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EVALUATING THE EFFECTIVENESS OF POULTRY MANURE IN IMPROVING SOIL QUALITY AND REDUCING THE EFFECTS OF PESTICIDES

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Abstract

Increasing agricultural productivity is one of the main objectives in the agriculture industry as the expanding population demands that there be adequate food available. In an effort to do this, farmers usually apply a lot of chemical fertilizers and synthetic pesticides to aid in plant growth and protect crops from pests and diseases. This study will evaluate poultry manure's capacity to improve soil quality and mitigate the impacts of pesticides. The methodology used in this study blends a qualitative approach with a literature study strategy. This study used secondary data from a range of literature sources, including credible websites, journal papers, and scientific publications. The study claims that poultry manure has been demonstrated to improve soil quality and plant growth while reducing the negative impacts of chemical pesticide use. Because of its high content of organic matter and macronutrients including nitrogen, phosphorus, and potassium, poultry manure is a biological agent that may improve soil structure, increase cation exchange capacity, and encourage the activity of soil microbes.

Keywords: Evaluating Effectiveness, Poultry Manure, Soil Quality, Pesticides

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تقييم فعالية سماد الدواجن في تحسين جودة التربة والحد من آثار المبيدات الحشرية

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الملخص

يُعدّ رفع الإنتاجية الزراعية أحد الأهداف الرئيسية في القطاع الزراعي، حيث يتطلب تزايد عدد السكان توفير الغذاء الكافي. ولتحقيق ذلك، يلجأ المزارعون عادةً إلى استخدام كميات كبيرة من الأسمدة الكيميائية والمبيدات الحشرية الاصطناعية لدعم نمو النباتات وحماية المحاصيل من الآفات والأمراض. تهدف هذه الدراسة إلى تقييم قدرة سماد الدواجن على تحسين جودة التربة والحد من آثار المبيدات الحشرية. وتعتمد منهجية هذه الدراسة على مزيج من البحث النوعي ودراسة الأدبيات ذات الصلة. استخدمت هذه الدراسة بيانات ثانوية من مصادر أدبية متنوعة، بما في ذلك مواقع إلكترونية موثوقة، ومقالات منشورة في دوريات علمية، ومطبوعات علمية. وتؤكد الدراسة أن سماد الدواجن أثبت فعاليته في تحسين جودة التربة ونمو النباتات، مع تقليل الآثار السلبية لاستخدام المبيدات الكيميائية. ونظرًا لاحتوائه على نسبة عالية من المواد العضوية والعناصر الغذائية الكبرى، بما في ذلك النيتروجين والفوسفور والبوتاسيوم، يُعد سماد الدواجن عاملًا بيولوجيًا قد يُحسّن بنية التربة، ويزيد من قدرتها على تبادل الكاتيونات، ويُحفّز نشاط الكائنات الحية الدقيقة في التربة.

الكلمات المفتاحية: تقييم الفعالية، روث الدواجن، جودة التربة، المبيدات الحشرية.

INTRODUCTION

Increasing agricultural productivity is one of the main objectives of the agriculture sector since the expanding population demands that there be adequate food available. In order to do this, farmers usually apply a lot of synthetic pesticides and artificial fertilizers to

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stimulate plant growth and protect crops from pests and diseases (Futa et al., 2023). Ongoing and excessive chemical usage, however, actually causes new problems that are hard to ignore, such degraded soil quality, environmental pollution, and harm to human health and other living things. A decrease in organic matter, structural disruption, and damage to soil microorganisms that are essential for plant nutrient absorption and breakdown cause once-fruitful soil to become less fertile (Tahat et al., 2020).

One of the numerous environmentally friendly practices that have arisen in agricultural sustainability that should be considered is the use of organic fertilizers. Organic fertilizers improve soil structure, increase cation exchange capacity, and encourage the growth of beneficial soil microorganisms in addition to assisting plants in obtaining macro and micronutrients (Liu et al., 2024). One type of organic fertilizer that shows promise and is widely available is fertilizer prepared from the feces of chickens, ducks, or quail. Poultry manure (see figure 1) is known to include microelements such as calcium and magnesium, as well as nitrogen, phosphorus, and potassium, all of which are essential for the life cycles of plants. Poultry manure is particularly helpful on dry or low-organic matter land because it improves water retention and speeds up the decomposition of organic matter in the soil (Sayed et al., 2024).

