ASSESSING THE EFFECT OF ORGANIC MANURE AND ARTIFICIAL FERTILIZERS ON THE PRODUCTIVITY OF IRISH POTATO (SOLANUM TUBEROSUM) GROWTH AND YIELD AS WELL AS PROFITABILITY

AMOS NGABIRANO

S21/BBUC/BASE/007

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UGANDA CHRISTIAN UNIVERSITY
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DECLARATION

The information in this research project report titled “Assessing the Effect of Organic Manure and Artificial Fertilizers on Productivity of Irish Potato (*Solanum Tuberosum)*

Growth and Yield as well as Profitability” is my original work, and where other texts have been cited, they have been fully acknowledged. The work has not been submitted for any academic purpose in any academic institution for any academic purposes.

SIGNATURE: ..... DATE: 07/08/2025

NGABIRANO AMOS

S21/BBUC/BASE/007.

APPROVAL

This is to certify that the research proposal titled “Assessing the Effect of Organic Manure and Artificial Fertilizers on Productivity of Irish Potato (*Solanum Tuberosum)* Growth and Yield as well as Profitability” has been carried out under my supervision and is ready for submission with my approval.

SIGNATURE: ..... DATE: 7/8/2025

UZATUNGA INNOCENT

(UNIVERSITY SUPERVISOR).

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First and foremost, I express my sincere gratitude to the almighty God who has protected me, given me good health as well, and been the source of wisdom and knowledge during my studies.

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ABSTRACT

The study was to assess the effect of organic manure and artificial fertilizers on the Productivity of Irish potato growth and yield. It was guided by the following study objectives: to determine the effect of different applications of organic manure and artificial fertilizers productivity of Irish potato growth and yields, and to determine the most profitable application of organic manure and synthetic fertilizers in potato production. The experiment was conducted using a randomized complete block design (RCBD) with three treatments, each replicated two times. Plant height was recorded every 3 weeks starting from the third week after emergence. The number of shoots per plant was recorded at 10 weeks after emergence, and it also had a parameter to measure the growth rate. The number of tubers and the weight (yield) of tubers for a sample of three plants per plot were measured at maturity/harvest. ANOVA was used to compare the results of different treatments, conduct the variance analysis to identify relationships between variables, and use graphical representations like bar graphs to visualize the data. The findings revealed that applying organic manure and artificial fertilizers has a profound impact on both growth parameters measured— plant height and number of shoots.

The findings revealed that as the rate of applying organic manure increases from Treatment 0 tons/ha to Treatment 5 tons/ha, the mean total weight of smaller-sized potato tubers generally tends to grow. The data points within each treatment group and the standard deviations also differ among the treatments, and applying more organic manure at greater rates could potentially increase the weight of smaller tubers. It was observed that there is variability in the weight of medium-sized potato tubers based on the application rates of organic manure. Treatments with higher

application rates, such as Treatment of 10,15, and 20 tons/ha, showed an increase in the mean total weight, while treatments with lower application rates, like Treatment 5 tons/ha, exhibited a decrease in the mean total weight. The findings revealed that the mean total weight of potatoes varies across different application rates of organic manure. Treatments with higher application rates (10, 15, and 20) tones/ha generally showed higher mean total weights compared to lower application rates (0) tones/ha. However, treatment with organic manure shows a lower mean total weight compared to other treatments.

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CHAPTER ONE: INTRODUCTION

1.0 Introduction

1.1 Background of the study

Potatoes, scientifically known as *Solanum tuberosum,* are starchy tuberous crops that belong to the nightshade family, Solanaceae. Originating from the Andes region in South America, potatoes were domesticated by indigenous peoples over 10,000 years ago. They were introduced to Europe in the 16th century and have since become one of the world's most important food crops. Potatoes are herbaceous plants with compound leaves and white, pink, red, blue, or purple flowers. (Brown, 2019)

Despite being a staple food for millions of people worldwide, potato cultivation faces several challenges that hinder increased productivity. These challenges include diseases such as late blight and pests like potato cyst nematodes, which can significantly reduce yields if not properly managed. Furthermore, climate change also endangers potato production because weather extremes have the potential to interfere with crop quality and development. (Williams, 2019).

Potatoes are grown in over 100 nations globally, with China topping the list as the largest producer, followed by India and Russia. Potato diversity of all forms of cuisine has led to high consumption levels globally, and different production systems depending on the scale, from subsistence small-scale farming to commercial large-scale production. (Jones, 2020).

Among the array of cultivated agricultural species, the potato is acknowledged as one of the most vital crops worldwide regarding production volume, serving as a fundamental food source for billions and a key element in generating income for agricultural producers (FAO, 2020). In light of the growing emphasis on soil quality, sustainable management of natural resources, and food safety, considerable attention has been devoted to the implementation of organic farming practices that emphasize the utilization of natural input sources, such as organic manures, to maintain soil fertility, reduce dependence on chemical fertilizers, and encourage sustainable agricultural practices (Vanlauwe et al., 2019). Findings from research that examines the effects of different levels of synthetic fertilizers and organic manures on the growth characteristics and yield potential of potatoes provide additional insights into the most effective approaches for nutrient management and plant-soil interactions (Brown & Johnson, 2020).

It originated in South America in the central part of Aude. Potatoes are believed to have been self- manufactured in many other cases as well as cultivated extensively in South America by the Incas for 1800 years. Spaniards who conquered South America took potatoes with them to Europe towards the end of the 16th century Smith, 2020).

African agriculture has the ability to contribute towards developmental advancement as well as food availability, largely due to the fact that most people on the continent depend on agricultural activities for their livelihood. Africa has high challenges such as soil erosion, loss of nutrients, as well as irregular distribution of rains, all contributing to poor crop performance. Use of both the organic and inorganic fertilizers has been cited as an effective method of dealing with these challenges

through the ability to increase fertility as well as buffer soils (Nhamo et al., 2019). Use of the organic method of agriculture in combination with the application of inorganic fertilizers has been cited as an effective method towards the realization of the regional food security as well as sustainability.

The East African region, characterized by its diverse agro-ecological zones, plays a vital role in agricultural practices, particularly with the cultivation of potatoes, which has garnered increased attention due to its significance in enhancing food security and supporting livelihoods. Nonetheless, farmers encounter persistent challenges pertaining to soil fertility degradation and the rising costs of chemical fertilizers. In this context, organic manures represent an economical and environmentally sustainable alternative capable of reversing the decline in soil fertility while simultaneously improving agricultural productivity. Research conducted in East Africa has yielded promising results, illustrating the considerable impact of organic manures on enhancing crop yields and ensuring the long-term sustainability of soil fertility (Onduru et al., 2019). Within Uganda, agriculture continues to be the predominant economic activity, with potatoes recognized as a widely consumed staple crop across various regions.Farmers are affected by a number of problems such as low soil fertility, pests, disease pressure, and climatic risk. Adoption of organic manuring is gaining popularity for a green environmentally friendly means of boosting fertility and potato productivity. Studies conducted in Uganda have indicated that the application of organic manure and chemical fertilizers not only enhances the growth and yield of potatoes but also enhances soil fertility and reduces dependence on chemicals (Muhumuza et al., 2020). The benefits of the above practices are encouraging even more farmers to adopt organic and

synthetic fertilizer agricultural practices, which are contributing to agricultural productivity and sustainability levels in the country. 1.2 Potato significance Potatoes are nutrient-dense foods that contain essential human nutrients, nutrients include proteins, starch, fiber, and primary and trace minerals, vitamins, antioxidants, and phytochemicals (Umesh C Gupta 2019). Potatoes play an important role in stabilizing food security in developing countries. (Ramani Wijesinha- Bettoni2019)

Potatoes are a source of income in the growing countries and also contain antioxidants, which may play a part in preventing diseases related to ageing and dietary fiber, which benefits health. (Egata Shunka Tolessa 2018)

Potato is one of the most important crops in East Africa with potential to abate hunger and increase economic status of farmers due to high yields per unit area. (UARC, 1990)

1.2 Production levels

China is the biggest producer of potatoes worldwide, accounting for 21.8% of the world's production, with about one-third of the world's potatoes produced in China and India. According to FAO estimates, in 2021, over 376 million metric tons of potatoes were produced worldwide, an increase from a production volume of 333.6 million tons in 2010. In Africa, Nigeria emerged as the largest potato producer on the continent, contributing to 58% of the overall volume in 2023. Furthermore, Nigeria's potato production surpassed Algeria, Egypt, and Mali, the second largest producer of potatoes in Africa, by a significant fivefold margin. Niger secured the third position with an 11% share of the total production volume. In Uganda, the leading producers

of potatoes are Kabale and Kisoro districts, with 60% of the crop produced. The annual yield will range between 800,000 to 1,000,000 MT. In Uganda, several potato species are cultivated, among them Cruza, Kachpot, Kimuli, Kinigi, Mbumbamagara, Rutuku, Rwashaki, Rwagume, and Victoria (FAO, 2021; Smith & Jones, 2023.

