

TITLE PAGE

AN INVESTIGATION INTO THE TREATMENT AND
DISPOSAL METHODS OF AGRICULTURAL WASTES

BY

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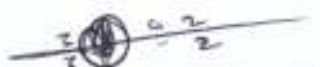
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A PROJECT SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL
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DEDICATION

To God Almighty and my parents (Mr and Mrs Lawrence Odubanjo).

DECLARATION

I hereby declare that this thesis is a record of my research work. It has neither been presented nor accepted in any previous application for a higher degree. All sources of information have been specially acknowledged

Signature

A handwritten signature in black ink, appearing to be 'Odubarjo O.O.', written over a dotted line. The signature is stylized with a circular flourish and a horizontal line extending to the right.

Odubarjo O.O

Date ..13-08-98

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ABSTRACT

Treatment of Agricultural wastes were conducted on three farms and two companies in Akure, Nigeria. (i.e FUTA, FCAA, and JOFA farms and Fembo Nigeria Limited and Bacita Sugar Company). Waste handling methods of the establishment surveyed were studied. The environmental consequences are discussed, for proper management of Agricultural wastes to prevent pollution of environment or receiving stream.

Samples from the visited farms and companies were collected and analysed for the determination of parameters that can aid in assessment of pollution levels. The mean values of 174.1Mg/l of hardness, 97.5Mg/l of chloride, 76.4% of organic matter, 10.0Mg/l of Iron, 247.5Mg/l of manganese, 190.2Mg/l of calcium, 206.6Mg/l of sodium, 202.7Mg/l of potassium, and 19.7Mg/l of zinc were determined. Also the effects of Agricultural wastes on soil and receiving stream were investigated. A mean pH value of 8.0 was discovered. Depletion of dissolved oxygen (DO) from 6.5Mg/l to 4.5Mg/l reduction of biochemical oxygen demand (BOD) from 570Mg/l to 350Mg/l and high metals determined from the receiving stream are evidences of stream pollution.

In most of the establishment visited, no treatment is administered before waste disposal. Odours, flies and mosquitoes constitute a common nuisance in their vicinities. It is recommended that measures be taken in treatment and management of Agricultural waste to minimise environmental pollution. Treatments suggested include the use of storage pit, stabillization ponds, activated sludge processes, anaerobic digestion, composting and possibility of waste re-use.

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CHAPTER ONE

INTRODUCTION

1.1 AGRICULTURAL WASTE AND THE ENVIRONMENT

Waste refers to useless, unused, unwanted or discarded materials. It includes solids, liquids and gases. The gases are principally industrial fumes and smoke; the liquids consist mainly of sewage and the fluid part of industrial wastes; the solids are classed as refuse. (Robert, 1970). Agricultural waste refer to waste generated from farms and agro-based industries. George and Samuel (1993) define Agricultural waste as wastes and residues resulting from diverse agricultural activities - such as the planting and harvesting of raw, field, tree and vine crops; the production of milk; the production of animals for slaughter; and the operation of feedlots - are collectively called agricultural wastes. Increase in population leads to proportional increase in Agricultural waste. Banks (1990) remarked that 'the intensive rearing of animals, birds and fish to provide food for human consumption is associated with a number of agricultural waste management problems'. Most of this waste is handled indiscriminately. As standards of living go up, the public demand for adequate waste management disposal service increases. At the same time, the higher standards of living complicate the problem by increasing the amount of waste produced and cost of properly disposing of it.

The current interest in environmental matters, waste collection, disposal and reclamation has attracted the attention of environmentalists, manufacturers, farmers, agro-based industries and developers of processes (Cope, 1976). In many parts of the world, simple survival or prevention of disease and poisoning are still serious concerns. In other areas, maintenance of an environment that is suited to man's efficient performance and to the preservation of comfort and enjoyment of living are the goals for the future (Joseph 1982). Environmental pollution is a major global concern. When sources of water pollution are enumerated, agriculture is with increasing frequency, listed as a major contributor (Ongley, 1996).

As nations make effort to correct abuses to their environment, there is a need to determine the causes of environmental problems resulting from

agricultural waste management. Existing knowledge indicate that poor handling of agricultural waste can contribute to deteriorating environment (Ongley, 1996). Poor agricultural waste management leads to poor environment. These are manifested by soil degradation diseases for man and animals, pollution of both surface and underground water and air pollution. Agricultural wastes have varied characteristics or parameters such as Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Chloride, Nitrate, Phosphate etc. That are dangerous to health and life of man and animals, pollution of both surface and underground water and air pollution. High levels of these parameters are noticeable in ponds, streams, lakes and rivers used by man for domestic activities.

The main liquid waste produced on farms in England and Wales are slurry from pigs and cows, dirty water, yard run off on dairy farms and silage effluent. All those wastes have a high Biochemical Oxygen Demand (BOD), particularly undiluted slurries and silage effluent. They also contain considerable Nitrogen and other nutrients. Polluted water with Biochemical Oxygen Demand of at least 1000mg l^{-1} must be handled with care in order to prevent stream, pond, lake and river contamination (Archer and Nicholson, 1992). This study focuses on problems and solutions to agricultural waste management and indirectly addresses the environmental health of man and animals. In China for example, environmental health programmes cover activities such as waste disposal, pollution control, water supply, food and industrial hygiene and solid waste management (Ongley, 1996). The community that protects the health and safety of its residents and is clean and attractive from waste problem must have an efficient, well-organised waste collection and disposal systems. Without one, disease-carrying rats, flies and insects abound, water and air become polluted and unpleasant odours are noticed (Robert 1970).