Figure 1. Fresh Poultry Manure (Dróżdż et al., 2022)

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Adding or replacing artificial fertilizers with chicken manure can improve the overall quality of the soil. According to Wang et al. (2024), a high organic matter content, loose soil structure, and a sufficient number and diversity of soil organisms are all signs of high-quality soil. With soil that has been maintained with organic matter, the carrying capacity of the soil is more stable over time, potentially reducing the need for external inputs such as chemical fertilizers and pesticides. It's also important to think about how chicken manure might help lessen the negative impacts of using pesticides. It is well recognized that overuse of pesticides reduces the amount of helpful microorganisms and increases resistance in target pests. Through improved soil conditions and balanced nutrient intake, poultry dung can help reduce dependency on chemical pesticides by boosting plants' natural resistance (Benbrook et al., 2021).

Research evaluating how efficiently poultry manure enhances soil quality and reduces the impacts of pesticides is badly required, especially in sustainable agriculture. As the importance of profitable and environmentally friendly farming techniques is increasingly acknowledged, scientific data is needed to support the deployment of ecologically sound agricultural technology (Armah et al., 2023). Farmers still commonly find it difficult to strike a balance between the need for high yields and the requirements of preserving environmental sustainability. The benefits of poultry manure for the biological, chemical, and physical properties of soil have been thoroughly studied and documented. In order to reduce the frequency and intensity of pesticide treatment, it also serves to encourage the growth of plants that are more resistant to insect attacks (Khan et al., 2024).

The utilization of chicken manure has important implications for animal waste management in addition to its agronomic benefits. Inappropriate management of chicken farm waste can result in stink, viral transmission, and groundwater pollution. By converting chicken waste into fertilizer, feces problems may be managed in a way that helps the agriculture sector (Zhang et al., 2022). This approach provides farmers and animal producers the potential for

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greater financial gain in addition to resolving environmental problems. Thus, in addition to concentrating on the technical aspects of agriculture, this study opens up possibilities for the combination of animal and agricultural systems into a single, sustainable, and circular production system.

Although poultry feces has a lot of potential, further study is required to ensure its effectiveness and safety. Factors that need to be considered include the balance of nutrient ratios, application doses appropriate for the kind of plant and soil conditions, and the fermentation or decomposition process to reduce the risk of pathogenic microbial contamination. Additionally, additional investigation is needed to ascertain whether use poultry manure as fertilizer might lessen the effectiveness of pesticides or whether it can actually increase plants' inherent resistance mechanism and provide even more protection. Thus, this study will assess how well poultry manure improves soil quality and lessens the effects of pesticides.

METHODOLOGY

The methodology used in this study blends a qualitative approach with a literature study strategy. This approach was chosen because it allows researchers to fully analyze a range of relevant information, concepts, and findings related to the topic, which is the effectiveness of chicken manure in improving soil quality and reducing the impacts of pesticides. This study used secondary data from a range of literature sources, including credible websites, journal papers, and scientific publications. Researchers examine and assess a range of past results, supporting theories, and the most current developments on the use of organic fertilizers, especially chicken manure, in sustainable agricultural systems through a review of the literature. This method provides a strong and thorough theoretical framework and allows researchers to make inferences based on data that has been validated by previous research (Creswell & Creswell, 2022).

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RESULT AND DISCUSSION

Effectiveness of Poultry Manure in Improving Soil Quality

Chicken feces may be used to produce the most rice. Chicken manure's high N content is absorbed by plants faster than that of goat and cow excrement. Additionally, the addition of nutrients to the chicken manure for plants is affected by the fact that it is mixed with leftover chicken food (Rayne & Aula, 2020). It is clear from the greenness of the plants that the types of cow, goat, and chicken excrement are almost identical. The growth of plant fruit depends on the K element, which is also essential for metabolism in a number of plant body parts, such as cell division and protein synthesis. Chicken manure has a comparatively greater nitrogen content than goat and cow dung, which speeds up the rate at which plants absorb nitrogen. Poultry manure contains a variety of nutrients that plants need, such as N, P, K, Cl, and others (Mahmoud et al., 2023).

