International Journal of Agriculture and Animal Production
ISSN 2799-0907
Vol : 03 , No. 04 , June-July 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.34.1.11

Granular Bioorganic Chicken Manure and Banana Peel (Musa Paradisiaca): an Alternative to Complete Fertilizer (14-14-14) for Rice Production

Feona S. Carollo[1*], Marvhel A. Lampa[2], James Carlo P. Frias[3]

[1*,2,3]*Department of Education, Pamplona National High School, Camarines Sur –Philippines.*

Email: [2]lmarvhel@gmail.com, [3]james.carlofrias@deped.gov.ph
Corresponding Email: [1]feonacarollo@gmail.com*

Received: 02 February 2023 **Accepted:** 18 April 2023 **Published:** 02 June 2023

Abstract:** This study explored the prospect of granular bioorganic chicken manure and banana peel (Musa paradisiaca) as an alternative to complete fertilizer (14-14-14) for rice production. It sought to attain the following objectives: (1) determine the level of effectiveness of granular chicken manure and banana peel mixture as an alternative fertilizer for rice production; (2) create a comparative analysis between the yields produced with the alternative fertilizer and complete fertilizer (14-14-14); and (3) assess the advantages, disadvantages, and effects of the organic fertilizer application on rice cultivation through observations. The data for the study were obtained through an experimental-evaluative method. To analyze the gathered data, descriptive statistics were used, specifically the measure of central tendency (MCT) using the mean and percentage of the sample and the measure of variability (MOV) using range. The chicken manure (CM) was air-dried for eight months, while the banana peel (BP) was stripped and solar-dried for three to five days. These were applied in different treatments: (T1) no application (pure application of complete fertilizer (CF)); (T2) a mixture of 1.225 kilograms (kg) of CM and 0.5 kg of BP applied with 50% of the CF in T1; (T3) a mixture of 2.45 kg of CM and 1 kg of BP; and (T4) a mixture of 3.675 kg of CM and 1.5 kg of BP. Considering the average height, rate of growth, and rate of water absorption, the results revealed that the treatment with an application of both organic fertilizer and complete fertilizer generated the highest level of effectiveness compared to the treatments with a pure application of either complete or organic fertilizer. However, when it comes to product yields, the treatment that had the highest product yield and number of panicle initiations during the reproductive phase was T3, the treatment with a standard application of organic fertilizer. Nonetheless, these implied that the mixture of chicken manure and banana peel could be an economical alternative to complete fertilizer for rice production.

International Journal of Agriculture and Animal Production
ISSN 2799-0907
Vol : 03 , No. 04 , June-July 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.34.1.11

Keywords: Banana Peel, Chicken Manure, Complete Fertilizer, Rice Production.

1. INTRODUCTION

One of the major agricultural crops in the Philippines is rice. It is planted and harvested twice a year; September to February (peak in November to December) is the Semester 1 (dry season), and April to August (peak in June to July) is the Semester 2 (wet season) (Gutierez et al., 2019). In addition, it is the staple food for most of the 112.1 million Filipinos (Worldometer, 2022), and its cultivation is considered as the most important agricultural sector in the country's production and consumption among the other branches of agriculture (livestock, poultry, and fisheries) (Dimas, 2021). Furthermore, rice farming is the source of income and employment of 11.5 million farmers, serving as the main source of livelihood for 25-30 percent of the labor force in agriculture (Food and Agriculture Organization of the United Nations, 2022).

Due to the disruption of COVID-19 pandemic in the agricultural sector during the first quarter of year 2020, approximately 3.11 percent or 17.03 million tons in aggregate volume of agricultural production in Southeast Asia was reduced (Gregorio & Ancog, 2020). Aside from the decline in agricultural farm labor that affected 100.77 million individuals, the Philippines' total land area for rice cultivation also decreased from 4.80 million hectares to 4.72 million hectares according to the annual publication of the Philippine Statistics Authority (PSA), The Palay Production in the Philippines 2018-2020. Despite these, the palay (unhusked rice) production in the country was still higher by 2.6 percent in 2020 than the 1.3 percent output in 2018 and 18.81 million metric tons in 2019. Along with this is the increase in yield per hectare and rate of commercial fertilizer application in palay (PSA, 2021).

