EVALUATION OF SOIL FERTILITY EFFECT OF DAIRY AND POULTRY WASTEWATERS ON MAIZE PLOT

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BY

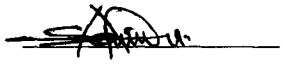
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BEING A FINAL YEAR PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B. ENG) DEGREE IN AGRICULTURAL AND BIORESOURCES ENGINEERING DEPARTMENT
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

OCTOBER, 2008.

DECLARATION

I hereby declare that this project work is a record of research work that was undertaken and written by me. It has not been presented before for any degree, Diploma or Certificate at any university or institution. Information derive from personal communication, published and unpublished work of other were duly reference in the text



Saidu Abubakar

21st -11-2018

Date

CERTIFICATION

This project entitled " Evaluation of Soil Fertility Effect of Dairy and Poultry Wastewaters on Maize plot" by **Saidu Abubakar** meets the regulation governing the award of the degree of Bachelor of Engineering (B. ENG.) of the federal University of Technology Minna, and it is approved for its contribution to scientific knowledge and literacy presentation.

Mr. Peter Adeoye — 21/11/08
Supervisor — Date

Engr. Dr. Mrs. Z. D. Osunde — 24/11/2008
H .O. D — Date

External Examiner — 19-11-08
Date

DEDICATION

This project is dedicated to Almighty Allah (God). And family members.

ABSTRACT

The experimental plot of maize which 16.46 x 10.05m was cleared of weeds and divided into four require plot for the experiment which include control experiment, Dairy wastewater experiment, poultry wastewater experiment and mixed Dairy and poultry wastewater experiment, after which the maize was planted on a seed bed at the interval of 30cm each, Dairy and poultry wastewater were collected and stored for five days before the application to maize. After the application, physical characteristics of maize plant were investigated and recorded at the interval of each one week. Dairy wastewater turned out to performed better in almost all the physical characteristic of maize plant with the highest stem diameter, Height and leaf Area as 11.14cm, 198.63cm, 700. 83cm^2 and leaf Area Index, 3504. 15cm^2 which is followed by mixed Dairy and poultry wastewater experiment with the stem diameter 10.98cm, stem height 186. 46cm, leaf Area, 668. 44cm^2 and the leaf Index 3342. 20 cm^2.

After the harvesting of the maize, the yield of the maize from each plot was obtained with Dairy wastewater having higher yield such as 2166. 67, followed by the mixed dairy and poultry wastewater, 1081.08 and followed by the control experiment and the poultry wastewater experiment.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Nigerian food production is enigmatic. It could feed the nation until the 1960s, became short of the demand in the 1970s, and after the mid-1980s, it soared up again to be able to feed the nation. However there is no substantial supporting data. There are several different production figures even for a single crop. And the increase rate of production of maize, cassava, rice and yams since the mid- 1980s, are extraordinarily high. The major problems confronting Nigerian Agriculture should be noted that agriculture has been beset by long standing problems impeding its productivity and contribution to national aggregate output.

Maize is a major cereal crop in west and central Africa, currently account for a little over 20% of domestic food production in Africa. Its importance has increased as it replaces others staple food, particularly sorghum and millet, and it has also became a major source of cash for small holder farmers (Smith et al 1997) Trends in maize production indicate a steady growth, mostly due to the expansion of cultivated areas, but also result of improved maize yields. In west and central Africa in the last 20 years widespread adoption of improved maize varieties in the savannas means that maize is no longer a backyard crop but a major cereal grown for both cash and food (Eckebil 1994).

Maize crop is one of the world three most important cereals crops (the other two are rice and wheat). The crop is primary grown for its grain which is consumed as human food. In some developed countries maize is also grown for animal feed on a base for industrial products such as oils and starch. The grain may be fermented to produce

Beverage and then distilled to provide whiskey or industrial alcohols, acids, acetone and glycerol. The crop residues can be used as fodder, bedding building materials and fuel. Maize has the same calorific value as wheat or rice but has lower levels of essential amino acids, lysine and tryptophane, it also has lower levels of tracin but higher in thiamine (Fajemisin, 1994)

Waste can be defined as a by-product of industrial, Agricultural, municipal and mining activities. The recent changes in agricultural production methods have causes agriculturally related pollutions to escalate; such pollution is no longer considered minor. The changing agricultural practices have altered the traditional view of agricultural production from small scale to large-scale production both in crop and animal.

Micro organisms in waste discharges may impair the use of surface waters for recreational use; impurities in ground water from land disposal of waste lead to depletion of dissolve oxygen in water causing deaths of fish and septic condition, and odours from concentrated waste storage and land disposal.

Animal manure contains a number of contaminants that can adversely affect surface and ground water. In addition, certain constituents in manure can impact grazing animals, harm terrestrial plants, and impair air quality. However, where manure is applied to agricultural land at acceptable rates, crop can receive adequate nutrients without the addition of commercial fertilizer (Hobson. P.N, Robbertson A.M. 1983)

In addition, the soil fertilizer are any natural or manufactured material, which contains at least 5% of one or more of the primary nutrients (N_2,P_2,O_5, or K_2o). Industrially manufactured fertilizers are called mineral fertilizer. It should be noted that sometimes some materials might be applied to soil primarily to improve the physical

condition of the soil, in particular to correct soil acidity or alkalinity. (Ano, 2004). The use of manure and fertilizer as nutrients sources of crop production must be managed properly to ensure that they do not contaminate ground or surface water. Nutrient content of animal manure is variable depending on the type of animal, feed source, housing types, handling method, temperature, and moisture content. Because of this variability in nutrient content, industrial land application decision should be based on the nutrient content of the manure to be applied.

1.2 Aims and objectives of the study

The objectives of the study are as follows:-

i) To evaluate the potential of dairy and poultry wastewater as soil amendments in maize production.

ii) To carry out analysis to know whether the diary and poultry wastewater used has any effect on soil pollution and yield of the maize.

1.3 Statements of the problems

The problems that are associated with the use of dairy and poultry wastewater could be the method of treating, handling and disposing of the farm waste which may adversely affect air, water and soil conditions and may be a nuisance to those who dwell near by.

In addition, the efficiency in agricultural production could also generate a variety of environmental problems resulting from by-product being produced from these farms (FAO, 2000). Example of adverse environmental problems attributed to agricultural operations includes, excessive nutrients farm land used for crop production or waste disposal that unbalance natural ecological system and increased eutrophication.

1.4 Justification

The work is expected to contribute to the development of alternative source of use of dairy and poultry wastewater in Nigeria, which would eventually reduce the dependence on some of the commercial fertilizer products for our form uses. This in turn contribute to alleviate the problems associated with the maize production in Nigeria, there by making life easier through affordable and easily accessible source of maize while waste is converted to wealth. Hence, the need to effectively utilize/manage farm manure so as to minimize environmental pollution is.

i. The knowledge of the qualities of wastewater/manure generated will enable the farm managers to plan on how the waste can be well and properly managed.

ii. The improved profound wastewater management processes will enable the farm managers or operators to control environmental impacts that the waste generate would have caused.

iii. The farm managers will have alternative ways of treating their farm waste/wastewater.

However Animal manure can be an economical source of crop Nutrients, three key steps to utilizing manure in an environmentally and economically sound manner are listed below:-

a) Know the nutrient content of the manure

b) Apply a uniform rate base on crop Nutrient

c) Adjust the rate of supplement fertilizer to compensate for the nutrients applied in the manure.

The principal constituent of animal manure that impact surface and ground water are (organic matter, nutrients and fecal bacterial). Utilization of manure nutrients to replace commercial fertilizers has focused research on forage (Adeli, 2002; Buns 1990). To determine the sufficiency of nutrients other than nitrogen, it is acceptable to take diagnostic tissues sample. These samples should be taken once a season at easily identified crop growth storages, such as heading for small grains and silking for corns. Yearly sampling can be used not only to assess the level of several nutrients in a year, but to follow changes in soil fertility over several seasons. Hence, nutrient uptake is a function of plant biomass and nutrient concentration, but both factors may vary due to differences in cultivars, weather, soil properties and management practice (Adeli 2003). The average nutrient content is useful in determining overall waste management plans, but should not be used to determined actual land application rates. Application rates are usually based on nitrogen (N) phosphorus ($P_2 O_5$) and /or potassium K_2o content.

