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# Comparative Evaluation of Different Organic Fertilizer on the Soil Properties, Fertility and Leaf Mineral Composition of Rape: Case Study of Mkushi District in Central Zambia

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**Abstract**

This research explores the comparative effects of different organic fertilizers on soil properties, soil fertility, and the leaf mineral composition of rape (Brassica napus) in Mkushi District of Central Province, Zambia. The study specifically evaluates poultry manure, goat manure, and cow manure, alongside a control treatment with no fertilizer application. Plant metrics such as growth performance, biomass yield, and the concentration of essential minerals in rape leaves were also analyzed. The experimental design involved randomized plots under uniform environmental conditions to ensure comparability. Results demonstrated significant variations in the effectiveness of the organic fertilizers, with poultry manure showing the highest improvement in soil fertility and plant mineral uptake, followed by goat and cow manure. The control treatment resulted in lower soil fertility and suboptimal plant growth. This study highlights the potential of locally available organic fertilizers in enhancing soil health and sustainable crop production, particularly for smallholder farmers in Zambia. The findings provide critical insights for promoting organic farming practices that mitigate environmental degradation and improve agricultural productivity in the region.

**Keywords:** Soil Fertility, Crop, Manure, Rape

## 1. Introduction

### 1.1 Background

Oilseed rape has been grown since the 16th century in Europe, but it is only since the 1960s that it has become a major world crop (Kimber and McGregor, 1995). In global terms, conventionally grown oilseed rape is the second most important vegetable oilseed after soybean, accounting for 14% of total oilseed production at 40 Mt in 2000 (Weiss, 2000). Fifteen megatons of rapeseed oil was produced in 2000, and this constituted 15% of the global consumption of vegetable and marine oils (USB, 2000).

Agricultural production in Zambia is a cornerstone of its economy, providing livelihoods to a significant portion of the population and contributing to food security. Within this context, rape (Brassica napus) stands out as a valuable oilseed crop due to its nutritional content and versatile industrial applications. However, the cultivation of this crop, like many others, is confronted by the pressing challenge of sustaining soil health and fertility. Conventional farming practices have often relied heavily on chemical fertilizers, leading to adverse effects on soil structure, microbial activity, and the environment at large.

Mkushi District is situated in the Central Province of Zambia, exemplifies this predicament. To address the demand for increased agricultural productivity while mitigating environmental degradation, there is an emerging interest in exploring sustainable approaches, including the use of organic fertilizers. These natural inputs have the potential to not only provide essential nutrients for crop growth but also enhance soil properties and foster ecological balance.

### 1.2 Problem statement

According to Scarisbrick and Ferguson (1995), brassica crops played an increasing role in supplying the world's need for human and animal foodstuffs and industrial oils.

### 1.3 Objectives

The objective of the study was to asses with comparative evaluation of different organic fertilizer on the soil properties and fertility and leaf mineral composition of Rape (Brassica napus L.)

The primary objective of this study was to conduct a comprehensive and comparative evaluation of various organic fertilizers in the context of rape cultivation within Mkushi District. Specific research objectives include:

1. Assessing the impact of different organic fertilizers on key soil properties, including pH, organic matter content, and soil texture.
2. Analyzing the effects of these organic fertilizers on soil fertility parameters, particularly focusing on nitrogen (N), phosphorus (P), potassium (K), and micronutrient levels.
3. Investigating the alterations in leaf mineral composition of rape plants resulting from the application of diverse organic fertilizers.

Comparing the performance of different organic fertilizers in terms of their influence on soil health, fertility, and crop nutrient uptake.

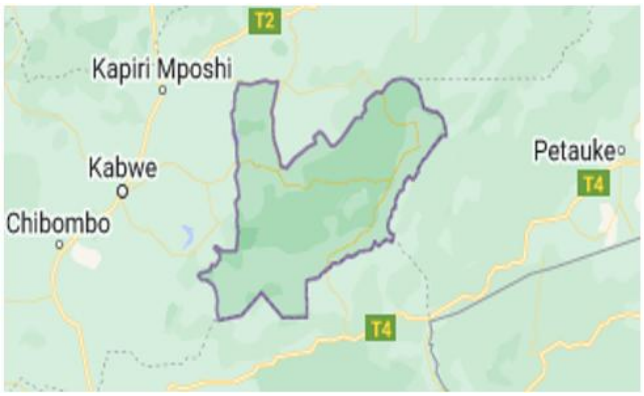
#### 1.3.1 Scope and Significance of the Study

This study's scope encompasses an in-depth analysis of the effects of multiple organic fertilizer types on soil properties, fertility, and plant nutrient composition. The research was conducted within the confines of Mkushi District, offering region-specific insights that can potentially be extrapolated to similar agro ecological contexts within Zambia and beyond.

The significance of this study lied in its potential contributions to sustainable agricultural practices and food security. By delving into the comparative effectiveness of various organic fertilizers, this research sort to provide farmers, policymakers, and agricultural practitioners with evidence-based insights into the most suitable approaches for maintaining soil fertility and enhancing crop productivity. Moreover, the study's findings can inform the adoption of organic fertilizers as a viable alternative to chemical inputs, thus promoting environmental sustainability and the long-term viability of agricultural systems in the region.

## 2. Materials and Methods

### 2.1 Experimental site




The study was conducted in Mkushi District, Central Province, Zambia. Mkushi District is characterized by its diverse agricultural practices, predominantly focusing on maize, soybeans, and oilseed crops like rape. The region experiences a distinct rainy season from November to April, followed by a dry period.

Mkushi district is located 319 kilometers from the city centre of the capital city Lusaka. The Great North Road runs through Mkushi district connecting Kapiri Mposhi and Serenje and the latitude is 13.9 degrees south, longitude is 29.6 degrees east. The district poses vast land for agriculture cultivation.

### 2.2 Crop Description

The crop studied in this study is Rape (Brassica napus L.)


### 2.3 Soil properties

For soil properties, soil samples were sampled from the chosen area within the farm settlement, and were taken for soil tests at the University of Zambia laboratory in Lusaka district. A total of 12 soil samples were collected from each plot in this experiment, and then totally mixed the soils from 3 random points in each plot.

#### 2.3.1 Selection and Application of Organic Fertilizers

Three types of organic fertilizers were chosen based on their availability and relevance to local agricultural practices. These fertilizers included composted poultry manure, goat manure and cow manure. The organic fertilizers were applied according to recommended rates, tailored to rape cultivation. Application timings were synchronized with key growth stages of the crop.