Although there is an increase in rice production and yield per hectare of palay, the higher costs and reduced access to human labor, machinery, animal, seeds, irrigation, fuel, fertilizers, pesticides, and herbicides due to the restrictions to reduce the spread of corona virus (McDermott et al., 2022) compel rice farmers and entrepreneurs to sell their harvest or palay products at higher costs. Otherwise, the high energy inputs would outweigh the energy outputs comprising rice yield and husk, resulting in financial loss. However, not all smallholder farmers and Micro, Small and Medium Enterprises (MSME's), including retailers and regular consumers, can conform to the constantly rising prices of energy inputs and products. For this reason, offering an economic and organic alternative to one of the inputs, complete fertilizer, is a way to address this problem.

The application of chemical and organic fertilizer has both positive and negative effects on plant growth and the soil. Chemical fertilizers, also known as inorganic, synthetic, commercial, or artificial fertilizers are made from inorganic materials along with chemical fillers including petroleum products and rocks (ECO Gardener, 2018). The usage of inorganic fertilizers for production of crops has been proven effective (Singh & Kumar, 2019) as it offers high nutrient content, with predictable results, and is taken rapidly by plants. However, excessive use of synthetic fertilizers can result in varieties of problems such as: soil carbon loss, organic soil matter reduction, compaction of soil, nitrogen leaching, serious degradation of soil (Lin et al., 2019), and other potential threats for the health and environment of soil, plants and humans as well. On the other hand, organic fertilizers offer multiple benefits such as: improvement in the productivity of soil, increased soil nutrient availability due to increased soil microbial activity, decomposition of harmful elements, etc. (Han et al., 2016). It is more beneficial than artificial fertilizers for the reason that it preserves soil properties and increases soil productivity (Assefa & Tadesse, 2019). Be that as it may, it still has a number of shortcomings, such as low nutrient content, slow decomposition, and different nutrient compositions depending on the organic materials, compared to chemical fertilizers (Han et al., 2016). Nevertheless, the use of natural fertilizer as an alternative to complete fertilizer is a substantial solution to high-priced and constantly rising prices of fertilizers for it is relatively economical and safer than the counterpart.

The macro nutrients needed for rice production are: nitrogen(N) for plant growth and development, photosynthesis, yield, quality and biomass of rice (Zhang et al., 2020), phosphorus(P) or phosphate (P_2O_5) for root development, flower formation and seed production, uniform and early crop maturity, and resistance to plant diseases (The Mosaic Company, 2022), and potassium(K) or potash(K_2O) for cell growth and quality improvement (Xu et al., 2020). According to EcoChem, a company helping to put the principles of sustainability into practice in a Global Market (2014), one of the excellent fertilizers containing these nutrients is manure. There are various types of manure, but chicken manure is the most preferable as it is an excellent source of N, P, and K, and can supply calcium (Ca), magnesium (Mg), and sulfur(S) (Buabeng, 2017). Research regarding chicken manure as a variable for organic fertilizer has been approved and accepted by the Agricultural Community, and has been widely implemented and used by our local farmers and several agriculturists all over the country. Its NPK ratio is 5 - 2 - 1 (The Nutrient Company, 2022). Furthermore, banana peels *(Musa paradisiaca)* can also be a good source of Ca, P, Mg, and iron (Fe) (Hassani, 2022). Its NPK ratio on a dry weight basis is 0.6 - 0.4 - 11.5 (Pavlis, 2022). It has a high potassium content which will complement the chicken manure for lacking K content. Consequently, the mixture of these variables can be a bioorganic alternative to complete fertilizer (14-14-14) as it contains all the main nutrients essential for rice cultivation.

2. METHODOLOGY

This study used an evaluative-experimental method to identify the effectiveness of using chicken manure with banana peel *(Musa paradisiaca)* as an alternative to chemical complete fertilizer (14-14-14). Evaluative method was used in determining the level of effectiveness and compatibility of using chicken manure and banana *(M. paradisiaca)* mixture while the experimental method was used to determine which formula of the organic fertilizer mixture applied to varying treatments was the most effective.

