WASTE MANAGEMENT IN MECHANIZED FARMS IN NORTH CENTRAL NIGERIA.

(CASE STUDY OF ABUJA, BENUE, KADUNA, NIGER AND PLATEAU STATES)

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MINNA NIGER STATE, NIGERIA.

DECEMBER 2005

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THIS PROJECT IS SUBMITED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A BACHELOR OF ENGINEERING (B.ENG). IN AGRICULTURAL ENGINEERING,

FEDERAL UNIVERSITY OF TECHNOLOGY,

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CERTIFICATION

This is to certify that this project work was carried out by Ahmadu, Isiaka Ameh in the department of Agricultural Engineering, Federal University of Technology, Minna, Niger state.

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DEDICATION

This project is dedicated to Almighty Allah by His favour and mercy I was able to accomplish this task.

I also dedicate this project to the entire members of the Ahmadu's family for their love, understanding and support.

ACKNOWLEDGEMENT

I give God all the praise and adoration for He alone has made this project a success and a reality, through thick and thin He has being my strength and source of inspiration.

My profound gratitude to Dr. B.A Alabadan, who apart from being my supervisor is more like a Big Brother to me; he is more than a role model to me. Also, special thanks to the Dean S.E.E.T. Engr. Prof. J. O. Odigure, The H.O.D. Dr. D. Adgidzi and the entire staff of Agricultural Engineering Department.

I also wish to express my profound gratitude to my parent Mallam and Mallama Ahmadu Aguda who have always been there for me and have never failed to motivate me in the right direction.

My greatest gratitude to my brothers and sisters, namely; Rabiu, Idris, Abdullahi, Rahmat, Maryam, Zainab and also to my uncle Mallam Garba and his family for their unflinching support.

I am also grateful to the following people for their help in one way or the other in making sure that this project is completed, Dare Ibiyeye, Eesuola Olushola, Kolapo Kazeem.

All those that were not mentioned, because of space constraint too were highly appreciated for their concerted effort towards the completion of this project, I love you all.

ABSTRACT

The increasing demand of food and raw materials for industries, leads to the development or mechanization of farmland which involves cultivation of large hectares of land for growing crops, raising of large number of livestock and other agricultural activities on the farm, such as, processing, storage, irrigation and drainage through the use of machineries and other equipment on the farm. This activity results into waste which could be enormous and demand proper management. This project focuses on waste generation, quantification, handling, treatment and disposal in mechanized farms in north central geo-political zone of Nigeria. Personal interview, administering of Questionnaire and experiments were carried out in other to collect information.

The management waste adopted on these farms include; composting, burning/incineration and feeds for livestock. There really exists large quantities of wastes on these farms and there is the need for improvement on the existing wastes management processes to curb the environmental impact that these will cause.

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CHAPTER ONE

1.0 INTRODUCTION

Waste is unwanted or undesired material left over after the completion of a process (Wikipedia, 2004).

This process can be any activities such as industrial, agricultural and mining. Waste can exist as a solid, liquid or gas. When released as a liquid or gas, waste is referred to as emissions. Identifying waste is a subjective matter, and waste is only Defined as such when perceived as such. Some see waste as a negative externality, But it can also be viewed as a potential resource as in industrial ecology. The recent changes in agricultural production methods have caused 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 production.

Farm mechanization has made possible the cultivation of large hectares of land for growing crops, raising of large number of livestock and other agricultural activities on the farm, such as; processing, storage, irrigation and drainage through the use of Machineries and other equipments on the farm. Mechanization of agriculture has removed drudgery in the farm operations, reduced time of operations and increased Farm incomes (Anthony and Ezedinma, 1985).

Mechanization of farms has also brought about the increase in agricultural production to meet the world demands of for food and fibre to meet the teaming Population and like wise provided raw materials for agro-based industries. This Efficiency in agricultural production has also generated a variety of environmental Problems

resulting from by-product (waste at one end of production but by-product at Another end) being produced from these farms (Raymond, 1974).The methods handling, treating and disposing of the farm wastes may adversely affect air, water and soil conditions, and may also be a nuisance to those who dwell nearby. Examples of adverse environmental problems attributed to agricultural Operations includes; Excessive nutrients from farm lands used for crop production or Waste disposal that unbalance natural ecological systems and increase eutrophication, Microorganisms in waste discharges that may impair the use of surface waters for Recreational use, impurities in ground water from land disposal of wastes Contaminants that complicate treatment, depletion of dissolved oxygen in surface Water causing deaths of fish and septic condition and odors from concentrated waste Storage and land disposal.

The large quantities of waste generated from intensive agricultural production have Caused serious and increasing problems of disposal. The large quantities of wastes from intensive animal production can no longer be disposed by merely dropping their wastes on pasture where the wastes can be absorbed by nature without affecting the environment. Also, wastes from crop production will have to be utilized in various manner to reduce the bulkiness of the waste generated.

1.1 Aims and Objectives

This project is aimed at investigating waste management practices in mechanized farms in north central Nigeria (case study of Niger, Abuja, benue,kaduna and Plateau states).

The objectives of the study are to;

1) Assess the various types of waste generated from each mechanized farms in this zone.

2) Evaluate the various methods of handling, treating and disposing of the farm wastes.

3) Assess the environmental impacts associated with these waste generated.

1.2 Statement of Problems

Waste management in farms have certain problems that must be considered, these Include;

1) Inadequate information on waste generation, handling, treatment or disposal on farms.

2) Farm waste handling is laborious and time consuming, consequently, it is capital intensive since most of the facilities for collecting, spreading and treating wastes are very expensive.

3) Environmental pollution resulting from improper waste management or handling.

1.3 Justification

This project is justified because of the effective desire to manage waste properly in order to enhance agricultural production in a pollution free environment.

1) The knowledge of the quantities or size of waste generated will enable the farm managers to effectively plan ways on how to manage the wastes.

2) The improved profound waste management processes will enable the farm managers or operators to control environmental impacts that wastes generated would have caused.

3) The farm managers will have several waste management techniques or method to choose from.

1.4 Scope of Study

This project is intended to carry out the following study;

1) Identification of the types of waste, sources and quantities of waste generated on the various farms, base on the harvested output.

2) Identification of the different types of waste treatment and disposal methods on the farm.

3) To find out the various types of waste utilization on the farms.

4) Assessments of the effects of waste generated and their treatments including disposal, on the quality of the environment.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 General

Farm wastes are excess of unwanted agricultural products that have not been effectively utilized. This consists of liquid and solid animal wastes, crop field residues, agricultural chemical losses, dead livestock, food processing wastes and obsolescent vehicles, equipment and building (Raymond, 1974). Also, farm waste is defined as the various organic residues which remain vegetal biomass in harvesting plant products and in preparing those product for direct use and for sale, or which occur in animal husbandry excrement more or less mixed with water and different solid matter (John, 1991).