The environment encompasses the sum of all external influences and conditions affecting life and development of an organism, including man (Michael, 1987). Included in this definition is the media such as land, and air Vagale, (1983) noted that the term environment has many connotations. It is undoubtedly a catch word of our times and is used in different senses by different disciplines. Environment has several dimensions such as physical, economic, social and

cultural. The achievement of an environment to enhance man's well-being requires the application of environmental science and engineering principles. This means that our goal should be the control of all those factors in man's physical environment which exercise or may exercise a deleterious effect on his physical development, health and survival. The application of engineering principles to the control, modification or adaptation of physical, chemical and biological factors of the environments in the interest of man's health, comfort and social well-being has become inevitable in the world today. This in turn requires application of the principle of physical, biological and social science to the improvement, with consideration of the impact of the control measures applied (Joseph, 1982).

For convenience, environment can be divided into physical and biological categories although the divisions may be slightly artificial. In the natural physical environment, climate is perhaps the most important influence. Geology affects the content of water supplies, which may in turn influence health. In particular, water hardness has frequently been associated with heart disease. Vagale (1983) defined physical environment as the sum of all social, biological, chemical and physical factors which compose the surroundings of man. The total environment embraces all types of environment and synthesizes them into an "Ecosystem". The total environment is concerned with the air we breathe in, the water we drink and use of recreation; the land we cultivate, build upon and mine; the human settlements in which we live and work; the wastes that we produce and all other phenomena on the surface of this planet which is the habitat of man as well as the fauna and the flora. The total environment can be described as the system of which the human community is a part. It consists of four elements :

- (a) **Atmosphere** : The gaseous envelope surrounding the earth, composed of the entire mass of air containing primarily oxygen, nitrogen, carbon dioxide, water and the gases.
- (b) **Hydrosphere** : The aqueous envelope of the earth including oceans, lakes, streams, water vapour in the atmosphere and water in the form of ice and snow.
- (c) **Lithosphere** : The solid rocky portion of the earth made up

mostly of silicates of manganese and iron and alloys of nickel and iron.

- (d) **Biosphere:** The biologic envelope that surrounds the globe containing and able to support life (Vagale, 1983).

The biological or organic environment makes its presence felt in areas of human health by the incidence of infectious diseases. Although such diseases are relatively minor, causes of mortality in developed countries, infections such as influenza, measles and whooping - cough are major causes of mortality. In the developing world, malaria, tuberculosis, typhoid, cholera etc. are significant causes of death.

Agricultural waste management is an essential part of daily life. Materials used by man are derived from the environment and ultimately are returned to it. To continue to do so requires careful management of the way that resources are used. In order to have good environment free of diseases, the problems of agricultural waste management, which is one of the sources of environmental disease infections must be handled with good care or handled effectively.

1.2 AGRICULTURAL WASTE CONTROL LEGISLATION

Control legislation is highly essential in Nigeria to enable the government tackle environmental pollution emanating from agricultural waste. Victor (1983) observed that natural resources are being utilised at rates unprecedented in the history of civilisation and the quality of environment continue to deteriorate. Thus there is increasing public demand for legal aid to the environment. Attorneys are being called upon to act as public defenders of the environment and the law is being asked to restore the quality of life. The delay in control legislation of agricultural waste in Nigeria until recently can be based on peasant nature of agriculture and the traditional ways of handling the waste. With intense mechanisation and increase in agricultural raw materials for many industries to function effectively, there is need for control legislation. Control legislation policies may include the setting of national standards, building codes, sub-division of regulations and environmental quality protection to guide the planning and management of environment from agricultural waste

problems. (CASSAD, 1996a). In pursuance of its mandate and worried about the increasing deteriorating of the environment, the Federal government of Nigeria in 1988 set up the Federal Environmental Protection Agency (FEPA), and in 1989, formally launched the National Policy on the environment. The policy lays emphasis on sanitation and waste management, as part of an integrated, holistic and systematic view of environment issues. Amongst the tasks specified by the National Policy on the environment on sanitation and waste management are :

- (i) study of the most reliable systems that are appropriate for local, domestic and industrial wastes;
- (ii) specification of waste disposal and treatment systems that will take into consideration the geological and environmental setting and encourage recycling;
- (iii) specification of waste disposal sites that guarantee the safety of surface and underground water systems;
- (iv) setting up and enforcement of standard for adequate sanitary facilities for the disposal of human and other solid wastes in dwellings, housing, estates and public facilities in both urban and rural areas;
- (v) establishment of monitoring programmes including periodic surveillance of approved waste disposal sites and their surroundings and waste water systems and,
- (vi) establishment of monitoring stations for the control of the disposal of leachate from dump-sites into surface and ground water systems (CASSAD, 1996b).

Legislation needed to establish national standards and controls for the discharge of agricultural waste that serves as pollutants to the environment comprises :

- (i) **The Clean Air Act** : To improve the quality of the nation's air. The Nigeria Federal Environmental Protection Agency is to establish national air quality standards to protect the public health and welfare from harmful effect of air

pollution from agricultural waste and to ensure that existing clean air is protected from significant deterioration by controlling and preventing harmful agricultural waste substances from entering the ambient air.

- (ii) **Occupational Safety Act and Health:** To prevent occupational disease and accidents and to establish workplace standards as well as national standards for agricultural waste and hazardous substances in the waste.
- (iii) **Safe Drinking Water Act:** To establish regulations for drinking water in public water systems and prevention of agricultural waste from contaminating surface and ground water (Williams, 1993).
- (iv) **Ports and Waterways Safety Act:** Regulates through the Coast Guard, the bulk of deposition of agricultural waste in the water and aquatic disturbances.
- (v) **Waste Regulation Authorities:** Waste regulation authorities (WRAS) are required to produce waste disposal plans. These consider the need for waste facilities in Nigeria including the type, quantity and origin of the waste. Waste regulation authorities will also need to take account of the strategy in drawing up their waste disposal plans. These plans fulfil the environmental protection method. John and Williams (1993), introduced the requirement that local authorities in England and Wales should separate their disposal and regulatory functions and that waste disposal authorities must subject their operations to competitive tender and enter into contracts with waste disposal contractors. This has enabled authorities to identify more clearly the costs and benefits of different waste management options.
- (vi) **Environmental Impact Act.** The environmental impact of the agricultural waste must be considered before

establishing factories that will generate wastes.