As an experimental research, the natural resources found in the local area were used in this study. It was applied in four varying treatments: (1) complete (14-14-14) fertilizer applied simultaneous with the application of fertilizer on rice fields in Pamplona, Camarines Sur (soil analysis was not conducted due to the limited duration of experimentation, observation, and resources of the researchers), (2) mixture of 1.225 kilograms eight-month-old chicken manure (CM) and 0.5 kg banana peel (BP), (3) combination of 2.45 kg CM and 1 kg BP, and (4) 3.675 kg CM and 1.5 kg BP mixture. These variables, excluding in the first treatment, was applied 3 days prior to planting.

This study underwent a preparation of the organic fertilizer, composed of chicken manure and banana peel, as well as main land preparations, seed selection and management, seedbed and seedling management, and water and field management up until harvesting and yield counting.

A. Preparation of Chicken Manure. During the preparation of chicken manure, it was air-dried for eight months at Caranan, Pasacao, Camarines Sur and was transported in bags a week prior to application.

B. Preparation of Banana Peel. The banana peel was acquired from vendors of banana-based products in Poblacion, Pamplona, Camarines Sur. It was separated from its neck to attain the maximum amount of potassium (Bellomo, 2016). Moreover, it was manually stripped before solar drying for three to five days.

C. Observation of the condition of the four treatments. The researchers observed the height of the rice plants, rate of increase in growth, rate of water absorption, average number of leaf and its colour and appearance, emergence of grass, infestations, panicle initiation, number of deceased plants, and product yield, for eleven (11) weeks.

D. Research Setting. The study was conducted at Zone 1, San Vicente, Pamplona, Camarines Sur as it was the agreed location of the experiment due to the convenience of soil transportation during the main land preparations, and favorable setting for weekly observation.

E. Research Instrument. In determining the level of effectiveness of the organic mixture of chicken manure and banana peel in comparison with the controlled variable (complete fertilizer), an observation sheet in matrix form was used to record pertinent data and provide information about the variables asked in this study. Components of matrix form include the matrix title, site location, land area per treatment, rice variety, instrument used, volume of water, a number of treatments, time and date, temperature, relative humidity, and height of the palay. The instruments used during the experimentation of this study were a hygrometer (to measure the temperature, time, and relative humidity), a ruler and measuring tape (to measure the height of the plants), a pail with a computed volume of water used to fetch water as an alternative irrigation method, and a digital weighing scale to weigh the rice yields of each treatment.

F. Data Gathering Procedure. The researchers prepared four treatments with different amounts of the variables (chicken manure and banana peel) including the complete fertilizer. Observation and data gathering on the growth and development of the rice plant were done within 3 months and a week (September 22, 2022 - December 1, 2022). A weekly observation (6:00 pm–8:00 pm) was done to observe any progress in the growth and development of the rice plant. The data recording the height of the plants, temperature, time, and relative humidity for every observation was all noted on a data sheet in a matrix format.

Research Elaborations

During the conduct of the experiment in the study, four treatments were observed for eleven (11) weeks: (T1) complete (14-14-14) fertilizer applied 21 days after transplanting (14-14-14); (T2) a mixture of 1.225 kilograms of eight-month-old chicken manure (CM) and 0.5 kilograms of banana peel (BP) applied with 50% of CF in treatment 1 (OF+CF); (T3) a standard formulation of organic fertilizer (2.45 kg CM and 1 kg BP) (Hassani et al., 2022) (Johnson, n.d.); and (T4) a mixture of 3.675 kg CM and 1.5 kg BP applied three days prior to the transplanting of 350 seedlings (50 hills) per treatment.