Historically, global efforts to maintain enhance safe and healthy environment have been directed towards problem caused by urban centers and industrial operations. Had agricultural production practice remain static, environmental problems caused by agriculture might have remained minimal. However, real and potential environmental problems have accompanied the changes in agricultural productivity in recent decades (after World War 2) to meet the increasing world demand of food and fibre (Kelvin, 1994). Farmers have concentrated either on intensive production which has led to the generation of large quantities of both animal and vegetal wastes (Tables 1 and 2 respectively).

TABLE 1: Excreta from livestock in England and Wales, 1980.

livestock	Number (millions)	Excreta output Kg/animal/day	Excreta from housed animals (million tons/yr)	Total excreta of all livestock (million tons/yr)
Cattle	9.44	18-41	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: Gasser (1984)

TABLE 2: Plant and Vegetable wastes in United Kingdom.

Sources of materials	Quantity(million of tones of dry matter)	Metabolisation energy (MJ $*10^6$)
straw	9.30	60450
Arable crops	0.85	8460
Sugar beat	0.50	600
Brewery	0.24	2640
Potato	0.20	1800
Vegetable	0.05	178
Spent mushroom compost	0.02	1300

Source: Gasser (1984)

The millions of tones of wastes produced above especially manure from livestock industries much of which cannot be treated or disposed off adequately where there is no enough land or facilities for treatment can lead to nitrate concentration in the soil and as a result affect crop production. This manure produces not only ammonia gas (NH_3) to pollute the atmosphere and damage vegetation, but also, nitrates that are washed into streams. The manure concentrates heavy metals into the soil at toxic levels. These heavy metals, such as copper, cadmium and zinc, which in high enough concentration become poisonous, were originally added to the animal feed to increase their growth. The animal (e.g. pigs), however, discharges these metals in their excrement (New scientist, 1988). When the manure is used as fertilizer or stock piled, the metals may then leach out and end up in streams and ground water. Large amounts of these heavy metals may be retained in the soil and can lead to the death of earthworms that are so essential for the breakdown and aeration of the soil. The knock-on effect of decreased soil breakdown is soil erosion, which then accelerates the input of the heavy metals to stream water. A various cycle results, the heavy metals are the washed into the drainage systems to find their way into the water used for human consumption and can ultimately cause serious illness. Excrement is often associated with particular microbes, bacteria, and various among which cholera and typhoid are numbered as particularly rampant and dangerous (Kelvin, 1994).

2.2 Environmental Effect of Agricultural Practices

2.2.1 Nitrates:

The application of artificial and natural organic manure or waste in areas where intensive agriculture is practiced has generated serious problems, as nitrates from the fertilizers causes pollution in streams, rivers, seas, and drinking water respectively. These nitrates are

naturally produced by nitrifying bacteria, which fix nitrogen from the atmosphere in process called nitrification, in the decomposing organic matter and form nitrates. The quantity of artificial nitrates used on arable land in attempts to improve agricultural yields has increased considerably over the last 20 years. In United Kingdom., for instance, 1.3 million tones of nitrates were used in 1998, twice that at 1996. 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 is not used as fertilizers, often leaked or intentionally released into water supplies in other to dispose of the large quantities produced by the 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.

The standard set by World Health Organization put an acceptable limit of 50 to 100mg per litre of nitrate concentration in public water supplies. These recommendation levels of nitrates are exceeded by the agricultural activities. In 1984, WHO produces evidence that nitrate pollution was responsible for " blue baby" births (methaemoglobinaemia). In this disease, nitrate react with bacteria in the gut and deplete the blood oxygen levels, which then affect the brain and heart muscles. It has even been suggested that some forms of stomach cancer result from nitrate poisoning.

2.2.2 Dangerous Organic Chemicals

The use of organic chemicals containing chlorine such as DDT (dichloro-diphenyl-trichloroethane) as pesticides for the control of pests on the crops has resulted in polluting streams, rivers and lakes to sea. Pesticide DDT is air sprayed on to crops, and can be transported to a considerable distances in the atmosphere as well as through rivers, lakes,

streams and seas. The adverse effect of DDT is most pronounced in animals with a backbone (vertebrates). For example, higher than expected levels of DDT were found in the 12,000 fish eating seabirds washed up on the shores of Britain in 1969. Also, in the summer of 1991, the ministry of Agriculture in the UK discovered PCB (polychlorinated biphenyl) levels up to 320ppm in a dead baby bottlenose dolphin found off dyked, Wales, and 93ppm in a porpoise in Cardigan Bay, Wales. Twenty two bottlenose dolphins are known to have died in Cardigan Bay in 1989 (Kelvin, 1994). Both DDT and PCB concentrate in the fatty tissues of living organisms and may become contracted along the food chain, as one animal eats another. These can inhibit normal growth in animal population, these exposes the animal to other dangers (i.e. lacks immunity against diseases). In many developed nations, legislation has made the use of DDT illegal but it is still widely used in the agriculture economy of developing countries.

2.3 Waste Characteristics

An understanding of the characteristics of waste permits the judgments on the type of treatment and disposal methods that may be effective.

Agricultural waste is characterized mainly by compound of carbohydrates, fats, proteins, lignin, cellulose and hemicellulose (Baader,1985). The waste is suitable for being degraded by micro-organisms except lignin which is resistant to microbial decay and only decomposable after pre-treatment. Parameters such as BOD (biochemical oxygen demand), COD (chemical oxygen demand) ratios and total or suspended solid ratio are used to estimate the feasibility of biological waste treatment process with specific wastes. With a liquid waste containing dissolved organic solids, biological treatment is appropriate. Solid wastes with a high organic content are 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 wastes are affected by decision on how the wastes are to be handled.

The following are some characteristics of livestock wastes: poultry manure contains total nitrogen of 0.0062lb (0.0028kg)/bird/day, and ammonia nitrogen 0.00159kg/bird/day. Also, an average dairy cow will produce between 14 and 18 tones 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 4.535kg N, 1.814kg P_2O_5 and 4.0815kg K_2O in each tones of wet manure defecated by cow (Raymond, 1974).

2.4 Methods of Waste Handling,Treatment and Disposal

2.4.1 General

Farm wastes generally are suitable for biological treatments, because their essential compounds are carbohydrate, fats, proteins etc. By biological treatment, farm wastes can be converted to different products, which are suitable for re-use in agriculture. Ponds and lagoons are among the simplest treatment systems available. They are widely used in treating agricultural wastes. The major types of ponds and lagoons can be classified as facultative, aerobic, anaerobic or aerated.

2.4.1.1 Definition of Some Terms

Facultative treatment units are those systems in which both aerobic and anaerobic oxidation takes place and anaerobic processes occurring in the bottom layers.

Aerobic processes: this is where wastes or organic matter are decomposed solely through aerobic oxidation. These processes are produced by bacterial which requires free oxygen.

Anaerobic processes: waste decomposition occur through bacteria that do not require free oxygen. These processes liquefies high BOD waste. BOD (Biochemical Oxygen Demand) is the quantity of oxygen used in the biochemical oxidation of organic matter in a specified time, at a specific temperature, and under specified conditions. Normally 5 days at 20^0C unless otherwise stated. COD (Chemical Oxygen Demand) is the amount of oxygen consumed from a chemical oxidant in a specified test.