Agricultural waste control legislation varies from one country to another, from state to state and local government to local government. Enforcement of legislation will basically result into environmental control and accurate management of agricultural waste in Nigeria. The implication of all the above is that the Federal Government should take adequate legislative steps to tackle agricultural waste management problems. However, much success is not going to be achieved due largely to the weakness of the enabling legislation and related agencies and the unwillingness in enforcing some of the laws. The implementation strategies for such laws leaves much to be desired. Maxima Ferrari of UNEP Regional office in Kenya once remarked that the painful reality is that African governments still pay lip service to environmental issues, actual action and the subject still lags behind resolutions and declarations of governments in many parts of Africa. The situation has not been helped by a lack of voluntary compliance with the laws by the public. Although a good law is necessary and useful voluntary compliance with the law is still a long way off in this country and so all the innovations contained in the law need to stand the test of time, Odeyemi and Olaoye (1984). The powerful people in the country, who the general populace should normally look up to, are the first to flout the laws and the other citizens take a cue from them (CASSAD, 1996b)

1.3 IMPORTANCE OF AGRICULTURAL WASTE

Agricultural wastes are essential today, because of the reasons listed below:

- (i) Fresh blood for example from slaughter house operation can be incorporated into stock food for pigs and poultry feeds and blood is a valuable source of protein.
- (ii) Sangodoyin and Olorunfemi (1996), observed that livestock waste, when accurately applied to soil, is expected to lead to increase crop yield owing to soil mineralization and improvement in soil physical properties.
- (iii) Fish waste or fish offal such as guts, gills, fins, tails, head, scales, unsold fish (refrigeration not being available) and small fry is a superior protein concentration for pigs and poultry.
- (iv) Agricultural waste can be used as biogas. The generation of biogas based on

the following : relatively large through put, relatively constant both over the week and annually (over 5 large stock per day or equivalent), previous history of successful biogas plants in the locality, shortage of low cost solid fuel for boiler, higher cost of alternate fuels and high pig kill (pig excrete yields more gas than cattle or sheep).

- (v) Agricultural wastes can be used as fertilizer.
- (vi) The return of agricultural waste to the land is playing an important role in Agriculture, especially in efforts geared towards the ren of food shortages.
- (vii) Agricultural waste water treatment prior to land application is necessary to reduce viruses reaching deep into the soil depth and risk to which persons living or working near spray sites or consumers of products may be exposed (Sangodoyin, 1992)
- (viii) Waste water from agricultural operations can be used for the purposes of garden watering and irrigation.
- (ix) Cassava wastes can be used as animal feed, fertiliser, starch recovery and biogas (Victor 1991).
- (x) Solid agricultural waste can be utilised as fuel in cement manufacture (Haley, 1979)

1.4 OBJECTIVES AND JUSTIFICATION FOR STUDY

The objectives of the present study include :

- (i) To identify the problems posed by increased agricultural activities in recent times with focus on wastes generated,
- (ii) The study also aims at providing guidelines on how these wastes can be managed in Nigerian communities through practices which minimize risks to the environment and to human health,
- (iii) To Suggest environmentally acceptable waste disposal methods.

1.5 SCOPE OF STUDY

Some agro-based industries and farms that have tendency for generating wastes will be investigated. This will be chosen with a view to reflect variety and complexity. The balance are included to provide specialised information, location of

such factories or farm sites, stage of technological development and environmental concerns. Other aspects to be investigated include the following:

- (i) Methods of agricultural waste treatment for the agro-based industries and farm settlements,
- (ii) In-depth study of present waste disposal methods,
- (iii) Evidence of by-product recovery,
- (iv) Evaluation of waste handling techniques,
- (v) Encouragement on the development of waste management technologies which reduce the environmental impact of agricultural waste.

CHAPTER TWO

LITERATURE REVIEW

2.1 AGRICULTURAL WASTES

Agricultural waste include, animals excreta, dairy produce meat processing waste, crop conservation waste, herbicide, pesticide and other chemical residues and peelings of yams, cassava, cocoa-yam, potatoes, banana, plantains, cocoa, kola, oil, palm etc. [CASSAD, 1996a]. John and William [1995] observed that, the bulk of agricultural waste and by-products consist of organic matter such as manure, slurry silage effluent and crop residues. The same study showed also that about 80 million tonnes of solid waste and other by-products arise annually from housed livestock alone. Agriculture waste are principally organic as indicated in Table 1.

Table 1: AGRICULTURAL WASTE COMPOSITION AND VOLUME OF UNITED STATE

WASTE	COMPOSITION	AMOUNT/MILLION TONS/YEAR
Crop Residue	Corn Stalks, Grain Stubble, Cull, Fruit and Vegetable, Vines, Rice Hulls, Bagasse, Tree Pruning etc.	552
Animal Manure	Organic matters, protein, fat, carbon-hydrate etc.	1.532 ^a
[Paunch Manure]	Nitrogen, Phosphorous	
Poultry Manure	Same as Animal Manure	30 ^b
Animal Carcaves	-	-
Forest Operations	-	25
Pesticides, Insecticides etc.	Chlorinatedhydrocarbons, organic-phosphorus compounds, other organics	-
Residue and Containers	In-organics e.g. sulfur, lead arsenate etc.	

(^a) Excludes horse and mule manure

(^b) Excludes ducks etc.

Source : Peter [1983].

The exceptions are chemicals used in various facets of the farming such as pesticides, containers and small amount of miscellaneous waste matter resulting from maintenance and general house keeping [Peter 1983]. Sangodoyin and Agbanhe [1992], study of slaughter house waste showed a high polluting strength with representative, Chemical Oxygen Demand [COD] and Total Solid [TS], values of 2410 mg/L and 13100 mg/L, respectively Leachates and effluents from the abattoir sites were

found to increase the COD, Ca^{2+} , Cl^- and No^3 values of underlying aquifer. The study concluded that slaughter activities if not properly controlled, may pose dangers to farmers and butchers as well as the consumers.