Quantities of secondary and micronutrient generated in manure are generally sufficient to prevent deficiency.

1.5 Scope of the study

This project study was carried out an a small piece of land and serve as a source and contribute to the information required for the production of maize on a large plot of land using dairy and poultry wastewater as a source of nutrient.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1 General

Wastewater contain various organic residues which remain as vegetal biomass in harvesting plant products and in preparing these products for direct use and for sale, or which occur in animal husbandry as excrement more or less mixed with water and different solid matter (John 1991). Hence waste water management is a critical concerned in many parts of the world where the expanding livestock industry is concentrating.

However, collection of wastewater is the initial capture and gathering of the manure from the point of origin or deposition point. Design consideration includes the volume and timing of manure and other livestock residues, the location and availability of power supplies and the opportunity to use topographic features.

2.2 Land Application

For a very long period, organic matter coming from livestock effluents, either mixed or not with other materials such as straw, was considered only as an interesting fertilizer for cultivated soils. However in develop countries intensification of most animal production, combined with new housing system using no litter has contributed for a number of years often in addition to other human activities to the pollution of underground and sub surface water. It is well known nowadays that too high a content of nitrogen in drinking water may be a danger to human health, especially where babies are concerned.

To those drawbacks of the over use of organic matters must be added those more recently put in to light in relation to new method of animal housing and manure

spreading: air pollution by ammonia and other volatile emission, and conflicts between farmers and other citizens to orders. Following such regulations, the farmers have to pay more and more attention to the environmental impacts of their activities and to improving their practices for a more sustainable agriculture. Their main points to be considered are storage capacities of animal waste, distance from water sources and dwellings, at appropriate fertilization allowing a sufficient supply of nutrients (but not more) applied only at revenant period for crops (Songodry A.Y, Mson. R. I 1997)

2.3 Storage capacities

One of the most important points is to have enough storage capacity for livestock waste in order to avoid spreading when period are not favorable for crop growth. These capacities have to be determined considering total waste coming from animals, and various other origins (silage, rainfall on uncovered exercise areas, or washing water). Of course, source of uncontrolled qualities of water drinking bowls, roofs without eaves) must be eliminated.

These quantities have to be established for the duration required by national regulation or after analysis of the agronomic and climatic context. In France, the minimum duration of storage has been determined by national authority to be four months, but local authorities are allowed to increase this minimum, often to 6 months or more and some times to 9 months or even 1 year as in Northern countries of the European union.

2.4 Manure storage

Manure storage structure are designed to either hold manure until it can properly applied to crop land or to provide storage and treatment of the waste prior to land

application. Manure holding or storage structure can be constructed above or below the ground or can be applied below the flow of a building. A treatment structure such as anaerobic lagoon is typically constructed below grade and to the side of the swine building. However laboratory analysis result for raw dairy sample wastewater storage composition is shown on the table below.

Table 2.1 Laboratory Analysis results for raw Dairy wastewater sample

S/No	Parameters	Sample 1 (Raw)	Sample 2 Three Days	Sample 3 Five Days	Sample 4 Seven Days
1	Conductivity (us/cm)	460	570	510	551
2	Temperature (^{0}C)	36	25	27	26^{0}C
3	Turbidity (FTU)	489	527	830	554
4	Colour (Pt CO)	550	580	410	673
5	pH	6.4	6.8	6.9	6.8
6	Odour	Odourless	Offensive	offensive	offensive
7	Total hardness (mg/l)	570	575	580	502
8	Nitrate (mg/l)	18.3	21.2	28.9	25.0
9	Nitrate (mg/l)	27.3	29.3	41.2	19.4
10	Phosphate (mg/l)	11.3	13.6	10.6	8.8
11	Phosphate (mg/l)	37.6	36.6	41.2	26.0
12	Iron content (mg/l)	11.63	9.46	7.2	7.9
13	Sulphate (mg/l)	11.6	17.5	18.2	19.5
14	Total alkalinity (mg/l)	130	194	133	104
15	Calcium (Mg/l)	541.6	55.4	56.2	41

16	Magnesium (mg/l)	37.30	42.3	18.4	13.1
17	Potassium (mg/l)	320	33.5	30.3	32
18	Sodium (mg/l)	410	41.3	44.6	40
	Organic parameters				
19	TDS (mg/l)	2400	298	345	223
20	Suspended solid (mg/l)	37.30	329	331	351
21	BOD (mg/l)	-	69	75	43
22	COD (mg/l)	-	55	51	51
23	DO (mg/l)	880	1020	1113	956

Source: Olaleye A.O, 2007

2.5 Environmental Effect of Agricultural Practices

i) Nitrates

The use of artificial and natural or traditional organic manure in areas where intensive agriculture is practiced has generated serious problems as nitrates from the fertilizer causes pollution in rivers, seas, and drinking water. These nitrates are naturally produced by nitro fixing bacterial, which fix nitrogen from the atmosphere in the decomposing organic matter and form nitrates.

The quantity of artificial nitrates used on arable land in attempts to improved agricultural yields has increased considerably over the last 20 years. Natural fertilizers also produce large quantities of nitrates as can be seen in animal husbandry. The huge amount of excrement (i.e urine and manure) which can not be used as fertilizers. This is

often leaked or intentionally released in to water supplies in order to dispose of the large quantities produced by animal husbandry. Soil itself will naturally produce nitrates through the microbial activity of nitro fixing bacteria by supplying nitrogen as nitrates directly to the plant when the plant decays nitrates are deposited in the soil.

Global efforts to maintain and enhance and health environment have been directed towards problems caused by urban centers and industrial operations. Had Agricultural production practice remained static, environmental problems caused by agriculture might have remained minimal. However, real and potential environmental problems have accompanied the changes in agriculture productivity in recent decade (after world war II) to meet the increasing world demand of food and fibre (Kelvin 1994).

Table 2.2: Excreta farm livestock in England and Wales (FAO. 2000)

Livestock	Number (millions)	Excreta out put Kg/animal/day	Excreta from House animal (million tons/year)	Total excreta all livestock (million tons/ years)
Cattle	9.44	18-14	43.06	83.17
Pigs	6.59	1.5-8.0	9.11	9.11
Poultry	109.77	0.115	4.60	4.60
Sheep	22.49	1.5-4.0	-	22.69

Source:(FAO, 2000)

The million of tonnes of waste produced above i.e manure from the livestock industries much of which can not be treated or disposed of adequately where there is no enough land or facilities for treatment can lead to nitrate concentration in the soil and as a result affects crop production.

This manure produces not only ammonia gas (NH_3) to pollute the atmosphere and damage vegetation, but also nitrate that are washed in streams.

2.6 Waste characteristics

An understanding of the characteristics of waste permits judgment on the type of treatment and disposal methods that may be effective. According to Boarder, (1985) as reported by Mathew, (1991) that agricultural waste are characterized mainly by compound of carbohydrates, fats, proteins, cellulose and hemicelluloses and lignin. The waste is suitable for being degraded by micro –organism except lignin which is resistant to microbial decay and only decomposable after per-treatment. Parameters such as BOD (Biochemical Oxygen Demand) COD (Chemical Oxygen Demand) ratios and or suspended solid ratio are used to estimate the feasibility of biological waste treatment processes with specific waste. With a liquid waste containing dissolved organic solids, biological treatment is appropriate. Solid waste with a high organic content is amendable to composting or incineration. Livestock wastes are solid, semisolid, or liquid depending upon how the production operation is designed and operated. The characteristics of livestock waste are affected by decision on how the wastes are to be handled.

The following are some characteristics of livestock waste: poultry manure contains total nitrogen of 0.006215(0.0028kg) bird/day, and ammonia nitrogen 0.00159kg/bird/day. Also an average dairy cow will produce between 14 and 18 tonnes of feaces and urine per year. Manure has about 300 to 400 pounds of dry matter/tones or 136.05 to 181.4kg of dry matter/ tones. There are about 4.535kgN, 1.814kg $P_2 0_5$ and 4. 0815kg $k_2 0$ in each tones of wet manure defected by cow.

