

**INFLUENCE OF LINE SPACING ON THE PERFORMANCE OF INDIGENOUS
MAIZE VARIETY (MAHINDA): CASE STUDY KABALE DISTRICT**

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**A DISSERTATION SUBMITTED TO THE FACULTY OF AGRICULTURAL SCIENCES IN
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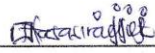
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DECLARATION

I NASASIRA ANACLET declare that this report is my original work and compiles of all the activities that are have been done in the selected garden where a practical research project was carried out, in accordance to my knowledge of understanding and have never been submitted to any institution of learning for any award of study.

Sign 

Date 4th / 08 / 2025

NASASIRA ANACLET.

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Firstly, I thank the almighty God for the gift of life and education and the far he has taken me from ever since the start of my life up to now. I secondly thank my beloved parents, brothers, sisters, friends and relatives for the financial and emotional support throughout my academic journey and particularly in this research project I am undertaking. My sincere thanks go to my supervisor **UZATUNGA INNOCENT** for the time and efforts that he has rendered in this research project, all the lecturers and instructors who have taken part in the part in journey of this part of education. Your continued support and efforts were of great value towards finishing this research project and shall always be appreciated.

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DEFINITION OF KEY TERMS.

Maize. Also known as corn, it is a tall stout grass that produces cereal grain.

Line spacing. The recommended space that should be left from one crop to another or from one row to another.

Indigenous maize. Maize that was first domesticated by indigenous people.

Hybrid maize. Type of maize that is the result of crossbreeding two genetically different maize varieties.

Variables. An element, feature, or factor that is liable to vary or change.

ABBREVIATIONS

RCBD:	Randomized complete Block Design.
IMWIC:	International maize and wheat improvement center
D.F:	Degrees of freedom.
NGOs:	Non-governmental organizations.
W.P.M:	Wet plant matter.
D.P. M:	Dry plant matter.

ABSTRACT

The study aimed and finding out the impact of line spacing on the performance of an indigenous maize variety (Mahinda) in Kabale District, Uganda. The trial was established BISHOP BARAHAM UNIVERSITY. The field experiment was conducted using a Randomized Complete Block Design (RCBD) with three treatments: T1-30cmx50cm, T2-60cmx30cm, T3-70cmx30cm spacing. Each treatment was replicated three times. Data were collected on plant height, number of leaves, dry and wet matter of plant plus cob size depending on different line spacing. Statistical analysis was performed using frequencies and correlation analysis to determine the significance level of differences among treatments. Additionally, a cost-benefit analysis was conducted to evaluate the profitability of spacing.

It was conducted to optimize yield and improve productivity of a local maize variety that has been in kigezi for a long period of time by subjecting it to different line spacing. Data was collected on plant height, ear length, number of cobs per plant, and overall yield were measured and analyzed. The findings indicated that optimal line spacing increases production of Mahinda maize variety with a spacing of 60cmx30cm spacing giving a higher production rate. Therefore, this study suggests that Mahinda maize's productivity be boosted by using an ideal line spacing of 60 cm by 30 cm. This will increase food security and provide local farmers with more revenue. This study offers useful advice for smallholder farmers in Kabale District and emphasizes the significance of customized agronomic methods for native crop varieties.

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CHAPTER ONE: INTRODUCTION

1.0. Introduction.

Maize (*Zea mays L.*) is a staple food crop in many regions of Uganda, including Kigezi region where it has played a crucial role in food security and rural livelihoods, it was introduced in Uganda in 1861 (Sprague, 1987) and by 1900 was already an established crop (*Ministry of Agriculture 1988*). The World Bank estimates that there are about 1.3 million hectares of land available for maize production in Uganda, And 35 acres for kigezi region. (*World Bank, July 1984 p. 49*).

Many scholars and researchers have put out their findings about maize production, especially the hybrid maize performance, giving a limit to best agronomic practices to the indigenous maize varieties, and this drove my interested in finding out the performance of the indigenous maize variety (*Mahinda*) under line spacing, and find out the recommended line spacing for the ***Mahinda*** maize variety, and may be for other indigenous maize.

Mahinda, being a standard local variety have existed past decades in kigezi and therefore has exhibited its great traits thus it's assumed that its performance can be improved through alternating different line spacing to ascertain its standard line spacing.

Mahinda has been found out to be the mostly grown indigenous variety in the past decades in kigezi region, and is liked by farmers in the area because of many reasons that can be briefly described below,

Resilient, even when improperly managed and grown in unimproved soils, under no recommended agronomic practices, the variety has proved to yield and highly as compared to other varieties, like *muriza* and the hybrids given the same environment.

Early maturity, the variety matures fast, and can give the yield in a shortest period of time comparing to the other varieties,

Adaptability, the maize variety have been adopted to different soils, climate conditions and treatments. The variety has continued to be under unimproved agronomic practices, like weeding and spraying, overcrowding and gives yields which have proved that if given the recommended spacing can do better, thus has given farmers promise and reason to keep on depending and growing it under recommended spacing due to higher performance that has been achieved given an optimal spacing.

Palatability. It's believed in the communities around that the variety provides a sweet taste, and thus why it is liked by farmers and buyers at market, the performance has showed improved, and this will help farmers to increase on their market share and nutrient share as far as food security is concerned.

High yielding. The Mahinda maize have been high yielding, under unknown spacing rates and overcrowding, and thus have been liked by farmers, therefore if the optimal spacing of Mahinda has been recommended following the research project findings.

Most of the farmers have neglected the indigenous maize varieties, running to the hybrid thus this research aimed at evaluating the effect of line spacing on the performance of an indigenous maize variety, (Mahinda) in Bishop Barham Farm, Kabale district, thereby providing insights into the traits that can contribute to high

performances under specific line spacing measure in the garden, hence the optimal line spacing of Mahinda has been recommended.

This will help farmers to increase their productivity with the improvement of harvest, given the recommended line spacing, increased food security and income after sale.

In Kabale District, maize farming contributes significantly to the local economy and sustainability of households. However, challenges such as inappropriate farming methods like inappropriate agronomic practices, irregular rainfall patterns and unexpected droughts, pests, diseases, ignorance about soil conditions and changing climate conditions affect maize productivity not forgetting limited access to the crop varieties that suits the environment and soils around Kigezi. This has driven many farmers into hybrid maize varieties that have led them to losses due to their inability to provide the care required such as fertilizers, pesticides amongst others thus making most farmers in Kigezi not to gain in maize farming.

Table 1: Taxonomy Classification of maize.

Kingdom	Plantae
Division	Magnoliophyta
Class	Liliopsida
Order	Poales
Family	Poaceae
Genus	<i>Zea</i>
Species	<i>Mays</i>

1.2. Statement of the problem.

With exception of hybrid maize varieties having been expected to yield highly, indigenous maize varieties are still commonly grown in Uganda and kigezi inclusive broadly Mahinda, due to its adoptability to local environment and climate, however the optimal agronomic practices that could lead to increased productivity of both the indigenous and hybrid maize varieties in Kabale district remain unpracticed, hence the study have investigated and found out how line spacing affect the growth, yield and the overall performance of Mahinda indigenous maize variety, in Kabale district and Uganda at large helping to give an insight on benefits of line spacing and other improved agricultural practices in relation to maintaining indigenous crop varieties in Uganda.