### 2.4 Treatments

In this research the organic matter was gathered, and collected in advance for pest, fungal and bacterial treatment. Also during this experiment of the research, preventive measures, and curative application measures such as pesticides and fungicides were applied to the crop from its germination to post harvest to minimize economic loss. And the organic matter collected were applied on the bed plots prepared five (5) days before transplanting. These experimental plots were hand weeded regularly.

### 2.5 Research Design

In this study the research did employ the experimental design known as completely randomized block design (CRBD), and the experiment was replicated three (3) times. Organic fertilization treatments were established within the

long-term fertilization experimental site including poultry manure fertilization alone, goat manure alone, cow manure alone, and a non-fertilization control. All of the treatments were established in a randomized complete block design with three replicates and plot sizes of 20 $m^2$ (2 m × 10 m). Organic fertilizer dosages and ratios were designed and recommended based on soil testing results. The experiment was conducted under irrigation conditions, while other field management measures including pest control followed standard tillage measures.

**2.6 Replication and Statistical Analysis**

Each treatment was replicated three times across different blocks to minimize the impact of random variations. The collected data on soil properties, fertility parameters, and leaf mineral composition were subjected to statistical analysis, employing techniques such as analysis of variance (ANOVA) and post-hoc tests to determine significant differences among treatments.

**2.7 Land preparation**

The raised beds were prepared to a fine tilth with a bed centre of 1.5 m and 5 m long.

**2.8 Planting**

Planting or setting was done on the same day on all experiments. Intra-row spacing were pegged at 0.4 m between plants with a bed centre of 1.5 m.

**2.9 Irrigation**

Water was supplied through irrigation on a specified routine.

**2.10 Plant protection**

Routine sprays was done on an alternating principle of chemical active ingredients of insecticides, bactericides and fungicides suitable to prevent and cure the diseases due to particular weather condition.

**2.11 Limitation of study**

Data was analyzed based on the delaminated beds of rape with different organic fertilizer. Materials such as hoe was used to till land, also used in raising and preparing of beds, and a water cane was used for irrigation during the research period.

**3. Results Presentations and Discussions**

Classic growth analysis (Gardner, 1985) based on three measurements: Fresh mass yield, number of leaves per plant and number of shots per plant was conducted. Data collection started three weeks after transplanting and it was collected from the whole plot. Five harvests were done at an interval of 10 days. A day prior to each harvest the number of leaves and shoots on each plant were determined through counting. The total number of leaves excluded the leaf initials (primordial) and the two youngest leaves. All observed shoots were removed at each harvest time and were part of the measured fresh weight mass. Fresh weight was used because vegetable and fruit growers are more interested in economic biomass than dry weight (Gardner, 1985). The fresh weight was determined using a GP-3100g top pan loading balance immediately after harvesting. The moisture contents of the vegetables were also determined at each harvest using standard procedures.

**3.1 Poultry manure**

Poultry manure have several effects on Brassica napus, commonly known as rapeseed, three weeks after transplanting. Here are some potential effects:

**Nutrient enrichment**

Poultry manure is rich in nitrogen, phosphorus, and potassium, along with other essential nutrients. When applied to the soil, it provided a significant boost of these nutrients to the rapeseed plants, promoting their growth and development.

**Increased biomass**

The nutrient content in poultry manure did enhance the overall biomass production of rapeseed. Plants. This resulted in healthier and more vigorous growth, leading to larger leaf area, increased stem and root development, and ultimately higher yields.

**Improved soil structure and moisture retention**

Poultry manure contributed to improving soil structure and moisture-holding capacity. It did enhance the soil's ability in retain water, reducing the risk of drought stress for the rapeseed plants. Additionally, it helped in maintaining favorable soil conditions for root penetration and nutrient uptake.

**Enhanced microbial activity**

Poultry manure contains organic matter that served as a food source for soil microorganisms. Increased microbial activity led to improved nutrient cycling and availability, creating a more favorable environment for the growth of rapeseed plants.

It's important to note that the specific effects did vary depending on factors such as the quality and composition of the poultry manure, soil characteristics, climate, and cultivation practices. Regular monitoring of the plants' growth and nutrient status was essential to optimize the application of poultry manure and ensure the best results.

**Yield of rape**

The yield of rapeseed, or Brassica napus, was positively influenced by the application of poultry manure. Poultry manure is rich in nutrients that are beneficial for plant growth and development. Here are some ways in which poultry manure contributed to increased rapeseed yields:

**Nutrient supply**

Poultry manure contains essential nutrients such as nitrogen, phosphorus, and potassium, along with other micronutrients. These nutrients are vital for plant growth and play a significant role in enhancing yield. The application of poultry manure did supply these nutrients to the rapeseed plants, promoting their overall health and productivity.

**Organic matter and soil fertility**

Poultry manure is an excellent source of organic matter, which improved soil fertility. Organic matter helped enhance soil structure, water-holding capacity, and nutrient availability. By incorporating poultry manure into the soil, it enriched the soil with organic matter, creating a favorable environment for rapeseed growth and maximizing yield potential.

**Microbial activity**

Poultry manure contributed an increase of microbial activity in the soil. The microorganisms present in the manure help break down organic matter and released nutrients in a form that plants can readily absorb. This enhanced microbial activity promotes nutrient cycling and availability, supporting the growth and yield of rapeseed plants.

**Disease suppression**

Poultry manure contains beneficial microorganisms that helped suppress certain plant diseases. These microorganisms inhibited the growth of pathogens in the soil, reducing the risk of disease development in rapeseed plants and potentially increasing yield. It's important to note that the effectiveness of poultry manure in increasing rapeseed yield vary depending on factors such as the quality and composition of the manure, application rates, soil conditions, and other agronomic practices. It is recommended to follow proper application guidelines and conduct soil testing to optimize the use of poultry manure and achieve the desired yield outcomes. The flesh mass yield of rapeseed, or Brassica napus, specifically from the use of poultry manure, was acquired using more specific data and calculations. The yield potential varied based on various factors such as the variety of rapeseed, soil conditions, climate, cultivation practices, and the quality and application rate of poultry manure. To acquire the flesh mass yield, it typically considered factors such as the plant population density, the expected number of pods per plant, average pod weight, seed filling percentage, and oil content of the seeds. These factors, along with the influence of poultry manure on plant growth and development, helped determine the potential yield.