2.7 Poultry manure

Poultry manure has long recognized as perhaps the most desirables of these natural fertilizers because of its high nitrogen content. In additions, manures supply other essential plant nutrients and serve as a soil amendment by adding organic matter. Organic matter persistence will vary with temperature, drainage, rainfall, and other environmental factors. Organic matter in soil improves moisture and nutrient retention. Poultry manure is often produced in area where it is needed for crops, hay and pasture fertilizer. The increased size and frequent clean out of many poultry operations make poultry available in sufficient quantities and on a timely basis to supply most fertilizer needs.

The most common procedure for determine the amount of manure to add per acre is to consider the manure's nitrogen content and the nitrogen needs of the crop.

2.8 Poultry Manure Handling System

The four main components of manure handling systems are collection, storage, treatment and use/disposal.

2.8.1 Poultry Manure Collection

In floor systems, the manure mixes with the bedding to from litter in no separation of the manure from the birds, but producers rely on the absorptive capacity of the bedding to maintain a good environment for the birds. In cage housing systems, manure falls in to pits or to conveyors. In pit systems, the manure remains in the barn until cleaning, while the conveyor systems allow more frequent removal of manure from the bird housing area

2.8.2 Poultry Manure Storage

All handling systems involve some storage of he manure between the time is excreted by the bird ad final application disposal. A storage system allows producers to hold manure until a convenient and optimum time for use of the produce many livestock and poultry producers use long-term manure storages t avoid winter spreading and make maximum use of the available nutrients.

In floor housing systems, the liter is removed at the end of each cycle and may be stockpiled until it is used. A similar system is used in deep pit houses, while manure from conveyor stored or stockpiled, consideration must be given to the potential for nuisance and environmental problems (Songodry A.Y, Mson. R. I 1997).

2.8.3 Treatment

The Alabama cooperative extension service defines treatment any system used to reduce the pollution potential of the waste or to otherwise alter its original condition. Other than the normal biological decomposition processes (usually anaerobic) that occur during storage, very little treatment of poultry manure occurs in Alberta.

2.8.4 Disposal of poultry manure

The most practical use of manure is to spread it on agricultural land where the organic matter and nutrients can be beneficial to the soil and plants. When manure is applied at a rate greater than that which the soil and crops can use, we view this as manure disposal. In disposal situations, producers really are using their fields as landfill sites. Those nutrients that are not used by the crops can be released in to the atmosphere and local water supplies where they can cause significant environmental impacts.

2.9 Use of Poultry Manure

If the most practical use of manure is to apply it to agricultural land, the best way to manage this resource, then, is to ensure that the timing, rate and method of manure application provide optimum growing conditions for plants this means that manures should be applied as close to the growing season as possible, given weather and storage constraints. On annual crop land, manure usually is applied spring application probably is best for protection against run off and loss nutrients, but many farms do not have sufficient time available before seeding.

The application equipment should be designed to distribute where plants can use the nutrients, solid manure is spread on the soil surface, while manure in to the soil is a recommended practice. This will reduce the losses of nitrogen to the air and eliminate the potential for nutrients to be carried away by run off water. Since incorporation is not possible during winter months, on forage crops, or in no-till cropping regimes, extra care must be taken when manure is applied to these fields. In all cases, the potential odour nuisance of the manure should be considered in decisions regarding the timing and method of application.

For best resource management, the rate of manure application should be based on the principle of nutrient management. Nutrient management involves balancing the nutrients added to the soil by fertilizers and manure with the nutrients removed from the soil by crops. The nutrients supplied by crop residues, mineralization and existing soil fertilizer are included in this balance, as are the nutrient lost through leaching, volatilization and soil microbial activity. Using the nutrient management concept,

producers can apply manure and fertilizers at rate that will contribute to optimum plant growth.

2.10 Nutrient content and Nutrient availability of manure

Nutrient content of animal manure is variable, depending on the types and age of animal, feed source, housing types, handling method, temperature, and moisture content. Because of this variability in nutrient content, individual land application decisions should be based and the nutrient content of the manure to be applied.

Average nutrient content are useful in determining overall waste management plans, but should not be used to determined actual land application rates.

Although manure application rate are usually based on N availability, managing manures for their P_2O_5 and K_2O contents can also be important. The availability of P_2O_5 and K_2O in manure in year of application is similar to that of fertilizer sources. So basing application rates an the manures P_2O_5 and K_2O content should be adequate. Determined how much P_2O_5 and K_2O are applied in the manure and supplement with fertilizer necessary. On soil testing high P_2O_5 and K_2O (No P_2O_5 and K_2O recommended from soil test), consider using the manure on other fields requiring P_2O_5 and K_2O incorporation of the manure in to the soil as soon as possible and controlling erosion and runoff minimizes the impact of Phosphorus on surface water quality Nitrogen availability from animal manure is difficult to predict. Availability of Nitrogen is dependent on release of Nitrogen from the waste and loss from the soil. Nitrogen is in manure in three forms- organic, ammonia/ ammonium, and nitrate. The quality of each is difficult to predict because of the dependence on the same environmental factors that affect nutrient. The

three forms of N have different plant availabilities and are lost from the sol in different ways.

Often, organic-N is the predominant form of N in animal manure. Organic-N is not available to crops until it has been decomposed to ammonium. The speed and extent of degradation are dependent on the type of manure, soil type, soil moisture and temperature and how well the manure is mixed with the soil. Estimates of organic –N availability range from 30-80 percent of the organic-N available in the first cropping season.

Considerable qualities of ammonia/ammonium N occur in most manure. Ammonia (NH_3) is a gas, and ammonia (HH_4^+) is a charged molecule dissolved in the soil water. Ammonia and NH_4^+ are rapidly interchangeable, dependent on the P^H of the solution. Increasing P^H increases the amount of NH_3 and NH_4^+ . Most crops will take up NH_4^+ as well as any other form of N but do not accumulate NH_3 any extent. Ammonia is readily lost to the atmosphere from the soil. As much as 15 percent of the NH_3 from surface applied manure can be lost each day with breezy, warm, moist conditions an sandy soils with a high P^H. considerable of NH_3 can occur when manure is applies to pasture. Leaching losses of NH_4^+ from soil are small.

2.11 Wastewater treatment methods

Methods of treatment in which the application of physical forces predominate are known as unit operations. Method of treatment in which the removal of contaminants is brought about by chemical or biological reactions are known as unit processes. At the present time, unit operations and processes are grouped together to provide various level of treatment known as preliminary, primary, advanced primary, secondary (without or

with nutrient removal, and advanced (or tertiary) treatment. In preliminary treatment, gross solids such as large objects, rags and grit are removed that may damage equipment. In primary treatment, a physical operation usually sedimentation, is used to removed the floating and settle able materials found in wastewater. For advanced primary treatment, chemicals are added to enhance the removal of suspended solid and to a lesser extent dissolved solids. In secondary treatment, biological and chemical processes are used to remove most of the organic matter. In advanced treatment, additional combination of unit operations and processes are used to remove residual suspended solid and other constituent that are not reduced significantly by conventional secondary treatment.

About 20 years ago, Biological Nutrients Removal (BNR) for the removal of nitrogen and phosphorus-was viewed as an innovative process for advanced wastewater treatment. Because of extensive research in to mechanism of BNR, the advantages of it's use, and the number of BNR system that have been placed in to operation nutrient removal, for all practical purpose, has become a part of conventional wastewater treatment. When compared to chemical treatment methods BNR use less chemical, reduced that production of waste solids, and has lower energy consumption.

Land treatment processes, commonly termed "natural system", combined physical, chemical and biological treatment mechanisms and produce waste with quality similar to or better than that from advance waste water treatment. Natural systems are not covered here as they are used mainly with small treatment system. (Metcalf and Eddy, 1991)

2.12 Land Disposal of Wastewater

Soil remains the best option for the ultimate disposal of wastewater. But of major concerned is the quantity to be applied to the land that will not cause any pollution in the soil and to the vegetation, including the ground water.

