KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

DEPARTMENT OF MATERIALS ENGINEERING
CENG 291

POOR MANAGEMENT OF POULTRY WASTE
A RESEATRCH DONE BY BROBBEY MORRISON AT NKRANKWANTA
(DORMAA WEST DISTRICT)
INDEX NUMBER: 1963322

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ABSTRACT

Objective
The poultry industry plays a significant role in the socio-economic and development of Nkrankwanta (D/W) and Ghana at large.
Waste generated from this industry poses a potential threat to the environment as dumping and usage of untreated poultry waste causes various pollution issues in the receiving environment of water, air and land.

Materials and Methods
A structural questionnaire-based survey was conducted in 30 large, medium and small-scale poultry farms in different communities in Dormaa west district (Nkrankwant).
Discussions were made, information taken, and knowledge acquired about practices involved in the handling of waste generated in this industry.

Result
The survey revealed that mostly middle-aged males, high school graduates and midlife males were in poultry farming. Most farmers had primary to secondary education and engaged in farming for about 1-10 years without training. In the study area, most farmers collected droppings monthly and used them as organic fertilizers. Others did not know the hygienic handling of droppings and faced health problems.

Conclusion
Appropriate poultry waste management practices can reduce environmental pollution and prevent human health risks.

Keywords: poultry, waste management, farmer's perceptions, hygiene

DEDICATION

I give thanks to God for the give of life and strength He has given me. I dedicate this research work to the pursuit of knowledge and relentless curiosity that drives us to explore the unknown.
I would like to express my deepest gratitude to my family and loved ones for their unwavering support and understanding throughout this research journey, and lastly, I give thanks to all my colleagues who assisted me.

□

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to anyone who contributed to the success of this research. A special thanks to my supervisor [] for accepting my topic and giving the go ahead of this project.
Additionally, I want to acknowledge the farmers for their immense contribution in gathering information and knowledge shared which made the project a success.
Finally, I extend my appreciation to my family and friends for their encouragement and understanding during this research journey.
Thank you for your contribution and support.

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CENG BACKGROUND

Engineering is the creative application of science, mathematical methods, and empirical evidence to the innovation, design, construction, operation, and maintenance of structures, machines, materials, devices, systems, processes, and organizations (Wikipedia). Engineering in society (CENG 291) is a new course introduced in the curriculum of the college of engineering in KNUST. The course is geared at inculcating the attitude of problem-solving among students at the college in their respective fields of study. The course also tends to encourage students to appreciate their course of study and broadens the scope of students in their chosen field. The course also tends to create a link between the chosen field of study of the students and solving societal problems using the said field. The objectives of this assignment are to identify a developmental challenge in a selected community and indicate how my chosen field of engineering (in this case computer engineering) can address the challenge

CHAPTER ONE

INTRODUCTION

Poultry farming refers to the commercial practice of raising domesticated birds, primarily to produce meat and eggs. The term "poultry" encompasses various bird species, with chickens being the most common, followed by ducks, turkeys, geese, and quail. Poultry farming plays a vital role in global agriculture, providing a sustainable source of protein-rich food products.

Poultry production in Ghana has a great value on the country's economy, accounting for **14%** of the country's total gross domestic product. In Ghana, as in other West African countries, chicken continues to be the main source of protein preferred by consumers.

Chicken consumption in the country is around **13 kg per Capita annual** (2021) and is expected to **demand reach 460 million tons** during this year, which implies an increase of 15% over the previous year. Population growth, along with the development of an economically middle class is favoring this growth demand, **[veterinariadigital.com poultry production in Ghana]**. On a global scale the poultry industry produce around 790 million tonnes in CO2 equivalents per year

Fig. 1.1 A picture of a poultry farm in Nkrankwanta

The poultry industry continues to grow in Nkrankwanta as more Youths sees it as their alternative source of employment. However, the rapid expansion of the poultry industry has led to an alarming increase in the generation of poultry waste. Some of these wastes includes bedding materials, feces, dead chicks, empty eggshells, feathers, etc. The mismanagement of

these waste poses substantial environmental, social, and economic challenges. In recent years, concerns have escalated regarding the inadequate handling, disposal, and utilization of poultry waste, leading to adverse effects on ecosystems, public health, and the overall sustainability of poultry farming in Nkrankwanta.

This research endeavors to delve into the intricate web of issues surrounding the poor management of poultry waste in Nkrankwanta. As the poultry industry continues to burgeon, so does the volume of waste produced, creating a pressing need for sustainable waste management practices. In this study, we aim to dissect the root causes of poor waste management within the poultry sector, analyze its far-reaching consequences, and propose innovative solutions to mitigate the environmental impact and enhance the overall sustainability of poultry farming.