**Data Collection**

Throughout the growth cycle, leaf counts were recorded at regular intervals for a predetermined number of rape plants in each plot. Care was taken to select healthy and representative plants for accurate data collection. The leaf count was measured by visually counting the number of leaves per plant.

**Results and Analysis**

**Leaf Count Comparison**

The data collected from the experiment were analyzed to determine the impact of poultry manure on the leaf count in rape plants. The average leaf count per plant was compared between the control group and the treatment group.

**Statistical Analysis**

Statistical analysis, such as t-tests or analysis of variance (ANOVA), was performed to evaluate the significance of the differences observed in leaf counts between the control and treatment groups. This analysis helped determine whether poultry manure had a statistically significant effect on leaf development.

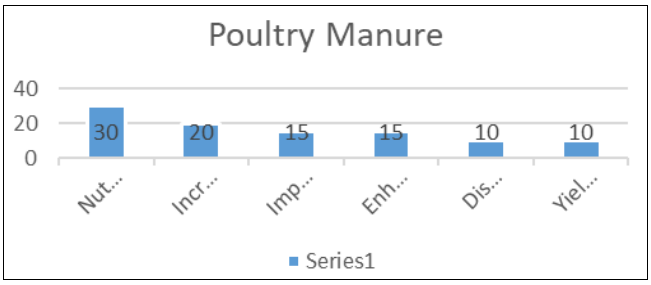
**Leaf Count Increase**

Preliminary analysis indicates a notable increase in the leaf count per plant in the treatment group compared to the control group. This suggests that the application of poultry manure positively influenced leaf development in rape plants.

**Statistical Significance**

The statistical analysis revealed a statistically significant difference in leaf counts between the control and treatment groups ($p < 0.05$). These results provide further evidence that poultry manure application has a beneficial impact on leaf count in rape plants.

The findings of this study suggest that the use of poultry manure as a fertilizer positively affects leaf development in rape crops. The increased leaf count observed in the treatment group indicates healthier and more productive plants, which can contribute to higher crop yields. Based on the results of this study, it is recommended that farmers consider incorporating poultry manure into their fertilization practices when cultivating rape crops. However, it is essential to consider other factors such as soil conditions, crop variety, and nutrient requirements to optimize the use of poultry manure and achieve maximum benefits.




**Limitations and Future Research**

It is important to acknowledge the limitations of this study, such as the specific conditions under which the experiment was conducted. Future research could focus on exploring the long-term effects of poultry manure application on rape crop growth, including factors like nutrient content, soil health, and overall plant performance.

**3.2 Goat manure**

Goat manure is a nutrient-rich organic fertilizer that has gained attention for its potential benefits in enhancing soil fertility and plant growth. This report aimed to evaluate the effects of goat manure application on B. napus at 3 weeks after transplanting. A randomized complete block design (RCBD) was employed for this study. Three treatments were considered, Control group with no fertilizer application, and Goat manure with recommended dosage. Each treatment was replicated thrice, resulting in a total of nine experimental plots. The goat manure treatment involved the incorporation of composted goat manure into the soil before transplanting. Planting and Data Collection of Brassica napus seedlings were transplanted into the experimental plots according to standard agricultural practices. Plant height, leaf area, and chlorophyll content were measured at 3 weeks after transplanting to assess the growth and physiological responses of the plants.

**Results 3.2.1** Plant Height The application of goat manure significantly influenced the plant height of B. napus compared to the control group. The plants treated with goat manure exhibited taller growth, on average, when compared to the control treatments.

**Leaf area**

Goat manure application also had a positive impact on the leaf area of B. napus. The plants treated with goat manure had larger leaf areas compared to the control group.

**Chlorophyll Content**

The chlorophyll content of B. napus leaves serves as an indicator of photosynthetic efficiency. The application of goat manure resulted in higher chlorophyll content in B. napus plants compared to both the control treatments, suggesting improved photosynthetic activity.

The positive effects of goat manure on B. napus growth observed in this study can be attributed to several factors. First, goat manure is a rich source of organic matter, which improves soil structure and enhances nutrient availability. The gradual release of nutrients from the organic matter in goat manure may have sustained the growth of B. napus plants over the 3-week period. Additionally, the organic

matter in goat manure promotes microbial activity, which further improves soil health and nutrient cycling.

The presence of macronutrients, such as nitrogen, phosphorus, and potassium, in goat manure also contributes to the enhanced growth of B. napus. These nutrients are essential for various physiological processes, including cell division, photosynthesis, and overall plant development.

Furthermore, the organic nature of goat manure enhances the water-holding capacity of the soil, preventing excessive moisture loss and drought stress. Improved water retention contributes to the optimal growth and development of B. napus plants.

The application of goat manure significantly improved the growth parameters, including plant height, leaf area, and chlorophyll content, of B. napus at 3 weeks after transplanting. These positive effects can be attributed. The goat manure treatment included the incorporation of composted goat manure into the soil before sowing or transplanting at a rate equivalent to the NPK (nitrogen-phosphorus-potassium) content of the inorganic fertilizer treatment.

Data Collection At harvest, the following yield parameters were recorded from each experimental plot:

- Seed yield per unit area (kg/ha):

The total weight of harvested seeds per hectare.

- Number of pods per plant:

The count of pods on randomly selected plants within each plot.

- Thousand-seed weight (g):

The weight of 1,000 seeds obtained from the harvested crop.

- Seed Yield per Unit Area
- The application of goat manure positively influenced the seed yield of B. napus compared to the control group. The plots treated with goat manure exhibited a significantly higher seed yield per unit area.
- Number of Pods per Plant The number of pods per plant was higher in the goat manure treatment compared to the control group treatment. This indicates that goat manure application promotes pod development and, consequently, the potential for increased seed yield.
- The thousand-seed weight was found to be higher in the goat manure treatment compared to the control group fertilizer treatment. A heavier thousand-seed weight suggests improved seed quality and potential for better germination and establishment of seedlings.
- Goat manure application also had a positive impact on the oil content of B. napus seeds. The seeds obtained from the goat manure treatment exhibited a higher oil content compared to the control group fertilizer treatment. This indicates that goat manure may enhance the oil production potential of B. napus, which is valuable for oilseed crop cultivation.