Plants need large amounts of the element N at every stage of their growth, but especially during the vegetative growth stage, which involves the development of stems and leaves. Plants can be encouraged to make proteins from amino acids by the N nutrient in fertilizer (Chrysargyris & Tzortzakis, 2024). Nitrogen is present in plant tissue and is used to make amino acids and other essential compounds for plants. Nitrogen is a component of both proteins and enzymes since all proteins are enzymes and all protein molecules are composed of amino acids. Moreover, nitrogen is a component of chlorophyll, auxins, and cytokinin hormones. Protein found in plant cells is then separated into the meristematic part (Corsetti et al., 2023).

Cells divide and differentiate into plant tissue, which causes the plant to grow taller. Plants grow more vegetatively when the N dose rises because of the faster rate of tissue development and cell division (Liu et al., 2022). The resulting protein is used to make growth hormones, specifically auxin, gibberellin, and cytokinin hormones. Gibberellin will accelerate metabolic processes and photosynthesis. The increased synthesis of carbohydrates and the consequent growth of roots, stems, and leaves will cause the plant to grow taller (Wu et al., 2022).

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Organic fertilizers are preferable than chemical fertilizers in terms of quality and results when applied to melon plants. The reason for this is that the organic components of this fertilizer contain micronutrients, which are necessary for melon plants in addition to macronutrients (Yu et al., 2025). Organic materials release nutrients from whole plants during the mineralization process. According to Suvendran et al. (2024), organic matter is essential in the soil because it enhances cation exchange capacity or nutrient availability, especially N, P, and K. It also helps retain water, which helps sustain water availability.

In addition to promoting the establishment of soil microorganisms that significantly aid in the breakdown process of soil organic matter, organic matter enhances soil aeration and root system development. There is no discernible variation in the root volume variable when the dosage of manure treatment is increased (Ahmed & Awadh, 2021). Roots that facilitate the easy passage of nutrients and moisture, allowing plants to thrive. The dry weight of the plant's roots and crown is compared to determine the crown-root ratio. This characteristic can be used to determine whether plants are under water stress. Crown growth is more inhibited by water deprivation than root growth. When soil moisture levels are high, crown growth increases, and when soil moisture levels are low, root growth increases (Li et al., 2023).

Figure 5 shows that the application of PMU fertilizer had a substantial impact on the baby corn's plant height, yield, nutritional quality, and N usage efficiency. PMU-treated plants had significantly higher levels of cob, fodder protein, and leaf chlorophyll than urea-treated plants (Yeasmin et al., 2024). When PMU was used instead of urea, the yield of cob and fodder rose by around 11% and 13%, respectively. Compared to urea-treated plants, PMU-treated plants exhibited a 28% better N usage efficiency by baby corn due to a 25% increase in N absorption. In addition, the application of PMU resulted in a modest increase in the quantity of soil organic carbon (SOC). The amounts of Pb, Cd,

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and Cr in plants treated with PMU were found to be within the WHO permitted limit (Yeasmin et al., 2024).

Effectiveness of Poultry Fertilizer in Reducing the Impact of Pesticides

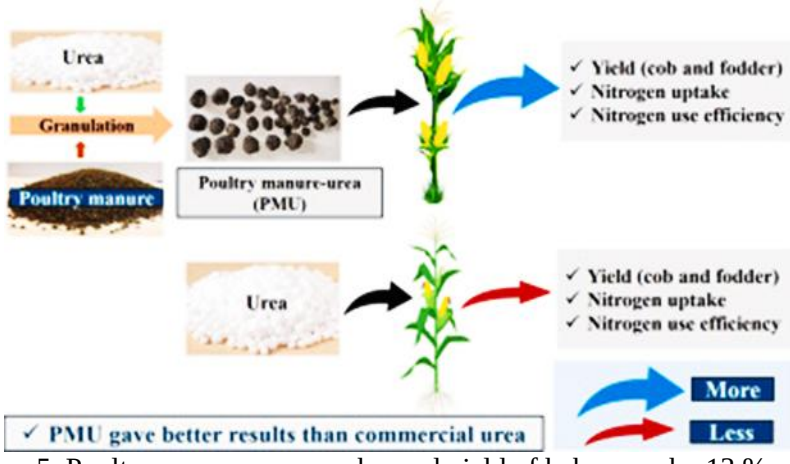

Figure 5. Poultry manure - urea enhanced yield of baby corn by 13 % compared to urea (Yeasmin et al., 2024)