By shedding light on the critical aspects of poultry waste mismanagement, this research strives to contribute valuable insights that can inform policymakers, industry stakeholders, and farmers alike. Through a comprehensive examination of current practices and the exploration of alternative strategies, we aspire to pave the way for a more sustainable and responsible approach to handling poultry waste in my community.

Fig. 1.2: Image of a large scale poultry farm

Fig. 1.3: Image of birds in a farm

MATERIALS AND METHODS

ETHICAL APPROVAL

The topic (poor management of poultry waste) was submitted to my supervisor Mr. F.O. Agyemang who gave his approval for this research to be carried out.

STUDY AREA AND DESIGN

d A structured questionnaire-based survey was conducted in 30 large, medium an small-scale poultry farms in different communities in Dormaa West District. These communities include Nkrankwanta, Nkt (n=10), Diabaa, Db (n=5), Brofoyedru, Bf (n=2), Krakrom, Kkm (n=3) and Yaakrom Yk (n=10) during the period of November to December 2023 to evaluate the recent status of poultry waste management practices.

During this study, three categories of poultry farms were considered, these are broilers, layers and cockerels.

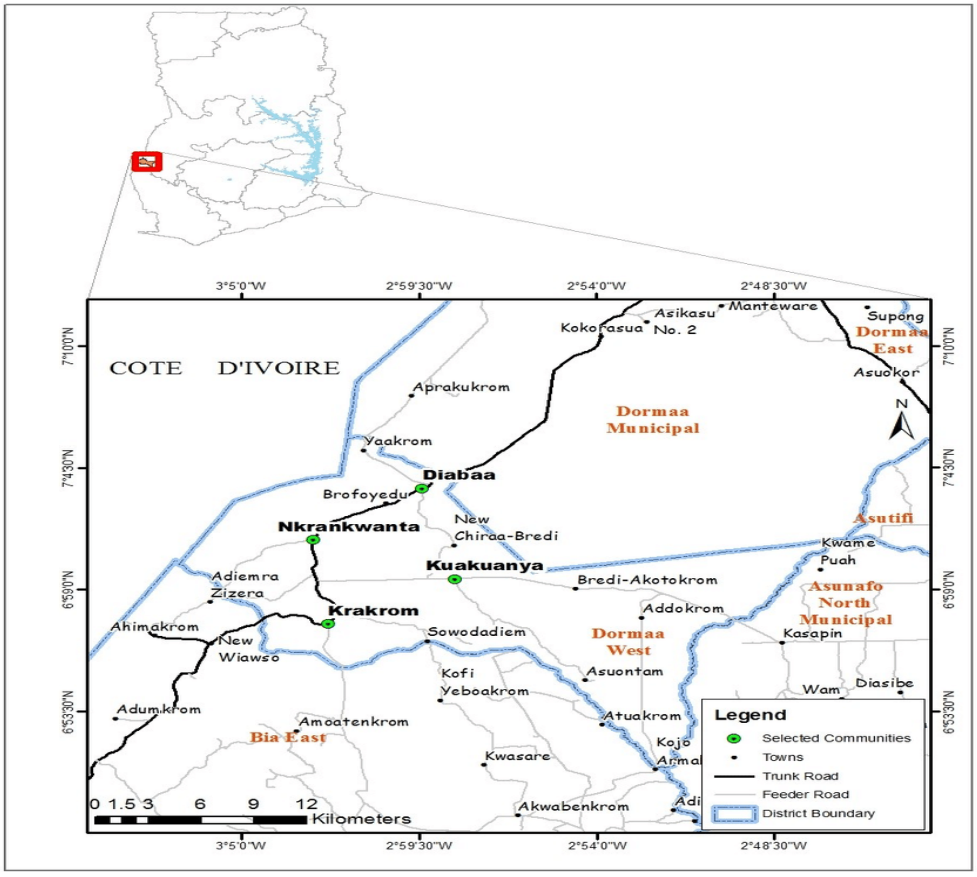

Figure 1.4: Map of Dormaa West District

COLLECTION OF DATA

The data were collected through direct interviews with correspondents. These data included socioeconomic structures of farmers (age, gender, level of education, main occupation, duration of farming, training on poultry farm management), description of farms under study (farm types, number of birds, quantity of litter), and environmental related issues of the poultry farm systems (birds dropping collections, cleaning tools, environmental issues, etc.). All collected data were then analyzed.

COMMUNITY	NUMBER OF FARMS UNDER STUDY	FARM SCALE		
		large	medium	small
Nkrankwanta	10	5	2	3
Diabaa	5	2	3	0
Brofoyedru	2	0	0	2
Krakrom	3	1	0	2
Yaakrom	10	7	2	1

Table 1.1: Table shows community, number of farms under study and different scale of farms involved.

RESULTS

Analyses from collected date showed shed light on many factors.