Aerated system: these are biological units in which the oxygen demand is met by mechanical aeration equipment.

2.4.2 Application to Farm Wastes

The uses of ponds and lagoons to treat farm/agricultural wastes were practicalised and have been successful. According to literatures, wastes from a milk processing plants were treated in pilot plant oxidation ponds with a BOD loading of 99.77kg acre/day and a 10-day detention period. BOD reduction of 80-90% were obtained. Average pond temperatures range from 17^0 to 30^0C (El Sharkawi, 1970) as reported by Raymond (1974).

Also meat packing wastes have been treated in a combination of anaerobic-aerobic ponds. Oxidation ponds treating effluent from the anaerobic ponds achieve a BOD reduction of 59% with a detention time of 18 days. The loading rate averaged 58.955kg BOD/acre/day.

An anaerobic lagoon for slaughter house waste was loaded at 6.8025kg BOD/28.3m^3 of lagoon volume per day (Hammer and Weber,968). The lagoon exhibited

the ability to handle intermittent loading without significant loss of treatment efficiency. LAGOONS BOD efficiencies ranged from 52 to 90 %, minor odour problems were noted. Dairy wastes have been treated by a combination of aeration lagoons and also, a laboratory aerated treating poultry wastes indicated that the minimum value to achieve high BOD REDUCTIONS 85%, ions 1.698m^3/kg of applied BOD/day (Hillman, 1970). The systems minimized odour and reduced the solids load on the ultimate disposal system by at least 50%. At above volume relationship, over 80% suspended solids destruction was observed. irrigation. The aeration was sized at 0.10Hp/cow. Odour was minimized (Dale et al, 1968).

2.5 Current Research and Development

A great number of researches have been carried out on the effective disposition of farm wastes, without endangering the environment. This write up focuses on the reduction of this waste to the barest minimum and possible utilization of these wastes (e.g. composting, pyrolysis, biogas, pelletisation e.t.c.)

Further research includes the design of digesters and integrated method of waste treatments aimed at solving the problems of large quantities of wastes generated without enough land to dispose it. Other research and development include nutrient reduction (e.g. nitrogen) so as to enhance large quantity disposal of wastes on a small piece of farm land without polluting the soil and the vegetation.

2.5.1 Compost

Compost is the decomposed remnants of organic materials (those with plant and animal origins). Compost is used in gardening and agriculture, mixed in with the soil. It improved soil structure, increases the amount of organic matter, and provides nutrients. Compost is a common name for humus, which is the result of the decomposition of

organic matter.

Decomposition is performed primarily by microbes, although larger creature such as worms and ants contribute to the process. Decomposition occurs naturally in all but the most hostile environments, such as buried in land fills or extremely arid deserts which prevent the microbes and other decomposers from thriving.

2.5.1.1 Composting

Composting can be defined as the biological decomposition of the organic constituents of wastes under controlled conditions. This process can take place in the presence or absence of oxygen, that is , aerobic or anaerobic composting. Aerobic composting, if efficiently carried out, can rapidly produce a pathogen free product: anaerobic composting requires more time and is seldom free of pathogens and odour problems. To encourage the most active microbes, the compost pile needs the proper mix of the following ingredients.

a) Carbon

b) Nitrogen

c) Oxygen (air)

d)Water

2.5.1.2 Decomposers

All guidelines for building compost piles have the goal of creating the proper environment for a decomposing ecosystem. The ecosystem in a compost pile is a microcosin of larger ecosystems. The correct environment must be maintained for a healthy and vigorous community of decomposers. In addition to the decomposers that work directly on the organic content of the pile, compost pile provide habitat for those

that prey upon the direct decomposers. Their waste also becomes part of the process. The most effective decomposers are bacteria and other micro-organisms. Also important are fungi, molds, protozoa, and actimony cetes which is something between a fungus and a mold, and is often seen as white filaments in decomposing organic matter. At a macroscopic level, earthworms, ants, snails, slugs, millipedes, sow bugs, spring tails, and others work on consuming and breaking down the organic matter centipedes and other predators feed upon these decomposers.

2.5.1.3 Composting Techniques

There are two primary methods of aerobic composting:

i) Active (or hot) composting, which allows the most effective decomposing bacteria to thrive, kills most pathogens and seeds, and rapidly produces useable compost.

ii) Passive (or cold) composting, which allow nature to take its course in a more leisurely manner and leaves many pathogens and seeds dormant in the pile.

Most commercial and Industrial composting operations use active composting techniques. This ensures a higher quality product and produces results in the shortest time.

Home composters use a range of techniques varying from extremely passive composting (throw everything in a pile in a corner and leave it alone for a year or two) to extremely active(monitoring the temperature, turning the pile regularly, and adjusting the ingredients over time) and combinations of both.

2.5.2 Pyrolysis

In the pyrolysis process, waste is heated indirectly from external heat source and is charred as in absence of air. This is a very recent modern method utilized as energy

recovery process from waste. The process incorporates a system of decomposing organic compounds in waste through application of heat. It is a process of destructive distillation carried out in a closed vessel in an oxygen free environment. Through pyrolysis, organic matter is converted into gases, liquid and inert char. Pyrolysis is a proven method for homogenous organic matter like wood, pulp etc. but as municipal waste is heterogeneous by nature, only about 50% of the input gets processed leaving 50% discards needing alternate disposal.

2.5.3 Bio-Gas

Slaughter houses, food packing industries and cold storage, produce organic garbage which was constituted by the planning commission in India, had recommended that in all centralized large slaughter houses, waste should be bio-digested near the slaughter house.

2.5.3.1 Thermophilic Bio-Digestion

Thermophilic bio- digestion kills the pathogens which may be present in the waste. Bio-gas produced in the process can be used directly in the slaughter house for heating water and for electricity generation. Electricity so generated can be used for refrigeration. For smaller slaughter houses, the waste could collected everyday and dumped in special areas through controlled sanitary land filling with or without the generation of landfill gases.

2.5.3.2 Bio-Methanation

Bio-methanation involves segregation of organic matter present in solid waste. This is then fed into a bio-reactor. The organic matter ferments due the presence of the

methanogenic bacteria. The bio-gas so derived is used to generate power. Over the past eight (8) years, India has made a major commitment to its All-India Co-ordinated Bio-gas Programme. About 62,000 bio-gas units have been installed since the program started in 1975.

A two phase digester system has been developed by Institute for Storage and Processing of Agricultural Products(IBVL) at Wageningen in the Netherlands (Hofenik, 1986) as reported by John (1991) for the anaerobic digestion of solid Wastes

2.5.4 Pelletisation

Pelletisation is the production of fuel pellets from solid waste. Pellets can be used for heating plant boilers and for the generation of electricity. They also act as perfect substitute for coal/wood used in home/industry. Pelletisation offers the possibility of decentralized garbage treatment facilities. A prototype pelletisation plant of 1.52 to 2.00 tones per hour per stream in two parallel streams, was designed and commissioned. Solid waste, after segregation of undesirable ingredients, was used for processing. Addition of bio-mass to the extent of 50 percent of plant output was ensured to enhance the calorific value of the fuel pellets. A three shift operation with average 20 hours per day and 250 days operation in a year was resorted to various sub-system components and process parameters were concurrently improvised during its commissioning and trial periods to perfect the technology package.