Eliassen [1969] observed that most crop waste is either plowed back into the soil or composted. Some open burning also takes place.

In some special cases such as bagasse (Sugar Cane Stalk) industries have been established to utilize the waste material. Majority of agricultural waste and by-products is slurry and manure and these are used again on farm. These fall outside the legal definition of waste. Animal wastes pose a different problem because much is produced in very concentrated areas such as feed lots, or poultry farms. The disposal of these wastes is posing a greater problem, than crop waste, but may be more easily solved because it is concentrated and therefore susceptible to processing without collection. Average waste yields for a variety of domestic animals are summarised in Table 2.

Table 2 : UNIT GENERATION RATES

ANIMALS	WASTES	(TONS/UNIT /YEAR)
Cattle	12.0	
Cows, Milk	10.6	
Dogs	8.0	
Sheep	3.0	
Chicken brovers		0.0045
Turkeys	0.025	
Chicken, Layers	0.047	

Source [Peter 1983]

Ministry of Agriculture [1973] studies showed that the amounts of excreta (faeces and urine) produced by the livestock vary with types of animal and with the kind and quantity of feed they eat and with various other factors. Table 3 shows the amount of this waste based on the categories of animals involved :

Table 3: ANIMAL WASTE BASED ON TYPE OF LIVESTOCK

TYPE OF LIVESTOCK	EXCRETA/ F A E C E S OUTPUT	MOISTURE CONTENT OF EXCRETA %	BOD mg/l
Cows [10-11 out Body Weight]	90 lb/day i.e.9 gal/day	87	1.3
Pig [150 lb Body Weight]	10 lb/day i.e.1 gal/day	85	0.3
1,000 laying hens [light or medium hybrids]	1 ton/week 200 gal/week	75	10.0

Source : (Ministry of Agriculture, 1973)

Farmers will need to dispose of pesticides and veterinary medicines and it is important for them to have a clear plan for dealing with such wastes. Pesticides concentrates and veterinary products such as syringe and used medicines will need to be taken to a specialist disposal facility incensed to take such wastes, or preferably collected by a specialist contractor John and William (1995), are of the opinion that most pesticides should be disposed of by incineration, unless a physico-chemical method exists. They added that the Government is also encouraging farmers to prepare their own farm waste management plans. These give farmers a practical guide to where, when and in what quantities they are able to apply their organic wastes to land in such a way as to derive optimum economic and fertilizer benefit from them and to avoid causing water pollution.

In planning for effective agricultural waste management systems, it is important to consider the pollution parameters emanating from agricultural activities. [George and Samuel, 1993]. Homer [1975] showed that raw sewage is putrescent, odoriferous, unsightly, and a health hazard. If it is dumped into a stream in quantities too high for the stream to assimilate the organic demand of the sewage for oxygen, the stream will become septic and fish and other aquatic organism will die. Domestic sewage is a term commonly used to describe the sewage exclusive of industrial wastes. Agricultural waste parameters can be divided into two ; viz

(a) Primary Pollution Parameters and

(b) Secondary Pollution Parameters

(a) Primary pollution parameters include biochemical oxygen demand chemical oxygen demand, dissolved oxygen, total organic carbon and volatile solids.

(b) Secondary pollution parameters include acidity, alkalinity, chlorides, hardness, nutrients and pH.

The parameters of agricultural wastes are expressed by many variables.

The variables most commonly used are shown in Table 4



Table 4 : VARIABLE USED TO SHOW WASTE PARAMETERS

VARIABLE	UNITS OF MEASUREMENT
Quantity Produced	kg/day
Moisture Content	%
Strength, 5-Days BOD	mg/litre
Solids	
Total	kg/day/unit
Volatile	kg/day/unit
Suspended	kg/day/unit
Nitrogen	
Total	mg/litre as N
Ammonia	mg/litre as N
Phosphorus, Total	mg/litre a N
PH	

Source : JAMES (1981).

Solids: The determination of solids is important for evaluating the strength of wastes and for determining the type of treatment needed. It is also used as an index for evaluating the efficiency and effectiveness of waste treatment system components.

Volatile and Fixed: Total solids may be separated into volatile matter and fixed matter. Generally, the volatile component represents the organic matter present in the waste. Thus, volatile solid are indicative of strength since it is this portion that may putrify. The fixed solids have little significance in terms of designing and sizing waste treatment systems.

Suspended and Dissolved : Solids can be further divided into suspended and dissolved, each of which can be separated into volatile and fixed portion. The breakdown of solids into their separate components can best be illustrated by the individual component comprising total solids and their relationship to each other. The suspended solid determine the strength of the waste but it is also used to evaluate the efficiency of treatment units. All suspended solids will eventually settle out of solution

due to biological and chemical flocculation.

Settleable Solids: Settleable solids is a term applied to solids in suspension that will settle under the effects of gravity. In raw sewage, it is generally a measure of the grit and dirt that can be removed by primary settling tanks before the waste enters into biological treatment processes. Settleable solids are also used to determine the effectiveness of biological treatment processes. It is particularly important in evaluating the performance of oxidation ditches and extended aeration systems based on breaking down of solids into separate components as shown in Figure 1.

$$\begin{aligned} \text{TOTAL SOLIDS} &= \text{TOTAL VOLATILE} + \text{TOTAL FIXED} \\ \text{TOTAL SUSPENDED} &= \text{VOLATILE SUSPENDED} + \text{FIXED SUSPENDED.} \\ \text{TOTAL DISSOLVED} &= \text{VOLATILE DISSOLVED} + \text{FIXED DISSOLVED} \end{aligned}$$

Fig 1 : Breakdown Of Solids Into Their Separate Components

SOURCE : James [1981]

Nitrogen: Nitrogen in liquid waste can exist in four forms, all of which are of interest to the soil and water resources engineer. The four forms are organic nitrogen, ammonia nitrogen, Nitrite Nitrogen, and Nitrate Nitrogen. The total of these four forms constitute total Nitrogen.