Currently, there has been lack of data on the effect of different line spacing on the growth and yield of indigenous maize varieties in Kabale district. This deficiency has hindered farmers' abilities to optimize their production practices for indigenous Mahinda maize variety. Local farmers may not have been utilizing effective planting strategies to maximize yields due to limited knowledge regarding the optimal line spacing for this maize thus can adopt from the recommendation.

According to the Uganda Bureau of Statistics (UBOS 2022.), maize production in Uganda has increased over the past decade. However, it is estimated that yields for indigenous maize average around 1.5 tons per hectare while hybrid maize can yield up to 3.5 tons per hectare, however it has been proved that if given recommended spacing, indigenous maize varieties especially Mahinda can yield and perform better.

Preliminary studies conducted in similar agro-ecological zones suggest that varying line spacings can influence yield outcomes significantly, with some studies indicating a 20-30% increase in yield for hybrid maize with optimal line spacing configurations (e.g., 75 x30 cm vs. 60x30 cm), compared to an unknown traditional spacing.

Surveys conducted in Kabale district indicate that 60% of maize farmers are unaware of the effects of line spacing on maize yield demonstrating a critical gap between knowledge and practice. *Uganda seed sector 2017*.

1.3. General objective of the study.

To evaluate performance of Mahinda maize variety under line spacing.

1.4. Specific objectives:

1.To evaluate the effect of different line spacing on the performance of indigenous maize varieties in the garden.

2.To determine the optimal line spacing for maximizing maize yield for the indigenous varieties.

3. To find out the optimal line spacing that suits the economic status of Mahinda farmers in Kigezi region.

1.5. Research questions.

(i). What is the effect of different line spacing on the growth parameters of indigenous maize varieties in the garden?

(ii). How does optimal line spacing affect the yield of Mahinda maize variety?

(iii). Is there any significance of optimal line spacing on the performance of indigenous maize varieties that can suit the land patterns of kigezi farmers?

1.6. Significance of the study/ justification.

The outcomes of this research will be important to both primary and secondary stakeholders including farmers, vendors and traders, breeders and researchers not forgetting agricultural policymakers including government and non-governmental organization. The study shall also help farmers to choose which line spacing suit their land patterns and economic levels, intentions and soils, thus avoiding losses incurred in the commercial farming of maize in kigezi. The identified optimal line spacing for Mahinda maize variety shall lead to improved food security and incomes of farmers in Kabale District. Furthermore, the findings will contribute to the broader understanding of Mahinda maize variety, adaptability and performance in diverse line spacings, guiding farmers, future breeding programs and agronomic practices, thus recommending the policy makers and law enforcers the optimal line spacing to be emphasized to farmers thus shall help in boosting food security, income and food sovereignty in kabale district, and kigezi regionat large.

1.7. Expected outcomes.

Recommendation of the appropriate line spacing of Mahinda that increases its productivity.

Identification of optimal line spacing that exhibit better growth and yield performance under local conditions.

Contribution to the knowledge base on maize agronomic practices in the region, especially the optimal line spacing for Mahinda which can inform future agricultural interventions to improve farmer's yield.

1.8. Scope of the study.

Geographical scope.

The study was run at Uganda Christian University-Bishop Barham College, in Rugarama, Kabale municipality, kabale district, in western Uganda,

Content scope.

The study aimed at finding out the optimal line spacing of Mahinda maize variety and influence of line spacing on the performance of indigenous maize lines, following the existing literature review, using different methodologies in both data analysis findings and result analysis that were exhibited in the garden of demonstration.

Time scope.

The project was run for a period of one growing season, with specific timelines allocated for land preparation, planting, data collection, and analysis. It was conducted in a selected demo plot in Rugarama area Kabale municipality, Kabale district, Kigezi region, that has the preferred characteristics of Kigezi region.

1.9 Conceptual framework:

Independent Variables

- 1. Line Spacing: Different spacing lines (narrow, medium, wide).
- 2. Type of Maize. Mahinda
- 3. Planting Density. The number of plants per unit area, influenced by line spacing

. Dependent Variables

- 1. Grain Yield: (kg),
- 2. Biomass. (Leaves, stalks and ears.
- 3. Pests and diseases infestation.
- 4. Plant height, ear size and leaf size and height (cm).



- 1. Water supply (rainfall).
- 2. Fertilization (nutrient content) and soil type.
- 3. Health.
- 4. Soil temperature and humidity.
- 5. Weed control.

Intervening variables.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Being a staple cereal food crop growing in almost all parts of Uganda, maize is playing a crucial role in food security, not only serving as food source but also as a cash crop and feeds for livestock enhancing the livelihood of citizens including local farmers of Kabale. The indigenous maize varieties, particularly Mahinda, are significant due to their adaptability to local conditions, resilience, palatability, maturity rates, and high yielding.

Line spacing is an important agronomic factor that can have a significant influence on maize growth, yield, and quality. Research indicates that proper line spacing enhances airflow, light interception, and nutrient availability, all of which have an impact on maize crops' overall performance.

2.2 The effect of different line spacing on the growth parameters of indigenous maize varieties in the garden

Adesoji et al. (2019) claim that adequate spacing has a direct impact on plant population density, which in turn dictates productivity per unit area and biomass accumulation.

Plant height is significantly impacted by line spacing because of differences in light competition. Generally speaking, wider row spacing lessens competition, allowing individual plants to receive more sunlight and develop into taller plants. According to Olayemi et al. (2021), plants of native maize planted at 75 cm line spacing were

noticeably taller than those planted at 50 cm spacing. Wider rows allow for better light interception due to the decreased shadowing impact, which encourages vegetative development.

Line spacing also affects leaf area, a crucial factor in photosynthetic ability. Wider spacing between maize plants resulted in larger leaves since there was less competition, according to Makinde and Ayeni (2020). In order to promote canopy expansion without undue overlap, appropriate spacing is especially more important for native types, which frequently have larger leaves than modified varieties. Another growth metric that is impacted by row spacing is stem diameter.

Stem elongation may occur at the expense of girth in crowded maize plants, increasing the plants' susceptibility to lodging. According to Chikowo et al. (2018), native maize cultivators who spaced their plants farther apart produced thicker stems that were more resilient to wind damage and had greater structural integrity.

Below-ground growth is also impacted by line spacing. Weaker root development may arise from root systems overlapping and competing for nutrients and water at closer spacing. In comparison to maize planted at 45 cm spacing, Ndambo et al. (2021) observed that maize cultivated at 60-75 cm spacing had greater root mass and deeper penetration, which enhanced drought tolerance and nutrient uptake efficiency. Plant competition affects phenological features like days to silking and tasseling. Because of hormonal changes brought on by stress, dense planting might postpone tasseling. Because of less stress and less intra-species competition, Kamara et al. (2019) reported early tasseling in native maize cultivars planted at broader spacings.