1. Socioeconomic characteristics of sampled farmers.

Age of farmers

The farmers' age ranges from 18 years to over 60 years. About 70% of respondents are between the ages of 30-60 years. 20% are between 18-25 years and the lowest respondents, about 10% being over 60 years.

Gender

Gender is a concerning and intriguing topic when it comes to the socioeconomic and institutional sphere of the developing world. Per the respondents, male owners dominate this industry being about 90% farm owners with the remaining 10% being females. Male owners are also involved in managerial activities such as immunization, debeaking, delivering of chicks, etc. Whilst in most cases women are more engage in routine activities like cleaning, providing feed and water and picking eggs.

Level of education.

Here, we grouped the education level of respondents in surveyed area into four categories consisting of illiterate, primary, secondary and tertiary. Among the sampled farmers, about 40% of respondents have completed secondary level of education, 30% completing primary level and 20% completing tertiary with only 10% of respondents being illiterate. According to this study's findings, many young, educated people are now keen on starting a poultry farm. Education broadens people's minds and inspires them to engage in initiatives to obtain success.

□

Main occupation

The respondents were mostly involved in business and farming. In the surveyed areas, only farming accounted for about 51% of respondents. Followed by business 19%, farming and business at 11%, farming and others at 10%. It was observed that businessmen are fiscally fit to sustainable enough to begin poultry farm.

Duration of farming

The duration of farming ranged from 1 to more than 10 years. Three categories of respondents were defined based on how long they had been farming. About 56% of farmers were involved in poultry farming for 1–5 years, 28% farmers were involved for 6–10 years, and 16% had been in this business for more than 10 years.

Management of poultry farming

In the study area, 40% of the respondents had received training for the management of their poultry farms, while 60% had not.

2. Description of sample farms.

Farm type and number of birds

There were three distinct types of farms practiced in the surveyed area. These were broilers, layers and cockerels, of these, layer farming was practiced by 50% followed by broiler farming at 30% with 10% being cockerels and another 10% being layers and broilers together.

Number of birds	**Farm type**			**Community under study**				
	Broiler	**layer**	**cockerel**	**Nkt**	**Db**	**Bf**	**Kkm**	**Yk**
100-400	1	3	1	3	0	2	2	1
500-1000	1	0	2	2	2	0	1	2
1001-2000	3	10	0	3	1	0	0	3
2001-3000	4	2	0	2	2	0	0	4

Table 2.1

Number of birds per farm, community under study and farm category presented in table above.
Keywords, Nkrankwanta (Nkt), Diabaa (Db), Brofoyedru (Bf) and Yaakrom(Yk)

Dropping collection

The frequency of dropping collection depends on the size of flocks and type of birds. From the study's findings, broiler droppings were cleaned once a week or month still depending on the size of flocks. Layers however, depending on farmers and size, about 50% of farmers with large scale cleans on monthly schedule whilst the about 70% of farmers on medium to low scale does cleaning on weekly schedule. Farmers observed the delay in dropping collection creates nuisance, odor and attracts flies.

Number of birds	**Farm type (droppings per sack)**			**Farm scale**
	broiler	layer	cockerel	
100-400	20	15	18	Small
500-1000	50	35	38	medium
1001-2000	150	70	75	Medium-large
2001-3000	300	150	250	large

Table 2.2

Table showing number of birds in farms, scale of farm and number of collected droppings per sack .

Fig. 1.4: Image showing birds dropping in sack.

Time and tools for cleaning

The majority of the respondents (71%) prefer to wipe the droppings in the early morning. Only 3% of respondents clean the droppings in the evening, compared to 26% of respondents who clean them around lunchtime. For droppings cleaning, most of the respondents use a shovel due to its availability and affordable price. Only 1% of respondents used a brush, whereas 4% used both a shovel and a brush at the same time for cleaning. However, 8% of respondents said they used other tools like broom, duster, or mop for sweeping dust, dirt, and crumbs from the floor.

Seasonal problems with cleaning

Most of the respondents (70%) faced the problem of dropping cleaning during the dry season and 20% in the rainy season. The common consensus among farmers is that during dry season, birds consume more water, which makes their droppings more watery and harder to clean. Due to damp weather in the rainy season, the droppings become wet and stick to the floor, posing a challenge throughout the cleaning process.

Place of waste disposal

Poultry waste poses a threat to the environment that can be minimized through adequate management and utilization. In the study farms, about 10% of respondents disposed of their droppings on the refuse damp, while 20% disposed of them on forest or bushy areas. On the other hands 2% disposed of composting in open spaces. A portion of the farmers (5%) disposed of the droppings directly to aquaculture pond while 63% farmers disposed of their poultry litter directly in agricultural lands.