According to literatures, the amount of waste to be applied to the soil depends on the soil type, nutrient requirement of the soil and vegetation. Also the quantities of waste to be applied vary from one livestock to another based ob their BOD pollution effect. Farmers are advised to apply dairy and poultry wastewater at the rate of not move 20, 321kg /acre/ year Rates above this level generally have not provided a comparable yield increase. Larger application depressed field yields due to accumulations of soluble salts in the soil. Also acceptable application rate for wastewater have ranged up to 2 Inches /week/acre for waste municipal waste.

2.13 Organic manures

Organic manures are composed mainly of waste and residues from plant and animal life. They contain much carbon and relatively small percentages of plant food, usually these come from the plants that fixed carbon.

Organic manure supplies some nutrients for plants like maize, and the carbon-containing compounds are food for small animals and micro-organisms. Manures often improve the structure of soils, they may do this directly through their action as bulky diluents in compacted soils, or indirectly when the waste products of animals or micro-organisms cement soil particles together. These structural improvements increase the amount of water useful to crop that soil can hold; they also improve aeration and drainage, and encourage good root growth by providing enough pores of the right sizes and preventing

the soil becoming too rigid when dry or completely water logged and devoid of air when wet.

2.14 Inorganic Fertilizer

Any substance that is added to soil to supply one or more plant nutrient and intended to increase plant growth is a fertilizer. Inorganic fertilizers are usually simple chemical compounds, made in a factory or obtained by mining, which supply plant nutrients and are not residues of plant or animal life. In most countries the term "Inorganic fertilizers" means materials that supply calcium are included, magnesium is less often. However all essential plant nutrients (major and minor) when added to soil to benefit crops are fertilizers.

2.15 Demerit of Using Organic Manure on Soil

A difficulty in predicting the effect of organic manures arises from their slow decomposition. Decomposition occurs largely through microbial activity and is accompanied by a marked increase in microbial populations. These raise the demand for nitrogen and may lead to temporary N deficiencies. Crops growing in the soil at this stage may therefore be hindered by lack of nitrogen. A number of other factors need to be taken in to account in assessing the value of organic manures. One of the main problems is in predicting the effect Farm Yard Manure (FYM) upon crop yield. In part this difficulty arises from the natural variability of manure; also it is due to the unreliable availability of the nutrient contained within the material. Thus, even if the composition is known, it is not easy to determine the quantity of nutrients that will be released to plants.

CHAPTER THREE

3.0 STUDY AREA

The project site is Gbegannu Village in Chanchaga Local Government Area of Niger State along Gidan Kwanu Campus of the Federal University of Technology Minna, located at latitude 09^0 30^1 and longitude 06^0 32^1 E (Ija; 2007) with the average annual rainfall of 1287.4mm.

3.1 Materials and method

The materials used were collected from Maizube farm and Abu Turab poultry farm and the equipment used were from the Soil Science department of the School of Agriculture and Agricultural Technology, Federal University Technology, Minna.

3.1.1 Materials

The materials used are

i) Dairy wastewater

ii) Poultry wastewater

iii) Maize

3.1.2 Equipment

The following equipment were used in the project:

i) Glass cylinder of approximately one liter capacity was used for containing soil suspension during settling.

ii) Special hydrometer for measuring density of soil suspension

iii) Thermometer for measuring temperature of the suspension

iv) Water buckets

v) 25 liters keg for dairy and poultry waste water collection

vi) Measuring tape for measuring stem diameter and leaf area.

vii) Watering can for wastewater application.

However, five clod soil samples were taken from the field of study in different places each at 20cm-40cm deep, clod soil samples at these depths were taken and transferred to the "cans" labeled A, B,C,D,E, from where they were taken to the laboratory for the bulk density and particle size determination.

3.1.3 Site Preparation and Maize Planting

The project site which is 16.46x10.36m was cleared of weeds after which the ridges was make of 30cm with and the planting of the maize followed up immediately at the distance of 30cm each between the planted maize on the seed bed, this was done on 26th may, 2008, the planting was done by digging a hole down on the seed bed to 3cm deep and the three maize seeds were put in each of the hole.

3.2.1 Bulk Density (clod method) Determination

Procedure

Clod soil samples were taken carefully at five different places from the field of study and was transferred to the cans labeled A,B,C,D,E, from where they were taken to the laboratory for bulk density determination.

The clods of soil were excavated and air dried for 24hours after which each of the clod samples was tied to a thin thread around it and weighed (Ws) from where the weight of clod soil was obtained. The clod samples was dip briefly in melted paraffin at 60°c in order to water proof the clod, the coated clod was weighed and the weight of paraffin coating was calculated (Anderson and Ingram, 1993).

The clod was suspended from the balance arm and was submerged completely in a beaker of water from which the weight was recorded.

However bulk density was calculated using the equation below

$\int_b$ =Ms/Vs----------3.1

Where Ms =Mass of clod soil = Weight of clod/g

Vs = Volume of clod = volume waxed clod/cm^3-volume of wax/cm^3 and volume of waxed clod/cm^3= $\frac{Wsp-Wspw}{Dw}$ =---------- 3.2

Where Wsp= Weight of clod + paraffin,

Wspw=Weight of clod + paraffin + Weigh of water

Dw= Density of water at temperature of determination also volume of wax/cm^3 = Wp/Dp

=---------- 3.3

Where Wp = Weight of paraffin

Dp = Density of paraffin (0.9)

3.3.0 Particles Size Analysis of the Soil

Hydrometer method was used for determine particles analysis of the soil, two millimeter (2mm) air dry soil was sieved and 50g of the sample was weighed – 100ml was added to the sample in a bottle and 5% sodium hexametaphosphate solution which serves as a dispersing agent was added. The mixer was placed in a shaker and the shake content was transferred quantitatively without loosing any particle in to sedimentation cylinder with distilled water, the soil sample was disturbed with the aid of the plunger to bring the soil particle suspension. 40 seconds reading of the hydrometer the taken and recorded. The blank experiment without soil sample in the sedimentation cylinder was done in the same way on that with the soil sample and the hydrometer reading for 40 seconds was also recorded. The experiment was left for two hours to allow for maximum

settling of the mixture. The hydrometer reading of the suspension was taking and recorded. Also the temperature of both was measured. After two hour the solution suspension was decanted and washed using distilled water several times to remove the organic matter and other suspensions.

The residues represent the soil sample of the soil. The sand grains were put in a canned and placed in an oven at 105°c over night.

The textural class of soil is obtained by using the equation as follows:

C=R-RL+0.36T----------3.4

Where C= corrected hydrometer reading

R= Soil Hydrometer Reading

RL= Blank Hydrometer Reading

T = Room Temperature 20^0c

Sample A, Area 1

Hydrometer reading at 40seconds is given by

$C_{40sec.}$ = R- RL + 0.36T

= 8- (-1) + 0.36(32)

= 8+ 1+11.52

$C_{40sec.}$= 20.52g/L

Percentage silt + clay =C_{40sec} X $\frac{100}{W}$

Where w = weight of sample = 50g

= 20.52 x $\frac{100}{50}$

% silt + clay = 41.04 %

Percentage sand = 100- (%silt + clay)

= 100-41.04

= 58.96%

Corrected hydrometer reading at 2 Hours

C_{2hrs} = R-RL + 0.36T

$= 0 - (-1) + 0.36\ (32)$

$= 1 + 11.52$

$= 12.52$ g/L

$$\% \text{ Clay} = C_2\text{hrs} \times \frac{100}{W}$$

$$= 12.52 \times \frac{100}{50}$$

$= 12.52 \times 2$

$= \%$ clay $= 25.04\%$

$\%$ silt $= \%$ (silt + clay) - $\%$ clay

$= 41.04 - 25.04$

$= \%$ silt $= 16.00\ \%$

Sample B, Area 2

Corrected hydrometer reading at 40 seconds is given by

$C_{4oscc.} = R\text{-}RL + 0.36T$

$= 8\text{-}\ (-1\text{-} + 0.36\ (32)$

$= 8+1+11.52$

$C_{40scc} = 20.52$

$$\% \text{ silt + clay} = C_{4oscc.} \times \frac{100}{W}$$

$$= 20.52 \times \frac{100}{50}$$

$= 20.52 \times 2$

$\%$ silt + clay $= 41.0\%$

$\%$ sand $= 100 - \%$ (silt + clay)

$\%$ sand $= 100 - 41.04$

$= \underline{\boldsymbol{58.96\%}}$

$= 0 + 11.52$

$C_{2hrs} = 11.52$

% Clay $= 11.52 \times 2$

$= 23.04$ %

% silt $= 45.04 - 23.04$

% silt $= 22.00$ %

However, the textural classes for the samples are sandy, clay, loam

Therefore from the above texture classes results obtained, the production of maize using dairy and poultry wastewater is reliable for efficient and maximum yield of the maize.