2.6 Land Disposal of Waste

Land (soil) remains the best option for the ultimate disposal of farm wastes, but of major concern is the quantity to be applied to the land that will not cause any pollution in the soil and to the vegetation, also to the groundwater.According to literature, the amount of waste

to be applied to the soil depends on the soil type, nutrients requirement of the soil and vegetation. Also the quantities of wastes to be applied varies from one livestock to another based on their BOD pollution effect.

According to Hillman (1970), that poultry manure and broiler litter should be returned to the soil at rates not exceeding 10,000 kg/acre annually. Where these rates are exceeded problems of excess salts and a chemical imbalance have occurred in the soil and also, problems of nitrate toxicity and grass tetany have occurred in grass pasture. Farmers are adviced to apply dairy manure at the rate of not more than

20,321 kg/yr (Lawton et al, 1960). Rates above this level generally have not provided comparable yields increase.

Rates from 15 to 25 tones of dairy manure were applied per acre of corn to evaluate the effect of heavy loading (Hill et al, 1972). These rates corresponded to loading rate of 165 to 6800lb of Nitrogen per acre. Growth on all plots was good and no toxic symptoms were observed. At the highest loading rate, the thickness of the applied manure interfered with plowing. Nitrates, chlorides and other salts moved through the well drained sandy loam soils.

CHAPTER THREE

3.0 METHODOLOGY

3.1 General

The methodology adopted in this study is the investigative approach, these includes: mechanized farms visitation and administering of coded questionnaires to the management of these farms in north central geo-political zones of Nigeria. Also journals, text book, and experienced personnel in related fields of environmental management were consulted, this is to enable one to get information and literatures, relevant for this study.

In the course of this investigation, a total of ten (10) mechanized farms were visited, with a total of two farms in each state. Two questionnaires were administered to each farm visited (i.e. to the management of each farms).

During the visits, conduction of interviews with some of the personnel of the farms, in charge of different units like crops, animals a (livestock), machinery etc. were made and also assessment of their wastes level and facilities for waste treatment and disposals were made.

3.2 Procedure for Data Collection

3.2.1 Site Visitation

A total of ten (10) farms was selected for this research work. The farms include;

I- Maizube Farm Limited;

Sabon Daga Bosso Local Government, Niger State.

II- Abu-Turab Investment Limited;

David-Mark Road, Tunga-Minna, Niger State.

III- Bambich Farms Limited;

Rantya Jos-South, Plateau State.

IV- Integrated Dairy Farms Limited;

p.o. box 97 Vom- Jos, Plateau State.

V- Wushishi Farms Limited

10 km Kaduna-Zaria Road, Kaduna State.

VI- Niya Farms Limited,

60 km Kaduna- Abuja Road.

VII- Rahama Farms Limited,

100 km Abuja- Kaduna Road.

VIII- Newshied Farms Limited,

90 km Abuja- Kaduna Road.

IX- Moji Farms Limited,

15 km Gboko Road, markurdi, Benue State.

X- Ikyogen Cattle Ranch

3.2.1.1 Description of Farms Visited/ waste

All the farms were privately owned and the activities of the farms ranges from livestock rearing, crop production and the practice of both (integrated farming). Most of the farms are situated far-away from cities or in the outskirt of towns.

The wastes generated originate from household wastes, machinery, crops, and livestock wastes. For the crops, the fields are left with large quantities of stucks, straws, leaves etc, after harvest.At the livestock section of these farms, large quantities of cattle drugs are

generated, these wastes are removed weakly and heaped outside the buildings, or pen, example of such farm is Maizube farms limited. The feaces are deposited in a semi- solid form on litters or beddings (straw, sawdust and stalks) which absorbs the moisture quickly and the solid feaces and beddings are the removed subsequently.

The dairy unit is usually fouled with stinking smells and also flies are nuisance in these surroundings, such as the cattle reared in Integrated

Dairy Farms Limited were the cattle are allowed to move freely in an open field.

3.2.1.2 How The Assessments Of The Wastes Was Carried Out.

The assessments of the farm wastes, which were considered are : the wastes level, which depends on the type of wastes, quantities of crops harvested, and the type/ number of animals on the farm.

3.2.1.2.1 Determination of Grain-Straw Ratio on Wet Basis

The method used by Kushan(1975) was used to determine thegrain-straw ratio.

This method involves collecting samples (crop stand) at differentpoints on one meter square area. The grain and the straw at each stand are separately weighed respectively. This process is repeated at six (6)points on one meter square area. The ratio of weight of grains to weight of straw is the grain-straw ratio. The average of the six samplesshall be taken as grain and straw ratio.

3.2.1.2.2 Determination of Digestibility

A digestion trial involves a record of nutrients consumed and of those voided in the feaces. The feaces collected represent

quantitatively the undigested residue of the measured amount offood consumed.

The animal (cow) is fed with the ration to be tested in constant daily amounts for some period of days. After allowing a certain number of days to elapse as a preliminary period to free the digestive tract of any indigestible materials coming from the feed consumed, prior to the start of the constant intakes of the ration under study. The collection of the feaces can then begin and is continued through the collection period (Leonard,1979).

Roughages (groundnut haulms and corn straw hay) is fed to the cattle for three days each and the feaces collected daily is weighed. This experiment is also repeated using concentrates and feaces level determined.

3.2.2 Administering of Questionnaires

A total of thirty (30) questionnaires were administered to the ten (10) section takes care of sewage management.

Section D: This section deals with crop waste management.

Section E: This section contains questions on animal waste management.

Section F: This section centered on machinery waste management.

.Section G: This takes care of other waste management practice.

The questions asked in these sections are structured to give precise

answers to the problem under investigation. This provides information on the type of wastes generated, sources, problems associated with the kind of wastes generated in relation to the environment, and how are these wastes managed to abate the pollution tendencies of the wastes. Also, questions are asked on the performance of the organizations in terms of their efficiency and rating in managing wastes in line with the specification of environmental protection agencies.

The detailed format of the questionnaire will be found in the appendix.

3.3 Method of Analysis

The nature and type of data required to achieve the objectives of this study, determines the use, the choice and the type of analysis and also the method of presentation. This data are in general terms pieces of information and facts which make up the raw materials of the subject to which they relate. Some information provided are rather quantitative other than qualitative on the subject under study. Data on research shows certain characteristics such as relationships, associations, variations, frequencies, trend and patterns. These characteristics can be seen or observed when described and summarized in statistical forms, diagrammatical forms and graphical illustrations.

For the purpose of analysis in this investigative study, the objectives are to classify data into like groupings and to uncover relationships whether correlative or casual.

The use of statistical analysis to form tables, graphs, charts for easy relationships and correlation will be employed as will be observed in chapter four.

3.4 Problems Encountered

Some of the farms are located in areas not frequented by commercial vehicles and even if there are, the transport fare is high. Sometimes motorcycles are hired to take one to some of the farms. Although in view of the importance attached the investigative study or the project, one was patient devoted to the work, so the studies were carried out.