Organic Nitrogen: All nitrogen present in organic compounds is considered to be organic nitrogen. The nitrogen - containing organic compounds any derivations of ammonia nitrogen.

Ammonia Nitrogen: The ammonia nitrogen is a result of bacterial decomposition of organic matter. Fresh sewage is generally high inorganic nitrogen and low in ammonia nitrogen. The sum of organic ammonia nitrogen should remain constant for the same liquid wastes, unless ammonia is allowed to escape to the atmosphere because of septic action. The total concentration of the two serves as a valuable index for evaluating the

strength of liquid waste and for determining the types of treatment process to select.

Nitrite Nitrogen: Nitrite Nitrogen is formed by bacteria oxidation of ammonia nitrogen. It is not present in fresh wastes but appears after bacterial activity has taken place. The presence of Nitrite Nitrogen indicates that the waste has undergone partial decomposition and is unstable. Nitrites can either be reduced back to ammonia or oxidized to Nitrates.

Nitrate Nitrogen: Nitrate Nitrogen is formed by the oxidation of nitrites and represents the most stable form of nitrogen. It is an indication of stability and is a determination of the completeness of the biological decomposition process.

Phosphorus: Phosphorus plays an important role in the life processes and thus is important in waste treatment facilities. Phosphorus is especially important in assessing the potential biological activities of aerobic treatment processes. Excessive amount of phosphorus in surface waters can stimulate algal bloom and eventually eutrophy the water.

pH: pH determinations have very little sanitary significance. It has no direct relationship to the strength of liquid waste or on the method of treatment to be used. Basically, pH is used to control the operation of various biological treatment processes. It is especially valuable in the design and control of anaerobic digestion.

2.3 GENERAL EFFECT OF AGRICULTURAL WASTE ON ENVIRONMENT

Many environmental problems have already emerged as a result of poor handling of agricultural wastes in Nigeria. The present section of this study singles out the effect of this waste on environment which may lead to specific problems of pollution of the environment. Although these problems are at present much more widespread in industrialised countries, they are already beginning and must be guarded against in the

African and other developing countries. This section of the study briefly discusses some of the problems that might arise or have already occurred from the poor management of agricultural wastes. The general effect of agricultural waste on environment will include its effect on men and animals, its impact on water quality, ground water and land or soil, etc.

Manure produced by cattle, pigs and poultry are used as organic fertilizer the world over. However, intensive livestock production has produced major problems of environmental degradation, a phenomenon which has been the subject of European and North American legislation and control. The problem is particularly acute in areas of intensive livestock production such as Eastern and Southern parts of the Netherlands where the production of manure greatly exceeds the capacity of the land to assimilate these waste [Ongley, 1996]. In addition to problem associated with excessive application of livestock waste as manure on the land is the problem of direct run-off from intensive cattle, pig and poultry farms. Although this is controlled in many Western countries, it constitutes a serious problem for water quality in much of the rest of the world. The discharge of pig wastes from intensive pig raising in luttinania is a major source of surface water pollution in that country. Applegan [FAO, 1994] reported similar problems in the PO River of Italy. The Canadian Department of Agriculture estimated in 1978, on the basis of detailed study of several feed lot operation, that cattle feed lots and manure storage facilities contributed 0.5 - 13% of total phosphorous load at that time to the Canadian portion of the lower [Agricultural Portion]. Great Lake [Coote and Hore, 1978]. To the typical pathways of degradation, that of surface run-off and infiltration into the groundwater, is added to the volatilisation of ammonia which adds to acidification of land and water. In a review of environmental impacts caused by animal husbandry in Europe, the FAO/ECE [1991] reported the following major categories of impacts :

- (i) Fertilization of surface waters, both as a result of direct discharges of manure and as a consequence of nitrate, phosphate and potassium being leached from the soil.
- (ii) Contamination of the groundwater as a result of leaching especially by nitrate. Phosphates are less readily leached out, but in area where the soil is saturated with phosphate this substance is found in the ground water more and more often.
- (iii) Surface waters and the groundwater are being contaminated by heavy metals. High concentrations of these substance pose a threat to the health of man and animals. To a certain extent these heavy metals accumulated in the soil from which they are taken up by crops. For example, pig manure contains significant quantities of copper.
- (iv) Acidification results from ammonia emission [Volatilisation] from livestock accommodation, manure storage facilities and manure being spread on the land. Ammonia constitutes a major contribution to the acidification of the environment especially in areas with considerable intensive livestock farming. Sangodoyin and Olorunfemi [1996] reported that resident close to the field where livestock waste is applied confirmed that the odour is highly offensive especially during spreading. In addition, elevated gas levels may become hazardous to the soil itself and also increase in the number of mosquitoes and flies at manure spreading sites [especially during wet conditions].