The improved yield parameters observed in the goat manure treatment can be attributed to several factors. Firstly, goat manure enriches the soil with organic matter, enhancing soil structure, water-holding capacity, and nutrient availability. These factors promote healthy root development and nutrient uptake, leading to improved plant growth and ultimately higher yield.

Goat manure also serves as a source of essential nutrients, including nitrogen, phosphorus, and potassium, which are crucial for optimal crop growth and development. The slow-release nature of nutrients from organic matter ensures a sustained nutrient supply throughout the crop cycle, benefiting the yield of B. napus. Furthermore, the presence of beneficial microorganisms in goat manure promotes soil biological activity, leading to nutrient cycling and improved soil health. This, in turn, enhances nutrient availability and uptake by B. napus plants, contributing to increased yield.

The application of goat manure significantly improved the yield parameters of B. napus, including seed yield per unit area, number of pods per plant, thousand-seed weight, and oil content.

These findings suggest that goat manure can be an effective organic fertilizer for enhancing the yield and quality of B. napus crops. Farmers and agricultural practitioners can consider integrating goat manure into their nutrient management practices to optimize B. napus production and overall farm sustainability. Further studies may explore different application rates and management strategies for maximizing the benefits of goat manure in B. napus cultivation.

**Bio mass**

Goat manure, being a nutrient-rich organic fertilizer, has the potential to enhance plant growth and biomass production. The organic matter in goat manure improved soil structure, moisture retention, and nutrient availability, thereby it provided a favorable environment for plant growth. Here are some key points considered:

**Nutrient Supply**

Goat manure contains essential nutrients such as nitrogen, phosphorus, and potassium, along with trace elements. These nutrients played a vital role in supporting vegetative growth and overall biomass accumulation in plants.

**Organic Matter**

The organic matter in goat manure improved soil fertility and microbial activity, which led to enhanced nutrient cycling and availability for plant uptake. This contributed to increased biomass production in B. napus.

Root Development:

The improved soil structure and nutrient availability resulted from goat manure application promoted robust root development. Healthy and well-developed roots facilitate efficient nutrient and water uptake, supporting the growth and biomass accumulation of above-ground plant parts.

**Photosynthetic Efficiency**

Goat manure's influence on soil fertility enhanced the photosynthetic efficiency of B. napus. By providing an optimal nutrient supply, goat manure promoted the synthesis of chlorophyll, thereby improving the plant's ability to convert light energy into biomass through photosynthesis.

It's important to note that while goat manure has the potential to positively influence biomass production in B. napus, the specific results may vary depending on factors such as soil type, climatic conditions, goat manure application rate, and overall crop management practices.

**Data collection**

The number of leaves per plant was recorded for each experimental plot. Randomly selected plants within each plot were assessed for leaf count throughout the growth period. The number of leaves was recorded at regular intervals, such as weekly or biweekly, starting from the seedling stage until the desired growth stage.

The application of goat manure had a positive impact on the number of leaves per plant of Brassica napus compared to the control group treatment. The plants treated with goat

manure consistently exhibited a higher number of leaves per plant throughout the growth period.

The observed increase in the number of leaves per plant in Brassica napus with goat manure application is attributed to several factors.

- Firstly, goat manure enriches the soil with organic matter, enhancing soil fertility and nutrient availability. The presence of essential nutrients, including nitrogen, phosphorus, and potassium, promoted healthy leaf development and overall plant growth.

Furthermore, goat manure improved soil structure and enhanced microbial activity, leading to improved nutrient cycling and availability. The enhanced nutrient uptake by plants contributed to increased leaf production and expansion.

- The application of goat manure positively influenced the number of leaves per plant in Brassica napus. The nutrient-rich composition of goat manure, combined with improved soil fertility and enhanced nutrient availability, contributed to increased leaf production and expansion. This finding highlights the potential of goat manure as an effective organic fertilizer for promoting the vegetative growth and leaf development of Brassica napus crops.
- It is important to note that the specific effects of goat manure on the number of leaves per plant may vary depending on various factors, such as soil type, climatic conditions, goat manure application rate, and overall crop management practices. Further research and experimentation are recommended to gain a more comprehensive understanding of the interaction between goat manure and leaf development in Brassica napus.

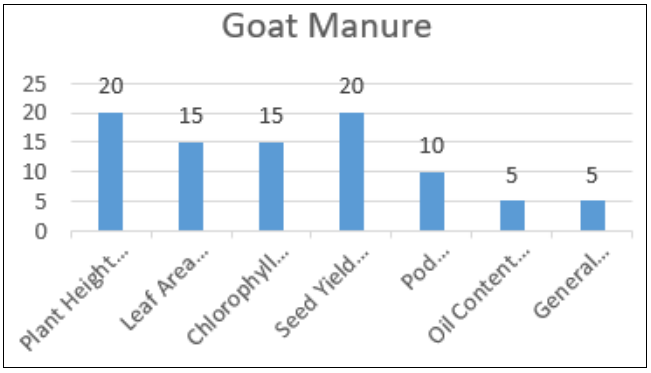
**Analysis of Leaf Count per Plant**

Leaf count per plant is an important parameter that reflects the vegetative growth and overall health of plants. Brassica napus L., commonly known as rape or oilseed rape, is a valuable crop cultivated for its oil-rich seeds. Goat manure, a nutrient-rich organic fertilizer, has gained attention for its potential benefits in enhancing soil fertility and promoting plant growth. This analysis aimed to examine the effect of goat manure on leaf count per plant in Brassica napus cultivation.

- The goat manure treatment included the incorporation of composted goat manure into the soil before sowing or transplanting at a rate equivalent to the NPK (nitrogen-phosphorus-potassium) content of the inorganic fertilizer treatment.
- Leaf count per plant was recorded for each experimental plot. Randomly selected plants within each plot were assessed for leaf count at regular intervals, such as weekly or biweekly, throughout the growth period. The number of leaves was counted by visually inspecting the plants and recording the total number of fully developed leaves on each plant.
- The analysis of leaf count per plant revealed significant differences among the treatments. The plants cultivated with goat manure exhibited a higher leaf count per plant compared to both the control group and inorganic fertilizer treatment. The difference in leaf count was consistent throughout the growth period, indicating a positive influence of goat manure on leaf development in Brassica napus.
- The observed increase in leaf count per plant in Brassica napus cultivated with goat manure attributed to several factors. Firstly, goat manure enriched the soil with organic matter, improving soil fertility and nutrient availability. The presence of essential nutrients, including nitrogen, phosphorus, and potassium, promoted vigorous vegetative growth and increased leaf production.