Use of droppings

Among farmers, 10% used droppings as fish feed, 10% used them as both fish feed and as fertilizer in organic farms. Droppings were used mostly as organic fertilizer in agricultural farms by 60% of farmers. 15% of farmers sold the droppings while 5% of farmers gave litter free of cost. The estimated number of droppings per sack is detailed in the table below.

Inclusion of feathers into droppings

In 78% cases, dropped feathers were included in the droppings. The inclusion of feathers with droppings could be due to the problem of separation of feathers from droppings.

Knowledge of farmers about hygienic aspect of poultry waste management

About 42% of people had knowledge about hygienic handling of droppings, while 58% of

farmers had no knowledge about it. Among respondents. Only 48% of farmers used gloves during handling of droppings, while 52% did not use them.

4. Health problems

Evidence exists that poultry manure or litter can carry a number of human infections, hence while managing poultry waste, biosecurity, and good hygiene have to be applied. In the study area, when farmers were asked about their health issues related to handling of poultry waste, farmers gave two different answers: 41% said they experienced health issues, and the remaining 59% said they never experienced any health issues related to waste handling. High ammonia emission from poultry houses leads to odor complaints from neighbors.

EFFECT OF POULTRY WASTE ON OUR ENVIFRONMENT.

The untreated disposal of poultry waste can have significant and detrimental effects on the environment. Poultry waste, which includes manure, bedding materials, feathers, and other by-products, contains high concentrations of nutrients, pathogens, and organic matter. When left untreated, it can lead to several environmental issues:

- **Water Pollution:**
  - Runoff from untreated poultry waste can contaminate nearby water bodies with excess nutrients such as nitrogen and phosphorus. This contamination can result in algal blooms, oxygen depletion, and the creation of "dead zones" where aquatic life cannot thrive.
- **Soil Contamination:**
  - The improper disposal or application of untreated poultry waste on land can lead to soil contamination. Excessive nutrients can disrupt the natural balance of soil, affecting plant growth and potentially leaching into groundwater.
- **Air Quality Issues:**
  - Decomposition of untreated poultry waste releases ammonia and other noxious gases into the air. This can contribute to air pollution, affecting local air quality and posing health risks to nearby communities.
- **Pathogen Spread:**
  - Untreated poultry waste may harbor pathogens such as bacteria, viruses, and parasites. If not properly managed, these pathogens can spread to humans, wildlife, and other livestock, leading to the potential for disease outbreaks.
- **Greenhouse Gas Emissions:**
  - Decomposition of organic matter in untreated poultry waste produces methane, a potent greenhouse gas. Methane contributes to climate change, and its release into the atmosphere without proper management exacerbates the environmental impact.
- **Odor Issues:**
  - The untreated disposal of poultry waste can result in foul odors, causing discomfort for nearby residents. This can lead to conflicts between poultry farmers and local communities.
- **Ecosystem Disruption:**
  - The introduction of high concentrations of nutrients into ecosystems can disrupt the balance of flora and fauna. This imbalance can lead to changes in biodiversity and ecosystem structure.

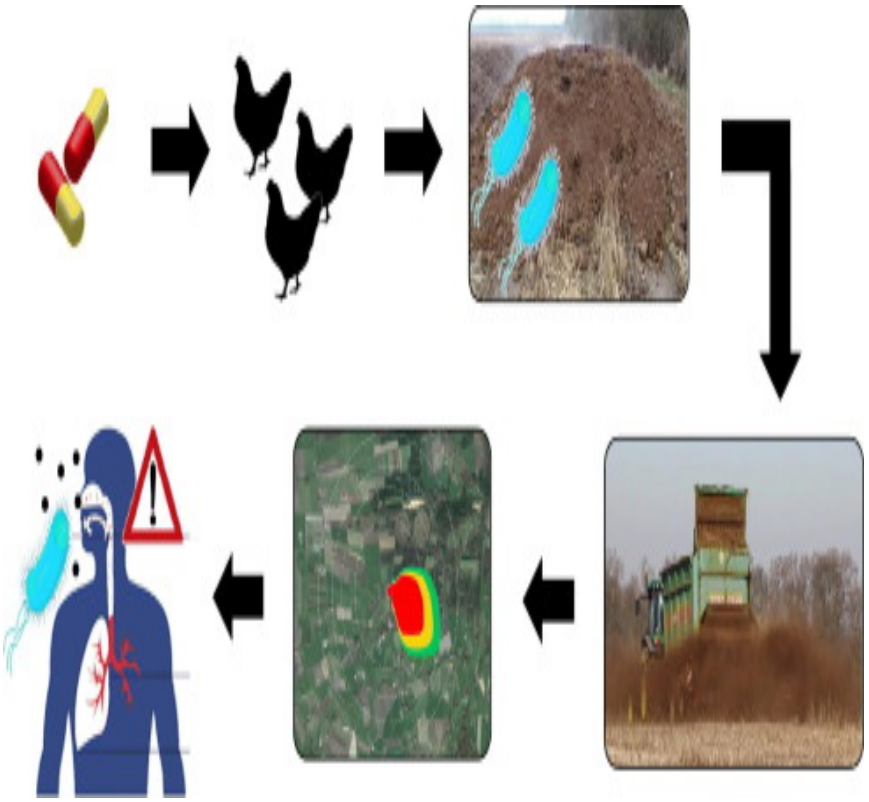

Fig. 1.5: Image showing the transfer of bacteria from untreated poultry waste to human host.

