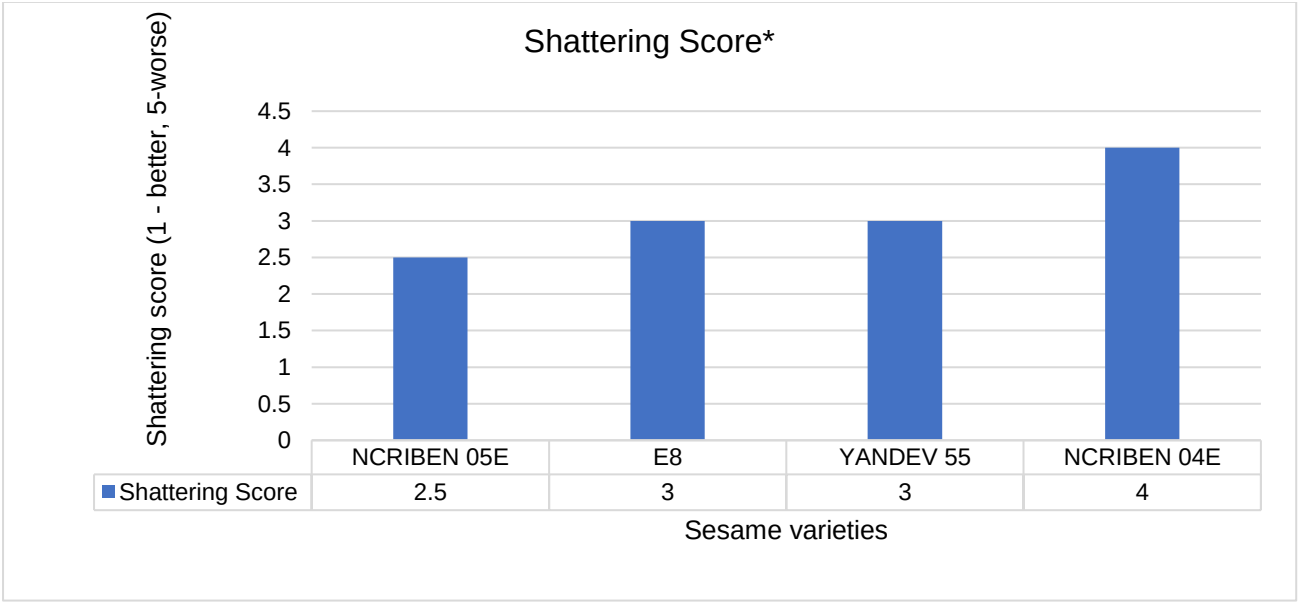

*Figure 3: Shattering score (*1- better, 5- worse)*

4.6 Production Cost

Sesame is a new crop in Namibia to determine the production cost per hectare the information on production expenses was supposed to be collected from all research sites, unfortunately, only one research site, Farm Rema provided information on production cost as shown in Table 4. Thus, information obtained from one research site is not sufficient enough to establish sesame production cost in Namibia. Therefore, during the second cropping season production cost information will be obtained from many if not all the research trial sites to enable a more comprehensive production cost analysis.

However, seed and dehulling cost could not be established as currently there are no sesame seeds suppliers in Namibia and the seeds were not dehulled. The sesame mechanised production and dehulling cost referenced in here, includes various costs from different countries, ranging from as low as USD 215 (N$3,436.71) in Nigeria to USD 240 (N$ 3,842.36) per ha in India, which brings the average total production cost to about USD 227 (N$3,639.54), see Table 4 below.

The average production tonnage is about 0.550 tons/ha, with an average export price of USD 2,000 (N$32 000) per ton, with total revenue of USD 1,100 (N$17,600) per ha, resulting in a net farm income (before tax and transport costs to the export market) of USD 872 (N$13,960.46) per ha.

However, this is based on the scenario of the sampled countries, and hence there is a need to establish the exact production costs and net farm income during the second trial in Namibia.

Table 4: Average mechanised sesame production cost per ha in Nigeria and India

	N$/HA	USD $/HA
NIGERIA	3,436.71	215
INDIA	3,842.36	240
AVERAGE	3,639.54	227

Table 5 below only shows the estimated sesame production cost of key inputs, based on the data collected from Farm Rema. This production cost is based on non-mechanized production method, and hence a high labour cost was realised.

Table 5: Estimated sesame production cost (inputs) per hectare, benchmarked on Farm Rema data.

Variables	Unit	Quantity	Price {N$} / Unit	Cost/ha {N$}
Seeds (Import)	**kg**	**5**	**18**	**90**
Fertiliser				**3,865.00**
NPK 4:3:4 (33)	kg	200	6.83	1,365

MAP	kg	50	1.17	513
UREA	kg	65	12.04	783
Mg Sulphate	kg	5	136.60	683
Zn sulphate	kg	5	104.2	521
Insecticides	-	-	-	-
Herbicides	-	-	-	-
Labour	**Man-day**			**12,000**
Planting	Man-day	30	100	3,000.00
Weeding	Man-day	20	100	2,000.00
Harvesting	Man-day	30	100	3,000.00
Threshing and winnowing	Man-day	40	100	4,000.00
Total Cost		**120**		**15,865.00**

The current sesame seeds' average retail price in Namibia is N$160,000.00 per ton (N$160 per kg)

5. DISCUSSION

Data quality: Farm Hoba and Farm Pfeffelbach had incomplete data. In cases where data was available, some measurements were uniform across all plots. For instance, the plant height and the number of branches in Rema Hochfeld farm were 85 cm and 4 branches respectively for all varieties in all replications. In real situations, there is no such 100% uniformity across varieties and plots.