In their summary of water quality impacts of fertilizer, FAO/ECE [1991] cited the following problems that are associated with extensive and intensive application of organic fertilizer [manure] :

- (i) Groundwater is being polluted mainly by nitrates. In all countries ground water is an important source of drinking water. In several areas the

groundwater is polluted to an extent that it is no longer fit to be used as drinking water according to present standards. Substantial contamination of groundwater by nitrate in the Netherlands was also reported [FOA/ECE, 1991]

- (ii) Appelgren [FAO, 1994] reported that 50% of shallow ground water wells that supply more than one million rural residents in Lithuania are unfit for human consumption because of a wide range of pollutants which include pesticides and nitrogen species. Nitrogen from agricultural non-point sources in the Netherlands amounted to 71% of the total nitrogen load generated from within the Netherlands [ECE 1992]. U.S. - EPA [1994] regards agriculture as the leading source of impairment of that nation's rivers and lakes with nutrients ranking second only to siltation as the pollutant most affecting rivers and lakes. Sangodoyin and Olorunfemi [1996] reported that continuous application of livestock waste on to small crop land will also result in run-off and deterioration of stream quality. The term "pesticide" is a composite term that includes all chemicals that are used to kill or control pests. In Agriculture, this includes herbicides (weeds) insecticides (Insects), fungicides (fungi), nematocides and rodenticides (vertebrate poison). [Ongley 1996] A fundamental contributor to the Green revolution has been the development and application to pesticides for the control of a wide variety of insectivorous and herbaceous pests that would otherwise diminish the quantity and quality of food produce. The use of pesticides coincides with the "chemical age" which has transformed society since the 1950s. In areas where intensive monoculture is practised, pesticides were used as a standard method for pest control. Unfortunate with the benefits of chemistry have also come dis-benefits. Some are so serious that they now threaten the long term survival of major

ecosystems by disruption of predator/prey relationships and less of biodiversity. Also, pesticides can have significant human health consequences. While agricultural use of chemicals is restricted to a limited number of compounds, agriculture is one of the activities where chemicals are intentionally released into the environment because they kill things [Ongley et al. 1992]. African and Asia, environmental, public health and water quality impacts of inappropriate and excessive use of pesticides are widely documented. For example, Appelgen [FAO, 1994] reported for Lithuania that while pesticide pollution has diminished due to economic factors, water pollution by pesticides was often caused by inadequate storage and distribution of agrochemicals. In the United States, US - EPA's national pesticide survey found the 10.4% of community wells and 4.22% of rural wells contained detectable levels of one or more pesticides [US - EPA, 1992]. In a study of ground water wells in agricultural South-western Ontario [Canada], 35% of the wells tested positive for pesticides on at least one occasion [Longmen, 1995]. The largest regional example of the pesticide waste contamination and human health is that of the Aral Sea region. UNEP [1993] linked the effects of pesticides to "the level of Oncological [cancer], pulmonary and haematological morbidity, as well as an inborn deformities and immune system deficiencies". The report added that human health effects are : skin contact [handling of pesticides waste products], inhalation [breathing of dust or spray], and ingestion [pesticides consumed as a contaminant on or in food or water [WHO. 1993]. Different pesticides waste have markedly different effects on aquatic life which makes generalization very difficult. The important point is that many of these effects are chronic [not lethal], are often not noticed by casual observers, yet have consequence for the entire food chain.

As far as the environmental situation is concerned, it has been pointed out that most of the cassava producing countries do not take care of treatment of Liquid waste [Victor ,1991] liquid waste will later result into environmental pollution of such countries that involve in cassava bread. Nevertheless, solid wastes are extensively used for feeding cows, pigs and donkeys. Victor [1991] reported that some Dominican Republic and Venezuelan producers often sell the solid wastes from peeling and sieving operations to farmers. For instance, in Matorin, Venezuela a sack of fresh peels [20kg] is sold for US \$0.25. In practise, many farmers often reject cassava peels as animal feed because they think cassava cyanide would kill their animals.

2.4 METHODS OF AGRICULTURAL WASTE TREATMENT OR MANAGEMENT

It is an acknowledged fact that agricultural waste could be treated in order to ameliorate its environmental effect on man and animals. Ministry of Agriculture [1973] report listed that the size of manure, its disposal problems and possible relationship with river pollution has drawn attention to potential river treatment system new to agriculture. Sangodoyin and Olorunfemi [1996] suggested that, to minimize food chain accumulation, land being used for manure disposal can be restricted to grass cultivation. The study noted that, the environmental effects of livestock waste handling suggest the need for installation of livestock units that are capable of minimising contact between livestock and wastes, between human beings and livestock wastes. Also, manure management and disposal techniques that result in minimal pollution of local water sources are required. Waste - forage ensiling were suggested, by Mson and Sangodoyin [1995] as a means of solving manure disposal problems and indirectly minimise air and land pollution. It was found out in the report, that the conservation and enrichment of forages by ensilation with poultry excreta would serve to provide a nutritious diet to the animals; make feeds available at critical periods, and serve as a disposal method for poultry wastes.

2.4.1 Aerobic Oxidation Treatment

This includes : The oxidation ditch, the high rate biological filter tower and the surface aerator method.

- (i) **The Oxidation Ditch:** This was devised to deal with human effluents in Holland and subsequently applied to agriculture. It has been demonstrated that such methods will not handle crude agricultural wastes and give full treatment. What has emerged is that it is possible to incorporate an oxidation ditch with animal house to effect significant but not complete reduction of BOD. Smell is eliminated and also the quantity of the resultant effluents is significantly reduced. In most cases such installations are working either on a six month - fill and empty basis, giving the ability to carry through long winters in heavy snow fall areas, or on the basis that the overflow from the ditch [if any] is either lost on the land or given further treatment. Not all sites are suitable for such installations. A high water table will introduce many complications in design. On the other hand, oxidation ditches have shown themselves very successful in the treatment of liquids which have a much lower level of pollution, e.g. under 1,00 mg/l BOD. In such cases they have proved satisfactory (Ministry of Agriculture, 1973).
- (ii) **The High Rate Biological Filter Tower:** This development from the old circular sewage filters has advantages in the agricultural context, in that by using a plastic media, the filter can be made higher and the BOD Load per cubic volume increased. Studies have shown that a 70% breakdown of BOD is relatively easy to achieve and the equipment use, e.g. pumps is kept to a minimum. Thus the power requirement is low and the unit can probably be designed for farmer erection. Essentially this treatment requires the removal of coarse solids to avoid blocking the tower and the provision of a ba

lancing tank and settling tank. Because it is only a roughing treatment, the resultant effluent require further polishing before it can be applied to the land or discharged to stream [Ministry of Agriculture, 1973].