Discussion

A structured questionnaire-based survey was conducted in 30 large, medium and small-scale poultry farms in different communities in Dormaa West District during the period of November to December 2023 to evaluate the recent status of poultry waste management practices.
During this study, three categories of poultry farms were considered, these are broilers, layers and cockerels. The study revealed that mostly middle-aged men (35-54) years were involved in the farming. They mostly ran the poultry shed whilst women took care of daily activities of poultry farms including feeding. From the study, most of the farms have completed secondary level of education (40%) with only 10% being illiterate per sampled farmers. In the research area, many young and Educated people seems to be interested in poultry farms with some stating as using that option as their alternative source of income and others seeing it as opportunity to generate more income. About 42% of farmers were aware of the detrimental effects of poultry waste on human and animal health as well as in the environment. The survey seems to have brought awareness to the community in which these farmers are as saw no need to treat poultry waste well (usually depending on the educational background and farmers location).

In our study, the majority of farmers collect droppings weekly or monthly depending on the flock size, farmer and flock type. The quantity of droppings collected depends on the flock size and type [Table 2.2]. About 42% of farmers had some idea about hygiene and awareness of careful handling of poultry waste, although only 48% of farmers used gloves while 52% of farmers did not use any protective measures. About 41% of farmers faced health trouble while 59% never faced any health trouble. Whilst some farmers disposed of their poultry droppings in open space compost (2%) and forest (bushy) area (20%) directly, 10% send them to refuse dumps. The study showed that 5% of farmers could not use their droppings for any work, 15% of them sold, 60% of them used for agricultural production, and 10% used for fish culture. In Dormaa west district, most of the small-scale commercial poultry farms manage their waste in an unorganized manner.

The waste is either dumped in open spaces without any sort of treatment or used as fish feed or as fertilizer on nearby agricultural land and sold to the buyer. However, individuals practicing large scale farms have close connections to regional brokers who buy discarded litter and sell it to farmers of crops and fish. Two-thirds (65%) of the respondents received no formal training in handling and management of poultry waste. Besides, most of the smallholder poultry farmers started poultry farming without having prior training in poultry rearing which plays an important role in making poultry farming successful. However, a lack of knowledge of environmental and health aspects of poultry waste hindered successful waste management in study areas.

Conclusion

This study describes the characteristics of large, medium and small-scale farms and farmers in Dormaa west district, and her local communities and their waste management practices and how it affects the environment at large. The study sheds light on the serious consequences untreated poultry waste disposal has on the environment. The findings underscore the urgent need for comprehensive and sustainable solutions to address the environmental, social, and economic challenges posed by the mismanagement of poultry waste.

□

CHAPTER 2

PROPOSAL OF SOLUTIONS TO POOR MANAGEMENT OF POULTRY WASTE

As a materials engineering student proposing solutions to the poor management of poultry waste. I shall consider solutions that involve the use of advanced materials and technologies. I shall consider two scenarios

1. Treating poultry waste as materials that can be processed into finished goods.
2. Suggestion of other theoretical solutions to the problem.

poultry waste as a material.

Poultry manure can be safely made into fertilizer using aerobic composting.

Aerobic composting is a method of composting organic waste using aerobic bacteria. The waste is exposed to air either by turning or by forcing air into it through pipes. This process is reasonably Oduor-free, and it generates more heat and is faster than anaerobic composting. Temperatures may become high enough to destroy pathogens and weed seeds.

Aerobic composting can be achieved using composting machines.

Organic fertilizer production line.

Organic fertilizer production line is a series of fertilizer machine the uses fermentation and composting technology to convert organic waste into high quality and easy-to-store organic fertilizer granules. The production line is mainly composed of raw material treatment system, fermentation and composting system, drying system and packaging system.