In all the farms visited and questionnaires issued, non gave a complete response or information about their operation and some misunderstood the questions as it was thought that it was away of exposing their problems and negligence so they were not willing to out

any information. Also, some questions that was not attended to in the questionnaires were due to non-participation of some establishments in these activities.

More so, in some instances, one was not allowed entrance into the premises, even when relevant letters from the school was presented to the security officials at the gate post, not until confirmation were made before permission were granted. One had to trek along distance before getting to the main farm administrative building.

The questionnaires administered were not completed immediately and a date for collection was fixed, this was not a guarantee that on the date scheduled on , one will get the questionnaires filled, and this makes the journey to such farms to be

more than thrice before collection was possible. In some instances, another questionnaires had to be re-administered due to misplacement or incorrect filling.

Conclusively, lack of documentation on the activities of the mechanized farms interims of wastes generated, its quantities and management practices in the five selected states in north central geo-political zone of Nigeria makes the task an uneasy one.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Organisation Visited and Questionnaires Retrieved

From the thirty (30) questionnaires administered, only twenty (25) was retrieved, from the ten (10) farms visited. It must be stated that no questionnaire was retrieved from Ikyange Cattle Ranch located in Benue state.

The following are the findings from the recovered questionnaires;

4.1.1 Information of Respondents and Activities of the Farms.

Based on the questionnaire retrieved, 100% of the respondents are male with 78% of them within the age group of 36-45 years and 22% within the 26-35 years. Of the total number of respondents, only 78% of them are Diploma holders. 33% have been working in these establishments for 11-20 years while 67% have working experience within the range of 1-10 years.

56% of the nine farms are integrated farms (i.e. they grow crops and rear livestock) while 33% solely rear livestock (i.e. either dairy animals or poultry) and lastly 11% of the farms cultivate the land only for crop production, as shown by figure 1 below;

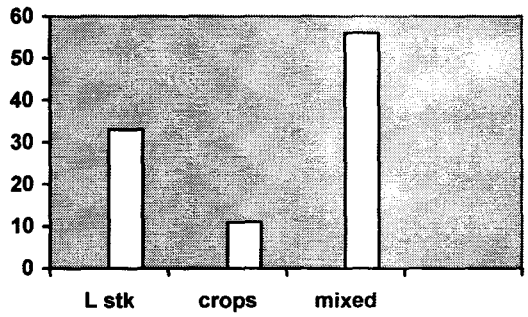

Figure 1: Bar chat showing the percentage of the farms practicing crop, livestock, and integrated (mixed) farming.

Table 3; The farms and their type of farming.

Type of farming	**Name of establishments**
Crop production	1. Rahama farms limited
Livestock farming	1. Bambich farms limited 2. Newshiede farms limited 3. Abu-Turab investment limited
Integrated farming	1. Moji farms limited 2. Niyya farms limited 3. Wushishi farms limited 4. Maizube farms limited 5. Integrated dairy farm limited

4.1.2 Household Waste Management

As regard to the residential buildings on the farm, 57% of the respondents said that their farms have buildings is within the range of 1-5, while 43% said their buildings is from 6-10 respectively.

Of the nine farms, two of it do not have residential buildings and 86% of the remaining seven farms, have 2-5 persons per building, while 14% accommodate 6-10 persons per building.

For the staffs leaving in the farm, 22% generate leathers, papers, tins, rags, broken bottles and peels as wastes, while78% generates left over food, dirty water, leathers, papers, tins, rags, broken bottles and peels as wastes.

Based on the methods of waste collection, 44% use dustbins only, while 56% use pits, sinks/cesspool and dustbins for their own waste collection.

Furthermore, of the nine respondents, only 11% sort their wastes into various categories like combustible and non-combustible, decomposable and non-decomposable, recyclable and non-recyclable etc, before disposal/treatment while 89% do not.

Consequently, on the method of treatment employed, 89% of the respondents employed the use of burning/incineration as a method of treatment for the generated household waste, while 11% use recycling and burning/incineration.

Figure 2, below clearly represent this;

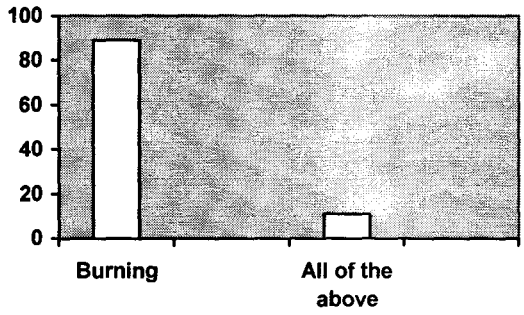

Figure 2: Bar chart showing the Percentage of farms employing various methods of waste disposal techniques.

4.1.3 Sewage Management

Based on the information provided by the respondents, 67% of the farms employ the use of water cistern as a type of toilet, 22% use pit latrine while the remaining 11% use both.

As for the treatment and disposal of the sewage waste, 22% of the farms deposit these wastes in burrow pits or trenched and covered, 67% employ the use of septic tank, while 11% use both methods.

Below is a chart representing this information;

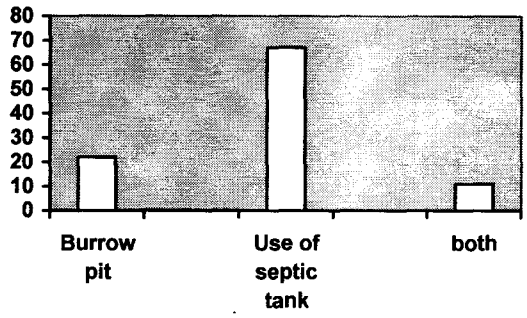

Figure 3: Bar chart showing the percentage of farms practicing various methods of sewage disposal.

4.1.4 Crop Waste Management

Only six farms, from the nine mechanized farms under consideration are into crop production. The size of farmland use in crop production ranges from 50-1000ha. The type of crops grown are mostly cereals, such as maize, sorghum and rice respectively. Of the six farms, 17% harvest crops within the range of 50-80 tonnes annually, while 83% harvest crops with quantity of above 80 tonnes annually. All the six farms employ the use of a combine harvester in harvesting their farm produce.

Table 4, below shows the type of crops grown, the area of land for cultivation, and the quantity of crops harvested yearly.

In terms of processing, 17% of the farms do not process the harvested crops on the field, while 83% do.

33% of the mechanized farms use the chaffs and other wastes generated after harvest as animal feeds, 50% leave it on the farm as litters, while 17% practice both method.

In terms of treatment of stalks after harvest, 50% of the farms use it for animal feeds,17% incorporate/buried in the soil while 33% gathers the stalks and burn them. Figure 4 is a bar chart representing this information.