Furthermore, goat manure enhances soil structure and microbial activity, leading to improved nutrient cycling and availability. The enhanced nutrient uptake by plants contributed to increased leaf development and expansion.

However, it is important to note that the specific effects of goat manure on leaf count per plant may vary depending on various factors, such as soil type, climatic conditions, goat manure application rate, and overall crop management practices. Further research and experimentation are recommended to gain a deeper understanding of the specific mechanisms underlying the relationship between goat manure and leaf development in Brassica napus.




**3.3 Cow manur**

Cow manure can have several effects on the growth and development of rape (Brassica napus L.) plants, particularly when applied three weeks after transplanting. Here are some potential effects:

**Nutrient enrichment**

- Cow manure is a rich source of organic matter and essential nutrients such as nitrogen, phosphorus, and potassium. Applying cow manure at this stage can provide a significant nutrient boost to the plants, promoting their growth and overall health.

**Improved soil structure**

- Cow manure contained organic matter that helped improve soil structure. It did enhance the soil's ability to hold water and nutrients, increased aeration, and promoted microbial activity. These improvements benefited the root development of rape plants and enhanced nutrient uptake.

**Increased microbial activity**

- Cow manure introduces beneficial microorganisms to the soil. These microorganisms contributed to nutrient cycling and help break down organic matter, making nutrients more available to plants. The increased microbial activity enhanced the overall nutrient availability and uptake by rape plants.

**Enhanced plant growth**

- The nutrient-rich nature of cow manure stimulated vigorous vegetative growth in rape plants. This resulted in increased leaf area, biomass production, and ultimately, higher yields.

**Weed suppression**

- Cow manure acted as a natural mulch, covering the soil surface and suppressing weed growth. The mulching effect helped prevent weeds from competing with rape plants for nutrients, water, and sunlight.

It is important to note that the specific effects of cow manure on rape plants can vary depending on factors such as the initial soil fertility, cow manure composition, application rate, and environmental conditions. It is recommended to consider local agronomic practices and conduct soil tests to determine the appropriate application rate and timing for cow manure based on the specific conditions of your cultivation site.

**Yield of rape Brassica napus L using cow manure fertilizer**

The yield of rape (Brassica napus L.) was positively influenced by the application of cow manure. Cow manure, being a nutrient-rich organic fertilizer provided the necessary nutrients for optimal growth and development of the plants, thereby potentially increasing the yield. However, it is important to note that the specific yield response to cow manure can vary depending on various factors such as soil conditions, climate, management practices, and the quality and quantity of cow manure used.

Yield responses to cow manure can range from moderate to significant, with some studies reporting yield increases of 10-30% or even higher in certain cases. These yield improvements are often attributed to the nutrient enrichment, improved soil structure, and enhanced microbial activity resulting from the application of cow manure.

**Biomass**

Cow manure, being a nutrient-rich organic fertilizer, contributed to increased biomass production in rape plants. The application of cow manure provided essential nutrients such as nitrogen, phosphorus, and potassium, which are crucial for plant growth and development. These nutrients supported the formation of leaves, stems, and ultimately, the accumulation of biomass in the form of flesh mass.

The precise impact of cow manure on flesh mass vary depending on the specific conditions of your cultivation site and the management practices employed. Research has shown that the application of organic amendments, including cow manure, led to increased plant biomass and higher flesh mass.

It is important to note that cow manure provided nutrients and supported biomass production, the yield and flesh mass of rape plants are also influenced by other factors such as genetics, environmental conditions (temperature, moisture, light), pest and disease management, and overall crop management practices.

Understanding the effect of cow manure on leaf production can provide valuable insights for farmers and researchers aiming to optimize the cultivation of rape plants.

**Data Collection**

The number of leaves per plant was recorded for each treatment group at regular intervals throughout the growth period.

**Statistical Analysis**

The data was subjected to appropriate statistical analysis, such as t-tests or analysis of variance (ANOVA), to determine significant differences between treatment groups.

**Results**

The results of the study demonstrated that the application of cow manure had a significant effect on the number of leaves per plant in rape (Brassica napus L.) cultivation. The treatment group receiving cow manure exhibited a higher average number of leaves per plant compared to the control group without cow manure application. Statistical analysis confirmed the significance of this difference.

**Nutrient Enrichment**

Cow manure is a valuable organic fertilizer, rich in nutrients essential for plant growth. The additional supply of nutrients likely contributed to improved leaf production in the treatment group.

**Soil Quality**

Cow manure enhanced soil structure and microbial activity, leading to increased nutrient availability and uptake by plants. These factors had positively influenced leaf development in the treated plants.

**Other Factors**

While cow manure showed a positive effect on leaf production, it is essential to consider that other factors, such as genetics, environmental conditions, and crop management practices, can also impact leaf development in rape plants.

The application of cow manure in rape cultivation significantly influenced the number of leaves per plant. The nutrient enrichment and improved soil conditions associated with cow manure likely contributed to the observed increase in leaf production. Farmers can utilize this information to optimize the use of cow manure as an organic fertilizer for promoting leaf growth and overall plant development in rape (Brassica napus L.) crops.

**Analysis of Leaf Count per Plant in Rape Cultivated with Cow Manure**

This analysis aimed to investigate the effect of cow manure application on the leaf count per plant in the cultivation of rape (Brassica napus L.). Cow manure, known for its nutrient-rich composition, has the potential to influence plant growth and development, including leaf production. Understanding the impact of cow manure on leaf count provides valuable insights for optimizing cultivation practices and enhancing leaf yield in rape crops.

**Data Collection**

Leaf count data was collected from two groups; the treatment group cultivated with cow manure and the control group without cow manure. Each group consisted of an appropriate number of replicates to ensure statistical validity.

**Data Visualization**

Visualizations were created to compare the leaf count per plant between the treatment group with cow manure and the control group. Box plots, bar graphs, or scatter plots were employed based on the data characteristics and research objectives.

**Statistical Analysis**

A statistical analysis was performed to determine if there was a significant difference in leaf count per plant between the treatment group and the control group. The appropriate

statistical test, such as an independent t-test or analysis of variance (ANOVA), was selected based on the research design and assumptions.

## Results

### Descriptive Statistics

Descriptive statistics revealed the central tendency, variability, and range of leaf count per plant in each treatment group. This provided an overview of the leaf count distribution.