1.3 Problem Statement

The use of organic manure and chemical fertilizers in agricultural fields has shown several benefits for the cultivation of potatoes in Uganda. Organic manure, for instance, raises the fertility of the soil, boosts the quality of the soil, and minimizes the use of chemicals (Namala et al., 2019). Studies in Uganda found that the yield of potatoes grown with organics manures greatly outweighed the yield obtained using synthetic fertilizers (Muhumuza et al., 2020). In addition, results showed that the addition of the organics manures resulted in better soil structure, with better water storage capability and air infiltration, hence the optimal growth and yield of potatoes. In addition, the use of organics manures by another study in Uganda not only boosted potato production but also had a positive impact on the health of the soil (Nabulo et al., 2015). This study noted that organics manures boosted the concentration of the organics in the soil, hence improving its structure and ability to store water. Organic matter has been described as an excellent indicator of sustainable agriculture due to its richness in nutrients for the growth of crops, its friendliness to the environment, and its ability to act as the renewable alternative for the use of mineral fertilizers. Despite the efforts of farmers and researchers in promoting organic farming, the appropriate and ideal quantity of organic manure to be used in potato cultivation is still a challenge. The research was thus undertaken in order to investigate the effect of organic manure and synthetic fertilizers on the

growth and productivity of potatoes.

1.4Objectives
1.5 General objective

The major objective of the study was to assess the effect of organic manure and artificial fertilizers on potato growth and yield.

1.6 Specific objective of the study

I. To determine the effect of organic manure and artificial fertilizers on potato growth and yields.
II. To determine the most profitable application of organic manure and artificial fertilizers in potato production.

1.7 Research Questions

II. What are the effects of organic manure and artificial fertilizers on potato growth and yield?
III. What is the most profitable application of organic manure and artificial fertilizers in potato production?

1.8 Justification of the study

Despite potatoes being a high-value food value and of economic importance, potato yields have remained low amidst an ever-increasing population that demands more food in the region. The low yields could be attributed to soil infertility, improper use of fertilizer, foliar pests and diseases, use of poor-quality tuber seeds, and low yielding varieties (Hillary Mo Otieno 2021)

He made his studies on the above and my research will justify which concentration of organic manure and artificial fertilizers use that gives higher yields to the farmers at an optimal cost of input.

This was to provide guidelines to the community farmers about which application of poultry manure and artificial fertilizers that is better for potato growing and this will increase production and profitability in Potato cultivation.

1.9 Limitations of the study

One significant limitation of this study on the effect of organic manure and artificial fertilizers on potato (Solanum tuberosum) growth and yield was the variability in the composition and quality of the organic manure and artificial fertilizers used. Organic manures and artificial Fertilizers can vary widely in nutrient content, microbial activity, and physical properties, depending on their source, processing, and storage conditions. This variability can lead to inconsistent results and make it challenging to draw definitive conclusions about the efficacy of organic manure and synthetic fertilizers as a fertilizer. Additionally, environmental factors such as soil type, climate conditions, and pest pressure can interact with the manure application and artificial fertilizers, further complicating the assessment. These limitations highlight the need for standardized protocols in future research to ensure more reliable and comparable results across different studies and conditions.

1.9.1 Significance of the study

The findings from the study were to enable the stakeholders to understand clearly the effect of organic manure and artificial fertilizers application on the growth and yield of potato.

The study findings were also to enable the Ministry of Agriculture, Animal Industry, and Fisheries to sensitize farmers on how to enhance the usage of organic manure (poultry manure) and artificial fertilizers application, and the overall yield of potatoes.

The study was to enable the researcher certify part of the requirements for the award of Degree of Bachelor of Agricultural Sciences and entrepreneurship at Bishop Barham University College.

The findings from the study were to enable future researchers to understand the optimum concentration of poultry manure and artificial fertilizers that yield high output in Potato crops, as well as further improvement of yields.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Effect of organic manure and artificial fertilizers on potato growth and yields.

Organic manure and artificial fertilizers are valuable sources of essential nutrients such as nitrogen, phosphorus, and potassium, along with organic matter and a binding effect that improves soil structure and promotes microbial activity. Smith et al. (2019) demonstrated that the application of organic manure and synthetic fertilizers significantly increased soil nutrient conditions and microbial biomass. Nutrient enriched soil fostered healthier potatoes with higher energy levels of root systems and more tuber formation, resulting in more than double the yield using untreated soil.

Determining the optimum rate of application of organic manure and artificial fertilizers is necessary to obtain maximum potato yields without encouraging nutrient imbalance or environmental degradation. Johnson et al. (2020) determined that moderate rates of levels of application rates (20-30 tons/ha) of organic manure and (10-20 tons/ha) provided the most optimal balance, which produced the highest increments of potato yields than lower and higher levels of application rates. High application rates were associated with nutrient leaching and lower efficiency, which would be detrimental to the environment and crop yields. Various studies have set up the positive association between the application of artificial fertilizers and organic manure and potato yields.

Lopez and Gonzalez (2021) reported that yield increase was realized with the use of 25 tons of well composted manure for each hectare giving a 35% increase in yield, and a 20 tons for each hectare giving a 45% increase in yield compared to untreated

control plots. This increase in yield can be related to increased soil fertility and enhanced water-holding capacity of the treated soil that promoted favorable conditions for potato plant growth. A number of growth parameters of potatoes like stem girth, leaf area, and number of plants all show a satisfactory response to these treatments of applying either organic manure or synthetic fertilizer applications. Kumar et al. (2022) showed that potatoes growing with organic manure and synthetic fertilizer showed considerably larger tubers and bigger leaf area compared to those growing with synthetic fertilizer alone. Credit for this was taken for slow release of nutrient content of the organic manure that ensured supply of nutrient throughout growing period to encourage sustained growth and vigor of plants.

The use of organic dung affects potato tuber quality as well as tuber yield. Organically dung-fertilized potato has higher dry matter content and better nutrient content than that of synthetic-fertilizer-fertilized potato. Patel and Singh (2023) stressed this fact.

Application of organic fertilizer increased both the concentration of starch and that of vitamin C in potato tubers, hence their nutrient content and marketability to consumers. Increased nutrient content thereby pushed up market value of potatoes to bring economic returns to farmers.

The soil health implications of organic manure applied in the long run are significant. Repeated use of organic manure increases soil organic matter concentration, hence enhanced soil structure, increased water- holding capacity, and provision of nutrients for longer durations. A study by Hernandez et al. (2021) showed that crops that

received organic manures for multiple growing seasons had increased soil organic carbon levels and higher soil aggregation, hence improved root penetration and water-holding capacity— factors that can help sustain high potato yields in the long run. Another area of great importance that comes with the use of organic manure is its role in soil microbial activity, of great importance in potato growth and yield improvement.

Organic manures offer a source of food and shelter to useful soil microorganisms that play a role in nutrient cycles and disease suppression. A study by Chen et al. (2018) showed that application of organic manures significantly enhanced microbial richness and density of soil, hence enhanced soil fertility together with plant growth. Microbial processes help to break down organic matter and hence release the nutrients for potato crop use. A comparison between organic manures and synthetic fertilizers has also brought to focus their positive impacts of organic amendments. Lee and Park (2020) demonstrated that while synthetic fertilizers exhibit initial larger nutrient availability, a10tificial fertilizers are poisonous to future soil wellbeing and sustainability.

Potatoes that were farmed with organic manure showed higher resistance to unfavorable conditions such as drought and infestation from insects and therefore ensured stable yields over several seasons compared to those that were farmed with synthetic fertilizers alone. The use and economic feasibility of organic manure over synthetic fertilizers for farmers depend on several parameters such as cost, availability, and

labour requirements. While organic manure is usually cheaper than chemical fertilisers, their bulking and requirement for proper composting and field application can offer huge challenges.

Martinez et al. (2022) determined that farmers who utilized the application of organic manure had lower input costs as well as enhanced margins over the long term due to better soil quality and reduced chemical input reliance.