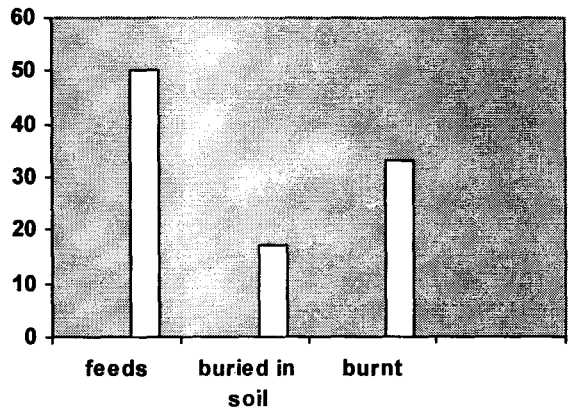

Figure 4: Bar chart showing the percentages of waste utilization.

Table 4: Quantity of crops harvested per annum in mechanized farms

s/no.	Name of farms	Type of crops harvested	Area of cultivation (ha)	Quantity of crops harvested (kg)
1	Integrated dairy farms limited	Maize	100	120,900
2	Niyya farms limited	Maize	120	110,300
		Sorghum		50,610
3	Wushishi farms limited	Maize	150	160,110
		Rice		70,200
4	Maizube farms limited	Maize	50	80,600
5	Moji farms limited	Maize	100	110,200
		Sorghum		40,100
6	Rahama farms limited	Maize	150	120,200
		Sorghum		80,100

4.1.5.1 Estimated Crop Waste from Mechanized Farms

Grain-Straw ratio on wet basis.

The grain-straw ratio is the ratio of weight of the grain to the weight of straw. The grain straw ratio for maize, sorghum, and rice was determined. The procedures for determination has been described in section 3.2.1.2.1.

The tables 5, 6, and 7, shows the grain –straw ratio on wet basis of maize, sorghum, and rice respectively. The grain straw ratio obtained for maize and sorghum is comparable with the existing information, i.e. 1:2.37 as regard to 1.2.50 for maize and 1:2.18 as regard to 1:2.45 for sorghum.

The determined grain-straw ratio is then used to multiply the quantity of the farms output for different crops to obtain the crop waste for each farm as shown in table 8 below.

From table 8, it can be seen that 2,142,140.5kg of crop residues or wastes is realized yearly by the entire six farms and a total crop output of 943,320kg.

Table 5: Grain-Straw ratio of maize test plots

Samples	Weight of grain (g/m^2)	Weight of straw (g/m^2)	Grain-Straw ratio
1	288.78	987.56	1:3.42
2	377.92	1145.35	1:3.03
3	432.41	620.22	1:1.43
4	270.50	652.21	1:2.41
5	127.62	247.12	1:1.94
6	150.09	251.30	1:1.67
Average	274.54	650.63	1:2.37

Table 6: Grain-Straw ratio of sorghum test plots

Samples	Weight of grain (g/m^2)	Weight of straw (g/m^2)	Grain-Straw ratio
1	28.84	82.22	1:2.85
2	126.06	277.23	1:2.20
3	60.78	98.83	1:1.63
4	42.94	132.20	1:3.08
5	36.03	79.04	1:2.19
6	70.02	124.92	1:1.78
Average	60.78	132.41	1:2.18

Table 7: Grain-Straw ratio of rice test plots

Samples	**Weight of grain (g/m^2)**	**Weight of straw (g/m^2)**	**Grain-Straw ratio**
1	300.2	473.0	1:1.6
2	415.3	638.5	1:1.5
3	452.9	578.3	1:1.3
4	359.6	603.9	1:1.7
5	330.0	477.7	1:1.4
6	476.6	668.5	1:1.4
Average	388.8	573.3	1:1.5

Adopted from Chukwu (1995).

Table 8: Estimated crop waste from mechanized farms based on grain-straw ratio.

S/No.	Name of farms	Type of crops	Grain-straw ratio	Total crop output (kg)	Total estimated crop waste (kg)
1	Integrated dairy farms	Maize	1:2.37	120,900	286,533
2	Niyya farms	Maize Sorghum	1:2.37 1:2.18	110,300 50,610	261,411 110,329.8
3	Wushishi farms	Maize Rice	1:2.37 1:1.5	160,110 70,200	379,460.7 105,300
4	Maizube farms	Maize	1:2.37	80,600	191,022
5	Moji farms	Maize Sorghum	1:2.37 1:2.18	110,200 40,100	261,174 87,418
6	Rahama farms	Maize Sorghum	1:2.37 1:2.18	120,200 80,100	284,874 174,618
	Total			943,320	2,142,140.5

4.1.5 Animal Waste Management

Based on the nine farms under investigation, eight of the farms are into livestock production. From these eight farms, 25% are in to dairy production, 63% are into poultry production and 12% are into the practice of both.

The total number of livestock for both the poultry and cattle/dairy is over 500.

In terms of the wastes generated by the livestock, 38% of the farms generates solid waste while 62% generate both solid wastes and liquid wastes respectively. Furthermore, all the farms generate less than 20 carcass/dead animals yearly.

Of the three farms that practice dairy production, 33% use slotted floors as a method of waste collection while 67% use slopping floor.

33.3% of the farms spread the waste on the field to decay, 33.3% also of the dairy production farms bury the wastes in pits while 33.3% use neither method.

All the eight farms use the animal waste as manure in crop production.

In addition, 60% of the farms reserve capital for waste management while, 40% do not. And lastly, 60% of the farms also generate money from the animal wastes while 40% do not.

4.1.5.1 Estimation of animal wastes in mechanized farms

4.1.5.1.1 Determination of digestible

The digestion trial involves a record or nutrients consumed and of the amounts of them voided in the feaces. The feaces collected represent quantitatively the undigested residues (excreta) of the measured amount of food consumed. The experiment was carried out using roughages (groundnut haulms and corn straw hay) and concentrate as feeds. The procedure is as described in section 3.2.1.2.2.

The table 9, shows different types of feeds given to the cattle at a constant amount per day and the amount of excreta voided out. It can be observed from the table that quantity of feaces from roughages feed is much higher than that from concentrates, despite the fact that the quantity of concentrate consumed is higher. Corn straw hay contains higher fibre content and that is responsible for it high quantity of indigestibility of 56.4% from the 5kg consumed.

The quantity of feeds consumed by animals depends on the type, size of animal and also on the type of feeds. Usually cow consumed about 2.5-3.0% of its body weight. Although concentrates can be consumed in large quantities than roughages owing to the bulky nature of roughage feeds. the fiber contents of most roughages are as high as 41% (Malcolm and Watkins, 1981).

Table 10, shows the quantities of excreta from the animals (cattle) per day and also, the estimated excreta for a year for the three farms that are practicing dairy production.