International Journal of Agriculture and Animal Production
ISSN 2799-0907
Vol : 03 , No. 04 , June-July 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.34.1.11

In the first and second weeks of observation, all of the seedlings in all treatments grew simultaneously, with an average height ranging from 11.22 centimeters (cm) to 11.88 cm at a mean relative humidity ranging from 91.5% to 93% and a temperature range of 26.95° Celcius (C) to 28.05 °C. This implied that there was no significant outlier in the population. In spite of this, there was a considerable difference in the rate of increase in growth among the four treatments: SOF had the lowest rate (21.95%), followed by SOF+AP with a rate of 24.23%, and CF with 29.32%, while the treatment with the fastest increase in growth rate (33.87%) was OF+CF. The treatments with the application of the organic fertilizer mixture alone (SOF and SOF+AP) had low rates of increase in growth due to the natural property of organic fertilizers to release nutrients slowly (Shaji et al., 2021). In SOF+AP, it was only increased by 10.39%, considering the 50% additional application of SOF. In CF, the expected rate of increase in growth was met given that synthetic fertilizers immediately release nutrients since they are highly soluble (Sabry, 2015). Consequently, the treatment with an application of both organic and complete fertilizer had the fastest rate by balancing the nutrient availability for the seedlings as the OF fed the soil and the CF fed the plants. These observations implied that the amount of both organic and complete fertilizer applied was directly proportional to the rate of increase in the growth of rice seedlings.

	Rate of Increase in Growth (WEEK 1 & 2)							
Week	1	2	1	2	1	2	1	2
Treatment	CF		OF+CF		SOF		SOF+AP	
Average Height	9.782 cm	12.66 cm	10.166 cm	13.61 cm	10.66 cm	13 cm	10.046 cm	12.48 cm
RIG	29.42%		33.87%		21.95%		24.23%	

Table I. Comparison of Rate of Increase in Growth in T1, T2, T3, and T4 for Week 1 & 2

Considering the equal volume of water poured, a significant difference in water absorption in four treatments were also observed. One of the factors that influenced this was the capacity of soil to retain its structure under conditions that may cause compaction, or simply the aggregate stability (WSA%) of the soil (Zhou et al., 2020). According to Zhou et al.(2020) of the Department of Biological Center, China, water-stable aggregates increase with manure application. Hence, the treatments with an application of pure organic fertilizer (SOF and SOF+AP) were muddier than the treatments with synthetic fertilizer (CF and OF+CF), which helped the soil resist water erosion and made the water absorption faster than in CF and OF+CF. On the other hand, the soil in T1 and T2 was compact, which made the water retention in each treatment longer than in T3 and T4. These observations implied that the type of fertilizer applied influences the rate of water absorption in soil. Regardless, two to three seedlings in 13–23 hills per treatment, showed signs of wilting and nutrient deficiency, particularly on the seedlings located at the outermost part of every plot. Older leaf tissues were erect, spindly, and appeared yellowish green.

In the third week of observation, significant outliers were observed in T3 and T4. In T3, the average height of the four hills was below 10 cm, while one hill grew more than 25 cm in SOF. Moreover, nine hills were necrotic, and seven hills had minimal tillers on the plant at an average relative humidity of 79% and temperature of 28.5 °C. In T4, the average height of the seven

International Journal of Agriculture and Animal Production
ISSN 2799-0907
Vol : 03 , No. 04 , June-July 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.34.1.11

hills was below 10 cm, while the rest of the plants' height ranged from 10 cm to 26 cm. Furthermore, at an average relative humidity of 84% and temperature of 27.3 °C, all the leaves of the 14 hills had dried tips, and eight hills had minimal tillers. Compared to T1 and T2, all plants grew in a height range of 14 cm to 26.5 cm, and the number of leaves per hill was approximately between 10 and 24. However, only T2 had the highest average height (21.79 cm) and a constantly high number of green leaves (15 to 24). Among the four treatments, it also had the fastest rate of increase from week 3 to week 4, at 24.93%, followed by CF (20.28%), SOF (19.91%), and SOF+AP (18.01%).