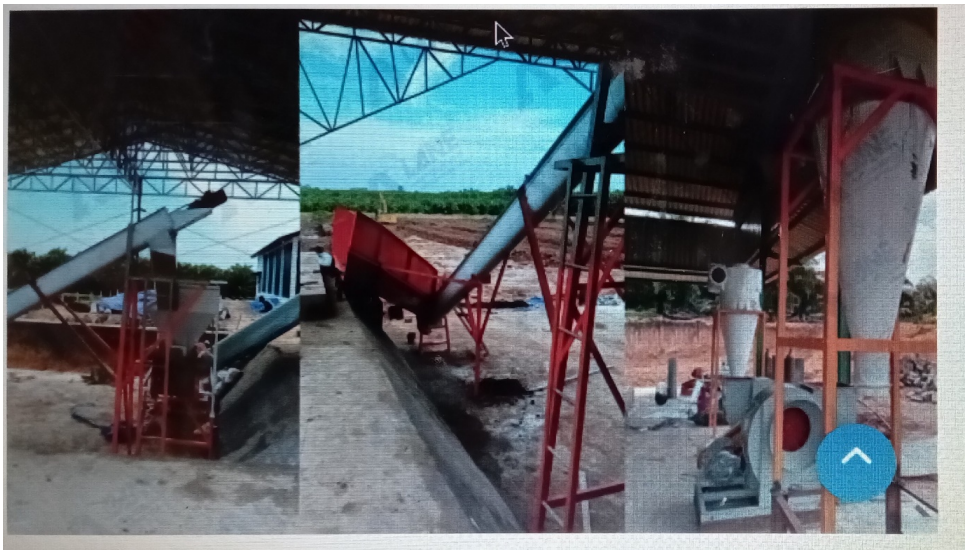

Fig. 2.0: Image of a fertilizer production machine.

The machines in the organic fertilizer production line contain compost turner, forklift feeder, crusher, organic fertilizer granulator, polishing machine, drying and cooling machine, screening machine, pecking machine and cyclone duct removal machine.

Machine process

- **Fermentation:** raw materials are fermented according to certain proportion and the materials are composted and turned in the process of fermentation, so that the materials can be fully and evenly fermented.

- **Crushing:** raw materials after fermentation will be crushed, and the crushed raw materials will reach the required granularity before granulation.

- **Screening:** part of the particle fineness of material is relatively large for screening, back to the second crushing to reach the standard fineness.

- **Mixing:** the crushed raw materials to join the corresponding auxiliary materials for mixing, to improve the overall uniformity of fertilizer particles fertilizer content.

- **Granulation:** stirred raw materials into the organic fertilizer granulator for granulation.

- **Drying:** granulator made of organic fertilizer particles sent to the dryer to dry particles contained in the moisture, increasing particle strength.

- **Cooling:** after drying the fertilizer particles temperature is too high, easy to cack, cooling treatment is convenient for preservation and transportation.

- **Screening:** the cooled particles are screened, unqualified particles return to the crusher for crushing, re-pelletizing, sieving out the qualified products into the next process.

- **Coating:** qualified organic fertilizer particles are coated to prevent particles from clumping, slow down the released of fertilizer and increase the brightness and roundness of the particles.

- **Packaging:** after filming the particles become finished organic fertilizer particles use automatic packing machine to pack them into bags, placed in a dry and ventilated place for storage.

Fig. 2.1: Image of processed poultry manure fertilizer granules.

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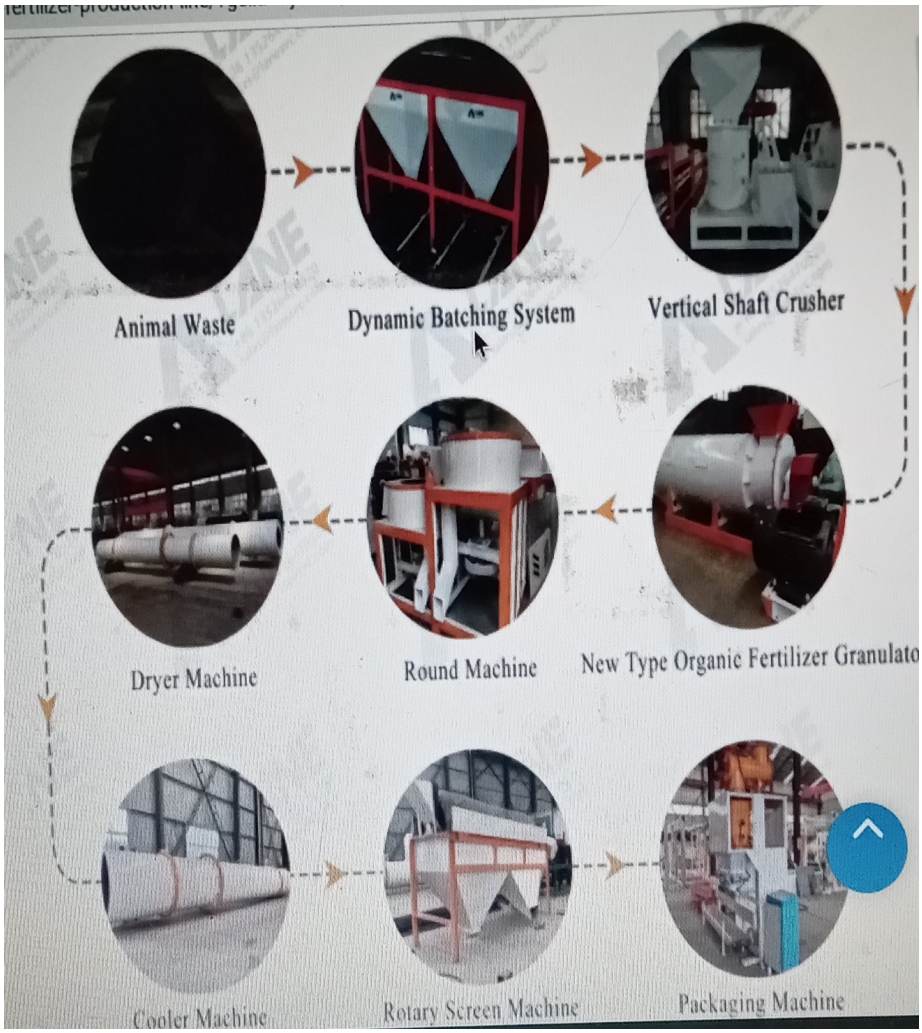