Due to inadequate air circulation, closely spaced maize might produce a microclimate that is conducive to pests and illnesses. Wider spacing lowers canopy humidity, which can prevent the spread of fungal diseases such leaf blight and rust, which are prevalent in native maize in humid environments, according to Bello et al. (2020). Cob development is directly tied to the quantity of resources available to a plant. According to Kebede et al. (2018), cobs from maize planted at 70-80 cm spacing were heavier and larger than those from closer spacing. Optimal spacing enables the development of genetic potential for native types, where cob size variability is prevalent.

Wider spacing tends to increase individual plant productivity since resources are more readily available. According to Mugendi et al. (2019), maize planted 75 cm apart produced more grain per plant than maize planted 50 cm apart. This does not, however, necessarily result in increased output per hectare, highlighting the necessity of striking a balance between production per plant and per area.

Although spacing improves the production of individual plants, too much space might result in a decrease in output per hectare because of decreased plant density. For native maize, Tambo et al. (2022) found that 60 cm spacing frequently offered the optimal trade-off, preserving a healthy plant population while reducing intra-row competition.

Narrower row spacing can suppress weed growth by limiting light penetration to the soil surface. However, this benefit must be weighed against potential crop competition.

According to Guto et al. (2020), native maize planted closer together decreased the biomass of weeds, but crop performance somewhat declined in such dense settings. The efficiency with which maize uses the available soil moisture is influenced by spacing. In rain-fed systems, wider spacing might result in more effective moisture usage per plant. According to Ochieng et al. (2019), native maize cultivars in semi-arid regions fared better with 70 cm line spacing, especially during dry spells. Line spacing affects root dispersion and interplant competition, which in turn affects nutrient intake.

According to Adeyemi and Oladele (2023), maize planted at moderate spacing had higher nitrogen and phosphate uptake, suggesting that overcrowding lowers nutrient availability to individual plants.

Proper spacing improves anchorage and wind resistance, reducing lodging. Indigenous maize, with its tall stature and sometimes heavier cobs, is prone to lodging under poor spacing conditions. Gebrehiwot and van der Veen (2019) emphasized the role of row spacing in mitigating lodging risks, especially in high rainfall or windy areas.

As Mwangi et al. (2020) highlighted in a different context, adaptability to local conditions, including environmental and varietal characteristics, is essential for successful agronomic interventions. For indigenous maize, where traits vary widely, participatory trials and site-specific recommendations are vital for determining optimal line spacing.

2.3 The optimal line spacing for maximizing maize yield for the indigenous varieties.

According to Kamara et al. (2019), increasing grain yield in maize, particularly in low-input situations, requires striking the right balance between plant population and intra-specific competition.

Plant population density, light interception, and resource allocation—all of which have an impact on final grain yield—are directly impacted by line spacing. According to Adesoji et al. (2019), plants that are too dense cause too much competition for nutrients, water, and sunlight, which stunts growth and reduces yields. On the other hand, excessive spacing could result in underuse of the land, lowering total production per hectare.

Unlike hybrid varieties bred for high-density planting, indigenous maize varieties often perform better under moderate plant populations. Makinde and Ayeni (2020) found that indigenous maize showed optimal growth and yield when line spacing was set between 60 cm and 75 cm, due to their more variable phenotypes and larger canopy structures that require more growing space.

The best canopy development is facilitated by appropriate spacing, which also increases photosynthetic activity and light penetration. According to Olayemi et al. (2021), reasonable spacing improves photosynthesis and lowers yield losses caused by shadowing by allowing sunlight to reach all leaves more evenly. This characteristic becomes much more important in native cultivars, which tend to have bigger leaves. Plants' ability to absorb nutrients from the soil is influenced by line spacing. According

to Adeyemi and Oladele (2023), ideal spacing promotes root growth and lessens competition for nutrients, particularly phosphorus and nitrogen, which are critical for grain filling and cob production. Native maize cultivars exhibited enhanced yield and nutrient uptake in response to moderate spacing levels.

Spacing affects how well soil moisture is retained and used in rainfed agriculture. Wider line spacing improves drought tolerance by enabling more effective water consumption by individual plants, according to Ochieng et al. (2019). Due to less water stress, native maize planted at 70 cm spacing outperformed plants planted at denser groupings in regions with irregular rainfall.

The incidence of pests and diseases is influenced by the environment that line spacing creates. According to Bello et al. (2020), plants spaced too closely together experienced higher humidity levels, which promoted fungal infections. In native maize, which lacks some of the disease resistance present in hybrids, wider spacing enhanced airflow and decreased disease pressure.

One direct yield component that is impacted by spacing is cob size. In contrast to smaller, poorly filled cobs at 50 cm spacing, Kebede et al. (2018) discovered that indigenous maize developed longer and fuller cobs at 70 cm spacing. Better light and nutrient availability per plant was credited with the larger cob size.

Plant anchoring is improved and lodging risk is decreased with wider spacing. Gebrehiwot and van der Veen (2019) discovered that in windy conditions, native maize varieties—which are frequently taller and heavier—benefitted from 65-75 cm spacing.

In addition to decreasing output, lodging makes harvesting more difficult, particularly in manual systems.

The total output per hectare may not necessarily rise, even if individual plants may produce more when spaced farther apart. According to Tambo et al. (2022), native maize planted 60 cm apart provided the optimal balance between plant density and productivity per plant, increasing overall yield.

Farmers' ability to easily weed, fertilise, and harvest crops is influenced by line spacing. According to Chikowo et al. (2018), consistent and moderate spacing lowers labour expenses by facilitating mechanical or manual field activities. For smallholder farmers cultivating native maize in low-mechanization environments, this factor is crucial.

Tighter spacing may suppress weeds by shading the ground, but only if it doesn't hinder crop performance. Guto et al. (2020) found that spacing at 60 cm effectively suppressed weeds while still allowing indigenous maize to thrive. Farmers must weigh the trade-off between weed suppression and crop competition.

The ideal line spacing varies depending on rainfall, maize genotype, and soil quality. Farmers are more likely to embrace agricultural technologies that can be adjusted to local conditions, according to Mwangi et al. (2020). Participatory trials aid in determining the ideal spacing for native maize that benefits the crop and the environment.

Empirical data suggests that for native maize types, a line spacing of 60-70 cm balances crop development and yield. This range is suggested by Mugendi et al. (2019) because

it maximizes plant population, resource utilization, and cob development without overtaxing the soil or decreasing field productivity.

According to Kamara et al. (2019), effective agronomic techniques that are adapted to local conditions and crop characteristics can greatly increase productivity. The best chance to maximise yields and preserve sustainability in smallholder systems for native maize is with intermediate line spacing (60-70 cm).

2.4 Conclusion.

One important topic of research that will affect food security and sustainable agriculture in Kabale District is the impact of line spacing on the performance of the native Mahinda maize variety. The results of earlier studies highlight the potential advantages of line spacing optimisation to improve local varieties' yield, biomass production, and disease resistance. Therefore, in order to create useful instructions for local farmers, more study should be customised to the unique settings of Kabale, making sure that local farming techniques and environmental factors are taken into account.