However, the initial work and knowledge associated with effective organic manure management are still barriers to widespread application. 7 2.2 Most Profitable Application of Organic Manure and chemical fertilizers in Potato Cultivation Organic manure add to the profitability of potato production by increasing soil fertility and structure, and in turn resulting in better yields and reduced dependence on chemical fertilizers.

According to Johnson et al. (2020), organic manure not only improves the nutritional quality of soil but also its water holding capacity, and this can lead to higher yields and, consequently, higher profitability for farmers.

The economic benefit of organic manure use was most strongly realized when applications were maximized and the traps of under-.

Lopez and Gonzalez (2021) had suggested that the most economically optimal rate for potato yield was 20- 30 tons per hectare. The interval yielded significant yield increases without decreasing returns at increased rates of application. The study

elicited the point that although rising rates would slightly increase the yields, marginal gains were not worth the extra cost, and that modest rates of application were the most economical.

It was reported by Kumar et al. (2022) that the highest economic benefits came with intermediate application rates (25 tons/hectare), resulting from the resulting high yield increments as well as improved tuber quality. High application rates did not result in the expected increase in yields but, on some instances, resulted in nutrient imbalances with adverse effects on tuber quality. This result underscores the need for optimizing manure application for the greatest economic returns.

A detailed cost-benefit analysis carried out by Patel and Singh (2023) investigated different levels of organic manure and chemical fertilizer utilization. Their results demonstrated that a treatment rate of 25 tons per hectare yielded the highest net returns.

The level equated manure, labor, and application costs with additional income arising from enhanced production and quality potatoes.

The research established that lower application rates produced savings on costs but did not reach the highest potential yield increase. On the contrary, high application rates caused costs larger than the benefits attached.

The profitability associated with the utilization of organic manure versus chemical fertilizers is contingent upon labor and operational inputs. Green et al. (2020)

indicated that, although organic manure is less expensive compared to chemical fertilizers, its implementation necessitates a greater allocation of labor. The research demonstrated that employing 25 tons per hectare in farmers' field trials resulted in enhanced potato yield and quality that justified the additional labor costs. Effective management strategies and adequate resources are imperative for optimal outcomes.

The timing concerning the application of synthetic fertilizers and manures is instrumental in maximizing economic productivity.

The long-run economic feasibility involved with organic manure and chemical fertilizer usage is also an integral component. According to Hernandez et al. (2021), frequent applications of organic manure and chemical fertilizer at their best recommended rates of 25 tons of organic manure per hectare and 20 tons of chemical fertilizer per hectare, respectively, has proven to enhance soil quality in the long run. Such a method has high sustainable yield rates while concurrently decreasing application of chemical fertilizers. The resultant long-run advantage of such practices is to ensure both the sustainably profitable and sustainable production of potatoes with healthier soils having minimum stress and ensuring more sustainably sound agricultural systems. Moreover, organic manure's contribution to promoting soil's soil microbial activity is still another integral component influencing potato growth and yielding capacity.

Organic fertilizers allow for the establishment of an environment conducive to beneficial soil microorganisms responsible for nutrient cycling as well as disease

suppression. Studies by Chen et al. (2018) revealed that the application of organic manures greatly increases the density and diversity of microbial communities in the soil, hence the fertility of the soil and the plants' overall health, in comparison with the use of only synthetic fertilizers. Metabolic activities conducted by the microorganisms result in the degradation of organic matter, hence the enhancement of the availability of nutrients for the growth of potatoes. Comparison between synthetic fertilizers and the use of organic manures reflects the economic benefits for the application of the latter. Presented by the results by Chen et al. (2018), where the use of the synthetic fertilizers results in an instant boost in the level of productivity, the application rate of 25 tons/hectare for the use of the organic manures results in sustainable economic benefits through the establishment of high fertility on the soil with the achievement of reduced input costs relative to the exclusive application of the synthetic fertilizers. Presented by the results by the study, the profitability for the use of the organic manure application was larger through the addition effect resulting from the enhanced fertility on the soil with the increase in the crops' resistance.

The economic efficacy of the use of organic manure can also vary according to local conditions such as the type of soil, climatic conditions, and prevailing agricultural practices. Ahmed et al. (2023) indicate that whilst an average application level of 25 tons per hectare is typically considered optimal, adjustments could need to be made to suit specific local conditions. In sandy soil conditions, for instance, slightly higher application rates would be needed in order to increase water-keeping potential, but lower rates may suffice in clayey soils due to the former's better water storage properties.

It underscores the need for localized guidance in obtaining optimal economic benefits. Farmer uptake of organic manure practice is affected by attitudes towards costs, gains, and labor demand. Martinez et al. (2022) established that although most farmers acknowledged the long- 9 term benefits of synthetic fertilizers and organic manure, initial adoption was regularly being postponed on account of the initial labor and management changes required. The study found that training and highlighting the economic benefits in the long term would increase adoption rates. Farmer education programmes and extension schemes were found to be instrumental in bringing about large-scale adoption of organic manure and synthetic fertilizers at remunerative levels of application. Environmental benefits of organic manure such as reduced greenhouse gas emissions and improved soil health agree with overall goals of sustainability. Organic manure can be promoted through greater government efforts along with agricultural policy.

Green et al. (2020) added that organic farming practice would be subsidized and incentivized to offset the cost and effort of applying organic manure, in contrast to applying synthetic fertilizers, so as to make it more economical and attractive for farmers to adopt. Organic manure policy can boost the profitability and adoption of organic manure as a whole.

CHAPTER THREE: MATERIALS AND METHODS

3.0 Introduction

3.1 Experimental site

The research was conducted at the Faculty of Agricultural Sciences experimental farm at BISHOP BARHAM UNIVERSITY COLLEGE, Kabale municipality. The district lies on latitude 1°14'54" S and longitude 29°59'23" E. The district experiences alternating wet and dry seasons with a mean annual rainfall of 1200-1400mm and temperatures of 18°C throughout the year that are favorable for agricultural practice according to Twagiramaria et al., (2018).The area also has favorable soils that support agriculture, including Irish cultivation

3.2 Experimental design

The experiment was conducted using a randomized complete block design (RCBD) with three treatments, each replicated two times, resulting in a total of 6 experimental plots. Each block contained two plots, corresponding to the different treatments, ensuring that each treatment appears once per block to account for variability within the field. The treatments involved applying organic manure and artificial fertilizers (poultry manure) to the potato crops: Treatment One (M0) with 0 tones/ha serving as the control, Treatment Two (M1) with 5 tones/ha, Treatment Three (M2) with 10 tones/ha, This design allowed for a comprehensive evaluation of how varying levels of organic manure and artificial fertilizers affect potato growth and yield while minimizing the influence of external variables.

3.3 Land preparation.

Land was prepared two weeks before planting the potatoes to give room for green grass to decompose and act as manure.

3.4 Digging of holes

Holes in the prepared plots was dug, and then after application of poultry manure was done before potatoes are put. The plots Mo, M1, and M2, received 0 tones/ha,5 tones/ha 10 tones/ha respectively of organic poultry manure and synthetic fertilizers in each block that was thoroughly incorporated with in soil of each individual plot.

3.5 Field management

3.6 Watering

Depending on seasonality of the rain, fifteen (12) liters of water was applied per Potato after germination to ensure that the water is saturated for proper growing. Since the temperatures will be expected to be high at the time of planting, watering may be done at two-day intervals after the initial watering for the first two weeks because potato roots grow to ensure effective water extraction depth of 60 cm and obtain 70% of the plants' seasonal water from the upper 30 cm depth. Watering cans with fine roses were to be used.

3.7 Weeding and earthing up

Weeds were removed as soon as they appeared, before they reached a height of 5 cm. The weeds were removed physically using garden hoes. Initial earthling up was done by adding more soil on the plants once the shoots of the plants reached an average of 20 cm in height, using enough soil so that just 5 cm of the stem were left visible above the mound. Thereafter, more soil was added every time the plant reached 15 cm of new growth above the soil, and the process was repeated three times before harvesting.

3.8 Disease and pest control

Fungal diseases, particularly late blight (Phytophthora infestans), was treated using protective sprays, specifically Mancozeb (Dithane–M-45), an alkylenebisdithiocarbamate containing manganese and zinc, and copper oxychloride.

