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Goat Manure and Carrageenan as Nutrient Source for Glutinous Corn

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Abstract
Aim: This study assessed the impact of integrating goat manure and carrageenan in glutinous corn production, focusing on growth and yield performance, soil characteristic changes, and economic returns.
Methodology: The experiment was conducted in Angadanan, Isabela, Philippines, utilizing a Randomized Complete Block Design (RCBD) with three replications and a total of 18 plots. Six treatments were evaluated: T1 (120-20-30 kg NPK ha^{-1} Fertilizer), T2 (25% Carrageenan plus 100% Goat Manure), T3 (50% Carrageenan plus 100% Goat Manure), T4 (75% Carrageenan plus 100% Goat Manure), T5 (Full Carrageenan plus 100% Goat Manure), and T6 (Full Goat Manure). The study is to assess the effects of these treatments on crop performance.
Results: The glutinous corn supplemented with carrageenan and goat manure showed a significant difference in plant height at 30 and 60 days after planting. The weight of unhusked ear per plant and per sampling area was remarkably significant result. In terms of ear length of the experimental plant, significant results were obtained. The plants that produced longer ears were those treated with 120-20-30 kg NPK ha^{-1} (T_1), along with the supplementation of Full Carrageenan plus 100% Goat Manure (T_5). Likewise, diameter of the ear was also noted significant result which Treatment 1 and 5 were produced longer ear. Computed yield per hectare showed that plants applied 120-20-30 kg NPK ha^{-1} (T_1) yielded highest followed by Full Carrageenan plus 100% Goat Manure (T_5). Soil Analysis showed significant changes before anf after the study.
Conclusion: This study highlights effective nutrient management options using carrageenan and goat manure, which improved crop growth and yield. However, in terms of profitability, the best results came from Full Carrageenan plus 100% Goat Manure (T_5) and 120-20-30 kg NPK ha^{-1} Fertilizer (T_1), as they provided the highest return on investment. Choosing the right approach depends on available farm resources, soil health, and financial goals. Organic methods help sustain soil fertility, while conventional fertilizers offer quick nutrient availability. Balancing these factors is crucial to maximizing productivity and profitability.
Keywords: *Carrageenan, Goat manure, Alternative fertilizer, Glutinous corn, and Soil fertility*

INTRODUCTION

Climate change has presented significant obstacles to farming systems, particularly in areas where staple crops such as maize play a crucial role in ensuring food security. The Philippines is among the most at-risk nations when it comes to climate change, holding the third position in the World Risk Index (Birkmann & Welle, 2016) and the fifth spot in the Global Climate Risk Index (Kreft et al., 2017). Every region in the country faces high susceptibility to climate-related dangers like frequent tropical storms, floods, dry spells, and mudslides. Furthermore, the Philippines' extensive coastlines, dense population, and heavy dependence on agriculture, natural resources, and forestry for sustenance further compound its exposure to the effects of climate change. Therefore, it is increasingly crucial to improve the resilience of major crops against stresses induced by climate change.

Furthermore, conventional farming methods may not be effective enough in addressing the consequences of extreme weather conditions like temperature changes. The rising levels of greenhouse gases from using artificial fertilizers pose a serious risk, limiting the efficiency of farming systems and leading to issues with food availability (Shakoor et al., 2022). The adoption of organic fertilizers is widespread in farming, playing a significant role in reducing greenhouse gas emissions by enhancing the efficiency of nitrogen use (NUE) and increasing nitrous oxide (N_2O) emissions through boosting soil organic matter levels and encouraging soil denitrification (Guenet *et al.,*

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2021). Consequently, the integration of these sustainable farming techniques enhances crop production and resilience, guaranteeing sustainable food supplies in the long term.

A significant issue in managed tropical soils is soil degradation, which can significantly reduce crop yields and soil ecosystem, requiring farmers to implement diverse coping mechanisms and adaptive strategies. Organic fertilizers like goat manure and carrageenan have been studied for their potential to improve soil health and crop yields in tropical soils. A study on glutinous corn production found that supplementation with carrageenan and fermented goat manure improved growth and yield (Butay,2019). These nutrients are crucial for vegetative and generative plant development, ultimately affecting crop productivity and the quality of agricultural products (Butay, 2019). However, despite its potential benefits, its effectiveness in improving soil quality and increasing crop yields in tropical agricultural systems requires further investigation to fully understand its effect and optimize its use in soil remediation strategies. A study on multiple cropping systems highlights their role in improving soil quality and crop yield, but also emphasizes the need for continued research to refine sustainable agricultural practices (Yin & Song, 2024). Research on soil fertility in tropical agricultural production units identifies key nutrient deficiencies and management challenges, reinforcing the importance of further investigation into soil remediation strategies (Yonli *et al.,* 2022). An analysis of soil quality indices for tropical soils discusses the influence of agricultural activities on soil health and the need for robust methodologies to assess and improve soil conditions (Rangel-Pereza *et al.,* 2017). Therefore, the problem is to assess the effect of organic fertilizers in enhancing the climate resilience of agricultural systems and identify the barriers and opportunities for scaling their use. Furthermore, the optimal levels and combinations of potential organic sources for glutinous corn production have not been adequately identified, which is why this study seeks to address this gap under local conditions.