	Rate of Increase in Growth (WEEK 3& 4)							
Week	3	4	3	4	3	4	3	4
Treatment	CF		OF+CF		SOF		SOF+AP	
Average Height	17.93 cm	22.6 cm	21.79 cm	28.07 cm	16.87 cm	21.56 cm	16.16 cm	19.86 cm
RIG	26.04%		28.82%		27.8%		22.89%	

Table II. Comparison of Rate of Increase in Growth in T1, T2, T3, and T4 for Week 3 & 4

In the fourth and fifth weeks, the chicken manure and banana peel were utilized at their maximum rate during the production cycle of the organic fertilizer (30–45 days). Hence, unlike in the first and second weeks of observation, SOF had the highest rate (12.41%) of increase in growth among the four treatments, followed by SOF+AP with 5.54%, then CF (2.35%), and lastly, OF+CF with the lowest rate (1.45%). Despite this, considering the fifth and sixth weeks of observation, T2 had the highest average height (35.37 cm), along with T3, followed by CF (26.65 cm), and SOF+AP (26.23 cm). Nonetheless, no defects, diseased leaves, or nutrient deficiencies manifested in all treatments.

On the other hand, grass and broadleaf weeds (e.g., knotgrass (Paspalum distichum), goose grass (Eleusine indica), cockspur grass (Echinochloa crus-galli), water spinach (Ipomoea aquatica), and false daisy (Eclipta prostrata) (IRRI Rice Knowledge Bank, n.d.) emerged first in T3 and T4, where the organic fertilizer was most concentrated, rather than in T1 and T2. This was because of the nitrogen provided by the chicken manure, which promoted the green leaves of the weeds and generated energy for root growth and disease prevention (Leghari et al., 2016). However, according to the published study by Rahman (2022), crops with high nitrogen levels are more susceptible to pest attacks due to the alteration of plant tissue nutrient levels, causing nutrient imbalance and low pest resistance. Moreover, the ability of a crop to resist or endure insect pests and diseases is linked to appropriate physical, chemical, and, most importantly, biological soil qualities. Hence, insects, such as the green semi-looper, rice bug, field cricket, plant hopper, field cricket, green leafhopper, and grasshopper, began to infest the treatments, mostly with complete fertilizer application (T1 and T2) than with treatments with organic fertilizer application (T3 and T4).

In the sixth to seventh week of observation, the remaining rice plants in every treatment reached their maximum tiller number and reproduction phase (35 days). Thus, the rate of increase in growth during this week was the lowest among the previous weeks of observation (2.68%). Unfortunately, on October 27, 2022, a tropical storm intensified over the Philippine Area of Responsibility (ABS-CBN News, 2022), affecting the whole Bicol region. This circumstance

International Journal of Agriculture and Animal Production
ISSN 2799-0907
Vol : 03 , No. 04 , June-July 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.34.1.11

negatively influenced the condition of the plants in all treatments: yellowish-brown leaf areas around the margin of leaf tissue began to appear and eventually dried up; 21 plants (three hills) were deceased in SOF, 28 plants (4 hills) in CF, and 49 plants (7 hills) in SOF + AP. The respective average height of the remaining plants was 31.40 cm at 93.5% relative humidity and 25.65°C average temperature, 27.13 cm at 96% and 25.35°C, and 27.77 cm at 93.5% and 25.35°C. Although all of the plants in OF+CF survived the storm, the leaves were severely damaged by the gusts and wind.

	Rate of Increase in Growth (WEEK 5 & 6)							
Week	5	6	5	6	5	6	5	6
Treatment	CF		OF+CF		SOF		SOF+AP	
Average Height	26.34 cm	26.96 cm	35.11 cm	35.62 cm	27.54 cm	30.98 cm	25.52 cm	26.94 cm
RIG	2.35%		1.45%		12.41%		5.54%	

Table III. Comparison of Rate of Increase in Growth in T1, T2, T3, and T4 for Week 5 & 6

In the eighth and ninth weeks of observation, the plants were in their reproductive stage, so further growth was no longer anticipated. In this phase, panicle initiation to flowering was evident; however, it was only true for 52% (26 hills) of the sample in T1, 56% (28 hills) in T3, and 54% (27 hills) in T4. Compared to these treatments, T2 had the highest number of panicle initiations at 80% (40 hills). In spite of this, it had the most damaged and dried leaves caused by the storm, followed by T1, which affected some of the plants by reducing the panicle initiation and delaying the development to maturity of the panicles. Furthermore, the number of deceased plants increased in every treatment except T2: 16% in T1 (8 hills), 8% in T3 (4 hills), and 12% in T4 (6 hills).