Pest incidences, Crop maturity, and Pod/capsule shattering: The crop experiences pod/capsule pests after flowering, at a time when the farmers were not ready with insecticides (Photo 2). The affected sesame capsules continued unhealthy (dark and shrunken) seeds. Other challenges encountered were related to the maturity period falling during the winter season. The crop was planted at the end of January and early February and harvested in June, some capsules matured in May while others remained green for one or more months due to the winter cold. This split maturity made the early maturing capsules shatter and lose grain. Rema Hochfeld farm harvested the crop in **128 days (4 months)** after sowing, while in Ombanje karst farm, harvesting was done in 150 days (5 months) after sowing, exposing the crop to shattering (Photo 3).

Growth Parameters: The variety NCRIBEN 04E (early maturing) had the highest plant height, number of capsules per plant, and higher number of seeds per capsule than other varieties. These factors could have contributed to higher yields of this variety.

Yield: Rema Hochfeld farm performed better in grain yield compared to other sites (with a high yield of over 600 Kg/ha). Its grain yield values per variety followed the varieties' performance curve in the country of origin, Nigeria. For instance, NCRIBEN 04E was the highest-yielding variety in Namibia as well as in Nigeria. The Asia-Africa average yield is 471.2 Kg/ha, while a well-managed crop yield can go up to 1200 - 1500 kg/ha under irrigated and 800 - 1000 kg/ha under rainfed conditions (Gebremariam, 2015).

Similar findings were also reported in Ethiopia by Sirany & Tadele (2022) on a sesame average yield of 300-400kg/ha. According to Ofosuhene-Sintim, & Yeboah-Badu, (2010) study conducted in Ghana, the average sesame yield is about 387kg/ha. The study implies that the recorded best yield of 600 Kg/ka for NCRIBEN 04E was within the expected margin considering the following challenges encountered during the trial:

a) Late planting (late January), then the cold winter curtailed the maturity of most varieties which were just almost maturing – those pods which matured earlier started shattering, while some pods remained green during winter time.

b) There was a small range of varieties (4 are too few to compare). Getting more varieties from another country will make a better comparison.

c) Insects infested the crop at the pod formation stage and most farmers did not control them despite insects and pest prevention and control guidelines provided. Some farmers were not familiar with the crop and its possible enemies, while others indicated that there are organic producers thus they cannot apply chemicals.

d) Most of the activities were done manually while the participating farmers are commercial, hence there was low motivation to employ manual operations.

6. CONCLUSION AND RECOMMENDATION

This section gives a few conclusions and recommendations from the trial results and discussions.

6.1. Conclusion

a) There is high potential for the cultivation of commercial sesame in Namibia. The yields attained in Namibia are about half of the potential obtainable in Nigeria, one of the top producers of sesame in the world. This was despite challenges associated with the cold winter, late planting, pests, and seed shattering.

b) Farm Rema in the Central production zone attained the highest yield in all four varieties (compared to the Ombanje karst farm). However, none of the 4 varieties attained potential yield in comparison to the country of origin.

c) Although the obtained sesame average yield in Namibia is below the average yields in the country of origin (Nigeria), some attained yield per variety in Namibia is above the **global sesame average yield of 471 kg per ha** according to the study by Gebremariam, (2015).

d) Insect infestation on pods and pod shattering could have contributed to low yields compared to the potential yield, though late planting was the main contributing factor.

6.2. Recommendation

It is therefore assumed that the sesame research trial could be repeated with several adjustments and recommendations on production and data collection aspects.

a) Seed sowing should be done in early January, depending on the rainfall received or expected since this is a dryland crop. Harvesting should be done on time to prevent shattering.
b) Training of participating farmers and technicians/ researchers on sesame production.
c) There is a need to place a technician (preferably BSc. Crop Science Honour graduate) in every site to support the hosting farmers for day-to-day management, data collection, fertilizer application, and pest and weed control.
d) UNAM-NAB should increase the number of varieties under evaluation, with more emphasis on early-maturing varieties with low shuttering potential, and given the late rainfall normally received in Namibia. Brown and Black sesame seed varieties to be included in future trials.
e) UNAM-NAB should explore mechanization possibilities for planting, weed control, harvesting, threshing, and dehulling to increase productivity or minimize the cost of production.
f) There is a need to include farmers from other production zones during the next cropping season.
g) At least two trials should be conducted on research stations such as Mannheim and Ogongo Campus to better monitor crop performance and data collection, while other trials can remain on-farm.
h) Comprehensive production cost data collection to be done during the next planting season, to ensure that a proper gross margin analysis is conducted.
i) Secure a reliable source of certified seeds, so that seeds supply should not be a problem once the harvesting.
j) There is a need for awareness creation and interlinkage of sesame producers with potential buyers in Namibia to enable farmers to sell their harvest after data analysis is completed.

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