Effective strategy is the integration of organic compounds like carrageenan and animal manures into corn cultivation. Organic amendments, such as compost, green manure, biochar, and animal manure, improve soil health, nutrient availability, and moisture retention, critical factors for plant growth under variable climatic conditions (Butay, 2019). Moreover, these natural substances have the potential to enhance soil organic carbon levels, enhance soil quality, and support beneficial microbial growth. These factors collectively enhance the strength and climate adaptability of farming practices, ultimately decreasing the necessity for detrimental chemicals.

Glutinous corn (*Zea mays var. ceratina*) is a versatile crop used in food production, industrial goods, and livestock feed in Region 02, leading to intense farming practices. Intensive farming uses expensive inorganic fertilizers that pose environmental risks, reducing overall production efficiency. Therefore, it is crucial to optimize the utilization of renewable resources from farms, manage ecological and biological processes, safeguard against pests and diseases, and ensure satisfactory returns to resources in order to create production systems that are compassionate, environmentally friendly, and economically viable.

This approach likewise offers a promising pathway toward achieving multiple Sustainable Development Goals (SDGs), addressing key global challenges through environmentally friendly and socially responsible practices. It contributes to crucial goals, including Zero Hunger (SDG 2), Good Health and Well-being (SDG 3), Clean Water and Sanitation (SDG 6), Decent Work and Economic Growth (SDG 8), Responsible Consumption and Production (SDG 12), Climate Action (SDG 13), and Life on Land (SDG 15).

The study was conducted to determine the influence of integrating organic compounds, Carrageenan, and animal manure in enhancing soil organic matter, crop yield, climate resilience, and environmental sustainability in glutinous corn. The positive result of this study will benefit the following:

This study provides valuable insights into sustainable agricultural practices and their broader impact. For researchers, it serves as a reference for understanding how organic compounds, carrageenan, and animal manure influence soil health, crop growth, yield, and climate resilience, while also validating environmentally friendly alternatives to chemical fertilizers. Educators can use these findings as a basis for integrating this technology into their teaching-learning process, helping students gain knowledge about sustainable farming and the application of organic amendments in corn production. Farmers, on the other hand, can benefit from the study's data on economically viable alternatives to chemical fertilizers, which can enhance crop yields while lowering input costs. By adopting these methods, they can improve production efficiency and resilience to climate variability, leading to more sustainable and profitable farming practices. Additionally, the environmental impact of the research findings is significant, as reducing reliance on artificial fertilizers helps minimize greenhouse gas emissions, prevent soil degradation, and reduce water contamination, ultimately contributing to a healthier and more balanced ecosystem.

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Objectives

This research aimed to assess the impacts of carrageenan and goat manure application in terms of growth yield on glutinous corn productivity.

Specifically, it aimed to:

1. evaluate the influence of carrageenan and goat manure on changes in soil pH, organic matter, phosphorus and potassium level;
2. determine the development and yield production of glutinous using carrageenan and goat manure; and
3. determine the most economical level and combination of carrageenan and goat manure using the simple cost and return analysis.

METHODS

Procurement of Seeds, Carrageenan, and Goat Manure

The seeds of glutinous corn was purchased at a reputable enterprise in Cabatuan, Isabela, Philippnes at Maharlika Agricultural Supply, and East-West Seed Company Incorporated manufactures it. The goat manure was acquired at the Cagayan Valley Agricultural and Aquatic Resources Research and Development (CVAARRD), Isabela State University, Echague, Isabela. Carrageenan was obtained and purchased at the National Institute of Molecular Biology and Biotechnology (BIOTECH), University of the Philippines Los Baños.

Soil Sampling and Analysis

Soil samples were collected before the land was prepared using a zigzag pattern with enough sub-samples and a shovel to reach the proper depth. The dirt was ground up, let air dry, and inert particles were eliminated. One kilogram of composite soil samples was brought to the Cagayan Valley Research Center (CVRC) for examination. The soil pH and NPK analysis results served as the basis for fertilizer recommendations.