Table 9: Determination of the quantity of excreta per cattle per day

Type of feeds (diets)	**Quantity of feed Kg/animal/day For three days**	**Quantity of wet solid excreta Kg/animal /day**	**Average kg**	**% excreta voided.**
Roughages:				
i- groundnut haulms	6.0, 6.0, 6.0	2.34, 2.40, 2.42	2.39	39.83
ii- corn straw hay	5.0, 5.0, 5.0	2.90, 2.75, 2.80	2.82	56.40
Concentrates	10, 10, 10	3.20, 3.00, 3.30	3.20	32.00

Table 10: Estimation of the quantity of animal excreta generated per annum in mechanized farms based on the quantity of feeds fed as in Table 9

Names of farms	**Type of animal**	**Number of animals**	**Excreta Kg/animal/ day**	**Total excreta Kg/day/ total no. of animals**	**Total excreta Kg/animal/ total no. of animals**
Integrated dairy farms ltd	cattle	217	Roughages: 2.39 2.82 Concentrates: 3.20	Roughages: 518.63 611.64 Concentrates 694.4	Roughages: 189,299.95 223,248.6 Concentrates: 253,456
Niyya farms ltd	cattle	115	Roughages: 2.39 2.82 Concentrates: 3.20	Roughages: 274.85 324.3 concentrates 368	Roughages: 100,320.25 118,369.5 Concentrates: 134,320
Maizube farms ltd	cattle	150	Roughages: 2.39 2.82 Concentrates: 3.20	Roughages: 358.5 423 concentrates 480	Roughages: 130,852.5 Concentrates: 175,200

4.1.6 Machinery Waste Management

Twenty nine percent of the farms visited have tractors less than five in number, while 71% of the seven farms have tractors within the range of 5-10 respectively. Eighty six percent of these farms employ selling as an option in overcoming the problem of scraps, 14% recycled scraps. In addition, 43% of the farms separate there machinery waste into recyclable and non-recyclable, while 57% do not. All the farms realize money from scraps.

4.1.7 Other Waste Management Practice

All the farms under investigation comply with regulations on waste management as issued by Federal Environmental Protection Agency (FEPA), and other environmental sanitary organizations.

Furthermore, they have all been visited by such organizations

They all claimed that they have never been accused of bad waste management practice by communities close to their establishment or other bodies. 89% said they have witnessed disease outbreak, while 11% said no.

On the number of times the organization witnessed disease outbreak, 11% chose none, 22% stick to ones, 56% ticked twice and 11% also chose thrice as shown in figure 5 below.

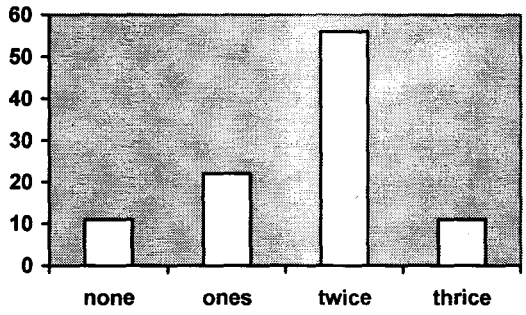

Figure 5: Bar chart showing the percentages of the number of times the farms have been affected by diseases.

The management of the farms were given opportunity to generally asses them selves in waste management and this was their response;

22% rated their waste management practice as good, 67% said it is very good, 11% said it is excellent.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The study has made available information on how waste from these farms can be estimated, the types of crop and animal residue on these farms and various management technique adopted by these farms have been studied and suggestions have be proffered on how to curb the menace of this waste.

It is therefore necessary that these waste are taken care of , in view of their increasing magnitude on these farms as the desire for increasing agricultural production is achieved through farm mechanization.

5.2 Recommendations

In line with the findings of this work, the following strategies and solutions are here by recommended towards the effective management of the generated waste.

Animal excrement must be discharged or disposed into the soil at rates not exceeding10,000kg/acre annually for poultry manure and broiler litter Also, farmers are recommended to apply dairy manure at the rate not more than 20,321kg/year, If these rates are exceeded, problem of excess salts and a chemical imbalance may occur in the soil.

Anti-odour chemicals should be used to suppress odour from animal units and piles of wastes gathered in one section of the farm to prevent flies nuisance in these environments.

The problems of large quantity crop wastes (residues) and animal excrement in the farms can be solved if the crop wastes are prepared as hays and silage to feed the animals and

also, the animal excrement will in turn serve as manure to be used or returned to the soil as conditioner to improve the fertility of the soil. It is therefore suggested that the mechanized farms run both crop and animal unit together to curb the problem s caused by wastes generation.

This write-up is not an exhaustive literature but can serve as a guide and reference to a study on waste management in mechanized farms in north central geo-political zone of Nigeria. One will also suggest that the experiment on digestibility of feeds by animal (cattle) should be conducted for longer period of time say seven to ten days after four days of conditioning the cattle digestive track by feeding it with a particular feed at a constant amount. This quantity of feed given to the animal should be continued for the period mentioned above whether a more accurate result could be achieved in the experiment.

The crop residues from these farms can be prepared and sold (source of income to the management) especially to the cattle rearers (mostly Fulani nomads) who are mostly experiencing shortage of feeds at the dry seasons period. Also, the animal excreta can be sold to the peasant farmers around the neighbourhood of the establishment to be used as manure for their farms.

Finally, waste management should be integrated as part of the farms production system, so that it can be cared for as much as the farms product in order to avoid any environmental consequences resulting from poor waste management practice.

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APPENDIX

FEDERAL UNIVERSITY OF TECHNOLOGY,

MINNA, NIGER STATE, NIGERIA.

A QUESTIONNAIRE ON WASTE MANAGEMENT IN MECHANIZED FARMS IN NORTH CENTRAL GEO-POLITICAL ZONE OF NIGERIA.

RESPONDENTS NOTE: The basis for this questionnaire is to obtain vital information for a research work on the above project title. The research is carried out in partial fulfillment of award of bachelor degree of engineering (B. Eng) in Agricultural Engineering department in the above named institution.

Please, answer the questions and tick where appropriate. All respondent answers shall be treated with utmost confidence and sincerity.

NAME: **ISIAKA AMEH AHMADU**

MAT. NO: **99/8058EA**

LEVEL: **500**

SIGN: .....

SECTION A

1. Name of establishment: .....
2. Address / Location: .....
3. Farm Ownership:
   (a) Government ☐
   (b) Private ☐
   (c) Joint ☐
4. Name of respondent: .....
5. Department / Unit : .....
6. [redacted]tional qualifications:
   [redacted]econdary school certificate ☐
   (b) Diploma degree ☐
   (c) Bachelors degree ☐
   (d) Masters ☐
   (e) PhD ☐
   (f) Others (specify): .....
7. Years of working experience in establishment;

(a) 1 – 10 ☐ (b) 11 - 20 ☐ (c) 21 – 30 ☐ (d) 31 – 40 ☐ e) 41 and above ☐

8. Sex of respondent:

(a) Male ☐ (b) Female ☐

9. Age of respondent:

(a) 16 – 25 yrs ☐ (b) 26 -35 yrs ☐ c) 36 – 45 yrs ☐ (d) 46 -55 yrs ☐

(e) 56 and above ☐

10. Activities of establishment:

(a) Livestock ☐ (b) Crop ☐ (c) A and B ☐ (d) others (specify);..... ...