3.4 Dairy and Poultry Wastewater Collection

Dairy and poultry wastewater were collected on a 25litre jerry can each from Maizube Farm and Abu Turab poultry farm respectively on 20th -06-2008. these wastewater collected were poured in an open rubber buckets separately and stored for 5 days before it was taken to the field of study for application, this was done to allowed the wastewater emit out some heat that are involved in the wastewater in order not to damage the maize plant. After the wastewater was kept for 5 days it was poured back in to the 25litres jerry cans before taken it to the field of study for application. The other wastewater collected from Maizube farm and Abu Turab poultry farm were stored for five (5) days continuously, these was done in order to determined the yield of maize at different stages after application of the wastewater.

3.5 Application of Dairy and Poultry wastewater

After keeping the dairy and poultry wastewater for 5 days respectively, it was taken to the field of study for application. On reaching the field of study, the wastewater was again poured in to a watering can and the irrigation was done with the respective wastewaters (plate 1).



Plate1: Application of Wastewaters to the Field.

3.6 Land preparation

Before the application of the wastewater, the land area 16.46 x10.05m was divided in to four (4) plots, 4m using for control experiment. 4m was used for dairy wastewater application only, 4m for poultry wastewater application only and 4.4m was used for the combination of dairy and poultry wastewater application and between each division asbestors was buried to a depth of 2m beyond the roof zone of the selected standing crops from each section of divisions for the experiments. After the demarcation of the field of study watering can was used to apply the wastewater on the required places of field of study.

The application rate of all the above were in the ranges of 15liter of dairy wastewater, 15liters of poultry and 20litre of mixed dairy and poultry wastewater. However these procedures was followed and repeated for the remaining applications of both dairy and poultry wastewater for consistency. After plating of the. Maize the field of study was

allowed the identification of total leaf number. The number of leaves per plant were registered and physical maturity on all tagged plant. Individual leaf area per plant was computed LA=lamina length x maximum width x 0.75.....3.5

And the leaf area index (LAI) was calculated as follows LAI=product of leaf area per plant and number of plants per unit land area.

LAI=LA x n.....3.6

Where n = number of plants per unit land area.

LA= leaf area per pants.

3.7.3 Stem height

Measuring tape was used to take the stem height by measuring the height from the root of the stem to the top of the leaf. Five standing maize crop were choosing from control experiment, dairy wastewater experiment, poultry wastewater experiment and the mixed dairy and poultry wastewater experiment respectively and the average stem Height for each was determined each two week.

Table 4.5: Physical Characteristic of the Maize 56 Days After Planting

	Replicate			
Treatment	Average Stem Diameter (cm)	Average Stem Height (cm)	Average Leaf Area (LA)(cm^2)	Leaf Area Index (LAI)(cm^2)
control	7.33	139.30	457.30	2286.50
Dairy Waste water	8.00	153.90	609.64	3048.20
Poultry Waste water	6.26	134.02	451.71	2258.55
Mixed dairy and poultry waste water	7.51	140.05	474.45	2372.25

From the table 4.5, Dairy wastewater turns out to be the best in terms of both stem diameter with the value 8.oocm, stem height 153. 90cm, leaf area 609.64cm^2 and leaf area index 3048.20 which is followed by the mixed dairy and control experiments then the poultry wastewater come next, this is because poultry wastewater is a wash poultry wastewater which implies it does not perform well as the other one.

Table 4.6 Physical Characteristic of the Maize 70 Days After Planting

	Replicate			
Treatment	Average Stem Diameter (cm)	Average Stem Height (cm)	Average Leaf Area (LA)(cm^2)	Leaf Area Index (LAI)(cm^2)
control	9.16	158.06	721.57	3607.85
Dairy Waste water	10.24	180.06	904.39	4521.95
Poultry Waste water	9.86	157.24	772.97	3864.85
Mixed dairy	10.38	177.30	832.06	4160.30

and poultry waste water				

From the table 4.6 above, mixed Dairy and poultry wastewater turn out to be performing well in stem diameter with the value 10.38cm, while the dairy waste turnout to be the one performing well in stem height with the value 904. 39cm^2 and leaf area index 452.95 which are followed by poultry waste waster and then control experiment.

Table 4.7: Physical characteristics of maize 84 days After planting

	Replicate			
Treatment	Average Stem Diameter (cm)	Average Stem Height (cm)	Average Leaf Area (LA)(cm^2)	Leaf Area Index (LAI)(cm^2)
control	10..08	187.88	657.25	3286.25
Dairy Waste water	11.14	198.63	700.83	3504.15
Poultry Waste water	10.66	175.40	625.49	3127.45
Mixed dairy and poultry waste water	10.98	186.46	668.44	3342.20

Form the table 4.7 above, Dairy wastewater is performing well in all the physical characteristics of maize with the stem diameter 11.14cm, stem height 198.63cm, leaf area 700.83cm^2 and leaf area index 3504.15cm^2, which is followed by the mixed dairy and poultry wastewater experiment followed by the control experiment and then the poultry wastewater, this is because poultry wastewater is not a drop poultry waste but poultry wash wastewater.

Table 4.8 Measurements of the Yield of Maize

Sample Description	control	Dairy	Poultry	Mixed dairy and poultry
Biggest cob with husk (kg)	0.35kg	0.45kg	0.30kg	0.40kg
Biggest cob without husk (kg)	0.20kg	0.25kg	0.10kg	0.30kg
Smallest cob with husk (kg)	0.15kg	0.20kg	0.30kg	0.10kg
Smallest cob without husk (kg)	0.10kg	0.15kg	0.05kg	0.06kg
Average grain per cob	6274.56	21734.4	4993.8	6951.75
Biggest grain size (kg)	1.23kg	2.44kg	1.40kg	3.14kg
Smallest grain size (kg)	0.45kg	0.88kg	0.53kg	0.76kg
Total number of cob	32	48	41	39
Total yield (kg/ha)	1000	2166.67	666.67	1081.08

4.3 DISCUSSION

4.3.1 YIELD FORM THE PLOT

From table 4.4, the total yield of the maize determined, Dairy wastewater turnout to be the one with heights yield with the value 2166.67kg / ha followed by the mixed Dairy and poultry wastewater with the value 1081.08kg /ha. Due to their combination which neutralize their mixture. The poultry wastewater is the one with the lowest kg/ ha with the value 666. 67 kg/ha which is not performing well as the other ones, this is because it is a wash poultry wastewater.

4 .3.2 Determination of Yield

Control experiment

$$\text{Kg/ha} = \frac{\text{Average grain size x10,000}}{\text{Area of control experiment}}$$

$$= \frac{0.3\text{ kg} \times 10,000}{10.05 \times 4}$$

$$= \frac{0.3\text{ kg} \times 10,000}{40.2\text{cm}^2}$$

$$= \boldsymbol{74.63\text{kg} / \text{m}^2}$$

Dairy waste water experiment

$$\text{Yield/ha} = \frac{0.35\text{kg} \times 10,000}{40.2\text{m}^2}$$

$$= \boldsymbol{87.06\text{kg/m}^2}$$

Poultry wastewater experiment

$$\text{Kg/ha} = \frac{0.2\text{kg} \times 10,000}{40.2\text{m}^2}$$

$$= \boldsymbol{49.75\text{kg/m}^2}$$

Mixed Dairy and poultry wastewater

$$\text{Kg/ha} = \frac{0.7\text{kg} \times 10,000}{10.05 \times 4.4}$$

$$= \frac{0.7\text{kg} \times 10,000}{44.22}$$

$$= \boldsymbol{158.29\text{kg/m}^2}$$

The samples of harvested maize were shown in plates 3, 4, 5 and 6.