Land Preparation

The experimental site was carefully arranged to have strong roots and uniform seedling growth. The land was plowed twice and then harrowed a week later. An animal-drawn harrow was employed to break up soil clumps and manage weeds efficiently.

Experimental Layout and Design

The prepared area was separated into three equal blocks, measuring six by 32.50 meters. Six identical plots were created from each block, each sized 4 x 5 meters and separated by 0.5 meters. The experimental treatments were assigned randomly following the Randomized Complete Block Design (RCBD) randomization process.

Experimental Treatments

The treatments for the study were the following:

T_1 – 120-20-30 kg NPK ha^{-1}
T_2 – 25% Carrageenan plus 100% Goat Manure
T_3 – 50% Carrageenan plus 100% Goat Manure
T_4 –75% Carrageenan plus 100% Goat Manure
T_5 – Full Carrageenan plus 100% Goat Manure
T_6 – Full Goat Manure

FERTILIZER APPLICATION PER HECTARE

T_{1}-451.54kg/Basal Application-176.01kg/Sidedressing Application-Once Per Single Cropping
T_{2}-2.50L Carrageenan + 10L Goat Manure Per Load/Weekly Basis-9 Application Per Cropping
T_{3}-5.00L Carrageenan + 10L Goat Manure Per Load/Weekly Basis-9 Application Per Cropping
T_{4}-7.50L Carrageenan + 10L Goat Manure Per Load/Weekly Basis-9 Application Per Cropping
T_{5}-10.00L Carrageenan + 10L Goat Manure Per Load/Weekly Basis-9 Application Per Cropping
T_{6}-20L Goat Manure Per Load/Weekly Basis-9 Application Per Cropping

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Construction of Furrows and Application of Fertilizer

Following the final harrowing, furrows were created, spaced 75 cm apart. The study's inorganic fertilizer reference was the fertilizer rate based on soil analysis. Carrageenan was diluted in water and sprayed on corn leaves, and 4,5 days after planting, goat manure was added to the soil before planting. To prevent contact with the seeds, the fertilizer in each treatment was evenly distributed along the furrows and covered with fine soil.

Planting and Replanting

Each hill was placed with two seeds, with hills spaced 25 cm apart and 75 cm between furrows. The seeds were foot-crushed and coated with fine soil to ensure consistent germination. Five days after planting, the missing hills were replanted.

Care and Management

Sidedressing, Weeding, and Cultivating. The sided dressing was done before hilling- up 14 days after planting. Hilling-up was done 30 days after planting to control weeds simultaneously. Manual weeding was done to remove the weeds between plants. Through cultivation, the plant's root zone was loosened to allow oxygen to enter the roots and control weeds' growth.

Crop Protection. Insect pests were managed by applying natural chemicals through the utilization of madre de cacao leaves immersed in water.

Watering. Watering the plants was done when extreme heat was needed.

Harvesting and Post-harvest Activities

The crop was harvested when the corn ear reached the physiological maturity stage. In order to prevent sample mixing, the corn ear was harvested one at a time and placed in a plastic bag with a tag.

Data Gathered

Growth and Yield Parameters

1. Plant Height after 30 and 60 Days of Planting. The measurement of the height of ten samples selected at random was taken with a measuring meter stick from the bottom to the top of the growing point 30 days after planting. After 60 days of planting, the plant's height was measured up to the initial node of the tassel.
2. Weight of Unhusked and Husked Ear (g). After the harvest, the weight of 10 ears with their husks was measured. The husks were taken off and weighed separately. The total weight was divided by ten to find the weight of each ear. A digital scale was used to determine the weights.
3. Length of Corn Ear (cm). The length of the husked corn ear from the 10 selected plants was determined by using a foot ruler to measure from end to end.
4. Diameter of Ear (cm). The sample ear that was utilized to measure the size of the husked ear was employed to measure the width with a Vernier caliper.
5. Yield from 6 m^2 Sampling Area (kg). All harvested ears in each sampling area with and without husk were weighed and used as the basis for the yield computation per hectare.
6. Computed Yield per Hectare (kg). The yield per hectare was computed based on the yield obtained from the sampling area.

Statistical Analysis

The data collected was tabulated and examined using the Analysis of Variance for the Randomized Complete Block Design. The Statistical Tool for Agricultural Research (STAR) was employed for data analysis. Duncan's Multiple Range Test (DMRT) was utilized to compare means when there were significant findings.