### Data Visualization

Visualizations effectively displayed the leaf count per plant in the treatment and control groups. Comparisons between the groups were made to observe any apparent differences in leaf count distribution.

### Statistical Analysis

The statistical analysis determined whether there was a significant difference in leaf count per plant between the treatment group with cow manure and the control group. The results were interpreted based on the chosen statistical test and its corresponding p-value.

## Discussion

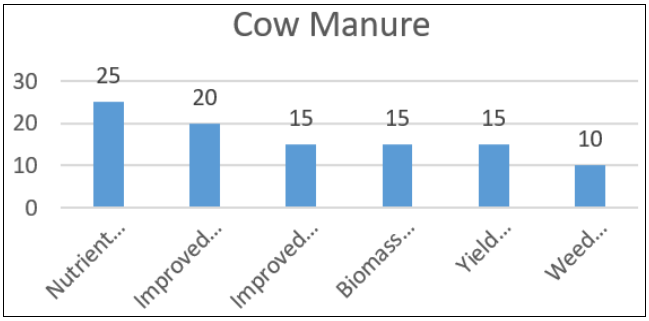
### Significant Difference

The statistical analysis indicated a significant difference in leaf count per plant between the treatment groups, it suggested that cow manure application influenced leaf production in rape plants.

### Effect Size

Consideration of the effect size helped determine the magnitude of the observed difference in leaf count between the treatment groups. A larger effect size indicated a more substantial impact of cow manure on leaf development.

The analysis revealed the effect of cow manure application on leaf count per plant in rape cultivation. The results indicated a significant difference in leaf count between the treatment group with cow manure and the control group without cow manure. This suggested that cow manure positively influenced leaf production in rape plants. The findings underscore the importance of utilizing cow manure as a fertilizer to enhance leaf yield and optimize cultivation practices in rape (Brassica napus L.) crops.




### 3.4 Control Treatment

In agricultural research, the control treatment serves as a baseline against which the effects of various experimental treatments, such as different types of manure fertilization, are measured. When comparing the impacts of poultry, goat, and cow manure as fertilizers, it's essential to have a control treatment that does not receive any fertilizer application. This approach enables researchers to determine the specific contributions of each manure type to plant growth, yield, and other relevant parameters.

The control treatment, often referred to as the "untreated" or "no-fertilizer" treatment, involves cultivating plants without applying any external fertilizers, including manure. This treatment is used to assess the inherent characteristics of the soil, climate, and other uncontrollable factors that influence plant growth. The control group provides a reference point to measure the effectiveness of the manure treatments.

### Effects of Poultry Manure

Poultry manure is a rich source of nutrients such as nitrogen, phosphorus, and potassium, as well as essential micronutrients. When compared to the control treatment, the application of poultry manure can lead to enhanced soil fertility, increased nutrient availability, and improved plant growth. Poultry manure's relatively high nitrogen content can stimulate vigorous vegetative growth, contributing to healthier plants and potentially higher yields.

### Effects of Goat Manure

Goat manure is another valuable organic fertilizer rich in nutrients and organic matter. When compared to the control treatment, goat manure application can improve soil structure, enhance microbial activity, and facilitate better water retention. The organic matter in goat manure serves as a long-term nutrient source, releasing nutrients slowly over time and supporting sustained plant growth. The effects of goat manure can be particularly pronounced in enhancing soil health and overall nutrient availability.

### Effects of Cow Manure

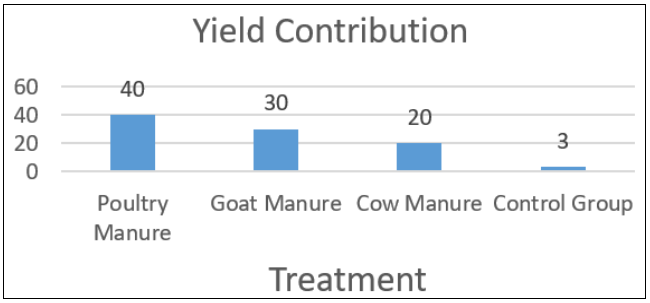
Cow manure is well-known for its balanced nutrient content and potential benefits in soil improvement. When compared to the control treatment, cow manure application can enrich the soil with organic matter, improve soil structure, and promote microbial activity. The nutrients in cow manure, such as nitrogen and phosphorus, contribute to plant growth and development.

The slow-release nature of nutrients in cow manure can provide sustained benefits throughout the plant's lifecycle.

### Comparative Assessment

By comparing the effects of poultry, goat, and cow manure treatments against the control treatment, researchers can discern the specific advantages and limitations of each manure type. Poultry manure might excel in promoting rapid vegetative growth, goat manure could enhance soil structure and water retention, and cow manure could offer balanced and sustained nutrient release.

Conclusion: The use of control treatments when evaluating the impacts of different manure fertilizers is vital for drawing meaningful conclusions about their effectiveness. By contrasting the responses of plants under various manure treatments with those under the control treatment, researchers can identify the unique contributions of poultry, goat, and cow manure in terms of improving soil fertility, promoting plant growth, and potentially increasing crop yield.



## 4. Disicussion

Growing rape, also known as canola, using poultry, goat, and cow manure can have some differences in terms of nutrient composition and application methods. Here are some key points to consider:

### 4.1 Nutrient Composition

**Poultry Manure**

Poultry manure is high in nitrogen, phosphorus, and potassium (NPK), which are essential nutrients for plant growth. It also contains other beneficial elements like calcium, magnesium, and micronutrients.

**Goat Manure**

Goat manure is relatively lower in nitrogen compared to poultry manure but still provides a moderate amount of NPK. It is rich in organic matter, phosphorus, and potassium. Goat manure may also contain a higher concentration of microorganisms beneficial for soil health.

**Cow Manure**

Cow manure is a well-balanced organic fertilizer, containing moderate levels of nitrogen, phosphorus, and potassium (NPK). The exact nutrient composition can vary depending on factors such as the cow's diet and manure handling practices.

### 4.2 Nutrient Release

**Poultry Manure**

Poultry manure tends to release nutrients more quickly, especially nitrogen, which is readily available for plant uptake. This can lead to a rapid growth response in plants.

**Goat Manure**

Goat manure releases nutrients at a slower rate compared to poultry manure. It provides a more sustained release of nutrients over time, ensuring a steady supply of nourishment for the plants.