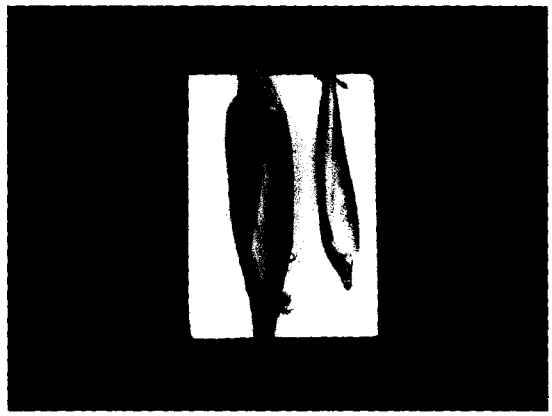


Plate 3: The Smallest and Biggest cobs from Mixture of Diary and Poultry Wastewaters Plot.

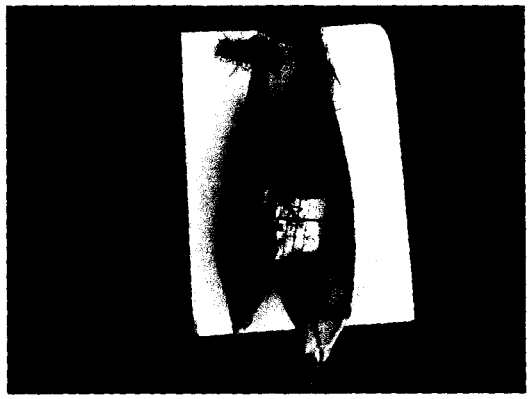


Plate 4: The Biggest and Smallest Cobs from Dairy Wastewater Plot.

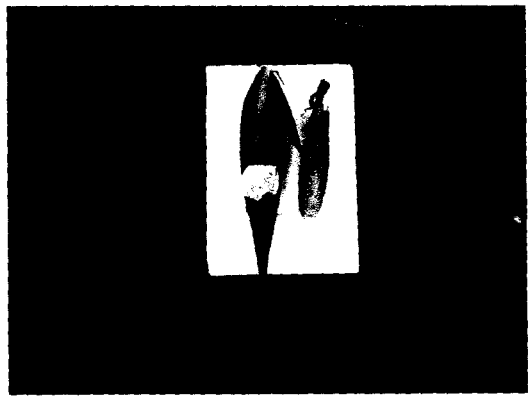


Plate 5: The Biggest and Smallest Cobs from Poultry Wastewater Plot.

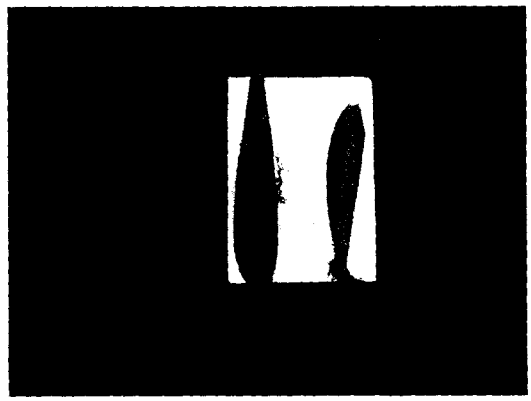


Plate 6: The Biggest and Smallest Cobs from the Control Plot.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1CONCLUSION

The project study permits us to understand the fundamental concept of wastewater application in the maize production and also the concept of Irrigation.

Experiment carried out at Gbegannu village has been achieved within 102 days form may to September 2008. Various aspect including Dairy and poultry wastewater application, plant height leaf area and stem diameter have been monitor and recorded.

It can be concluded form the discussion of results that the crop yield of maize increases with increase in Dairy wastewater application' to known finally the characteristics of the soil, the textural classification and bulk density have been determined.

5.2 RECOMMENDATION

Since the stated aims and objectives has been achieved in this project work by comparing the growth yield of the maize produced using control experiment, Dairy and poultry wastewater for the experimental results obtained in the tables 4.3a to 4.3d and table 4.4

It is therefore recommended that Dairy wastewater should be adequately used in the production of maize and it is efficient out put, and the disposal of Dairy wastewater should be done in such a way that will not contaminate the drinking water for the people living around the environment. It is further recommended that the poultry wastewater that should be used in the production of maize should be the drop poultry wastewater and not the poultry wash wastewater.

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APPENDIX A

Formulary used in calculating physical properties

1. Bulk Density

$\int_b = Ms/V_s$

Where $\int_b$ = Bulk Density, M_s = Mass of clod soil,

V_s = Volume of clod

2. Soil Classification

$C = R - RL + 0.36T$

Where C = Corrected Hydrometer Reading

R = Soil Hydrometer Reading

RL = Blank Hydrometer Reading

T = Room Temperature 20^0c

3. Average Mean stem Diameter, height.

$$\dot{y}_K = \sum_{i=1}^{n} \frac{N}{n}$$

Where $\dot{y}$= Average Mean of the experiment

K = experimental type

N = number of selected crops

n = Total number of selected crops

a. For control experiment.

Average stem Diameter and height are computed as follows

$$\dot{y}_{cs} = \sum_{i=1}^{n} \frac{N}{n}$$

Where $\dot{y}_{cs}$ = Average Mean stem Diameter of control experiment.

For the height

$$\dot{y}_{ch} = \sum_{i=1}^{n} \frac{N}{n}$$

Where $\dot{y}_{ch}$ = average Mean height of control experiment

b. For Dairy wastewater experiment

$$\dot{y}_{Ds} = \sum_{i=1}^{n} \frac{N}{n}$$

Where $\dot{y}_{DS}$ = Average Mean stem Diameter of Dairy wastewater experiment

For the height

$$\dot{y}_{DH} = \sum_{i=1}^{n} \frac{N}{n}$$

Where $\dot{y}_{DH}$ = Average Mean height of Dairy wastewater

c. For poultry wastewater experiment

$$\dot{y}_{ps} = \sum_{i=1}^{n} \frac{N}{n}$$

Where $\dot{y}_{ps}$ = Average Mean stem Diameter of poultry wastewater experiment

For the height

$$\dot{y}_{pH} = \sum_{i=1}^{n} \frac{N}{n}$$

Where $\dot{y}_{pH}$ = Average Mean height of poultry wastewater experiment

d. For mixed Dairy poultry wastewater experiment

$$\dot{y}_{Dps} = \sum_{i=1}^{n} \frac{N}{n}$$

Where $\dot{y}_{Dps}$ = Average Mean stem Diameter of mixed Dairy and poultry wastewater experiment

For the height

$$\dot{y}_{Dph} = \sum_{i=1}^{n} \frac{N}{n}$$

Where $\dot{y}_{DPH}$ = Average Mean height of mixed Dairy and poultry wastewater experiment.

4.a LEAF AREA, LA

LA = LL*Mw x 0.75

Where LA = Leaf Area

LL = Lamina Length

Mw = Maximum width

b. LEAF AREA INDEX, LAI

LAI = LA x n

Where LAI = Leaf Area index

LA = Leaf Area

n = number of selected plant per unit Area.

APPENDIX B

Determination of Bulk Density in the table 4.1

Sample A.