Cost and Return Analysis

The Return of Investment was calculated through a basic economic evaluation. The production expenses were determined by the current costs of agricultural materials and workforce in the area. The total revenue was established according to the current price of fresh sticky corn per kilogram. The profit is the difference between the total revenue and the production costs. The ROI was calculated by dividing the profit by the production costs and then multiplying by 100.

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RESULTS and DISCUSSION

Growth and Yield Parameters

Plant Height (cm) at 30 and 60 Days After Planting (DAP). The growth of corn plants 30- and 60 days post-planting influenced by fertilization led to a notable difference illustrated in Table 1. An increase in the average heights was observed, with plants treated with 120-20-30 kg NPK ha^{-1} (T_1) and Full Carrageenan plus 100% Goat Manure (T_5) recording the tallest among all treated plants with a mean of 61. 10 and 54. 67 centimeters. These were followed by the plants treated with 75% Carrageenan plus 100% Goat Manure (T_4) at 54. 23 cm, 50% Carrageenan plus 100% Goat Manure (T_3) at 53. 23 cm, and 25% Carrageenan plus 100% Goat Manure (T_2) at 52. 43 cm, whereas the shortest was noted in the plants fertilized with Full Goat Manure (T_6) at 51. 00 centimeters.

A similar notable result was observed 60 days after planting, where the average heights of the plants treated with 120-20-30 kg NPK ha^{-1} (T_1) and Full Carrageenan plus 100% Goat Manure (T_5) were 212: 60 cm and 206. Forty-seven centimeters, respectively, marking them as the tallest among the treated plants. This was followed by the plants treated with 75% Carrageenan plus 100% Goat Manure (T_4), 50% Carrageenan plus 100% Goat Manure (T_3), 25% Carrageenan plus 100% Goat Manure (T_2), and Full Goat Manure (T_6) with corresponding averages of 206. 03 cm, 204. 13 cm, 203. 27 cm, and 200. 57 centimeters, respectively.

The result shows that the plants in Treatment 5 (Full Carrageenan plus 100% Goat Manure) were as tall as the plants with sole 120-20-30 kg NPK ha^{-1} (T_1), which means providing liquid fertilizer in corn can reduce the use of inorganic fertilizer by 50 percent. Adding inorganic fertilizer and Carrageenan, which contains various macro and micronutrients and amino acids, can support plant growth development.

Begum et al. (2018) emphasized the beneficial impact of seaweed extract, known as Carrageenan, on the growth and yield of corn. This extract contains a variety of growth regulators such as cytokinin, auxins, gibberellins, as well as essential macro and micronutrients that are vital for the development of plants.

Several research studies have investigated the influence of goat manure on corn growth. One particular research project analyzed how sweet corn (Zea mays L. saccharata) performed when treated with varying amounts of goat manure. The findings revealed that the application of goat manure significantly enhanced all growth aspects of sweet corn (Talip & Sison, 2017).

Table 1. Plant Height (cm) at 30 and 60 Days after Planting as Affected by Carrageenan and Goat Manure.

TREATMENTS	Mean 30 Days after Planting	Mean 60 Days after Planting
T_1 – 120-20-30 kg NPK ha^{-1}	61.10^{a}	212.60^{a}
T_2 – 25% Carrageenan plus 100% Goat Manure	52.43^{bc}	203.27^{b}
T_3 – 50% Carrageenan plus 100% Goat Manure	53.23^{bc}	204.13^{ab}
T_4 –75% Carrageenan plus 100% Goat Manure	54.13^{b}	206.03^{b}
T_5 – Full Carrageenan plus 100% Goat Manure	54.67^{b}	206.47^{ab}
T_6 – Full Goat Manure	51.00^{c}	200.57^{b}
F-RESULTS	**	**
C.V. (%)	1.99	1.22

Note: Means with common letters are not significantly different with each Honest Significant Difference (HSD)
**-significant at 1% level

Weight of Unhusked and Husked Ear (kg). Regarding the weight of unhusked ears, a notable increase was observed where plants with longer ears also tended to yield heavier husked ears. Plants in Treatments 1, 5, 4, and 3 were the best treatments, recording the highest averages of 3. 65 kilograms, 3. 24 kilograms, 3. 12 kilograms, and 3. 07 kilograms. In contrast, plants in Treatment 2 (25% Carrageenan plus 100% Goat Manure) and Treatment 6 (Full Goat Manure) exhibited the lowest weights, which were 2. 48 kilograms and 2. 29 kilograms.