Depending on their chemical makeup, the kind of soil, the crops they are used on, and the ecological circumstances, pesticides can infiltrate different environmental compartments. According to estimates, at least 50% of the pesticides that are administered may evaporate into the atmosphere (Tudi et al., 2020). For sustainable agriculture and environmental preservation, it is essential to comprehend how pesticides migrate through the ecosystem. One important route is airborne drift, in which wind carries pesticide dusts or sprays, possibly contaminating non-target regions and creating serious problems. Another crucial route is runoff, which happens during irrigation or rainfall and transports pesticides from treated fields into adjacent surface water bodies. This poses a hazard to aquatic ecosystems and calls for close monitoring. A major worry is groundwater pollution, which happens when pesticides seep through the soil and end up in groundwater, endangering drinking water sources and perhaps creating long-term environmental damage (Figure 6) (Kariyanna et al., 2024).

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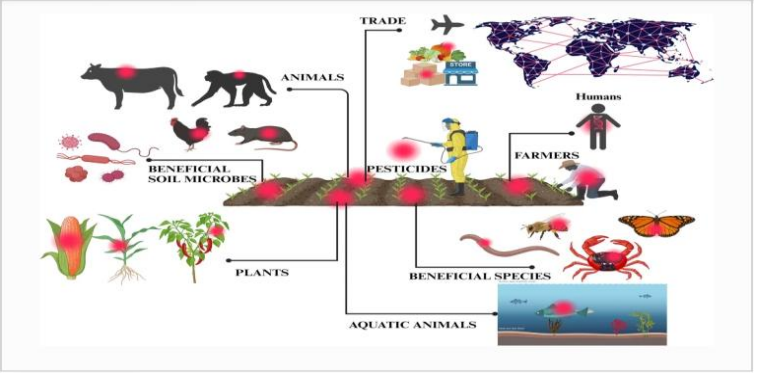

Figure 6. Consequences Of Unregulated Pesticide Use (Kariyanna et al., 2024)

An increasingly important question in the context of sustainable agriculture and environmental management is how well poultry manure works to lessen the effects of pesticides. The manure of chickens, ducks, and other birds is used to make poultry manure, which is high in organic matter and nutrients like potassium (K), phosphorus (P), and nitrogen (N). It also helps to improve the quality of soil (Adamczyk et al., 2021). Beyond these agronomic advantages, chicken manure has a significant ecological function, particularly in mitigating the adverse effects of overuse of chemical pesticides. Pesticides are known to kill non-target creatures like pollinating insects, disturb the soil's microbiological equilibrium, leave residues in soil and water, and jeopardize human health. Under these circumstances, the addition of organic matter from chicken manure may be a natural way to improve the soil's ecological function and lessen the negative environmental effects of pesticide use (Carpio et al., 2021).

By boosting soil microbiological activity, poultry manure is one of the primary ways it lessens the effects of pesticides. Several soil bacteria use the organic content in poultry manure as a source of energy when it is spread on the ground. Pesticide chemicals may be broken down into simpler, non-toxic forms by these microorganisms, which include bacteria and saprophytic fungi (Krupka et al., 2023). The process of detoxifying soil can be

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accelerated by some bacteria that can particularly exploit pesticide chemicals as a carbon source. This process, called biodegradation, is one of the best ways to lessen the buildup of pesticides in agricultural settings. This degrading process proceeds more quickly in soils with more biological activity, which eventually lowers the risk of contaminating soil and water (Dehkordi et al., 2024).

Furthermore, poultry manure can improve the soil's ability to absorb chemical compounds and its cation exchange capacity (CEC). Porosity and the soil's capacity to absorb water and nutrients are increased by the stable soil aggregates produced by the organic matter in poultry manure (Agbede & Oyewumi, 2022). Organic matter and enriched soil particles have the ability to capture or adsorbed pesticide chemicals that enter the soil, reducing their mobility and making it more difficult for them to dissolve into groundwater. To put it another way, poultry manure helps keep pesticides in the topsoil, where soil microbes may more readily break them down. Preventing groundwater contamination is crucial because it can jeopardize aquatic life and human health (Nuruzzaman et al., 2025).