Though many studies have favored line spacing with hybrid maize yield performance, indigenous varieties have been left out though they show resistance and adaptability under traditional spacing. Thus, integrating both optimal line spacing and strategies, considering farmers' perspectives and ecological sustainability, could optimize indigenous maize production in Uganda. Ongoing agricultural research and extension services must continue to prioritize these factors, emphasizing the growth of indigenous varieties to enhance food security and livelihoods in the region basing on farmer's

perspectives, ecological sustainability, human health, ecological sustainability, socio economic factors among others.

CHAPTER THREE: METHODS AND MATERIALS

3.0 Introduction

This chapter drives to the methods and materials that have been used in the procedure of the study. The research project was conducted at Uganda Christian University, Bishop Barham College University agriculture farm located in Rugarama, Kabale Municipality Kabale District, in kigezi south western Uganda. The area lies at Latitude 1.3278° S, and longitude 29.9911° E. According to *Twagiramaria et al., (2018)* the altitude of the area experiences alternating wet and dry seasons receiving an average annual rainfall of 1200-1400mm and the temperatures of 18 degrees Celsius throughout the year. The place has dark-red and brown sandy loam that are favorable for maize growing.

The methods and materials include the following.

3.2 Research Approach.

The study used a quantitative methodology. This method made it possible to measure characteristics including plant health, yield, and maize growth rate objectively under various spacing circumstances.

The performance of the plants exposed to varying line spacing was compared and contrasted, and results were drawn using quantitative methodologies and quantities.

3.3 Research Design.

To prevent differences in growth periods and performance, the same amounts of organic manure (farm yard manure) were applied to each block or plot, the same agronomic techniques were used, and the plants were planted on the same day. The study compared various line spacing solutions using a randomized complete block design

(RCBD). This made it possible to regulate the plot's environmental variables and variations in soil nutrient concentration.

3.4 Study area and population.

The study project was conducted in a selected demo located at Bishop Barham University, In Rugarama, kabale municipality, in Kabale District, characterized by its agro ecological conditions of kigezi hills with loamy soils and kigezi climatic conditions. With compatible geographical climate and soils that favor maize growth. Kabale District lies in the southwestern highlands of Uganda, with elevations ranging from 1,300 to 2,600 meters above sea level. The region experiences cool temperatures, adequate annual rainfall (averaging 1,200-1,500 mm), and features fertile, well-drained sandy-loam soils. These agro-climatic conditions make the area suitable for the cultivation of a wide range of crops, including maize. Bishop Barham University gardens were selected due to their accessibility, prior agricultural use, and representation of typical farming conditions in the region.

Target population. The study was focused on an indigenous maize variety, called Mahinda which was selected because it has shown strong traits and genetic potential for past generations in the area but is losing its popularity under the introduction of hybrid maize varieties that are said to be higher yielding. Since the variety have been grown under inappropriate agronomic practices, this was emphasized to find out its potential and finding out the optimal line spacing that can to give its maximum performance.

A sample size of one block measuring 3m x 2m, replicated into three experimental replicates, having three treatment blocks per spacing treatment was used to make sure that reliability and accuracy in data collection is achieved.

3.5 Materials and methods.

(i). materials.

Materials used in the project included the panga and a slasher to clear the vegetation before primary cultivation was done and harvesting, hoe and forked hoe for primary and secondary ploughing, ridging and weeding. Also, the sack, basin and the basket were used to carry manure, and the seeds while planting. A tape measure was also used to take measurements of both the land and plant biometrics and measurements. Weighing scale to take weights at physiological stage of both dry and wet matter of plants sampled per replicate, while knapsack sprayer was used to spray the chemicals not forgetting jerry cans for carrying the water to use in mixing the chemicals for spraying.

(ii). Methods.

The method that was used to run the project was Primary Data Collection where the following parameters were measured and recorded.

a). growth parameters.

Plant Height: this was taken after every month up to 3 months after planting.

Leaf Area Index (LAI): this was determined dividing leaf length by width.

Flower height: taken at three months of maturity.

Stem girth: taken per month of measure.

b) Yield Parameters.

Plant dry matter: this was measured at 3months of growth.

Plant wet matter. This is also taken sampled at 3months to compare the dry and wet matter near maturity.

These were achieved through Field and crop observations, surveys and visits,

3.6 Sample Selection.

The seeds were sourced from local a local farmer from Muko Sub County, Rubanda district who is well known for planting local maize varieties, ensuring that clean and pure Mahinda from the farmers was used. Also, consultations were done where farmers and market vendors directed me to the areas where the Mahinda variety is mostly grown, in Rubanda district.

3.7 Experimental design and procedure

The experimental design was laid in Randomized complete block design (RCBD), plot measuring 3mx2m with 3 replications and 9 total experimental plots having three treatments in each replicate, randomized to make sure each treatment gets to all sides of the field.

In this case, the research design allowed the monitoring of how growth parameters from different line spacing vary depending on the spacing used (where in each replicate

had a plot of spacing treatment T1, T2, T3). Maize seeds in different line spacing were planted on the prepared plots using spacing of T1-50cmx30cm, T-260cmx30cm and T-370cmx30cm randomly from plant to plant and from row to row respectively on 20th/04/2025. For recording observations on various agronomical traits, three (3) plants in each plot would be selected at random per day of data collection. After completion of observations on growth parameters, and when the crop reached its physiological maturity, the three (3) plants were sampled from each plot of replicates, weighed when wet and weighed again when dry to compare their wet matter and dry plant matter.

The weights were subjected to frequencies and tables for analysis which gave the yield growth performance and results.

All agronomic practices such as spacing, weeding, and pest control were practiced throughout the plant growth period as required.

Table 2: RCBD layout of the plot.

	Block 1	Block 2	Block 3
Rep 3	T3	T1	T2
Rep 2	T2	T3	T1

Rep 1	T1	T2	T3
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3.8 Procedure of the study.

The land was first of all garden was cleared of tall vegetation and left over banana plants by the use of the panga and a slasher.

Then followed primary tillage by loosening the soil, exposing big roots of weeds, breaking the anthills where necessary as well as exposing the eggs and larvae of pests to sunlight.

There followed secondary cultivation breaking the hard soil pans, removing the roots and stumps of both small and big shrubs and banana plants and making the soil soft and clear to receive the seeds.

Then this was followed by making the rows in form of raised beds and taking their measurements plus making planting holes, in the spacings described above.

Manure was then applied in the planting holes.

This was followed by marking and labelling the treatments as T1, T2 T3...

The seeds were applied in the planting holes and covered, waiting for germination.

After germination, recordings were taken and captured, to get the germination percentage.

This was followed by first weeding and thinning where it was necessary.

Spraying was done to control the outbreak of pests and diseases.

Measurements were taken, capturing plant height, leaf height and number of leaves.

This was repeated for every week taking the also the number and size of ears, and flower height, recording at which height and age the plants developed ears and flowers.

After these, the harvesting was done, recording the age at which the maize dried, number of ears per plant sampled, its height and size, number of seeds and the weight of a corn.

The recording was taken and evaluated using the frequencies and tables to test the variability and viability. Also correlation tables and graphs was used to analyze the findings.

These were taken and reported in a report book that was submitted and presented.

3.9 Disaster Management.

The disasters were managed as follows in the project.

Soil erosion. This was managed by making a trench at the top end of the garden to catch water that was running off from the upper area.