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As the weight of ears husked, likewise variation existed in which plants fertilized with 25% Carrageenan plus 100% Goat Manure (T_2) and Full Goat Manure (T_6) attained the lightest husked ears per plant with a mean of 2.48 and 2.29 kilograms. All the rest of the treatments have registered the heaviest weight of husked ears.

The result justified the claim that studies (Butay, 2019) have shown that supplementing glutinous corn with Carrageenan and fermented goat manure can significantly improve its growth and yield. Research conducted in the Philippines found that these organic inputs positively affected plant height, ear length, ear diameter, and overall projected yield per hectare.

Table 2. Weight of Unhusked and Husked Ear (kg) as Affected by Carrageenan and Goat Manure.

TREATMENTS	Mean	Mean
	UNHUSKED	HUSKED
T_1 – 120-20-30 kg NPK ha^{-1}	4.46^{a}	3.65^{a}
T_2 – 25% Carrageenan plus 100% Goat Manure	3.01^{c}	2.48^{bc}
T_3 – 50% Carrageenan plus 100% Goat Manure	3.70^{b}	3.07^{ab}
T_4 –75% Carrageenan plus 100% Goat Manure	3.93^{b}	3.12^{ab}
T_5 – Full Carrageenan plus 100% Goat Manure	4.15^{ab}	3.24^{a}
T_6 – Full Goat Manure	2.70^{c}	2.29^{c}
F-RESULTS	**	**
C.V. (%)	4.84	8.23

Note: Means with common letters are not significantly different with each Honest Significant Difference (HSD)
**-significant at 1% level

Ear Length Husked (cm). The productivity of corn is primarily influenced by its nutrient needs and management, particularly nitrogen, phosphorus, and potassium. The results regarding the length of husked ear per plant indicate significant variations. It demonstrates that applying inorganic fertilizer and foliar fertilizer resulted in longer ears, especially in the plants treated with the 120-20-30 kg NPK ha^{-1}, measuring 29. 43 cm (T_1), Full Carrageenan plus 100% Goat Manure at 28. 66 cm (T_5), 75% Carrageenan plus 100% Goat Manure at 26. 80 cm (T_4), and (T_3) 50% Carrageenan plus 100% Goat Manure at 26. 07 centimeters. These treatments surpassed the ear lengths produced by the plants treated with 25% Carrageenan plus 100% Goat Manure (T_2) and Full Goat Manure (T_6), which recorded shorter ears, measuring 23. 91 and 22. 66 centimeters, respectively.

The significant increase in the ear length of the crop applied with the recommended rate of inorganic fertilizer compared with the plants applied foliar fertilizer may be associated with sufficient macro and micronutrients from Carrageenan. According to DOST-PCAARRD (2016), Carrageenan plant growth promoter (PGP), extracted from red edible seaweeds, proved beneficial. In a 6,000 square square-meter field, it was observed that rice yield increased from 2.4 tons last year to 3.9 tons or an increase of 6,2.5%.

Calvo *et al.,* (2014) reported that seaweed, particularly brown seaweeds from the *Phaeophyceae* group, receive significant focus within biostimulants. These brown seaweeds, such as *Ascophyllum nodosum, Macrocystis pyrifera*, and *Durvillea potatorum*, find extensive utilization in sustainable agricultural practices as well as in various applications within the food and industrial sectors. Seaweed extracts can trigger various beneficial effects in plants, such as promoting growth, enhancing germination rates, facilitating chlorophyll production, improving fruit quality, and extending post-harvest shelf life. Additionally, they have the potential to accelerate germination, flowering, and fruiting while encouraging the growth of secondary roots.

Bhattacharyya *et al.,* (2015) extensively detailed the chemical components found in extracts from brown seaweed and their effects on plants, especially in horticultural crops. The research aimed to examine the chemical characteristics and hormone-like effects of various extracts obtained from Laminaria and Ascophyllum nodosum species that are available commercially. It also sought to explore how these extracts impact different aspects of maize plant physiology. The main objective was to establish a strong connection between the distinct features of each biostimulants and the particular physiological responses they induce. This would help in predicting the metabolic targets for other seaweed biostimulants that are available in the market. The choice of these commercial seaweed extracts was influenced by the wide range of products in the biostimulants industry, which can vary depending on the type of algal species utilized and the addition of extra chemicals or bioactive compounds during the manufacturing process.