Fig. 2.2: Detail of production process of organic fertilizer.

Fig. 2.3: Picture of bagged organic poultry manure (fertilizer).

2. other theoretical solutions include,

i. Biodegradable Bedding Materials:

Develop biodegradable bedding materials that can be used in poultry farming. These materials should have optimal absorbent properties, reducing the moisture content in poultry waste. This can enhance the efficiency of waste management systems.

ii. Smart Sensors for Monitoring:

Integrate smart sensors into poultry waste management systems. These sensors can monitor factors such as temperature, moisture levels, and gas emissions in real-time. The data collected can be used to optimize waste treatment processes and identify potential issues early on.

iii. Composite Materials for Waste Treatment:

Design composite materials with specific properties suitable for waste treatment processes. For example, develop materials that can efficiently filter or absorb contaminants from poultry waste, making the treatment process more effective and environmentally friendly.

Iv. Encapsulation Technologies:

Explore encapsulation technologies to encapsulate nutrients and pathogens in poultry waste. This can prevent the leaching of harmful substances into the environment, reducing the impact on soil and water quality.

v. Biochar for Soil Amendment:

Investigate the use of biochar, a carbon-rich material produced through the pyrolysis of organic waste, as a soil amendment. Biochar can improve soil fertility, enhance nutrient retention, and mitigate the environmental impact of poultry waste when applied to agricultural lands.

Vi. Nanotechnology for Odor Control:

Utilize nanotechnology to develop materials for effective odor control. Nanomaterials can absorb and neutralize odorous compounds, addressing one of the major concerns associated with poultry waste management.

Vii. Bio-based Packaging for Poultry Products:

Promote the use of bio-based and biodegradable packaging materials for poultry products. This initiative can contribute to a circular economy, reducing the environmental footprint of the entire poultry production and distribution chain

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APPENDIX

Copy Of Questionnaire
Research On the Poor Management of Poultry Waste

Dear Participant
Thank you for participating in this survey. Your insights are valuable for understanding and addressing challenges related to poultry waste management in Dormaa west District. Thank you for participating in this survey. Your insights are valuable for understanding and addressing challenges related to poultry waste management. Please answer the following questions thoughtfully.
Thank you for taking the time to assist me with this research. Under no responsibility are you mandated to answer any of the questions, however, doing so will greatly assist me in completing my research. Please proceed to the questions.

Name: Brobbey Morrison
Index number: 1963322
BSc. Materials Engineering,
Faculty of chemical and Mechanical Engineering KNUST
Supervisor: Prof. F. O. Agyemang

Section 1: Demographic Information

1.0 Gender:

a. Male
b. Female

c. Prefer not to say

1.1 Age:

a. 18-25
b. 26-35
c. 36-45
d. 46-55
e. 56 and above

1.2 Occupation:

a. Poultry Farmer
b. Government worker (please specify,)
c. Businessman / woman
d. Agricultural farmer
e. Other (please specify)

Section 2: Poultry Farming Practices

2.0 **Type of Poultry Farming:**

a. Broiler Farming
b. Layer Farming
c. Cockerel Farming
d. Other (please specify,)

2.1 Scale of Poultry Farm:

a. Small-scale (fewer than 500 birds)
b. Medium-scale (1,000 to 2,000 birds)
c. Large-scale (more than 4,000 birds

2.2 Current Poultry Waste Management Practices:

a. Land Application
b. Composting
c. Anaerobic Digestion
d. none

2.3 Challenges in Current Waste Management Practices:
(Select all that apply)

a. Odor issues
b. Water contamination
c. Soil degradation
d. Air pollution
e. Regulatory compliance
f. Lack of awareness/training
g. Other (please specify)

Section 3: Awareness and Training

3.1 Awareness of Sustainable Poultry Waste Management Practices:

a. Very Aware
b. Somewhat Aware
c. Not Aware

3.2 Training Received on Waste Management:

a. Yes
b. No
c. Partially (please provide details.....)