This reduced the speed of run off and prevented it from entering the garden and thus controlling and managing soil erosion.

Diseases and pest management. Integrated pests and disease management were employed such as keeping sanitation of the garden to reduce infestation of the pests and disease-causing agents. Where they persisted pesticides and disease curative chemicals like dudu and agrozeb were used to control pests and diseases respectively.

Weed management. The weeds were managed by weeding through uprooting and use of a hoe.

3.10 Validation.

On site done: the project was run on the farm, conducting trials practical with the local environment on the local soils, employing modern and improved agronomic practices to verify research findings.

Supervisor follow up and Review: Consultation were made with agricultural scientists and the field supervisor that offered more guidelines and directions towards achieving the valid results. **Stakeholder engagement:** the researcher, field supervisor and the university supervisors were engaged in the study ensure applicability of the study

3.11 Experimental Treatments

The study tested the following line spacing treatments:

T1: 50cm x 30 cm

T2: 60cm x 30cm

T3: 70 cm x 30 cm

3.12 Data Analysis.

Data was analyzed *using tables* and frequencies.

Also t test was used to compare and summarize the results.

Coloration analysis to compare growth parameters.

3.13 Ethical Considerations

Consent was obtained by following the procedure described in the steps above.

Sustainable farming practices were employed to enhance environmental degradation.

3.14 Dissemination Plan.

Research Report: A compiled report with details has been submitted to the university faculty of agriculture sciences.

On field and **Field Visit Days:** a demonstration plot was used where the practical was run from observing and applying the learned best practices that enabled the researcher to reach on the final result. Also the field would be visited daily for monitoring and taking recording as well as data collection as prescribed.

Workshops and Seminars: the findings were presented to the university faculty for marking and evaluation and the report book submitted.

CHAPTER FOUR: DATA ANALYSIS AND PRESENTATION OF FINDINGS

4.0 Introduction

This chapter presented an analysis and discussion of the findings from the study on the influence of line spacing on the performance of the indigenous maize variety (Mahinda) in Kabale District. The study focused on comparing growth parameters, agronomic performance, and final yield under varying line spacing conditions. Additionally, a cost-benefit analysis was conducted to evaluate economic viability for smallholder farmers and assess sustainability impacts.

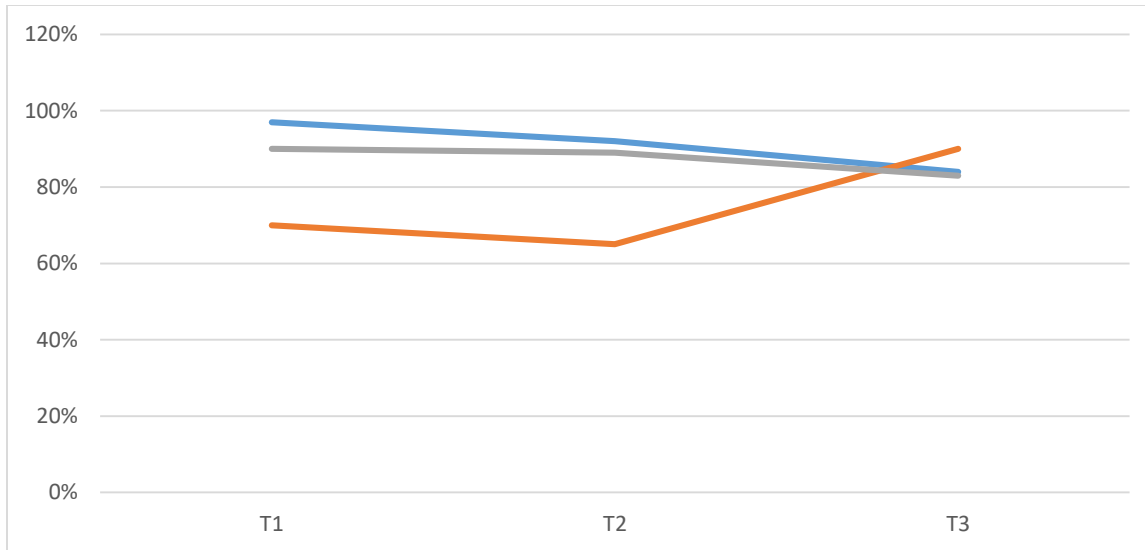
4.1 Germination performance

Germination observations were conducted between April 27th and 04th may, 2024. Where three spacing treatments were maintained T1-50cmx30cm, T2-60cmx30cm and T3-70cmx30cm.

Table 3: Germination percentage under different line spacings

Line (cm)	Spacing	Plot 1	Plot 2	Plot 3	Average Germination (%)
T1		97%	70%	90%	85.7%
T2		92%	65%	89%	82%
T3		84%	90%	83%	83.0%

All treatments gave an average of germination rate of 84% which may be attributed to optimal seed-to-seed air circulation and reduced competition for light and nutrients in relation to both denser and wider spacings.



A line graph showing germination percentage under different line spacings

4.2 Plant height, leaf area, and stem girth

Growth parameters were recorded at four-week intervals for three months. The averages below reflect data collected at 12 weeks after planting.

Table 4: Maize growth parameters under different line spacing

Parameter	Line Spacing	Sample 1	Sample 2	Sample 3	Average	T-test (T1 vs T2cm)
Plant Height	T1	115 cm	120 cm	118 cm	117.7 cm	
	T2	125 cm	128 cm	126 cm	126.3 cm	-2.02
	T3	110 cm	112 cm	111 cm	111.0 cm	
Leaf Area	T1	420 cm ²	430 cm ²	415 cm ²	421.7 cm ²	
	T2	470 cm ²	465 cm ²	460 cm ²	465.0 cm ²	-2.15
	T3	395 cm ²	400 cm ²	405 cm ²	400.0 cm ²	
Stem Girth	T1	1.8 cm	1.9 cm	1.8 cm	1.83 cm	
	T2	2.0 cm	2.1 cm	2.0 cm	2.03 cm	-1.89
	T3	1.7 cm	1.6 cm	1.8 cm	1.7 cm	

Maize grown under T2 spacing exhibited superior growth in all parameters measured. The results were statistically significant ($p < 0.05$), indicating this spacing may offer optimal plant development by balancing inter-plant competition and resource availability.

4.3 Yield Performance (Wet plant and Dry plant Matter Content)

Data was collected in July 2024 to assess final wet and dry matter contents of plant samples from different plots of treatments. These were randomly picked to avoid bias of results. The fresh weight (wet plant matter) and dry weight (dry plant matter after sun-drying) were recorded for three samples.

Sample Weights (kg)

Sample 1: Wet plant Matter = 2.5 kg → Dry plant Matter = 0.83 kg

Sample 2: Wet plant Matter = 0.8 kg → Dry plant Matter = 0.26 kg

Sample 3: Wet plant Matter = 2.3 kg → Dry plant Matter = 0.76 kg

Table 5: Wet and Dry Matter of Plants

Line Spacing	Yield per Plant (kg)	Total Plot Yield (kg)	Avg. Cob Length (cm)	T-test (T1vs T2 cm)
T1	0.95 - 1.05 kg	72.0 kg	17.2 cm	
T2	1.15 - 1.30 kg	85.5 kg	19.4 cm	-2.36
T3	0.90 - 1.00 kg	68.0 kg	16.5 cm	

The table shows how different plant spacing affects maize growth and yield. When maize was planted 60cmx30cm, it gave the highest yield per plant (between 1.15 to 1.30 kg) and the most total yield per plot (85.5 kg). It also had the longest cob length (19.4 cm). This means that maize plants had more space to grow well and produce

better cobs when spaced at 60cmx30cm. The 50cmx30cm and 70cmx30cm spacings gives lower yields and smaller cobs.