Alternate spraying with pesticides such as dimethoate and carbaryl as pesticides was done at two-week intervals starting from the first week after emergence. Dimethoate is an organophosphate under the group of phosphorothiolates and carbaryl, a systemic insecticide in the subclass of phenyl carbamates and these are effective against insect pests such as potato beetles (Leptinotarsa decemlineata), aphids.

Data collection

Plant height was recorded every 3 weeks starting from the third week after emergence. The average number of stems per plant was recorded at 10 weeks after emergence and it also had a parameter to measure the growth rate. Number of tubers and weight (yield) of tubers for a sample of three plants per plot was measured at maturity/harvest.

The quality of the potatoes was determined and classified them into small (<45g), medium (4570g) and large (>70g). Quality was also measured considering number of marketable and unmarketable tubers per plant. For quality and yield, all the parameters were noted at the time of harvesting which was carried out 100 days after sowing and readings were taken from a representative sample of three plants per plot for all the treatments.

3.9 Data analysis

Statistical technique like ANOVA was applied to compare the data obtained and comparing the outcome of varying treatments, perform variance analysis in an effort to identify relationships between variables, and employ graphical presentation such as bar graphs or scatter plots to illustrate the data on growth as well as yield. ANOVA

statistical technique applied to compare the outcome of varying treatments, perform the variance analysis to establish relationships between variables, and employ graphical presentation such as bar graphs or scatter plots to illustrate the dat

CHAPTER FOUR: PRESENTATION OF RESULTS

4.0 Introduction

This chapter talks about the results, arranged in accordance with the objectives of the study.

Table 4-1: Analysis of variance (ANOVA) to show the effect of different rates of organic manure and synthetic fertilizers on potato development.

	Height of plant(cm)			Number of shoots	
Source of variation	d.f	Mean Square	Fpr	Mean Square	Fpr
Treatments(tones /ha)	8	160.9	<.001	5.302	0.012

		4			
Residual (Error)	102	26.26		2.027	

The above findings indicate that differential rates of application of organic manure and synthetic fertilizers create a tremendous impact on the height and shoot number of potato plants.

The highly significant p-value for plant height (<0.001) confirms that different levels or quality of organic manure and synthetic fertilizers applied lead to significant variations in growth performance.

Similarly, with a p-value for shoot number at 0.012, we can conclude that organic manure and synthetic fertilizers application also significantly affects this aspect, though with slightly less statistical strength than plant height.

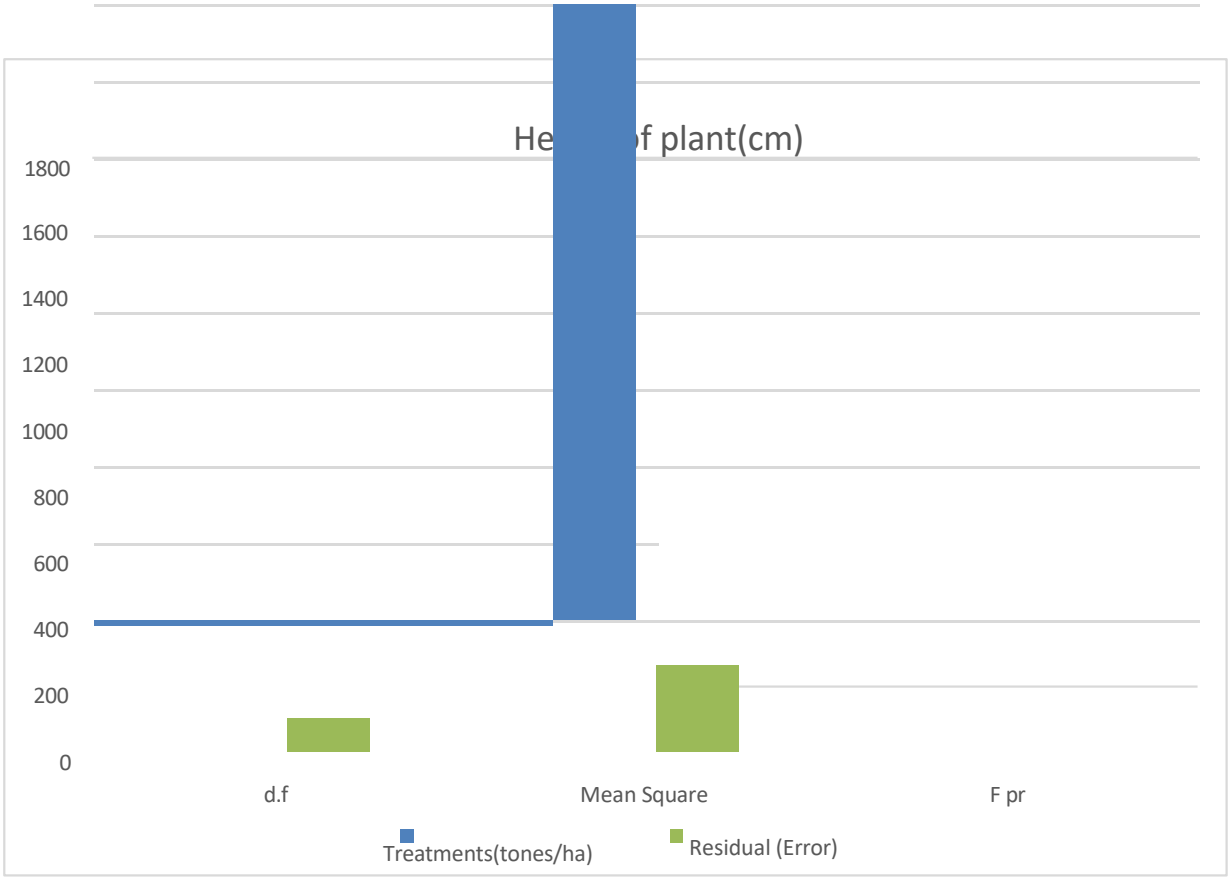

Figure 4-1: A bar graph showing the effect of organic manure and artificial fertilizers on the plant height of potato

There is a clear trend where increasing the rates of organic manure and synthetic fertilizers leads to higher mean heights in potato plant. The standard deviations indicate that as treatments increase, variability tends to decrease slightly, suggesting that higher levels of treatment may result in more uniform growth among plants.

Increasing the amount of treatment applied per hectare correlates positively with plant height. The graph suggests an effective range for treatments from none up to at least 20 tons/ha for maximizing plant growth.

The decreasing standard deviations imply improved consistency in plant heights as

treatments increase.

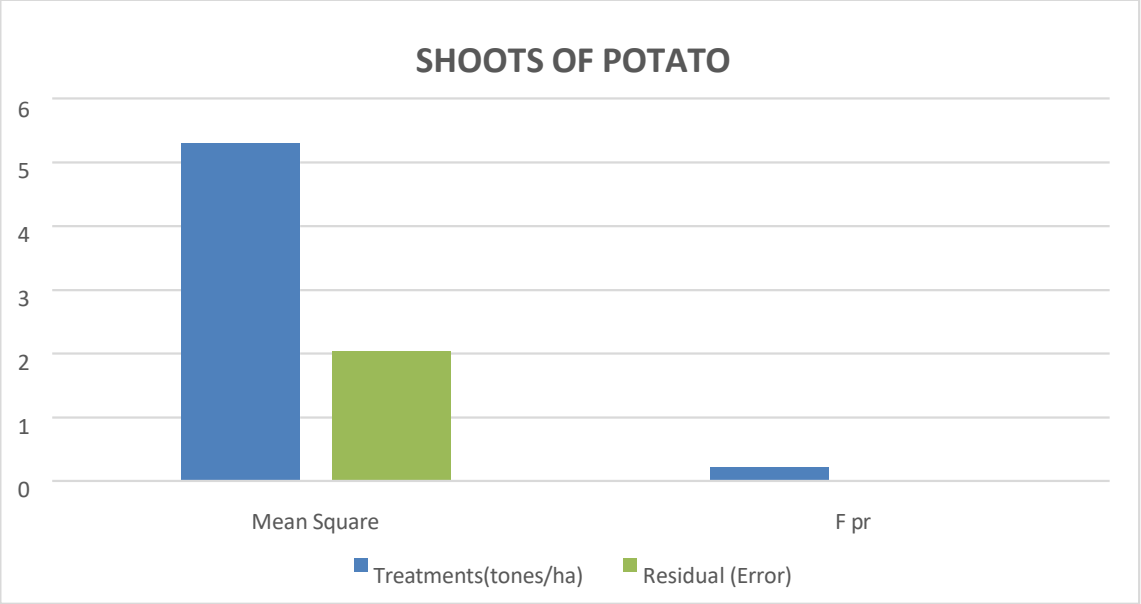

Figure 4-2: A graph showing the effect of organic manure and artificial fertilizers on the number of Shoots of Potato

There is a clear trend showing that as the rate of manure and artificial fertilizers increases from 0 to 20 tons and 15 tons per hectare respectively there is a corresponding increase in the mean number of shoots produced. The data supports a positive correlation between treatment levels and plant growth indicators that is shoots which could imply that higher nutrient or resource availability enhances plant development. The consistent rise in means suggests that applying more resources up to at least 20 tons per hectare is beneficial for maximizing shoot production.