Additionally, it has been demonstrated that regular application of poultry manure increases plant tolerance to diseases and pests. According to Mrid et al. (2021), plants that are cultivated in soil that has a large amount of organic matter tend to be healthier, have more robust root systems, and can produce secondary metabolite chemicals that serve as organic defenses against insect assaults. Over time, this inherent plant resilience may lessen farmers' reliance on chemical pesticides. This is consistent with the integrated pest management (IPM) tenets, which stress the value of minimizing the use of pesticides and substituting them with ecological strategies including crop rotation, the use of natural enemies, and organic fertilization. Therefore, chicken manure helps lower the total intensity of pesticide usage in addition to lessening the impact of pesticide residues (Kiss et al., 2023).

The capacity of poultry manure to restore soil structures harmed by chemical buildup is another indication of its efficacy. It is well recognized that a variety of pesticides, particularly broad-spectrum

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and systemic ones, can harm soil tissue by destroying vital soil creatures including earthworms and bacteria that fix nitrogen (Zhou et al., 2025). Air circulation in the soil is hindered, drainage deteriorates, and the soil structure gets heavier when the population of these organisms is disrupted. Because of its high organic matter concentration, poultry manure may help the soil become more fertile and loose. Because the soil condition is more hospitable and conducive to their survival, soil organisms also start to thrive anew (Babu et al., 2021)..

Soil that has been damaged by pesticide usage can eventually heal and resume its productive state. But it's crucial to remember that how poultry manure is applied greatly affects how well it works to lessen the effects of pesticides (Ning et al., 2022). Before being used, poultry manure needs to undergo a fermentation or composting process in order to break down any germs and excessive ammonia levels. Poultry manure can really contaminate the environment by producing aromas, encouraging the growth of weeds, or raising nitrogen levels in groundwater if it is utilized excessively and in fresh form (Kacprzak et al., 2022).

Poultry manure must thus be used carefully and in accordance with the requirements of the soil and the kind of plant being grown. In fact, some conventional and organic agricultural regions that are making the switch to ecologically friendly agricultural systems have implemented the use of chicken manure as a tactic to lessen the effects of pesticides (Mahmoud et al., 2023). According to studies, compared to land that solely uses chemical fertilizers, agricultural land that receives regular applications of poultry manure has superior soil quality and lower levels of pesticide residues. Using chicken manure has both ecological and economic benefits since the raw ingredients are readily available and reasonably priced, particularly in regions with large poultry populations. Farmers also help to develop resource-recycling agricultural systems and lessen environmental pollution by using animal manure as fertilizer (Nurhapsa et al., 2024).

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CONCLUSION

Poultry manure has been shown to increase plant growth and soil quality while also lessening the adverse effects of chemical pesticide usage. Poultry manure's high organic matter and macronutrient content—including nitrogen, phosphate, and potassium—makes it a biological agent that may enhance soil structure, boost cation exchange capacity, and promote soil microbial activity. In the biodegradation of pesticides, these microbes are essential because they transform dangerous substances into environmentally friendly forms. Regular addition of chicken manure to soil also tends to generate plants that are more resilient to pests and diseases, which lessens the need for chemical pesticides.

Because it can naturally improve soil fertility, decrease environmental pollution, and make good use of animal waste, the usage of chicken manure also has economic and ecological advantages. To prevent adverse consequences like groundwater pollution or undesired weed development, chicken manure must first undergo a fermentation or composting process in order to achieve this efficacy. As a result, using chicken manure has to be a key component of any sustainable agriculture plan, particularly when attempting to lessen the long-term effects of pesticide usage and support ecologically oriented agricultural systems.

According to the findings and debate over the efficiency of chicken manure in enhancing soil quality and lessening the effects of pesticides. Poultry manure that has undergone fermentation or composting should be used by farmers before being spread on the ground. To lower the ammonia concentration and eradicate dangerous microorganisms that might endanger plants and the environment, this is crucial. In order to lessen reliance on chemical pesticides, poultry manure should be utilized in conjunction with other sustainable agricultural practices such crop rotation, integrated pest management (IPM), and the adoption of pest-resistant plant cultivars.

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