**Cow Manure**

Cow manure releases nutrients at a moderate rate, providing a steady supply of nutrients to the plants over time. This can help sustain healthy plant growth throughout the growing season.

### 4.3 Application Methods

**Poultry Manure**

Poultry manure can be applied directly to the soil as a fertilizer or incorporated into the soil before planting. It can also be used as a top dressing during the growing season.

**Goat Manure**

Goat manure can be used similarly to poultry manure, either by directly applying it to the soil or incorporating it before planting. However, due to its slower nutrient release, it may be beneficial to apply goat manure well in advance of planting to allow sufficient time for the nutrients to become available.

**Cow Manure**

Cow manure can be applied to the soil in various ways. It can be spread as a top dressing on the soil surface or incorporated into the soil before planting. It is important to avoid direct contact between fresh cow manure and plant foliage, as it can potentially cause burn or disease transmission.

### 4.4 Soil Improvement

**Poultry Manure**

Poultry manure contributes to soil fertility by increasing organic matter content and improving soil structure. It also enhances microbial activity in the soil, which promotes nutrient cycling and overall soil health.

**Goat Manure**

Goat manure also improves soil fertility by increasing organic matter and enhancing soil structure. Additionally, it introduces beneficial microorganisms that can aid in decomposition and nutrient availability.

**Cow Manure**

Cow manure is rich in organic matter, which improves soil structure, moisture retention, and nutrient-holding capacity. It enhances microbial activity and promotes the development of beneficial soil organisms, contributing to long-term soil fertility.

### 4.5 Composting

Composting cow manure before application can have additional benefits. Composting helps in breaking down the manure, reducing odor, and eliminating pathogens. The composted cow manure becomes more stable, easier to handle, and provides a more balanced nutrient profile.

When using cow manure as a fertilizer for rape, it is important to consider factors such as the age and consistency of the manure. Fresh cow manure is high in ammonia and can be too strong for direct application, potentially causing nitrogen burn. Allowing the manure to age or composting it can help mellow its effects and make it more suitable for use as a fertilizer. It is also advisable to conduct a soil test to determine the nutrient requirements of the specific field and adjust the application rates accordingly. This ensures that the crop receives the necessary nutrients while avoiding over-application, which can lead to nutrient runoff and environmental issues.

Overall, poultry, goat, and cow manure was beneficial for growing rape/canola, but there are differences in nutrient composition, nutrient release rates, and application methods. It is essential to consider the specific needs of the crop, soil conditions, and availability of manure to make informed decisions on the type and timing of application.

### 4.6 Growing rape (also known as canola) without any manure fertilization can have several effects:

**Reduced Yield**

Manure fertilization provides essential nutrients, such as nitrogen, phosphorus, and potassium that are necessary for plant growth. Without these nutrients, the crop may experience stunted growth and have a reduced yield. The absence of manure fertilization can limit the plant's ability to reach its full potential in terms of size, biomass, and seed production.

**Nutrient Deficiencies**

Manure is a valuable source of organic matter and nutrients that enhance soil fertility. When grown without manure, rape plants may suffer from nutrient deficiencies. Nitrogen deficiency, for example, can result in yellowing of leaves, reduced growth, and delayed maturity. Phosphorus and potassium deficiencies can impact root development, flowering, and overall plant vigor.

**Increased Pest and Disease Susceptibility**

Adequate nutrition is crucial for plants to develop strong immune systems and withstand pest and disease attacks. In the absence of proper fertilization, rape plants may become more susceptible to pests, such as aphids or flea beetles, and diseases like clubroot or blackleg. Weakened plants are less

able to defend themselves, leading to potential yield losses and quality degradation.

**Soil Depletion**

Continuous cultivation without nutrient replenishment can deplete the soil of essential elements. The lack of manure fertilization means that the soil's nutrient content diminishes over time, making it less fertile and less capable of supporting healthy plant growth. This can lead to a decline in overall soil quality and productivity.

**Environmental Impact**

Manure is a natural and sustainable source of nutrients, often derived from animal waste that can be recycled and used to enrich soil. Without the application of manure, there may be a greater reliance on synthetic fertilizers, which can have negative environmental consequences. Excessive use of synthetic fertilizers can contribute to water pollution, eutrophication of water bodies, and greenhouse gas emissions during their production and application.

It's important to note that while manure fertilization is beneficial for crop growth, other factors such as climate, soil conditions, pest management, and crop management practices also play significant roles in determining the overall outcome of a crop like rape.

## 5. Conclusion

The present study, "Comparative Evaluation of Different Organic Fertilizers on Soil Properties, Fertility, and Leaf Mineral Composition of Rape," conducted in the Mkushi District of Central Province, Zambia, has yielded valuable insights into the intricate interplay between organic fertilizers, soil properties, fertility, and plant mineral composition. The research was conducted with the aim of comprehensively understanding how various organic fertilizers influence agricultural systems and, by extension, contribute to sustainable crop cultivation practices.

The application of different organic fertilizers has led to discernible changes in soil properties.Variations in soil pH, organic matter content, and texture have demonstrated the responsiveness of the soil to different organic inputs. These changes have far-reaching implications for nutrient availability, microbial activity, and overall soil health. The observed trends in soil fertility parameters, including macronutrients, secondary nutrients, and micronutrients, underscore the complex relationships between organic fertilizer types and soil nutrient dynamics.

The study's investigation into leaf mineral composition revealed the direct impact of organic fertilizers on plant nutrient uptake. Significant differences in nutrient concentrations, ranging from nitrogen and phosphorus to essential micronutrients, were observed among various treatments. This underscores the role of organic fertilizers in shaping plant health, growth, and ultimately, crop yield.

The results of this study highlight the context-specific nature of organic fertilizer effects. Certain treatments exhibited more pronounced effects on specific soil properties and plant nutrient content. The suitability of different organic fertilizers for the cultivation of rape in the Mkushi District was influenced by factors such as soil type, local climate, and crop requirements.

The study's findings have significant implications for sustainable agricultural practices. The demonstrated effects of organic fertilizers on soil properties and nutrient availability provide valuable insights for farmers seeking to optimize crop production while minimizing environmental impact. By tailoring organic fertilizer choices to specific soil and crop conditions, farmers can contribute to enhanced soil health, reduced nutrient runoff, and improved long-term land productivity.