Table 4-2Analysis of variance (ANOVA) for the effect of different application rates of organic manure and artificial fertilizers on small sized potato tubers.

	Number of small sized tubers			Weight of tubers	
Source of variation	d.f	Mean Square	Pr(>F)	Mean Square	Pr(>F)
Treatments(tones/ha)	43	7.0	4.356e-09	2.264	0.0792

				4 0 . 2 6 9	
Residual (Error)	1 4	0 . 2 4 6			

Number of Small-Sized Tubers: The P-value associated with treatments affecting the number of small sized tubers is extremely low (4.356e-09), which is significantly below 0.05. This indicates that there is a statistically significant effect of different application rates of organic manure and artificial fertilizers on the number of small-sized potato tubers produced.

In contrast, Weight of Tubers has the P-value of 0.0792, which is above the conventional threshold for significance (0.05). This suggests that while there may be some effect from different application rates, it does not reach statistical significance at this level.

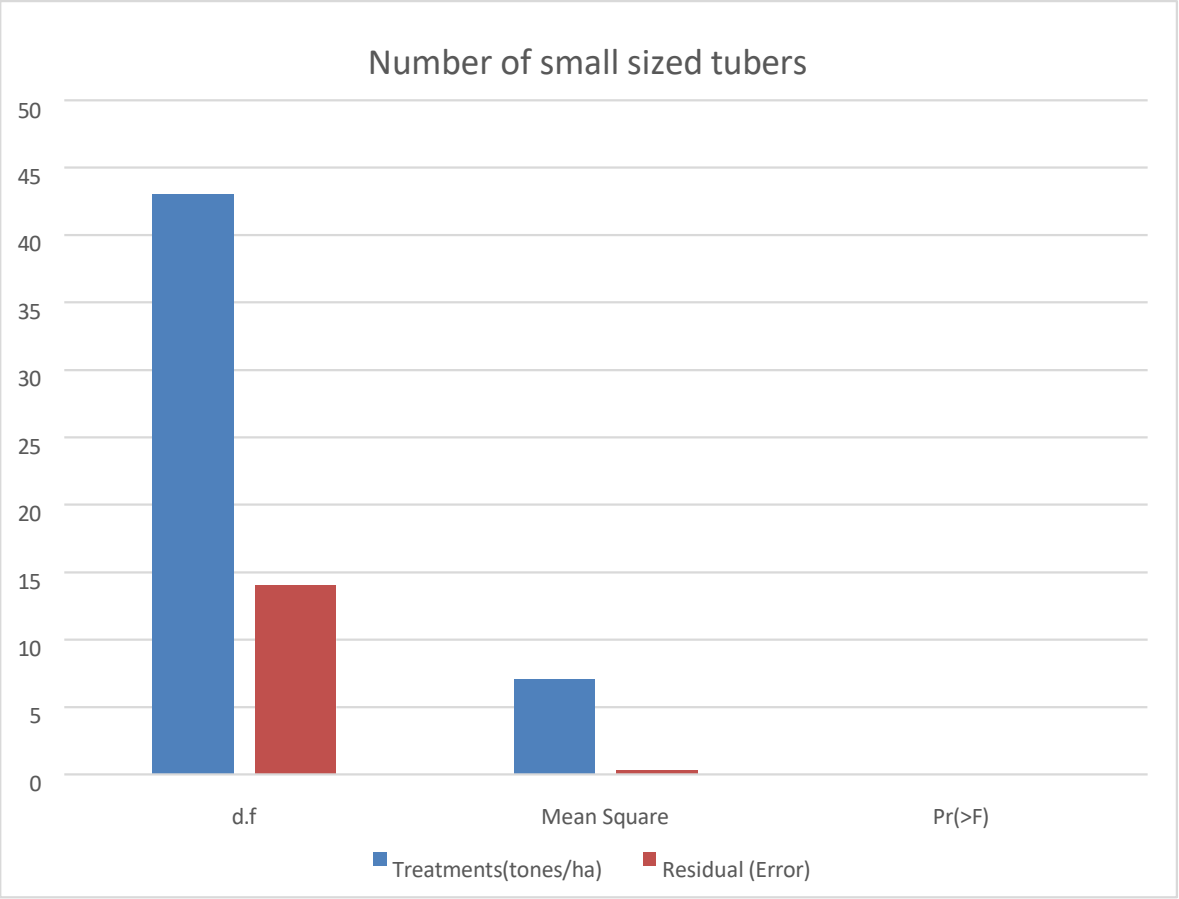

Figure 4-3: A graph showing the effect of different application rates of organic manure and artificial fertilizers on the number of small sized tubers

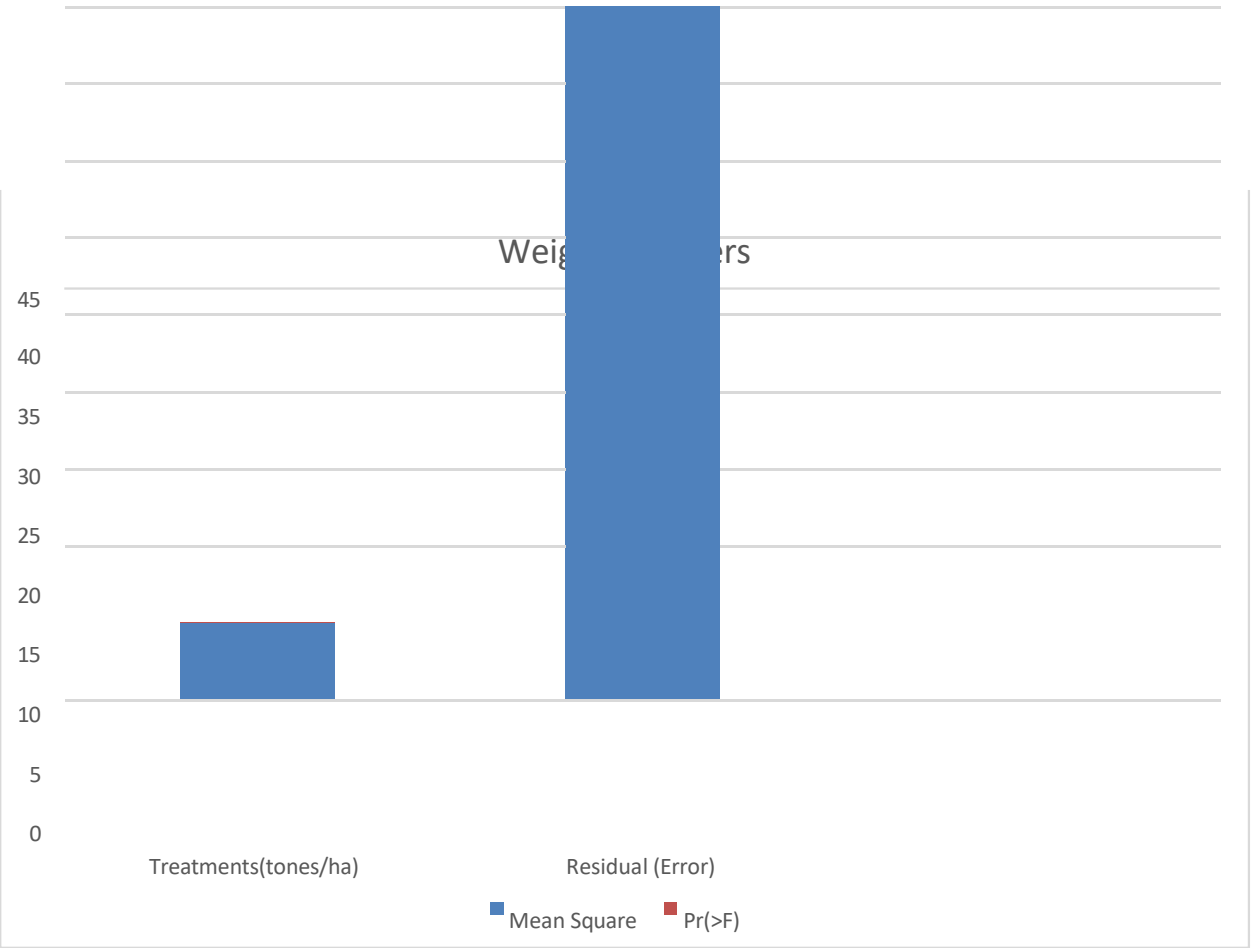

Figure 4-4: A graph showing the effect of different application rates of organic manure and artif ical fertilizers on the weight of tubers

As the rate of applying organic manure increases from Treatment 1 to Treatment 2, the mean total weight of smaller sized potato tubers generally tends to grow, as can be seen in the above graph. Indicating variability in the data points within each treatment group, the standard deviations also differ among the treatments. Based on the available data, it appears that applying more organic manure and artificial fertilizers at greater rates could potentially increase the weight of smaller tubers.