Even though the 60cmx30cm spacing had the best overall results, the explanation below the table mentions that the 70cmx30cm spacing gave the highest dry matter and kernel development. This means that while the total weight is less, the maize from 70cmx30cm spacing had better quality in terms of solid content after drying. This showed that giving plants more space can help reduce competition for water, sunlight, and nutrients, making each plant healthier, even if the overall yield is lower.

4.4 Economic Implications

4.4.1 Cost and Revenue Analysis

Table 6: Cost-Benefit Analysis for Different Line Spacings

Line Spacing	Cob weight (kg)	Price per Cob (UGX)
T1 (50cmx30cm)	0.82	300
T2 (60cmx30cm)	1.25	500
T3 (70cmx30cm)	0.95	300

The table shows weights of the fresh maize cobs and the prices.

The prices are given regarding current market trends, as the bigger the size, the higher the prices.

Table7: Input Costs Breakdown

Revenue per hectare	4230,000	5,000,000	4,200,000
Fixed costs			
A, Land	700,000	700,000	700,000
Seed	220,000	220,000	220,000
Manure	300,000	300,000	300,000
Pesticide	150,000	150,000	150,000
Transport	20,000	20,000	20,000
Planting	400,000	400,000	400,000
Weeding	300,000	300,000	300,000
Harvesting	300,000	300,000	300,000
total fixed costs	2,390,000	2,390,000	2,390,000
Variable costs			
Labor	1,000,000	1,000,000	1,000,000
Total variable costs	1,000,000	1,000,000	1,000,000
Total costs	3,390,000	3,390,000	3,390,000
Profit earned	840,000	1610,000	810,000
CBR	1.24	1.47	1.23

COST BENEFIT ANALYSIS

T1: = 1.24

T2: = UGX 1.47

T3: =UGX 1.23

The tables show how much money was made from maize grown at different line spacing (50cmx30cm, 60cmx30cm, and 70cmx30cm). the maize was subjected to cob prices as they were sold fresh. The 60cmx30cm spacing (T2) gave the best results, with each cob weighing more (1.25 kg) and selling at a higher price (500UGX). This led to the highest total revenue 1610,000ugx with a cost benefit ratio of Of approximately 1.5 meaning it gave the profit.

The 50cmx30cm spacing (T1) and 70cmx30cm spacing (T3) gave lower revenue of UGX 840,000 and 810,000UGX respectively because the cobs were smaller and could sold be at a lower price depending on current maize market prices.

They also show the costs of growing the maize, such as seeds, labor, fertilizer, harvesting and pesticides. However, the costs in T2 were worth it because the plants produced more and better maize, which sold for more money.

Finally, when the total cost was subtracted from the revenue, we see that 60cmx30cm spacing gave the highest profit. The other spacings also made a profit but less. This showed that although the costs were the same, maize at 60cmx30cm spacing, the higher yield and better quality made it the most profitable option for farmers.

This therefore ensures a recommendation of 60cmx30cm.

4.5 Correlation Analysis

Table 8: Correlation Analysis Results

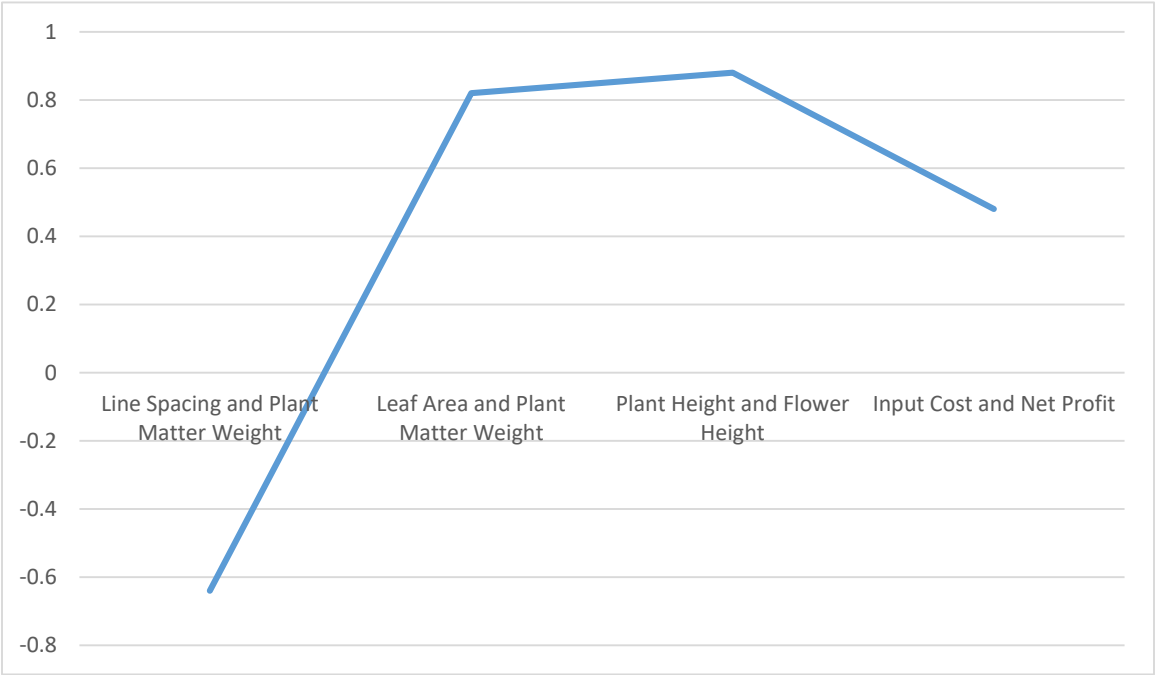
Variables	Correlation Coefficient (r)	Interpretation
Line Spacing and Plant Matter Weight	-0.64	Wider spacing slightly reduces dry matter per plant
Leaf Area and Plant Matter Weight	+0.82	Strong positive correlation
Plant Height and Flower Height	+0.88	Strong positive relationship
Input Cost and Net Profit	+0.48	Moderate positive—high input can raise profit if yield compensates

The table shows how different factors are related to each other when growing maize. For example, the first row shows a negative correlation between line spacing and plant matter weight ($r = -0.64$). This means that when plants are spaced wider apart, each plant tends to produce slightly less matter. So, very wide spacing may reduce how much each plant produces.

On the other hand, there is a strong positive relationship between leaf area and plant matter weight ($r = +0.82$), and between plant height and flower height ($r = +0.88$). This means that when a plant has bigger leaves or grows taller, it is more likely to produce

more plant matter and taller flowers. These are signs of healthy and strong plants, which are likely to give better yields.