	Rate of Increase in Growth (WEEK 7& 8)							
Week	7	8	7	8	7	8	7	8
Treatment	CF		OF+CF		SOF		SOF+AP	
Average Height	27.3 cm	25.78 cm	36.86 cm	37.62 cm	31.81 cm	33.36 cm	28.6 cm	33.44 cm
RIG	-5.56%		2.06%		4.87%		16.92%	

Table IV. Comparison of Rate of Increase in Growth in T1, T2, T3, and T4 for Week 7 & 8

During the tenth and eleventh weeks of observation, the plants were at their ripening stage, and the flowers developed into grains. These grains have ripened in the last two to three weeks, changing their color from green to yellow and their leaf color from greenish yellow to greenish brown. However, asynchronous flowering and grain ripening were observed in all treatments. Also, due to the storm and pests that fed on the leaves and panicles in the eighth and ninth weeks, the yields produced were minimal. Moreover, rice husks (empty grains) and frail grains were evident as much as sturdy grains during the harvest. During the cleaning of the setting of the study, after the plants were already dug out of the soil, white rice husks were observed on the land. It was highly concentrated in T3, followed by T4, and T2, where the organic fertilizer was applied. It was only absent in T1, where there was a sole application of complete fertilizer.

These observations implied that the kind of fertilizer applied to the soil influenced the post-harvest state of the crop and soil.

Considering the product yields in four treatments, weighed on a fresh weight basis, the treatment with the standard application of the organic fertilizer (SOF) or (T3) had the heaviest weight with 0.47 kilogram (kg), followed by OF with an application of CF (OF + CF) (0.45 kg), then SOF with an additional application of the organic fertilizer (SOF + AP) (0.45 kg), and lastly, the treatment with the complete fertilizer application (0.185 kg).

3. RESULTS OR FINDINGS

Considering the average height, rate of growth, and rate of water absorption, which influenced the water retention in the soil and the overall state of the rice plants, the results revealed that among the four kinds of treatments (T1: pure complete fertilizer (CF), T2: application of both the organic fertilizer (OF) and CF (OF+CF), T3: pure standard application of the organic fertilizer (SOF), and T4: SOF plus the additional application of the organic fertilizer (SOF + AP), OF + CF was the most effective, followed by SOF, then SOF + AP, and lastly, the CF.

The results also revealed that the treatment with the heaviest product yield on a fresh-weight basis was the treatment with a standard application of organic fertilizer (SOF), followed by OF + CF (application of both organic and complete fertilizer), then SOF with an additional application of OF, and lastly, the treatment with an application of pure complete fertilizer.

Regardless of amount, the application of organic fertilizer on rice cultivation increased the rate of growth of plants, water absorption, panicle initiation, and development to maturity of grains. It also made the soil less compact, improving the aggregate stability of the soil. Moreover, insects and pests were less attracted to the treatments with organic fertilizer applications. However, due to the natural slow release of nutrients, asynchronous growth of plants was observed. Various weeds also emerged first in treatments with the organic fertilizer application. Furthermore, although abundant, the preparation and utilization of the organic chicken manure and banana peel took one to three weeks, unlike complete fertilizer, which was immediately utilized.

4. CONCLUSION

The findings endorsed that the treatment with an application of both organic fertilizer and complete fertilizer generated the highest level of effectiveness compared to the treatments with a pure application of either complete or organic fertilizer. According to the published article entitled Three Reasons for Adopting a Hybrid Fertilizer Program (2021), a self-sustaining ecosystem can be achieved with the right application of both organic and synthetic fertilizer, as the chemical fertilizer provides the immediate nutrients that the plants need while the organic fertilizer supplies long-term nutrients for the microorganisms to thrive in the soil. However, when it comes to product yields, the most effective treatment was SOF. It also had the highest number of panicle initiations during the plant's reproductive phase.