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Begum *et al.,* (2018) highlighted the positive effect of seaweed extract on corn growth and yield. The extract contains various growth regulators like cytokinin, auxins, gibberellins, and essential macro-nutrients and micro-nutrients crucial for plant development. Numerous investigations indicate that applying seaweed extract through foliar spray or seed inoculation can result in heightened plant height, increased plant dry weight, and a greater number of cobs per plant. Moreover, seaweed extract contributes to improved yield attributes in corn, affecting cob length, girth, weight, and overall cob yield. It has also been observed to enhance green fodder yield and elevate the nutritional quality of corn. In conclusion, incorporating seaweed extract in corn cultivation displays the potential for bolstering yield and enhancing overall crop performance.

Some studies explore the effects of goat manure on corn growth. One study examined the performance of sweet corn (Zea mays L. saccharata) when applied with different rates of goat manure and found that goat manure significantly improved all growth parameters of sweet corn (Talip & Sison, 2017). Another study investigated the impact of organic-N and nature-P enriched manure, including goat manure, on plant growth and sweet corn production and found that goat manure plus had a similar effect on plant growth and sweet corn production compared to manure combined with inorganic fertilizer (Lukiwati& Slamet, 2021).

Diameter of Corn Ear (cm). In terms of the corn ear diameter, notable differences were noted, such as adding various levels of foliar fertilizer and goat manure, which can influence the ear diameter of the plants. A comparison of means for applying the 120-20-30 kg NPK ha^{-1} and different levels of carrageenan and goat manure was conducted. It demonstrates that the use of inorganic fertilizer same with foliar fertilizer led to longer ears, particularly in the plants treated with the 120-20-30 kg NPK ha^{-1} measuring 2. 20 cm (T_1), Full Carrageenan plus 100% Goat Manure at 2. 11 cm (T_5), 75% Carrageenan plus 100% Goat Manure at 2. 04 cm (T_4), and (T_3) 50% Carrageenan plus 100% Goat Manure at 1. 97 centimeters. These treatments were somewhat distinct from the ear diameter produced by the plants treated with 25% Carrageenan plus 100% Goat Manure (T_2) and Full Goat Manure (T_6), which achieved shorter ears measuring 1. 90 and 1. 88 centimeters.

The significant result of the study research from (Butay 2019) suggests is that supplementing corn with Carrageenan and fermented goat manure can positively impact its growth and yield. A study conducted in the Philippines found that applying these bio-fertilizers influenced various growth parameters, including the diameter of both husked and unhusked corn ears. This study noted that the treatment with fermented goat manure resulted in the highest projected yield per hectare.

Table 3. Length Husked and Diameter of Corn Ear (cm) as Affected by Carrageenan and Goat Manure

TEATMENTS	Mean Length	Mean Diameter
T_1- 120-20-30 kg NPK ha^{-1}	29.43^{a}	2.20^{a}
T_2- 25% Carrageenan plus 100% Goat Manure	23.91^{cd}	1.88^{c}
T_3- 50% Carrageenan plus 100% Goat Manure	26.07^{bc}	1.97^{b}
T_4- 75% Carrageenan plus 100% Goat Manure	26.80^{abc}	2.04^{ab}
T_5- Full Carrageenan plus 100% Goat Manure	28.66^{ab}	2.11^{a}
T_6- Full Goat Manure	22.66^{d}	1.90^{c}
F-RESULTS	**	*
C.V. (%)	4.12	4.29

Note: Means with common letters are not significantly different with each Honest Significant Difference (HSD)
*-significant at 5% level
**-significant at 1% level

Yield of Unhusk and Husked Ear per 6m² Sampling Area. The results clearly demonstrate that fertilization plays a crucial role in enhancing both the yield and weight of ears per sampling area in sweet pearl corn production. The highest yield was achieved by plants treated with 120-20-30 kg NPK ha-1 (T1) and Full Carrageenan plus 100% Goat Manure (T5), with ear weights of 19.06kg and 17.12kg, respectively, indicating that both treatments provided optimal nutrient availability. The trend continues with 75% Carrageenan plus 100% Goat Manure (T4) at 15.80kg, followed by 50% Carrageenan plus 100% Goat Manure (T3) at 14.57kg, and 25% Carrageenan plus 100% Goat Manure (T2) at 13.79kg, while the lowest yield was observed in Full Goat Manure (T6) at 11.86kg, showing that

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organic fertilizers alone may not be as effective without additional nutrient supplementation. Similarly, husked ear weight followed the same pattern, with T1, T5, and T4 producing the highest yields, confirming that nutrient-rich fertilization enhances both ear size and crop productivity. These findings suggest that while inorganic fertilizer remains the most effective, organic alternatives like Carrageenan and Goat Manure significantly contribute to sustainable yet productive farming practices. This insight is valuable for farmers seeking cost-efficient yet environmentally friendly fertilization strategies to optimize both yield and profitability.