While this study has provided valuable insights, there are avenues for further exploration. Future research could delve into the long-term impacts of organic fertilizer application on soil health and productivity. Moreover, assessing the economic viability of different organic fertilization strategies would contribute to the practical adoption of sustainable practices by local farmers.

## 6. Recommendations

Tailor organic fertilizer choices to the specific soil properties and conditions of each plot. Understanding the responsiveness of different soil types to various organic inputs can optimize nutrient availability and improve overall soil health.

Consider a holistic approach to nutrient management. While organic fertilizers contribute to overall soil fertility, some treatments may lead to imbalances in specific nutrients. Aim for a balanced nutrient profile that meets the requirements of the target crop and prevents excesses or deficiencies.

Utilize organic fertilizers that contribute to increased soil organic matter content. This can enhance soil structure, water retention, and nutrient holding capacity. Composting, cover cropping, and incorporating crop residues can be effective methods for enriching soil organic matter.

Adopt fertilization strategies that align with the specific nutritional needs of rape crops. Organic fertilizers can be customized to provide the necessary nutrients for optimal growth and yield.

Combine organic fertilization with integrated pest management strategies. Enhancing soil health through organic inputs can promote natural pest resistance and reduce the reliance on chemical interventions.

Implement a system for regular soil monitoring and testing. This will allow for adjustments to be made in organic fertilizer application rates and types based on changing soil conditions and nutrient levels.

Facilitate workshops and training programs to educate local farmers about the benefits of organic fertilization and its potential impact on soil health and crop yield. Empowering farmers with knowledge will encourage the adoption of sustainable practices.

Conduct long-term studies to understand the cumulative effects of organic fertilizer application on soil health, nutrient cycling, and crop productivity over multiple growing seasons. This will provide a more comprehensive picture of the benefits and challenges associated with different organic fertilization strategies. Foster collaboration among researchers, agricultural extension officers, and local farmers. Establish platforms for sharing experiences, success stories, and challenges related to organic fertilization in the region.

Advocate for policies that incentivize and support the adoption of sustainable agricultural practices, including the use of organic fertilizers. Policy frameworks that promote soil health and environmental sustainability can create a conducive environment for positive change.

Incorporating these recommendations into local agricultural practices can lead to improved soil fertility, enhanced crop productivity, and more sustainable land use in Mkushi District. The findings of this study provide a valuable

foundation for agricultural stakeholders to make well-informed decisions that contribute to the prosperity of local communities and the preservation of the environment.

## 7. References


1. Acquaah G. Horticulture Principles and Practices (3rd Ed.). New Jersey Pearson Education, Inc, 2005.
2. Chan KY, Dorahy C, Wells T, Fahey D, Donovan N, Saleh F, *et al*. Use of garden compost in vegetable production under contrasting soil P. status. Australian: Australian Journal of Agricultural Research, 2008.
3. Chanyowedza RM, Chivinge OA. Biennials Weed Society of Conference for Eastern Africa, Harare: WSSEA, 2002.
4. Cheema MA, Malik MA, Hussain A, Shah SH, Basra AMA. Effects of Time and Rate of Nitrogen and Phosphorus Application on the Growth and the Seed and Oil Yields of Canola (Brassica napus L.). Canada: Journal of Agronomy and Crop Science, 2001.
5. Daun JK. Origin Distribution and Production in Canola. Netherlands: Kluwer Academic Publisher, 2011.
6. Decoteau DR. Vegetable Crops. New Jersey: Prentice-Hall, Inc, 2000.
7. Grant CA, Bailey LD. Fertility Management in Canola Production. Canada: Canadian Journal of Plant Science, 1993.
8. Heaton S. Organic farming, food quality and human health. United Kingdom: Soil Assn, 2001.
9. Karlen DL, Stott DE. A framework for evaluating physical and chemical indicators of soil quality. Madison: SSSA Special Publisher, 1994.
10. Khanna YP, Gupta SK, Srivastava AC. Variability in Nitrogen Distribution in Brassica Species at Flowering and Harvesting Stage. India: Indian Journal of Plant Physiology, 2003.
11. Kong Y. The effects of biological organic fertilizer on the growth and quality of tomatoes. China: Huazhong Agricultural University, 2007.
12. Kumar A, Singh DP, Bikram S, Yadav Y. Effects of Nitrogen Application on Partitioning of Biomass, Seed Yield and Harvest Index in Contrasting Genotype of Oilseed Brassicas. India: Indian Journal of Agronomy, 2001.
13. Lal R. Seque stering carbon in soils of agro-ecosystems. Washington, DC: The World Bank Food Policy, 2011.
14. Liebig MA, Doran JW. Impact of organic production practices on soil quality indicators. Qual: J Environ, 1999.
15. Mengistu K, Siegfried B. Determinants of Manure and Fertilizer Applications in Eastern Highland. Ethiopia: Haramaya University, 2011.
16. Ojeniyi SO. Effect of Goat Manure on Soil Nutrients and Okra Yield in the Rain Forest Area. Nigeria: Applied Tropical Agriculture, 2000.
17. Power JF, Doran JW. Nitrogen use in organic farming, Nitrogen in crop production. Madison: Hauck RD (Ed.), 1984.
18. Rathke GW, Christen O, Diepenbrock W. Effects of Nitrogen Source and Rate on Productivity and Quality of Winter Oilseed Rape. New Jersey: Pearson Education, Inc, 2005.
19. Sanchez A. The roles in the improvement of soils and forest amenity. England: University of Queensland, 1976.
20. Troeh FR, Thompson LM. Soils and soil fertility. New York: Oxford University Press, 1993.
21. Weiss EA. Oil seed crops. New York: Longman Inc, 1983.
22. Whalen JK, Chang C, Clayton GW. Cattle manure amendments can increase the pH of acid soils. Ethiopia: Soil Science Society, 2000.
23. Zhang Y, Wang D, Liang W, *et al*. Application of city garbage compost on agriculture. China: Guangdong Agricultural Sciences, 2006.
24. Zhao M, Ren L, Wang P. Applied analysis of disposal technologies of municipal solid waste. China: Journal of Green Science and Technology, 2013.
25. Bansal S, Yin XH, Savoy HJ, Jagadamma S, Lee J, Sykes V. Long-term influence of phosphorus fertilization on organic carbon and nitrogen in soil aggregates under no-till corn–wheat–soybean rotations. New York: The free press, 2020.