Regardless, it was also concluded that the application of organic fertilizer in rice farming mainly affects and influences the plants from seedling to maturity, the quality of the soil, and the yields produced. Compared to complete fertilizer, it is more cost-efficient, safe, and abundant; however, it is inconvenient to prepare for the farmers and offers uncertain nutrient availability for the plants. Thus, actual nutrient requirements may or may not be met.

Acknowledgment
The authors of this research study express their gratitude to Pamplona National High School for granting permission to accomplish this study. Moreover, a profound appreciation is given to IMCCRT organizing committee for accepting the paper to be presented in research colloquium making the study reach many people. A humble acknowledgment is also given to everyone who has contributed and made this research study possible and successful. Thank you, everyone.

5. REFERENCES

1. ABS-CBN News. (2022, September 7). Cyclone to enter PAR now a tropical storm: PAGASA. ABS-CBN News. https://news.abs-cbn.com/news/09/07/22/cyclone-to-enter-par-now-a-tropical-storm-pagasa
2. American Plant Food. (2021). Three Reasons for Adopting a Hybrid Fertilizer Program. American Plant Food. https://americanplantfood.com/three-reasons-for-adopting-a-hybrid-fertilizer-program/
3. Assefa, S. (2019). The Principal Role of Organic Fertilizer on Soil Properties and Agricultural Productivity -A Review. Juniperpublishers.Com. https://doi.org/10.19080/ARTOAJ.2019.22.556192
4. Bellomo, R. O. (2020, September 23). You've Been Throwing Away The Best Part Of The Banana. Delish. https://www.delish.com/food-news/a45812/why-you-should-eat-banana-peels/
5. Buabeng, F. (2017). Performance Analysis of Three Sustsainable Green Technologies for Delmarva Broiler Production. 10.13140/RG.2.2.27943.65442 - Scientific Figure on ResearchGate. https://www.researchgate.net/figure/Nutrient-content-of-livestock-and-poultry-manures-g-kg-1-dw_tbl5_326877151 [accessed 12 Apr, 2023]
6. (Dimas, 2021). Rice cultivation is considered as the most important agricultural sector in the Philippines' production and consumption among the other branches of agriculture (livestock, poultry, and fisheries)
7. EchoChem. (2014). Manure is an excellent fertilizer. http://ecochem.com/t_manure_fert.html
8. Food and Agriculture Organization of the United Nations. (2022). Philippines at a glance | FAO in the Philippines |. https://www.fao.org/philippines/fao-in-philippines/philippines-at-a-glance/en/
9. Gardener, E. (2018). The Pros and Cons of Organic and Chemical Fertilizers. ECOgardener. https://ecogardener.com/blogs/news/the-pros-and-cons-of-organic-and-chemical-fertilizers
10. Gregorioa, G. B., & Ancog, R. C. (2020). Assessing the Impact of the COVID-19 Pandemic on Agricultural Production in Southeast Asia: Toward Transformative Change in Agricultural Food Systems. Asian Journal of Agriculture and Development, 17(1), 1–

13.
https://doi.org/10.22004/ag.econ.303781hl=en&scisbd=1&as_sdt=0%2C5&q=contribution+of+rice+production+in+the+philippines&oq=contribution+of+rice+production+#d=gs_qabs&u=%23p%3DUgEWnEIVdQEJ