Section 4: Attitudes and Willingness to Change

4.1 Willingness to Adopt New Waste Management Technologies:

a. Very Willing
b. Somewhat Willing
c. Not Willing

4.2 Perceived Barriers to Implementation: (Select all that apply)

a. Cost
b. Lack of Information
c. Technological Complexity
d. Time Constraints
e. Other (please specify.....)

Section 5: Suggestions and Recommendations

5.1 Suggestions for Improving Poultry Waste Management:

.....

.....

.....

5.2 Recommendations for Policy or Industry Changes:

.....

.....

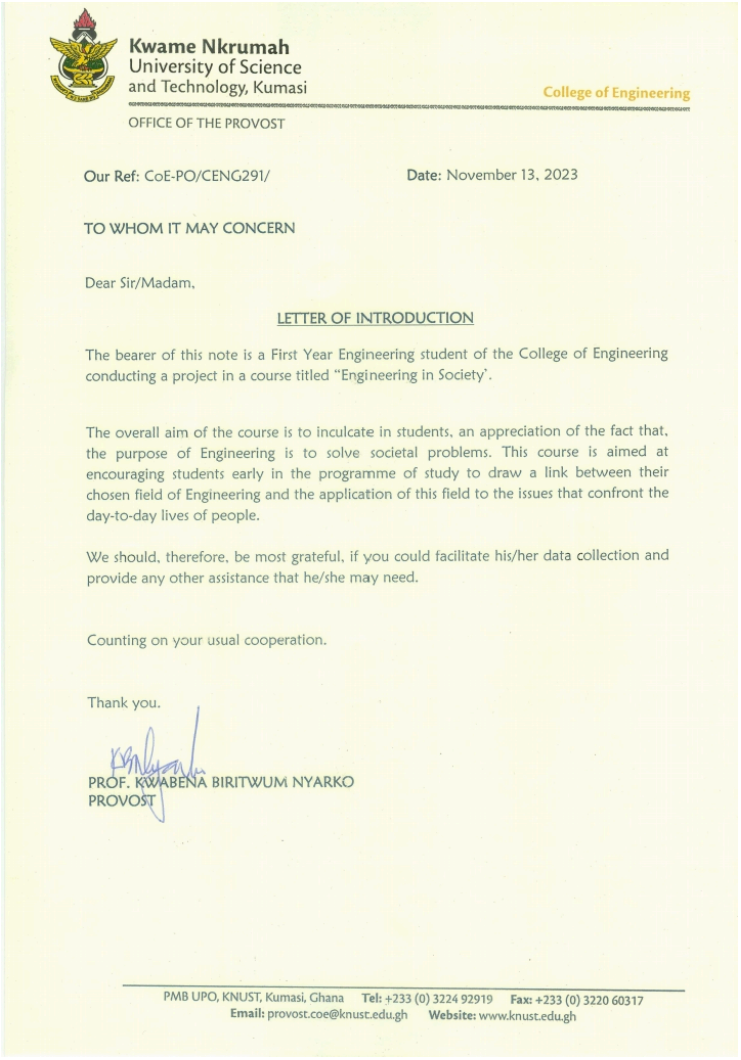
.....

Thank you for taking the time to complete this survey. Your input is crucial for identifying opportunities and challenges in poultry waste management. If you have additional comments or insights, please feel free to share.

Remember to pilot test your questionnaire with a small group to identify any potential issues with wording or question clarity before administering it widely.

Additionally, consider the anonymity and confidentiality of respondents when collecting sensitive information.

The end



Kwame Nkrumah
University of Science
and Technology, Kumasi

College of Engineering

OFFICE OF THE PROVOST

Our Ref: CoE-PO/CENG291/ Date: November 13, 2023

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION

The bearer of this note is a First Year Engineering student of the College of Engineering conducting a project in a course titled "Engineering in Society'.

The overall aim of the course is to inculcate in students, an appreciation of the fact that, the purpose of Engineering is to solve societal problems. This course is aimed at encouraging students early in the programme of study to draw a link between their chosen field of Engineering and the application of this field to the issues that confront the day-to-day lives of people.

We should, therefore, be most grateful, if you could facilitate his/her data collection and provide any other assistance that he/she may need.

Counting on your usual cooperation.

Thank you.

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