SECTION B

HOUSE HOLD WASTE MANAGEMENT

1. What is the number of persons per building in the farm:

(a) 2 – 5 ☐ (b) 6 – 10 ☐ (c) 11 – 15 ☐ (d) 16 and above ☐

2. How many residential buildings are on the farm?

(a) 1 – 5 ☐ (b) 6 – 10 ☐ (c) 11 – 15 ☐ (d) 16 and above ☐

3. Type of waste generated:

(a) Left over food ☐

(b) Leathers, papers, tins, rags, broken bottles and peels ☐

(c) Dirty water ☐ (d) all of the above ☐

4. What are the methods used in waste collection:

(a) Dustbins ☐ (b) pits ☐ (c) sinks / cesspool ☐ (d) all of the above ☐

5. What method of treatment do you use?

(a) Burning / incineration ☐ (b) recycling ☐ (c) A and B ☐ (d) none of the above ☐

6. Do you sort your wastes into various categories before disposal / treatment?

(a) Yes ☐ (b) No ☐

(i) If yes, tick from the list below, which one is applicable:

(a) Combustible and non - Combustible ☐

(b) Decomposable and non - decomposable ☐

(c) Recyclable and non - recyclable ☐

(d) All of the above ☐

(ii) if no, how do you sort and treat: ....

SECTION C

SEWAGE MANAGEMENT

1. What type of toilet do you use?

(a) Water cistern ☐ (b) pit latrine ☐ (c) a and b ☐ (d) others (specify):

.....

2. How do you treat and dispose your waste:

(a) Deposited in burrow pits or trenched and covered ☐

(b) Chlorination and discharged into lagoons ☐

(c) Use of Septic tank ☐ (d) all of the above ☐

(e) None of the above ☐

SECTION D

CROP WASTE MANAGEMENT

1. What is the size of the farm?

(a) 1 – 10 ha ☐ (b) 11 – 20 ha ☐ (c) 21 – 30 ha ☐ (d) 31 – 40 ha ☐ (e) 41 and above. ☐

2. What type of crops do you harvest?

(a) Cereals ☐ (b) roots and tubers ☐ (c) legumes ☐ (d) fruits and vegetables. ☐

(e) all of the above ☐

3. Give an example of the chosen harvested crops in 2 above: .....

4. What Quantity of crop/crops is harvested annually?

(a) 1 – 10t ☐ (b) 11 -20t ☐ (c) 21 -30t ☐ (d) 31 – 40t ☐

(e) 41 and above ☐

5. Do you process the crops on the farm?

(a) Yes ☐ (b) No ☐

6. How do you treat your stalks after harvest?

(a) For animal feeding ☐

(b) It is left in the farm to decay ☐

(c) It is incorporated/buried into the soil as manure ☐

(d) It is gathered and burnt ☐

(e) It is transported away from the farm ☐

(f) all of the above ☐ (g) None of the above ☐

7. What do you do to chaffs and other waste generated on the farm:

(a) as poultry feeds ☐ (b) as animal feeds ☐ (c) as litters ☐

(d) all of the above ☐ (e) none of the above ☐

SECTION E

ANIMAL WASTE MANAGEMENT

1. Types of livestock reared

(a) dairy ☐ (b) sheep/goat ☐ (c) poultry ☐ (d) all of the above ☐ (e) others (specify): .....

2. Total number of livestock?

(a) less than 200 ☐ (b) 201 -300 ☐ (c) 301- 400 ☐ (d) over 400 ☐

3. What type of wastes do you generate?

(a) Liquid waste ☐ (b) solid waste ☐ (c) All of the above ☐ (d) None of the above. ☐

4. What do you use the generated wastes for?

(a) Manure ☐ (b) feeding poultry ☐ (c) Bio- gas ☐ (d) All of the above ☐

(e) None of the above. ☐

5. Do you keep dairy animals?

(a) Yes ☐ (b) No ☐

6. If yes, what is the total number of dairy animals kept?

(a) Less than 100 ☐ (b) 100-200 ☐ (c) 201-300 ☐ (d) Above 300 ☐

7. What volume of milk do you produce daily?

(a) Below 1000 litres ☐ (b) 1000-2000 litres ☐ (c) 2001-3000 litres ☐

(d) Above 3000 litres ☐

8. What volume of water do you use in the dairy house daily?

(a) Below 1000 litres ☐ (b) 1000-2000 litres ☐ (c) 2001-3000 litres ☐

(d) Above 3000 litres ☐

9. What is the numbers of animals slaughtered and packaged daily?

(a) Below 50 ☐ (b) 50-100 ☐ (c) 101-150 ☐ (d) 151-200 ☐ e) Above 200 ☐

10. What Number of carcass / dead animals do you generate yearly?

(a) Below 50 ☐ (b) 50-100 ☐ (c) 101-150 ☐ (d) 151-200 ☐ (e) Above 200 ☐

11. Do you process the milk obtained from the dairy animals into any of the following:

(a) Yoghurt ☐ b) Butter ☐ (c) Cheese ☐ (d) All of the above ☐

(e) None of the above ☐

12. What type of waste do you generate from this processing unit?

(a) solid waste ☐ (b) liquid waste ☐ (c) all of the above ☐ (d) none of the above ☐

13. What method of waste collection do you use?

(a) Slotted floors ☐ (b) Slopping flow ☐ (c) Scrapers and blades ☐ (d) Littered floors ☐ e) All of the above ☐ (f) None of the above ☐

14. What method of disposal/treatment do you use? (a) Spread on the field to decay ☐ (b) Buried in pits ☐ (c) Collected and stores in earthen basins ☐

(d) Purified and transported to the lagoons/rivers ☐ (e) All of the above ☐

(f) None of the above ☐

15. Does the establishment reserve capital for waste management?

(a) Yes ☐ (b) No ☐

16. If yes, how much do you spend yearly?.....

17. Does the establishment generate money from the animal waste management practice?

(a) Yes ☐ (b) No ☐

SECTION F

MACHINERY WASTE MANAGEMENT

1. How many tractors do you have on your farm?

(a) Below 5 ☐ (b) 5-10 ☐ (c) 11-15 ☐ (d) 16-20 ☐ (e) Above 20 ☐

2. How do you overcome the problem of scraps?

(a) Selling ☐ (b) Recycling ☐ (c) Burying ☐ (d) All of the above ☐ (e) None ☐ of the above

3. Do you separate your machinery waste into recyclable and non-recyclable?

(a) Yes ☐ (b) No ☐

4. Do you realize money from scraps?

(a) Yes ☐ (b) No ☐

SECTION G

OTHER WASTE MANAGEMENT PRACTICE

1. Do you follow regulations on waste management as issued by FEPA and other environmental sanitary organizations?

(a) Yes ☐ (b) No ☐

2. Have you ever been visited by any of these organizations?

(a) Yes ☐ (b) No ☐

3. Have you ever been accused of bad waste management practices either by the communities close to your establishment or other bodies?

(a) Yes ☐ (b) No ☐

4. Has your organization ever witnessed a disease outbreak ?

(a) Yes ☐ (b) No ☐

5. If yes, what type of disease? .....

6. How many times has the organization witnessed disease outbreaks?

(a) None ☐ (b) Ones ☐ (c) Twice ☐ (d) Thrice ☐ (e) Above three ☐

7. General assessment of the organization/establishment in waste management:

(a) Poor ☐ (b) Fair ☐ (c) Good ☐ (d) Very good ☐ (e) Excellent ☐