Table 4-3: Analysis of variance (ANOVA) for the effect of different application rates of Organic manure and artificial fertilizers on medium sized potato tubers

	Number of medium sized tubers			Weight of medium sized tubers	
Source of variation	Df	Mean Square	Pr(>F)	Mean Square	Pr(>F)
Treatments(tones/ha)	43	13.079	2.2e-16	0.8244	0.519

Residual (Error)	14	4.010		4.414	

Df=43, (MS) = 13.079, Pr(>F) = 2.2e-16: These values demonstrate that the quantity of medium-sized potato tubers is significantly impacted by varying rates of organic manure and artificial fertilizers application. Strong evidence to reject the null hypothesis that there is no effect is indicated by the p-value (2.2e-16). The residual (error) df = 14, (MS) = 4.010 indicates the variation in the quantity of medium sized tubers that cannot be accounted for by the treatment (rates of applying organic manure and artificial fertilizers).

The Medium-Sized Tuber Weight, with df = 43, (MS) = 0.824, and Pr(>F) = 0.51. This demonstrates that the weight of medium-sized potato tubers is not significantly affected by varying the rates at which organic manure and artificial fertilextremare applied. The null hypothesis, according to which there is no effect, cannot be rejected due to inadequate evidence, as the p-value (0.519) above the conventional significance level of 0.05. The quantity of medium-sized potato tubers produced is therefore significantly impacted by the rates at which organic manure and artificial fertilizers are applied. The weight of medium-sized potato tubers is not considerably

impacted by these application rates, though.

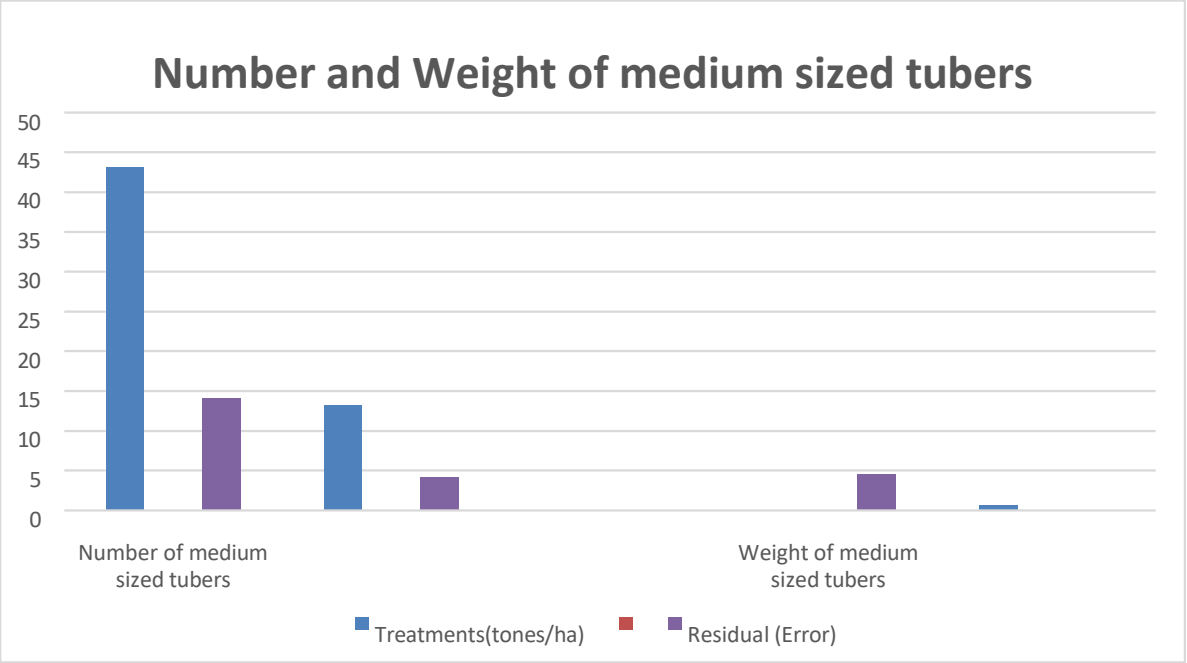

Figure 4-5: A graph showing the effect of different application rates of organic manure on medium sized tubers

From the graph above, it can be observed that there is variability in the weight of mediumsized potato tubers based on the application rates of organic manure. Treatments with higher application rates, such as Treatment of 15 tons/ha, show an increase in the mean total weight, While treatments with lower application rates, such as Treatment 5, exhibit a decrease in the mean total weight.

Table 4-4: Analysis of variance (ANOVA) for the effect of different application rates of Organic manure on large sized potato tubers

	Number of large sized tubers			Weight of large sized tubers	
Source of variastion	df	Mean Squaree	Pr(<F)	Mean Squaree	Pr(>F)
Treatments(tones/ha)	43	14.496	0.0010610	5.036	0.8755

Residual (Error)	14	3.203		4.0	

Based on the results of the Anova Table There is a substantial impact of varying rates of organic manure application on the quantity of large-sized potato tubers, as indicated by the number of large-sized tubers with df: = 43, (MS) = 14.496, p-value = 0.001061 (significant). The standard significance level of 0.05 is not exceeded by the p-value (0.001061). With df=43, (MS) = 5.036, and Pr(>F) = 0.875, the weight of large-sized tubers Regarding the weight of large-sized potato tubers, there is no discernible difference in the application rates of organic manure. The null hypothesis that there is no effect is not sufficiently supported by the p-value (0.875), which is higher than the usual significance level of 0.05. Large-sized potato tuber production is therefore significantly impacted by the rates at which organic manure is applied; nevertheless, these application rates do not significantly affect the Weight of large sized potato tubers

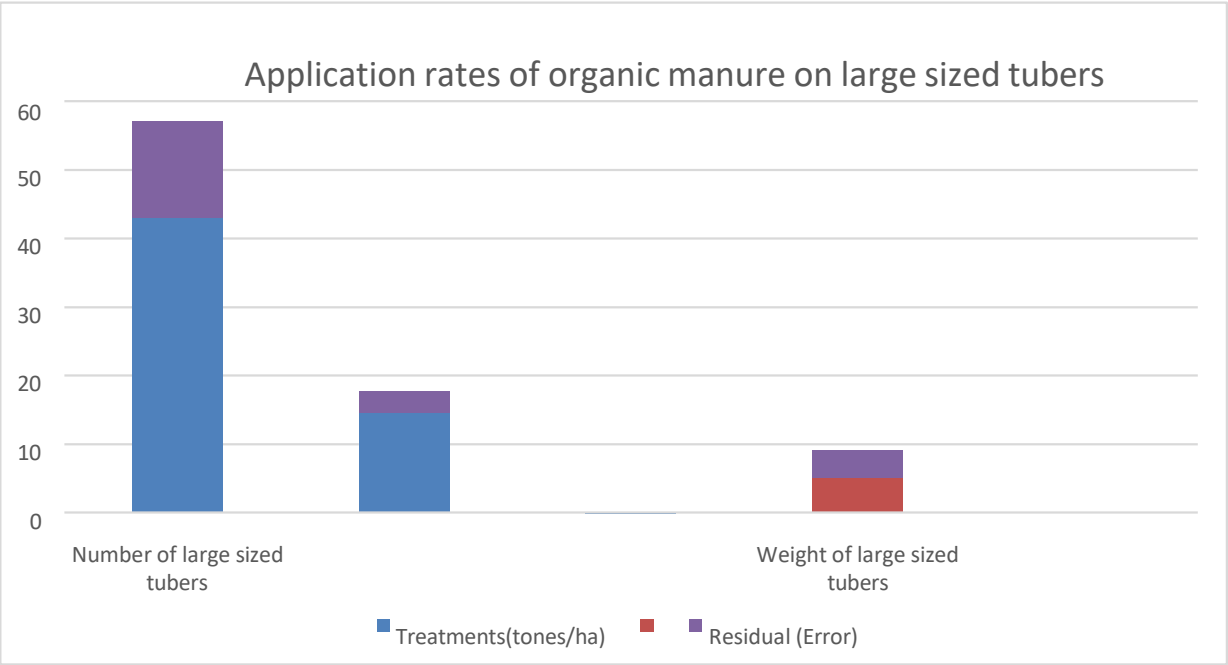

Figure 4-6. A graph showing the effect of different application n rates of organic manure on large sized tubers