- (iii) **The Surface Aerator :** This has aroused considerable interest in Europe and the Americas whilst the Dutch have tended to use it recently instead of the oxidation ditch which they first pioneered. It is capable of a roughing treatment to liquid farm wastes. It is much less susception to floating solids, pretty robust and will run satisfactorily with minimum attention. In essence, it is a mixing apparatus floating or being suspended in the surface of the water which moves the liquids and the drives air into mixture. Thus we have an aerobic microflora created which breakdown organic matter. It is normal for continuous feed into the aerator to take place. Such displacements flowing into a settling tank and then perhaps a 'polishing' lagoon. Both the surface aerator and the filter tower treatments have the advantage that they can be farmer installed, they can be above ground situations contained completely in tanks or Butyl lined lagoons. They are relatively easy to maintain with the high rate filter in particular being resistant to the sort of shock loading that one find in a farm situation. At the present time, it is possible to design such a plant to within 80% accuracy when it would run satisfactorily and give a very significant reduction in the pollution load of effluent. [Ministry of Agriculture, 1973].

2.4.2 Anaerobic Digestion Treatments

The anaerobic digestion of sewage sludge has many advantages non- applied to agricultural waste management. Agriculture is concerned with two aspects of anaerobic digestion.

Firstly, as the question of whether such units can be designed to separate on the farm. Although background information is often available, the equipment may be costly and sometimes delicate to handle. A number of such units have been tried on farm but have operational and economic problems often difficult to resolve. The second aspect concerns the design of storage ponds. The anaerobic digestion tank is proving promising and cheap. Initially, such storage has often been designed for one year retention. Such stores are large and difficult to empty. The present trend is towards smaller but deep storage ponds of about 100 days retention. If properly designed so that the daily input cannot short circuit to the outlet several effects are produced. A daily affluent displacement takes place. There is provision for up to a year storage of solids. The contents stratify with a layer of settled liquid sand inched between the solids at the bottom and a crust on top. The BOD of such settled liquid is much reduced. When treatment of the displaced effluent is needed before disposal then the capital costs involved are much lower. The solids from such a system will have to be much on land, probably on a yearly basis.

Work is proceeding on the development of machine for separating solids from liquids. Such machines will be sited between the animal house and the store and may take the whole excreta flow with the resultant solids going one way and the liquid another. It will be easier to handle the solids though these will still be 70% or 80% water and there will be advantages associated with the pumping and treatment of liquids that are free of crude solids. On the other hand, there is the disadvantage that if one takes a given volume of excreta with a known BOD, then the BOD of the resultant liquid will be higher. A disadvantage may be that to get efficient separation, some pre-treatment will be necessary. The anaerobic 100 days retention tank is probably the most efficient. Method of natural separation is available. This is the case with cow manure where the small fine fibre particles tend to float to the top and be trapped in bits of

silage, straw and other matter. There are also advantages in separating pig hairs in such a manner [Howard et al, 1985].

2.4.3 Landfill Method

Sanitary landfill is an acceptable method of disposal of agricultural wastes and provides for the ultimate disposal of many types of agricultural waste items such as toxic chemicals, and hazardous materials are not allowed in land fills for safety. [Peter, 1983]. According to Eliassen [1969], sanitary landfills method have low initial and operating costs. Other advantage and disadvantages are : Most economical method when land is available, low initial investment, complete and final disposal, short period of time from need to fill operation, flexible daily capacity with same working force. Reclamation of marginal land for recreational and other uses and all types of agricultural waste are acceptable.

Disadvantage of landfill method includes:- Lack of close-by suitable land in urban areas may make uneconomical, public opposition in or near, residential areas, setting after completion means continued maintenance, public nuisance and health hazard if not properly operated, products of decomposition, methane and other gases may create hazard and requires special practise for construction on completed fill.

Sanitary landfill is basically the dumping of agricultural wastes followed by compaction and the daily application of an earth cover. [Kupchick 1966]. Several techniques are available. Fig. 2 adapted from Peter (1983) illustrates plus concept. Most operations require daily earth cover preferably with a sandy loam and amounts to, one part earth for every four parts refuse. Another, which is being required in new land fills, is leachate collection and treatment. In addition these types of waste disposal are limited to "non-hazardous" materials unless the land fill is especially constructed, licensed and managed. [Peter, 1983].

2.4.4. Incineration Method

Incineration is essentially a method for reducing agricultural waste volume and at the same time producing essentially in-organic solid effluent from material which is largely organic. In addition to the solid product, a gas is produced consisting mainly of CO_2 , H_2 , O_2 and N_2 but containing other gaseous components in that the solid residue which is primarily an ash containing some metal must still be disposed of usually as landfill [Peter, 1983]. The primary advantage is that it reduces the volume to be disposed off and results in a "clean" inert fill. For every 0.1kg of the material fed to the incinerator approximately 0.02 kg of residue result. The volume reduction is even more significant often resulting in a 90% lower solids volume for organic material [Kupchick, 1966]. The theory of incinerator operation is very simple. A unit is designed to expose combustible material to sufficient air at high temperature to achieve complete combustion. Combustion is usually carried out in fuel beds to ensure good contact of air and agricultural waste [Eliassen, 1969]. A large control incineration facility is schematically shown in Figure 3. It can be divided into five areas :

- (i) The receiving section which includes the weight station, storage hopper and bucket crane;
- (ii) The effluent gas treating facilities;
- (iii) The furnace - which includes the changing hopper, stokers furnace chamber and air feed system;
- (iv) The ash handling system and;
- (v) The cooling water system.