$\int_b = \frac{Ms}{Vs}$

Ms = weight of clod/g = 10.38g

Vs = 10.00 – 1.66 = 8.34cm^3

$\int_b = \frac{10.38}{8.34}$

$\int_b = \boldsymbol{1.245 g/cm^3}$

Sample B

$\int_b = \frac{Ms}{Vs}$

Ms = weight of clod/g = 11.74g

Vs = 11.00 – 2.49 = 8.51cm^3

$\int_b = \frac{11.74}{8.51}$

$\int_b = \boldsymbol{1.380 g/cm^3}$

Sample C

$\int_b = \frac{Ms}{Vs}$

Ms = weight of clod/g = 11.81g

Vs = 10.00 – 1.48 = 8.52cm^3

$\int_b = \frac{11.81}{8.52}$

$\int_b = \boldsymbol{1.386 g/cm^3}$

Sample D

$\int_b = \frac{Ms}{Vs}$

Ms = weight of clod/g = 9.58g

Vs = 9.50 – 1.78 = 7.72cm^3

$\int_b = \frac{9.58}{7.72}$

$\int_b = 1.241 g/cm^3$

Sample E

$\int_b = \frac{Ms}{Vs}$

Ms = weight of clod/g = 14.38g

Vs = 11.00 – 2.61 = 8.39cm^3

$\int_b = \frac{14.38}{8.39}$

$\int_b = 1.714 g/cm^3$

APPENDIX C

Determination of Row Data obtained in the table 4.3a Average stem Diameter of control experiment is computed as follows

$$Y_{cs} = \frac{5.0 + 6.2 + 5.8 + 4.9 + 6.7}{5}$$

$$= \frac{28.60}{5}$$

$$\boldsymbol{Y_{cs} = 5.70cm}$$

Average stem Diameter of Dairy wastewater experiment

$$Y_{Ds} = \frac{7.5 + 6.4 + 6.2 + 7.1 + 6.9}{5}$$

$$= \frac{34.1}{5}$$

$$\boldsymbol{Y_{Ds} = 6.82cm}$$

Average stem Diameter of poultry wastewater experiment

$$Y_{Ps} = \frac{5.7 + 5.3 + 6.2 + 5.9 + 5.7}{5}$$

$$= \frac{28.80}{5}$$

$$\boldsymbol{Y_{ps} = 5.76cm}$$

Average stem diameter of mixed Dairy and poultry wastewater experiment.

$$Y_{DPS} = \frac{6.5 + 5.8 + 6.2 + 6.3 + 5.1}{5}$$

$$= \frac{29.9}{5}$$

$$\boldsymbol{Y_{DPS} = 5.98cm}$$

For the determination of average stem height in the table 4.3a

Average height of control experiment

$$Y_{CH} = \frac{40+54+48+39+55}{5}$$

$$= \frac{236}{5}$$

$Y_{CH} = 47.20cm$

Average height of Dairy wastewater experiment

$Y_{DH} = \frac{59 + 51 + 50 + 58 + 54}{5}$

$= \frac{272}{5}$

$Y_{DH} = 54.40cm$

Average height of poultry wastewater experiment

$= \frac{48+42+50+49+50}{5}$

$= \frac{239}{5}$

$Y_{PH} = 47.80cm$

Average height of mixed dairy and poultry wastewater experiment.

$Y_{DPH} = \frac{60 + 61 + 58 + 55 + 50}{5}$

$= \frac{284}{5}$

$Y_{DPH} = 56.80cm$

Determination of leaf Area, LA in the table 4.[illegible]

Leaf Area of control experiment

LA_C = Lamina length x maximum width x 0.75

= 82.82 x 8.34 x 0.75

$LA_C = 518.04cm^2$

Where LA_C= Leaf Area of control experiment

Leaf Area of Dairy wastewater experiment

$LA_D = 86.74 \times 9.02 \times 0.75$

$= 586.79cm^2$

Where LA_D = leaf area of Dairy wastewater experiment

Leaf Area of poultry wastewater experiment

$LA_P = 83.82 \times 8.38 \times 0.75$

$LA_P = 526.81\ cm^2$

Where LA_P = Leaf Area of poultry wastewater experiment

Leaf Area of mixed Dairy and poultry wastewater experiment

$LA_{DP} = 83.06 \times 8.54 \times 0.75$

$LA_{DP} = 531.99\ cm^2$

Where LA_{DP} = Leaf Area of mixed dairy and poultry wastewater experiment

For the Determination of leaf Area Index, LAI

$LAI = LA \times n$

Leaf Area Index of control experiment, LAI_C

$LAI_C = LA_C \times n$

$=518.004 \times 5$

$LAI_C = 2590.2$

Leaf Area of dairy wastewater experiment, LAI_D

$LAI_D = LA_D \times n$

$= 586.79 \times 5$

$LAI_D = 2933.95$

Leaf Area Index of poultry wastewater experiment, LAI_P

$LAI_P = LA_P \times n$

$= 526.81 \times 5$

$LAI_P = 2634.05$

Leaf Area of mixed Dairy and Poultry wastewater experiment, LAI_{DP}

$LAI_{DP} = LA_{DP} \times 5$

$= 531.99 \times 5$

$LAI_{DP} = 2659.95$

Determination of Row data obtained in the table 4.5b

Average stem diameter of control experiment, Y_{cs}

$$Y_{cs} = \frac{7.30 + 8.40 + 6.25 + 7.70 + 7.00}{5}$$

$$Y_{cs} = \frac{36.65}{5}$$

$$\boldsymbol{Y_{cs} = 7.33cm}$$

Average stem diameter of diary wastewater experiment

$$Y_{DS} = \frac{7.80 + 8.00 + 7.90 + 8.50 + 7.80}{5}$$

$$= \frac{40}{5}$$

$$\boldsymbol{Y_{DS} = 8.0cm}$$

Average stem diameter of poultry wastewater experiment

$$Y_{ps} = \frac{5.60 + 6.55 + 6.15 + 6.80 + 6.20}{5}$$

$$= \frac{31.3}{5}$$

$$\boldsymbol{Y_{ps} = 6.26cm}$$

Average stem diameter of mixed Dairy and poultry wastewater experiment

$$Y_{Dps} = \frac{7.50 + 7.35 + 7.20 + 7.70 + 7.80}{5}$$

$$= \frac{37.55}{5}$$

$$\boldsymbol{Y_{Dps} = 7.51cm}$$

For the Determination of average Height in the table 4.3b average height of control experiment, Y_{CH}