There is a general tendency for the mean total weight of large-sized potato tubers to rise with increasing rates of application of organic manure—that is, from Treatment 0 tons/ha to

4.1 Treatment 10 tons/ha and Treatment 20 tons/ha.

Treatment 15 tons/ha decreased the mean weight when compared to Treatments 10 tones/ha and 20 tones/ha demonstrates the heterogeneity in the efficacy of various application rates. Each treatment group's potato tuber weights appear to vary consistently, as indicated by the standard deviation (St.d.) o 113.8 for all treatments.

Table 4-5: Analysis of variance (ANOVA) for the effect of different application rates of Organic manure on total potato tuber yield.

	Total tuber yield		
Source of variation	df	Sum of Squares	Fpr
Treatments(tones/ha)	43	2.21976	0.302
Residual (Error)	40	7.354	

The ANOVA table above shows that there are notable variations in the overall yield of potato tubers that can be attributed to varying rates of applying organic manure. The F value (0.302) for treatments indicates that the variation between treatment

means is relatively small when compared to the variation within treatment groups (residual) and the sum of squares (2.21976) for treatments indicates the amount of variability in tuber yield that can be attributed to varying rates of manure application.

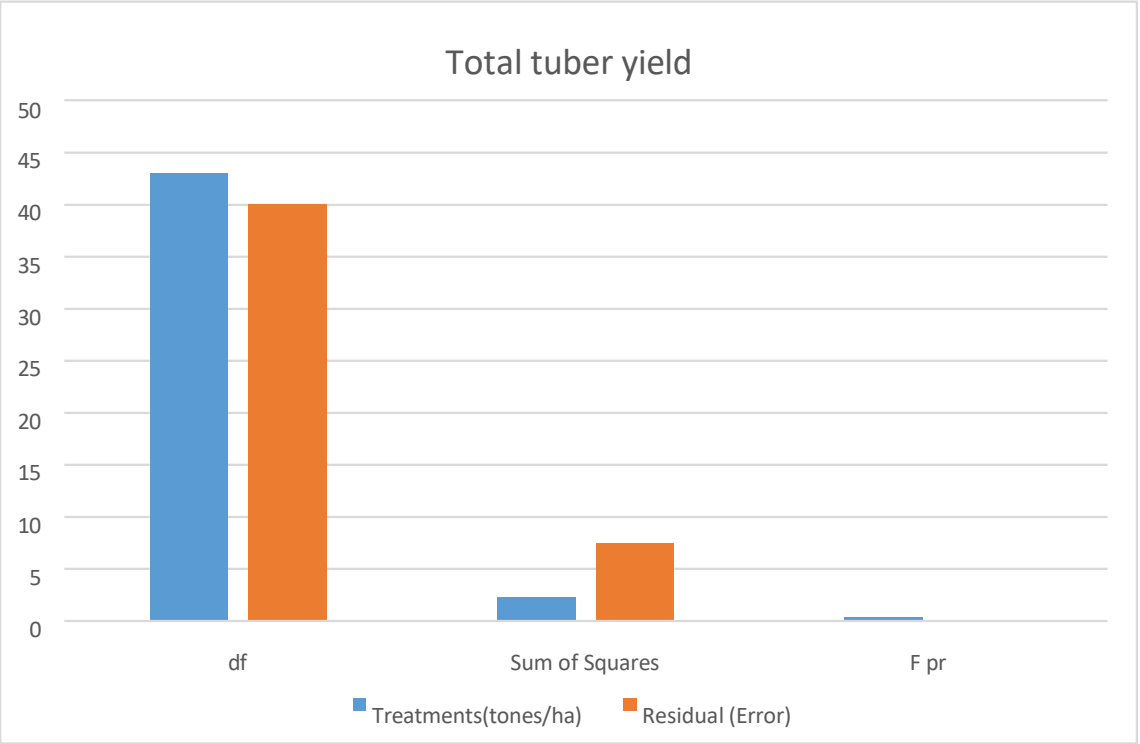

Figure 4 -7: A graph showing the effect of different application rates of organic manure on total potato yields

As can be seen from the graph above, the average total weight of potatoes changes depending on how much organic manure and artificial fertilizers are applied. In comparison to lower application rates (0 tones/ha), treatments with greater application rates (10, 15, and 20) tones/ha typically displayed larger mean total weights. In contrast to other treatments, the therapy with an application rate of 0tones/ha exhibits a lower mean total weight.

Higher standard deviation treatments (e.g., Treatment 5 of 20 tones/ha) show a more widely dispersed distribution of data points around the mean total weight.

On the other hand, treatments with smaller standard deviations (such as Treatment 2 of 10 tones/ha) imply that the data points are more in line with the average. Based on the trend seen in this study, higher rates of organic manure application seem to have a beneficial effect on potato yields.

The most profitable application rate of organic manure and artificial fertilizers in potato production

The study found out the profitable application rate of organic manure and artificial fertilizers on potato production by analyzing the cost of inputs and the revenue after harvest, and the results were presented below.

5.2 Table 4-6: The Costs of Inputs

Item	Quantity	Unit price	Total Amount
Seed potato	30kg (1basin)	1,000/=	30,000/=
Poultry manure	90kg	100/=	9,000/=
Fungicide (mancozeb)	1 sachet	5,000/=	5,000/=
Insecticid	50mls	2,000/	2,000/

e	bottle	=	=
Transport		5,000/ =	10,000 /=
Labour	2	5,000/ =	10,000
Grand total			66,000 /=

4.2 Table 4-7: Revenue after the harvest

Marketable yield (kg)	Unit cost	Total cost	Unmarketable potato yield (kg)	Unit cost	Total cost
60	1500	90,000	34	1300	44,200

		0 / =			0 / =
Grand total for marketable yield and unmarketable potato yield = 134,200/=					

The table provides a breakdown of the costs associated with both marketable and unmarketable potato yields. The marketable yield is measured in terms of 60 kilograms of potatoes, with a price of each piece being 1500/=. Accordingly, it gives a total cost of 90,000/=. In contrast, the unmarketable potato yield comprises

The quantity of 34 kilograms is associated with a unit price of 1300/=. The cumulative expenditure for the yield deemed unmarketable is estimated to be 44,200/=. Upon aggregating the overall expenses related to both marketable and unmarketable yields, the resulting grand total amounts to 134,200/=

4.3 Table 4-8: Shows cost benefit analysis

a). Total Revenue	cost
Fixed cost Variable cost Seed potato Poultry manure Fungicides	0 30,000/= 9,000/=

	5,000/=
d). Total Variable Cost	46,000/=

Total Cost =FC+VC=0+66,000

=66,000/=

Gross Profit=TR-TC 134,200-66,000

= 68,200/=

CHAPTER FIVE: DISCUSSION, RECOMMENDATIONS, CONCLUSION, AND AREAS FOR FURTHER RESEARCH

5.0 Introduction

The chapter gives a description of findings, recommendations, and inferences that relate to study goals and research queries, placing these features in the topic of study.

5.1 Discussion

The impact of organic fertilizers and synthetic nutrients on the growth of potatoes. The F-value, which is less than 0.001, indicates a statistically significant influence of organic manure and synthetic fertilizers on plant height. This suggests that there exists at least one treatment group that exhibits a significant difference from others regarding the height of potato plants when exposed to diverse application strategies of organic manure and synthetic fertilizers. Likewise, the F-value concerning the number of shoots similarly demonstrates a statistically significant distinction among treatment groups as it remains beneath the conventional threshold ($p < 0.05$). This signifies that the different concentrations of organic manure and inorganic fertilizers also have an effect on the quantity of shoots produced by potato plants. The results indicate that the utilization of various concentrations of organic manure and synthetic fertilizers significantly influences both growth parameters evaluated—plant height and the number of shoots.