11. Gutierrez, M. A., Paguirigan, N. M., Raviz, J., Mabalay, M. R., Alosnos, E., Villano, L., ... & Laborte, A. (2019). The Rice planting window in the Philippines: An analysis using multi-temporal SAR imagery. The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 42, 241-248.https://noa.gwlb.de/servlets/MCRFileNodeServlet/cop_derivate_00049529/isprs-archives-XLII-4-W19-241-2019.pdf
12. Han, S. H., An, J., Hwang, J., Kim, S. B., & Park, B. J. (2016). The effects of organic manure and chemical fertilizer on the growth and nutrient concentrations of yellow poplar (Liriodendron tulipiferaLin.) in a nursery system. Forest Science and Technology, 12(3), 137–143. https://doi.org/10.1080/21580103.2015.1135827
13. Hassani, N. (2022). Using Chicken Manure as Garden Fertilizer. The Spruce. https://www.thespruce.com/chicken-manure-fertilizer-5189920
14. Leghari, S. J., Wahocho, N. A., Laghari, G. M., HafeezLaghari, A., MustafaBhabhan, G., HussainTalpur, K., ... & Lashari, A. A. (2016). Role of nitrogen for plant growth and development: A review. Advances in Environmental Biology, 10(9), 209-219.
15. Lin, W., Lin, M., Zhou, H., Wu, H., Li, Z., & Lin, W. (2019). The effects of chemical and organic fertilizer usage on rhizosphere soil in tea orchards. PLoS ONE, 14(5). https://doi.org/10.1371/journal.pone.0217018
16. McDermott, J., & Swinnen, J. (Eds.). (2022). COVID-19 and global food security: Two years later. Intl Food Policy Res Inst.https://books.google.com.ph/books?id=tjFjEAAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
17. Pavlis, R. (2023, March 3). The Magical Power of Banana Peels in The Garden - Or Not - Garden Myths. Garden Myths. https://www.gardenmyths.com/banana-peels-garden/
18. Philippines Population (2023) - Worldometer. (n.d.). https://www.worldometers.info/world-population/philippines-population/Philippine Statistics Authority .GoogleDocs.(2021).Palay Production in the Philippines, 2018-2020.pdf.https://drive.google.com/file/d/1TATOsgzDFoKSjrxE0oPOMYY5sA7k1ROC/view?usp=drivesdk
19. Rahman, K. M. Z. (2022). Effects of nitrogen fertilization on crops and their associated insect communities: a global food security perspective. Asian-Australasian Journal of Food Safety and Security, 6(2), 48-56.
20. Sabry, K. H. (2015). Synthetic Fertilizers; Role and Hazards. ResearchGate. https://doi.org/10.13140/RG.2.1.2395.3366
21. Shaji, H., Chandran, V., & Mathew, L. (2021). Organic fertilizers as a route to controlled release of nutrients. Elsevier eBooks, 231–245. https://doi.org/10.1016/b978-0-12-819555-0.00013-3
22. Singh, T. B., Ali, A., Prasad, M., Yadav, A., Shrivastav, P., Goyal, D., & Dantu, P. K. (2020). Role of organic fertilizers in improving soil fertility. Contaminants in agriculture: sources, impacts and management, 61-77.

International Journal of Agriculture and Animal Production
ISSN 2799-0907
Vol : 03 , No. 04 , June-July 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.34.1.11

23. The Mosaic Company. (2022).Mosaic Crop Nutrition. Phosphorus - Nutrient Management. https://www.cropnutrition.com/nutrient-management/phosphorus
24. The Nutrient Company. (2022.). Organic NPK values. https://thenutrientcompany.com/blogs/horticulture/npk-value-of-everything-organic-database
25. Xu, X., Du, X., Wang, F., Sha, J., Chen, Q., Tian, G., ... & Jiang, Y. (2020). Effects of potassium levels on plant growth, accumulation and distribution of carbon, and nitrate metabolism in apple dwarf rootstock seedlings. Frontiers in Plant Science, 11, 904.https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Effects+of+Potassium+Levels+on+Plant+Growth%2C+Accumulation+and+Distribution+of+Carbon%2C+and+Nitrate+Metabolism+in+Apple+Dwarf+Rootstock+Seedlings&btnG=
26. Zhang, J., Tong, T., Potcho, P. M., Huang, S., Ma, L., & Tang, X. (2020). Nitrogen effects on yield, quality and physiological characteristics of giant rice. Agronomy, 10(11), 1816. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Nitrogen+Effects+on+Yield%2C+Quality+and+Physiological+Characteristics+of+Giant+Rice&btnG=
27. Zhou, M., Chunzhu, L., Wang, J. J., Meng, Q., Yuan, Y., Ma, X., Liu, X., Zhu, Y., Ding, G., Zhang, J., Zeng, X., & Du, W. (2020). Soil aggregates stability and storage of soil organic carbon respond to cropping systems on Black Soils of Northeast China. Scientific Reports. https://doi.org/10.1038/s41598-019-57193-1