Computed Yield per Hectare (kg/Hectare) The computed The computed yield per hectare of plants affected by Carrageenan and Goat Manure shows notable variations based on the fertilizer treatment used. The highest yield was observed in plants applied with the recommended rate of inorganic fertilizer, producing 11,994.40 kg/hectare. However, the use of Full Carrageenan plus 100% Goat Manure resulted in a yield of 10,744.40 kg/hectare, proving to be the closest alternative to inorganic fertilizers. This highlights the positive impact of combining foliar fertilizers and organic manure on crop growth and productivity, as the nutrients provided are readily absorbed by plants, leading to improved yield. Other treatments also demonstrated significant results, with T4 (75% Carrageenan plus 100% Goat Manure) yielding 10,347.87 kg/hectare, followed by T3 (50% Carrageenan plus 100% Goat Manure) at 9,841.65 kg/hectare, T2 (25% Carrageenan plus 100% Goat Manure) at 8,530.50 kg/hectare, and T6 (Full Carrageenan plus 100% Goat Manure) at 8,286.17 kg/hectare. These findings suggest that while inorganic fertilizers remain highly effective, organic alternatives such as Carrageenan and Goat Manure can still provide competitive yields, making them a promising option for sustainable agriculture. Additionally, organic fertilizers contribute to improved soil health and long-term fertility, which may enhance productivity in future planting seasons while reducing dependency on synthetic inputs. This balance between high yield and environmental sustainability could be beneficial for farmers looking for cost-effective and eco-friendly farming methods.

Table 4. Yield Performance of Glutinous Corn as Affected by Carrageenan and Goat Manure.

TREATMENTS	Mean	Mean	
	Yield of Unhusked 6m^2	Yield of husked 6m2	Yield per Hectare
T_1 – 120-20-30 kg NPK ha^{-1}	19.06^a	14.39^a	11994.40^a
T_2 – 25% Carrageenan plus 100% Goat Manure	13.79^{cd}	10.36^d	8530.50^d
T_3 – 50% Carrageenan plus 100% Goat Manure	14.57^c	11.81^c	9841.63^c
T_4 –75% Carrageenan plus 100% Goat Manure	15.80^{bc}	12.53^b	10347.87^b
T_5 – Full Carrageenan plus 100% Goat Manure	17.12^{ab}	12.89^b	10744.40^b
T_6 – Full Goat Manure	11.86^d	9.94^d	8286.17^d
F-RESULTS	*	**	**
C.V. (%)	5.76	1.79	1.95

Note: Means with common letters are not significantly different with each Honest Significant Difference (HSD)
*-significant at 5% level
**-significant at 1% level

Cost of Return Analysis. The cost-return analysis provides valuable insights into the profitability of glutinous corn production using different fertilization treatments. The highest return, recorded at 200.57%, was achieved by the treatment using 120-20-30 kg NPK ha-1, indicating that inorganic fertilizer application remains the most economically viable option for maximizing profit. However, organic alternatives also demonstrated competitive returns, with T4 (75% Carrageenan plus 100% Goat Manure) at 180.83% and T5 (Full Carrageenan plus 100% Goat Manure) at 180.57%, proving that combining natural fertilizers like carrageenan and goat manure can still yield substantial financial benefits. Following closely, T3 (50% Carrageenan plus 100% Goat Manure) resulted in 174.93% return, showing a decreasing trend as carrageenan application was reduced. Meanwhile, T6 (Full Goat Manure) achieved a 146.61% return, and T2 (25% Carrageenan plus 100% Goat Manure) recorded the lowest return at 146.24%, suggesting that while goat manure alone offers sustainability benefits, its economic return may be slightly lower than treatments incorporating carrageenan.

This analysis highlights that while inorganic fertilizer provides the highest return, organic treatments combining carrageenan and goat manure are viable alternatives that still generate considerable profitability. Farmers looking for cost-effective yet eco-friendly fertilization strategies may find carrageenan and goat manure beneficial, as they improve soil health while maintaining competitive yield and profit margins.

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Table 5. Cost of Return Analysis in Hectare Corn Production Applied Carrageenan and Goat Manure.