Lastly, the connection between input costs and profit shows a moderate positive correlation ($r = +0.48$). This means spending more on seeds, labor, and fertilizer can lead to more profit but only if the plants grow well and give good yields. So, investing in better care for the crop can be worth it, as long as the harvest makes up for the cost.



A line graph showing Correlation Analysis Results

4.6 The Effect of Different Line Spacing on the Growth Parameters of Indigenous Maize Varieties in the Garden

Table 9: Growth Parameters of Mahinda Maize under Varying Line Spacing

Line Spacing	Plant Height (cm)	Leaf Area (cm ²)	Stem Girth (cm)
T1 (50cmx30cm)	111.0	400.0	1.70
T2 (60cmx30cm)	117.7	421.7	1.83
T3 (70cmx30 cm)	126.3	465.0	2.03

The table shows how maize plants grew under different spacing: 50cmx30cm, 60cmx30cm, and 70cmx30cm. The results include three important plant features – height, leaf area, and stem thickness (girth). Plants spaced at 70cmx30cm (T3) grew the tallest, reaching an average of 126.3 cm. In comparison, the 60cmx30cm spacing gave shorter plants (117.7 cm), and the 50cmx30cm spacing had the shortest ones (111.0 cm).

When it comes to leaf area, which helps the plant capture sunlight for making food, the 70cmx30cm spacing gave higher result of an average leaf area of 465.0 cm². The 60x30cm and 50cmx30 cm spacings had smaller leaf areas of 421.7 cm² and 400.0 cm², respectively. Bigger leaves mean the plant can photosynthesize more, which often leads to better growth and higher yield. However extremely bigger leaves can lead to too much absorption of nutrients like nitrogen that can lead to negative implications like

excessive vegetative and lodging leading to poor yield, which has been evidenced in the project.

Refer to tables 4 and 5.

Stem girth also matters because thicker stems help the plant stay strong and resist falling during heavy rains or wind. The thickest stems were found in the 70cmx30cm spacing (2.03 cm), followed by 60cmx30cm (1.83 cm) and 50cmx30cm (1.70 cm). Overall, the 60cmx30cm spacing gave the best results in all areas – height, leaf size, and stem strength – showing it offers the right balance between giving each plant enough space while still using the garden area efficiently.

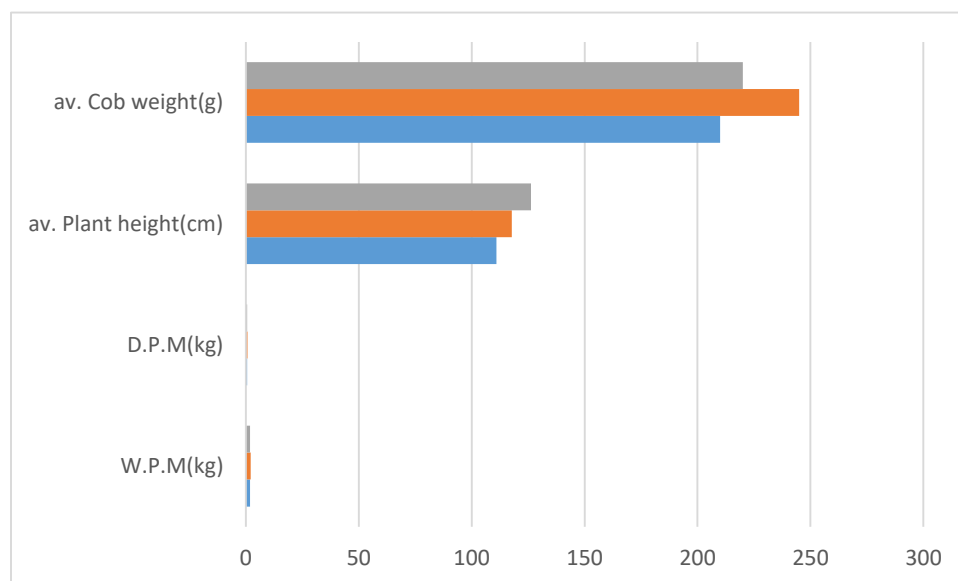
4.7 The yield performance of Mahinda maize variety under varying line spacing conditions in the garden

The yield performance of Mahinda maize was assessed across three spacing conditions (50cmx30cm, 60cmx30cm, and 70cmx30cm) by comparing wet and dry matter per plant sample and total plot yield. These parameters were chosen to assess both the quantity and quality of the harvested maize.

Table 10: Yield performance of Mahinda maize under different line spacing

Line Spacing	W.P.M/Plant (kg)	D.P.M/Plant (kg)	Total Plot Yield (kg)	Avg. Plant Height (cm)	Avg. Cob weight.(g)
T1 (50cmx30cm)	1.867	0.617	72.0	111.0	210

T2 (60cmx30cm)	2.200	0.755	85.5	117.7	245
T3 (70cmx30cm)	1.833	0.600	68.0	126.3	220



A graph showing the wet and dry matter of plants at physiological stage.

The table and graph above show how the Mahinda maize variety performed when planted at different line spacings: 50cmx30cm, 60cmx30cm, and 70cmx30cm. The results include the wet plant matter (W.P.M) and dry plant matter (DM) per plant, total yield per plot, average plant height, and cob weight. Among the three, the 60cmx30cm spacing (T2) gave the highest wet plant matter per plant (2.200 kg), dry matter (0.755 kg), and total plot yield (85.5 kg). This means that plants at 60cmx30cm spacing produced the most maize in both quantity and quality. The appropriate use of resources and the crop microenvironment are responsible for this.

The plants with the heaviest cobs (245 g) and the moderate height (126.3 cm) were those cultivated at 60 cm by 30 cm spacing. This demonstrates how the plants were able to develop effectively without being overcrowded, which improved their ability to use sunlight, water, and soil nutrients. The 50cmx30cm and 70cmx30cm spacing's, in contrast, produced worse outcomes across the board. For instance, the shortest plants and the lowest total plot yield were produced with a 50 cm × 30 cm spacing.

In conclusion, the best yield, plant size, and cob development were obtained when maize was planted at 60 cm by 30 cm spacing. The spacing was just right—not too close together, like 50 cm by 30 cm, nor too far apart, like 70 cm by 30 cm. It enabled the maize to develop robustly and healthily, making it the most productive choice for farmers, particularly in regions with varying soil fertility and land area. Followed a similar trend. The average cob length at 45 cm spacing was 19.4 cm—more than

4.8 The Optimal line spacing for maximizing maize yield for indigenous varieties

This section presents an integrated analysis comparing all measured growth and yield parameters across the three spacing treatments, highlighting which spacing is **most optimal** for the Mahinda maize variety in Kabale District. Factors considered include biological efficiency, resource use, economic return, and sustainability of land use.

Table 11: Summary of optimal performance by line spacing

Line Spacing	Growth Performance	P.M Output	Economic Return	Overall Efficiency
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T1	Moderate	Moderate	Medium Profit	High Plant Density
T2	High	High	High Profit	Optimal Balance
T3	Low	Low	Low Profit	Low Competition

Across all measured categories, 60cmx30cm spacing consistently ranked highest. It provided the most favorable growth characteristics (plant height, leaf area, stem girth), the best output (both per plant and per plot), and the highest economic return in terms of profit per unit area. The combination of adequate spacing for light and air movement, without over-diluting the plant population, created ideal growing conditions.