Effect on Crop Height: Organic manure has been said to enhance soil structure, nutrient supply, and microbial activity of soil (Ghosh et al., 2017).

It is most likely to increase plant height. These all lead to enhanced root growth and

efficiency of nutrient uptake. Additional application may induce enhanced effects due to greater availability of nutrients and higher availability of Nitrogen for utilization by the plants during vegetative growth. Impact on Shoot Number: The positive association between the application of organic manure and synthetic fertilizer and the development of shoots is due to improved soil fertility, leading to greater vegetative growth (Khan et al., 2020). More shoots may translate to higher potential tuber yield since each shoot has the capacity to produce tubers under favorable conditions.

The effect of different application rates of organic manure and artificial fertilizers on potato yields.

On small-sized tubers: The extremely low p-value (4.356e-09) indicates a statistically significant effect of different application rates of organic manure and artificial fertilizers on the number of small-sized potato tubers produced. This suggests that as the application rate varies, there is a notable difference in the yield concerning small-sized tubers. In contrast, the p-value for the weight of tubers (0.0792) is above the conventional threshold for significance (0.05), indicating that while there may be some effect from different application rates, it is not statistically significant at this level. The important result for the number of small- sized tubers suggests that the application of organic manure and artificial fertilizers has a direct influence on increasing or decreasing this specific yield category, where low application rates of 0 tons/ha and 5 tons/ha had the highest number of small-sized potato tubers. This could be attributed to several factors. Organic manure improves soil fertility by enhancing nutrient availability. It may also improve soil structure and moisture

retention, leading to better growth conditions for potatoes. These insights can help farmers optimize their use of organic fertilizers to achieve specific yield outcomes in potato cultivation.

On medium-sized tubers: The p-value associated with the treatments is extremely low (2.2 × 10^16), indicating a statistically significant effect of different application rates of organic manure and artificial fertilizers on the number of medium-sized tubers produced. This suggests that variations in organic manure and synthetic fertilizers, when applied, significantly influence tuber production, leading to differences in yield. In contrast, the p-value for the weight of medium-sized tubers is notably higher at 0.824, which indicates no statistically significant effect from varying application rates. This suggests that while the number of tubers may be affected by organic manure and fertilizers, their individual weights do not show a corresponding change with different application rates. The highly significant effect on the number of medium-sized tubers implies that farmers can optimize yields by adjusting their organic manure and artificial fertilizers applications strategically. However, since weight does not show a significant change, it may suggest that while more tubers are produced with increased organic manure but not fertilizers, these additional tubers do not necessarily translate into heavier individual weights.

On large sized tubers: The p-value for the number of large-sized tubers is reported as Pr(<F) = 0.001061, which is significantly lower than the conventional alpha level of 0.05. This indicates that there is a statistically significant effect of different application rates of organic manure and artificial fertilizers on the number of large-sized potato tubers produced. In practical terms, this suggests that varying amounts

of organic manure and artificial fertilizers can lead to differences in how many large-sized tubers are harvested, which is crucial for farmers aiming to maximize their yield. In contrast, the mean square for weight shows a value with a reported p-value of Pr (>F) = 0.875, indicating no significant treatment effect on the parameter at an alpha level of 0.05. This indicates that despite different application rates potentially affecting the number of tubers with larger diameters, they statistically are not shown to have an impact on their total weight.

With regard to total potato tuber yield, it was determined that different rates of application of organic manure and chemical fertilizers had a considerable effect on potato yield. This conclusion is also the result of previous studies, which illustrate that the use of organic manures can increase the fertility and physical properties of the soil, thereby resulting in increased crops (Liu et al., 2021). Greater tuber yields are potentially due to an increased availability of nutrients and an increase in microbial function in amended soils. Furthermore, current studies have confirmed that optimum rates of application can increase water retention properties as well as aesthetic properties—two key components for optimal potato growth (Smith & Jones, 2020).

However, over-application can lead to low returns or even negative effects due to leaching of nutrients or nutrient imbalances in supply.

The average total weight of potatoes changed depending on how much organic manure and artificial fertilizers that was applied. In comparison to lower application rates (0 tones/ha), treatments with greater application rates typically displayed

larger mean total weights. In contrast to other treatments, the therapy with an application rate of 0tones/ha exhibits a lower mean total weight. This signifies that increasing organic manure increases the yield of potatoes due to supply of the required nutrients for more tuber formation and enlargement till the optimum point where the resulting returns from the input starts to diminish.

The most profitable application rate of organic manure and artificial fertilizers in potato production.

Basing on the results from the analysis of the growth and yields as well as the economic analysis of the production costs and revenue obtained from production: the most profitable application rate can be seen at different perspective of; whether the agribusiness practioner is targeting vegetative production, seed production business or direct potato consumption by the market and thus under those different assumptions, the most profitable application rates for different agricultural practioners will vary basing on the findings gotten from the analysis as they have different costs attached to them basing on the different rates of manure and artificial fertilizers and the output obtained in terms of numbers and weight of tubers which will help to determine the most optimal/most profitable application rate of organic manure and artificial fertilizers in potato production based on target by the farmer.

For farmers aiming at maximizing the growth parameter as being more interested in the vegetative production of potato the most profitable application rate falls in the ranges of high to very high rates of organic manure and artificial fertilizers application, as they were seen to provide increased vegetative growth as compared

to low and moderate rates of 0-10 tons/ha.

For farmers aiming at seed production, the most profitable application rate is 5 tones/ha, as it provides the most significant number of small-sized potato tubers, which are most suitable for seed and cost more when sold as seed.

For farmers aiming at optimizing the overall production by minimizing the cost of production should take the rate of moderate to high organic manure and artificial fertilizers production, that is 10-15tones/ha as they provide considerably high yields at low cost but having 15 tons/ha as the one that offers the best output in both growth and yield at the optimal/reduced cost of Input.

5.2 Conclusion

The growth parameters of height and number of shoots showed significant changes at different rates of organic manure and artificial fertilizers application where they were so vigorous at high application rates due to the increased nutrients supplied by the moderate to high and very high amounts of organic manure for example increased nitrogen level that enable rapid and vigorous vegetative growth in height and increased generation of more shoots by the potato plant as well as due to favorable soil conditions that are provided by the application of organic matter and artificial fertilizers.

Large number of small sized tubers was produced at low application rates of organic manure and synthetic fertilizers, that is 0 and 5tons/ha and this could be attributed to low nutrient supply for enlargement of the potato tubers after their formation due to low levels of manure applied to the soil thus ending up remaining small sized.

Increased yield was obtained at moderate application rates of organic manure and artificial fertilizers, that is 05-15tons/ha and this could be attributed to the available nutrients that are supplied to the potato plants for growth resulting into increased yield of potato.

The most profitable application rates of organic manure and artificial fertilizers application was determined basing on whether the agriculture practitioner is most interested in vegetative part of potato, seed potato or in overall yield for immediate consumption by the market.

5.3 Recommendations

Potato farmers should use moderate to high tons/ha of organic manure if they are interested in optimizing the overall yield of potato for direct market consumption to have maximized revenue and reduced cost of production by having more of medium to large tubers that can be directly sold to the market and taking 15tons/ha as the most optimal for overall production.

For farmers and agribusiness practioner who are interested within potato seed production and multiplication to use low rate of application of organic manure that is 5tons/ha as it is suitable for use as it showed a significant yield number of small sized tubers that are suitable for use as seed potato.

Famers should emphasize and practice organic manure use in potato production as it has long term benefits on consistent yields and maintaining the soil health and productivity for quite long period of time.

5.4 Areas for Further Study

For future research endeavors in this field, it is recommended to explore the following areas.

Investigate the long-term effects of continuous organic manure application on soil health, nutrient retention, and overall sustainability of potato cultivation systems.

Study the nutrient dynamics in soils treated with organic manure and artificial fertilizers over time to understand how different nutrients interact with each other and influence potato growth and yield.

Assess how organic manure and artificial fertilizers applications can enhance the resilience of potato crops to climate change-induced stresses such as drought, heat waves, or extreme rainfall events.

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APPENDICES

Figure 5-1: Harvesting of potatoes

Figure 5-2: Showing primary cultivation

Figure 5-3: Showing Data Collection