TREATMENTS	Cost of Production	Gross Income	Net Income	ROI%
T_1	59858.48	179916.00	120057.52	200.57
T_2	46025.00	127957.00	67307.50	146.24
T_3	51650.00	147624.45	90349.45	174.93
T_4	57275.00	155218.05	103568.05	180.83
T_5	60650.00	161166.00	109516.00	180.57
T_6	50400.00	124292.55	73892.55	146.61

Cost of Glutinous Corn-P 15.00/kg

Soil Analysis Before the Conduct of the Study

pH, Organic Materr, Phosphorus and Potassium levels before conducting the study. The soil analysis before the study is conducted is reflected in Table 6. The pH was ranged from 7.20, and a soil pH level of 7.20 falls in the neutral to slightly alkaline range. This is generally acceptable for corn production, but slightly acidic soil (around pH 6.0 to 6.8) tends to be more optimal. It also appeared that organic matter ranged from 2.36; when soil analysis shows an organic matter level of around 2.36%, it generally falls within a moderate range. A soil organic matter level of 2.36% helps in holding moisture, which is beneficial during dry periods; however, if soil organic matter is at 2.36%, managing residue, applying organic amendments like compost or manure, and using cover crops can help maintain or improve this level for optimal corn production. Availability of phosphorus ranged from 18.25. In soil analysis for corn production, available phosphorus (P) is a crucial nutrient influencing root development, energy transfer, and overall crop yield. A phosphorus level of 18.25 ppm (parts per million) falls within a moderate range, meaning the soil has a decent phosphorus supply but might need supplementation depending on other soil factors. Corn requires adequate phosphorus for early growth, firm stalks, and kernel development. If the soil test shows 18.25 ppm, it may be sufficient for moderate yields, but higher levels could be needed for maximum productivity. Regarding potassium availability, a soil test result indicating an available potassium level of 280.73 mg/kg (or ppm) suggests a moderate to high potassium concentration. Ideal potassium levels for optimal corn production generally range between 150–300 mg/kg, depending on soil type, cropping history, and environmental conditions. If the soil test shows 280.73 mg/kg, this suggests a sufficient potassium level for healthy crop development.

Soil Analysis after the Conduct of the Study

Soil analysis following the application of Carrageenan and Goat Manure in sweet pearl corn production reveals crucial changes in soil health and nutrient composition. The pH levels across treatments ranged from 6.25 to 7.45, indicating that organic amendments helped maintain a neutral to slightly alkaline soil environment, which is ideal for nutrient availability. Organic matter content was highest in Treatments 2, 3, 4, and 6, demonstrating that goat manure significantly contributed to soil fertility and improved microbial activity. Phosphorus levels varied, with Treatment 6 showing the highest concentration (255.97 mg/kg), followed by Treatment 2 (219.14 mg/kg) and Treatment 4 (200.99 mg/kg), suggesting enhanced phosphorus retention from organic inputs. Potassium levels were notably high in Treatments 3 and 4, exceeding 1,200 mg/kg, highlighting the ability of goat manure to release potassium essential for plant resilience. However, some treatments recorded "ND" (not detected) for potassium, possibly due to variable absorption rates or soil leaching effects. Overall, the results suggest that Carrageenan and Goat Manure positively influenced soil health by boosting organic matter, phosphorus, and potassium levels, making them viable alternatives to synthetic fertilizers for sustainable and productive farming.

Table 6. Soil Analysis Before and After Conduct of the Study.

Report Analysis before Conduct of the Study			
pH	Organic Matter %	Available Phosphorus, P ppm	Available Potassium, K ppm
7.20	2.36	18.25	280.73

Report Analysis after Conduct of the Study				
Treatment	pH	Organic Matter%	Available Phosphorus P ppm	Available Potassium K ppm

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T1	6.25	3.11	67.90	277.65
T2	7.11	6.69	219.14	ND
T3	7.42	6.26	193.33	1312.48
T4	7.30	6.22	200.99	1234.22
T5	7.45	4.67	151.96	963.80T6
T6	7.23	6.33	255.97	ND

Soil Analysis

Conclusion

Based on the result of the study, glutinous corn applied with carrageenan and goat manure as a source of nutrients responded favorably, as shown in their growth and yield performance. However, considering the return on investment, plants applied with Full Carrageenan plus 100% Goat Manure (T_5) and 120-20-30 kg NPK ha^{-1} (T_1) produced the highest return.

Recommendations

Based on the result of the study, plants applied with carrageenan and goat manure as organic fertilizer are recommended as a source of nutrients for Sweet Pearl Glutinous Corn. Such nutrient management practices are highly recommended since their effects have been proven to improve the overall performance of glutinous corn production. Further study for this line is recommended to attain a more inclusive result.

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