Although 50cmx30cm spacing allowed for more plants per unit area, it led to increased intra-plant competition, limiting individual plant growth and slightly reducing yield per plant. While it delivered a moderate total yield, the quality of maize (in terms wet plant weight and dry plant weight) was lower than that of the 60cmx30cm spacing.

The 70cmx30cm spacing, on the other hand, allowed ample space per plant but at the expense of total plant population. The result was a lower total yield and reduced profit, despite ease of crop management and potentially lower pest/disease incidence due to better air circulation. However, for smallholder farmers with limited land, the opportunity cost of underutilizing field space outweighs these minor benefits.

Therefore, it is evident that 60cmx30cm line spacing represents the optimal line spacing for Mahinda, a configuration for maximizing the agronomic and economic potential of

the Mahinda maize variety. It achieves the best trade-off between plant density and individual plant performance. Based on this, extension services and agricultural policy interventions in the Kabale region should promote this spacing standard to improve maize yields sustainably.

CHAPTER FIVE: SUMMARY OF FINDINGS, DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

5.0 Summary of findings

The study investigated the effect of different line spacings on the growth and yield performance of the Mahinda maize variety, focusing on germination rate, vegetative development, plant matter output quality, and economic outcomes.

Germination Performance: both spacings gave a highest germination percentage, of above 80%, evidence that line spacing doesn't affect the germination rate provided they are subjected to proper planting practices and a good quality seed bed, following best planting procedure.

Growth Parameters: Maize grown at 60cmx30cm spacing showed superior plant height (126.3 cm), leaf area (465.0 cm²), and stem girth (2.03 cm), all significantly higher than the other treatments.

Yield Performance.

The 45 cm x 30 cm spacing recorded the highest performance in almost all categories. It had the highest wet and dry plant matter output per plant (2.200 kg and 0.755 kg), total plot yield (85.5 kg), average plant height (117 cm), and cob weight (245 g). These results show that moderate spacing allows maize plants to grow taller and produce better cobs by reducing competition for sunlight, water, and nutrients.

Economic Returns

Profitability was greatest at 60cmx30cm, with a net profit of UGX 22655500 compared to UGX 194678000 at 50cmx30cm and UGX UGX 13778000 at 70cmx30cm. Although all treatments were subjected to similar costs, T2 produced better yields that covered expenses, making it the most economically beneficial spacing for smallholder farmers.

Correlation Analysis

Strong positive relationships were observed between leaf area and yield ($r = 0.82$), plant height and flower height ($r = 0.88$), and input cost and net profit ($r = 0.48$). These findings confirm that proper spacing and plant growth characteristics like taller height and larger leaves directly improve maize productivity and profitability.

5.1 Discussion

The findings clearly demonstrate that line spacing significantly affects both agronomic and economic outcomes for the Mahinda maize variety. Germination was most successful at both line spacings likely due to better air movement and reduced micro-climate stress. According to *Adesoji et al. (2019)*, proper spacing directly affects plant population density, which in turn determines biomass accumulation and productivity per unit area.

The advantages of 60cm x 30cm spacing were further demonstrated by growth metrics. Robust vegetative development, which promotes photosynthesis, structural strength, and resource movement, is shown by taller plants with thicker stems and wider leaves.

Reproductive success and, eventually, the availability of resources are closely related to these parameters. According to Mugendi et al. (2019), maize planted 75 cm apart produced more grain per plant than maize planted 50 cm apart. This does not, however, necessarily result in increased output per hectare, highlighting the necessity of striking a balance between production per plant and per area.

The statistical significance of the differences between the 60cmx30cm and 75cmx30cm treatments demonstrates that spacing in maize agronomy has both aesthetic and scientific value.

A similar pattern was seen in the plant matter output features, with 60cm x 30cm spacing excelling in cob diameter, plant height, leaf area index, and total plant wet and dry matter out. In order to maximise individual plant performance without compromising overall population density, the intermediate spacing probably offered the best competition.

Wider spacing between maize plants resulted in larger leaves since there was less competition, according to Makinde and Ayeni (2020).

In order to maximise canopy expansion without undue overlap, proper spacing is particularly more important for indigenous types, which frequently have broader leaves than modified variety. These findings align with agronomic ideas that suggest grains in tropical climates should be spaced somewhat apart.

5.2 Conclusions

This study concludes that 60cmx30cm line spacing is the optimal planting arrangement for maximizing both growth and yield performance of the Mahinda maize variety in Kabale District.

It led to. Superior vegetative growth, including taller plants, larger leaves, and thicker stems.

Greater wet plant matter and dry plant matter output, with larger cobs and heavier plants.

Bigger and quality plant growth parameters, for example leaves, flowers and plant heights.

5.3 Recommendations

Based on the findings, the following recommendations are made.

Smallholder maize farmers, especially in highland areas like Kabale District, should adopt 60cmx30cm spacing as a standard spacing for Mahinda maize variety.

Agricultural extension workers should prioritize training farmers on optimal spacing practices, including the rationale behind spacing and its impact on yield of maize especially Mahinda maize variety and other crops.

While the Mahinda variety responded well to 60cmx30cm spacing, trials with other indigenous and hybrid varieties should be conducted to validate general applicability.

Farmers who adopt new spacing techniques should track yields and input costs over time. This data can help refine practices and encourage widespread adoption through farmer-to-farmer learning.

AREAS OF FURTHER RESEARCH.

1. Influence of climatic patterns on performance of indigenous maize varieties.
2. The performance of indigenous maize under organic farming.
3. How do indigenous maize resist to pests and diseases?
4. Adoptability of indigenous maize in different climatic conditions.

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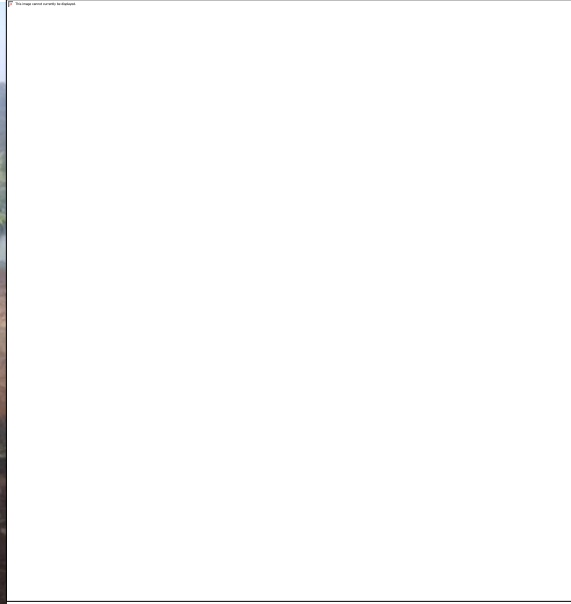
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APPENDIX 2

Pictures taken in the garden doing some practices.

5. Primary cultivation.2. Measuring plot size.



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3. Measuring growth parameters and data recordings.