$$Y_{CH} = \frac{147 + 122 + 133.5 + 154 + 140}{5}$$

$$= \frac{696.5}{5}$$

$$\boldsymbol{Y_{CH} = 139.cm}$$

Average height of dairy wastewater experiment, Y_{DH}

$$Y_{DH} = \frac{178.00 + 149.00 + 145.00 + 157.50 + 140.00}{5}$$

$$= \frac{769.50}{5}$$

Y_{DH} = 153.90cm

Average height of poultry wastewater experiment, Y_{PH}

$$Y_{PH} = \frac{130+141.70+131.60+136.60+130.20}{5}$$

$$= \frac{670.10}{5}$$

Y_{PH}= 134.02cm

Average height of mixed dairy and poultry wastewater experiment, Y_{DPH}

$$Y_{DPH} = \frac{127.20 +130.70+ 152.00 + 139\ 85 + 150.50}{5}$$

$$= \frac{700.25}{5}$$

Y_{DPH} = 140.05cm

Determination of leaf area, LA in the table 4.5

Leaf area of control experiment, LA_C

LA_C Lamina length x maximum width x 0.75

= 62.60 x 9.74 x 0 .75

LA_C = 457 .30cm^2

Leaf area of Dairy wastewater experiment, LA_D

LA_D = Lamina length x maximum width x 0.75

= 80.80 x 10.06 x 0.75

LA_D= 609.64cm^2

Leaf Area of poultry wastewater experiment, LA_P

LA_P = Lamina length x maximum width x 0.75

= 72 .13 x 8.35 x 0.75

$LA_P = 451.71cm^2$

Leaf Area of mixed Dairy and poultry wastewater experiment, LA_{DP}

LA_{DP} = Lamina length x maximum width x 0.75

= 69.90 x 9.05 x 0.75

$LA_{DP} = 474.45cm^2$

For the determination of leaf area index, LAI in the table 4.3b

Leaf area index of control experiment, LAI_C

$LAI_C = LA_C$ x n

= 457.30 x 5

LAI_C = 2286 . 50

Leaf Area index of Dairy wastewater experiment, LAI_D

LAI_D = LAD x n

= 609. 46 x 5

LAI_D = 3048. 20

Leaf area index of poultry wastewater experiment, LAI_P

$LAI_P = LA_P$ x n

451. 71 x 5

LAI_P = 2258 . 55

Leaf area index of mixed dairy and poultry wastewater experiment, LAI_{DP}

$LAI_{DP} = LA_{DP}$ x n

474. 45 x5

LAI_{DP} = 2372 .25

Determination of row data obtained in the table 4.2

Average stem diameter of control experiment, Y_{cs}

$$Y_{cs} = \frac{8.90 + 10.00 + 8.60 + 8.80 + 9.50}{5}$$

$$= \frac{45.80}{5}$$

$$\boldsymbol{Y_{cs} = 9.16cm}$$

Average stem diameter of dairy wastewater experiment, Y_{DS}

$$Y_{DS} = \frac{10.20 + 10.10 + 10.40 + 10.30 + 10.20}{5}$$

$$= \frac{51.20}{5}$$

$$\boldsymbol{Y_{DS} = 10.24cm}$$

Average stem diameter of poultry wastewater experiment, Y_{ps}

$$Y_{ps} = \frac{8.50 + 10.80 + 9.70 + 10.10 + 10.20}{5}$$

$$= \frac{49}{5}$$

$$\boldsymbol{Y_{ps} = 9.86cm}$$

Average stem diameter of mixed dairy and poultry wastewater experiment, Y_{DPS}

$$Y_{DPS} = \frac{11.10 + 10.20 + 10.10 + 9.80 + 10.70}{5}$$

$$= \frac{51.90}{5}$$

$$\boldsymbol{Y_{DPS}\ 10.38cm}$$

Determination of average Height in the table 4.6c

Average Height of control experiment

$$Y_{CH} = \frac{140.20+154.10+153.20+193.60+149.20}{5}$$

$$= \frac{790.30}{5}$$

Y_{CH} = 158. 06cm

Average Height of Dairy wastewater experiment, Y_{DH}

$$Y_{DH} = \frac{201.20+174.30+186.60+166.60+171.60}{5}$$

$$= \frac{900.30}{5}$$

Y_{CH} = 180. 06

Average Height of poultry wastewater experiment, Y_{PH}

$$Y_{PH} = \frac{142.30+145.60+170.50+150.20+177.60}{5}$$

$$= \frac{786.20}{5}$$

Y_{PH} = 157. 24cm

Average Height of mixed Dairy and poultry wastewater experiment, Y_{DPH}

$$Y_{DPH} = \frac{180.20+180.70+170.10+165.20+190.30}{5}$$

$$= \frac{886.50}{5}$$

Y_{DPH} = 177. 30cm

Determination of leaf area, LA in the table 4.6c

Average leaf area of control experiment, LA_C

LA_C = Lamina length x maximum width x 0.75

= 82.94 x 8.70 x 0.75

LA_C = 541.18cm^2

Average leaf area of Dairy wastewater experiment, LA_D

LA_D = Lamina length x maximum width x 0.75

= 83.74 x10.80 x 0.75

$LA_D = 678.29cm^2$

Average leaf area of poultry wastewater experiment, LA_P

LA_P = Lamina length x maximum width x 0.75

= 77.92 x 9.92 x 0.75

$LA_P = 579.72cm^2$

Average leaf area of mixed poultry wastewater experiment, LA_{DP}

LA_{DP} = Lamina length x maximum width x 0.75

= 83.54 x 9.96 x 0.75

$LA_{DP} = 624.04cm^2$

Determination of leaf area Index LAI, in the table 4.6

Leaf area Index of control experiment, LAI_C

$LAI_C = LA_C$ x n

= 541.18 x 5

$LAI_C = 2705.90$

Leaf area Index of dairy wastewater experiment, LAI_d

$LAI_D = LA_D$ x n

= 678.29 x 5

$LAI_D = 3391.45$

Leaf area Index of poultry wastewater experiment, LAI_P

$LAI_P = LA_P$ x n

= 579.72 x 5

$LAI_P = 2898.60$

Leaf area Index of mixed Dairy and poultry wastewater experiment, LAI_{DP}

$LAI_{DP} = LA_{DP} \times n$

$= 624.04 \times 5$

$LAI_{DP} = 3120.2$

Determination of row Data obtained in the table 4.3d

Average stem diameter of control experiment

$$Y_{CS} = \frac{10.20+11.01+9.90+9.10+10.20}{5}$$

$$= \frac{50.41}{5}$$

$Y_{CS} = 10.08cm$

Average stem diameter of Dairy wastewater experiment, Y_{DS}

$$Y_{DS} = \frac{11.05+10.90+11.03+11.60+11.10}{5}$$

$$= \frac{55.68}{5}$$

$Y_{DS} = 11.14cm$

Average stem diameter of poultry wastewater experiment, Y_{PS}

$$Y_{PS} = \frac{9.20+11.30+10.30+11.02+11.50}{5}$$

$$= \frac{53.32}{5}$$

$Y_{PS} = 10.66cm$

Average stem diameter of mixed Dairy and poultry wastewater experiment, Y_{DPS}

$$Y_{DPS} = \frac{11.80+10.90+10.90+10.20+11.10}{5}$$

$$= \frac{54.90}{5}$$

$Y_{DP0.S} = 10.98cm$

Determination of Average Height in the table 4.3d

Average Height of control experiment

$$Y_{CH} = \frac{190.30+170.10+180.3+202.29+196.50}{5}$$

$$Y_{CH} \quad \frac{939.40}{5}$$

Y_{CH} = 187.88cm

Average Height of Dairy wastewater experiment, Y_{DH}

$$Y_{DH} = \frac{210.05+195.50+204.20+198.30+185.10}{5}$$

$$Y_{DH} \quad \frac{993.15}{5}$$

Y_{DH} = 198.63cm

Average Height of poultry wastewater experiment, Y_{PH}

$$Y_{PH} = \frac{160.10+167.20+189.40+171.10+189.20}{5}$$

$$Y_{PH} \quad \frac{877.00}{5}$$

Y_{PH} = 175.40cm

Average Height of mixed Dairy and poultry wastewater experiment, Y_{DPH}

$$Y_{DPH} = \frac{191.10+189.70+181.20+172.10+198.20}{5}$$

$$Y_{DPH} \quad \frac{932.30}{5}$$

Y_{DPH} = 186.46cm

Determination of leaf area LA, in the table 4.7d

Leaf area Index of control experiment, LA_C

LA_C = Lamina length x maximum width x 0.75

= 83.94 x 10.44 x 0.75

LA_C= 657.25cm^2

Average Leaf area of Dairy wastewater experiment, LA_D

LA_D = Lamina length x maximum width x 0.75

= 84.26 x11.09 x 0.75

LA_D= 700.83cm^2

Average Leaf area of poultry wastewater experiment, LA_P

LA_P = Lamina length x maximum width x 0.75

= 78.53 x 11.09 x 0.75

LA_P= 625.49cm^2

Average Leaf area of mixed Dairy and poultry wastewater experiment, LA_{DP}

LA_{DP} = Lamina length x maximum width x 0.75

= 84.08 x 10.60 x 0.75

LA_{DP}= 668.44cm^2

Determination of leaf index LAI in the table.4.3d

Leaf area index of control experiment, LAI_C

$LAI_C = LA_C$ x n

= 657.25 x 5

LAI_C= 3286.25

Leaf area index of Dairy wastewater experiment, LAI_D

$LAI_D = LA_D$ x n

= 700.83 x 5

LAI_D= 3504.15

Leaf area index of poultry experiment, LAI_P

$LAI_P = LA_P \times n$

$= 625.49 \times 5$

$LAI_P = 3127.45$

Leaf area index of mixed dairy and poultry experiment, LAI_{DP}

$LAI_{DP} = LA_{DP} \times n$

$= 668.44 \times 5$

$LAI_{DP} = 3342.20$