For mixed waste, a typical refractory - wall incinerator will have 0.36m^3 in the primary furnace chamber and 0.52m^3 in the secondary chamber per ton of waste per 24 hours with a grate loading of 51.74 kg/ms. Volume and loading requirements will vary with the type of feed as well as furnace configuration. [Peter, 1983]. Incinerators are

typically operated with about 50 to 150% excess air in order that the gas temperatures do not drop below that required for good odour-free combustion. This is usually in the 1700 - 2300°F range. John and William [1995] are of the opinion that pesticides waste should be disposed of by incineration.

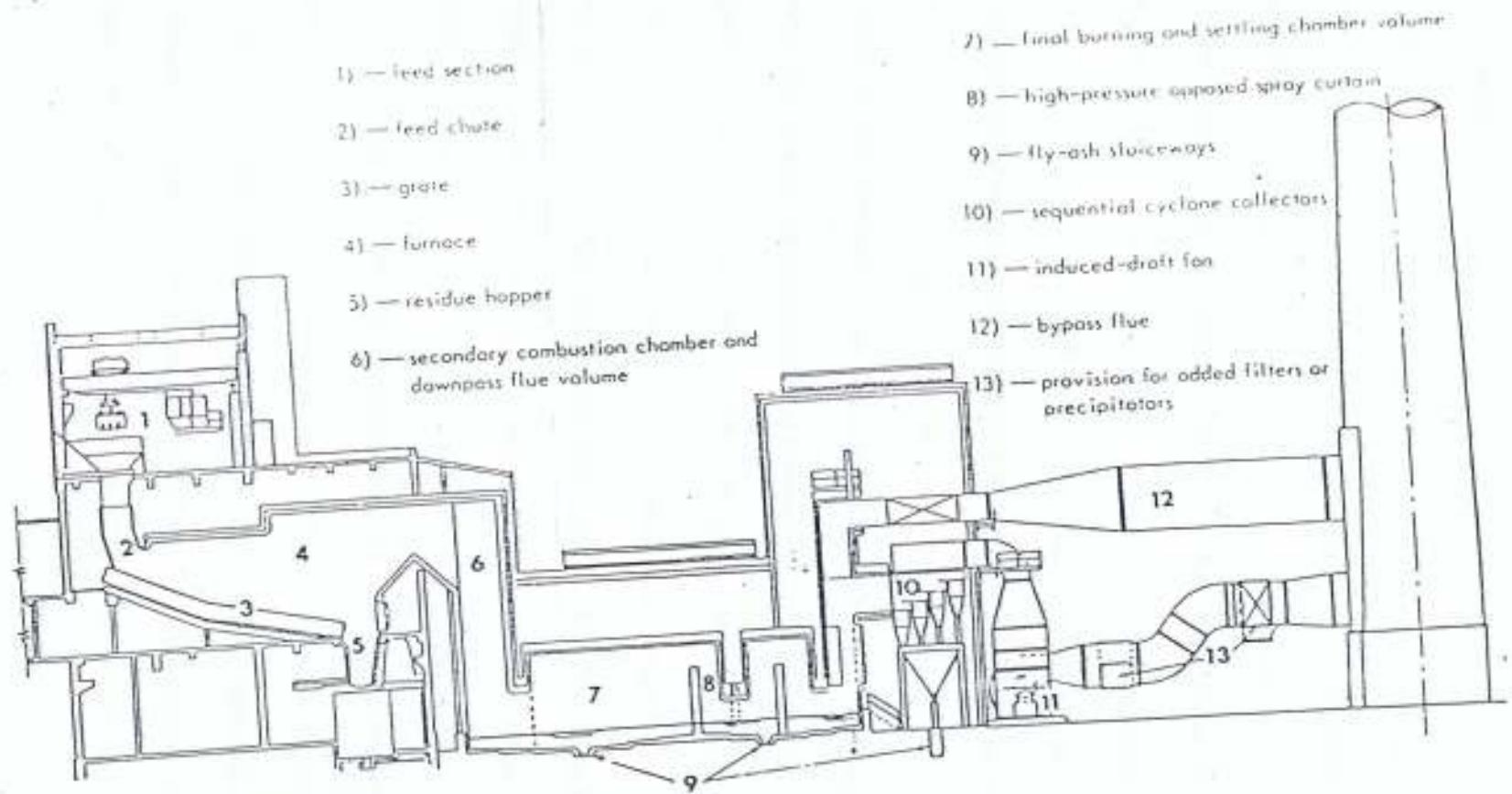


FIGURE 3 Large incinerator schematic.
 SOURCE: (PETER, 1983)



2.4.5 Compaction Treatment

The reduction of agricultural waste volume is receiving considerable attention in an effort to reduce collection costs. Compaction is one of the favoured methods to achieve the reduction. High pressure compaction has been developed by Tezuka Kosan of Japan to provide a high density product suitable as an essentially inert fill or even as building materials. The Japanese process collects waste and subjects it to three stages of compression with final main press exerting 674.43N on the waste. The resulting bale is usually wrapped in chicken wire and coated with asphalt for ease of handling and to prevent crumbling and/or leakage. The bales have a density of between 648.92 and 797.63 kg/m^3 resulting in a volume reduction of about 90%. This compares to densities of about 416.16 to 520.20 kg/m^3 achieved in lower pressure compaction. The product bale is inert and such bales have survived exposure in Tokyo Bay without visible signs of degradation. [Peter, 1983]. Eliassen [1969] reported a reduction in BOD from 6000 in the raw waste to a third of that value in the product. Similarly the COD of 800 [which compared to about 14,000 in US refuse] was reduced to about 150. The report added that the only other product of the compaction is waste liquor which amount to 5% of the feed in Japan and will probably be about 35% with US waste because of its lower moisture content. The system also appear to be of particular interest where long hauls are required to dispose of waste [Kupchick, 1966]. In addition, it is attractive where it is desirable to reclaim tidal lands or obtain prompt use of land fill areas because the highly compacted fill eliminates the usual hazard and nuisances associated with the usual land fill operations.

2.4.6 Stream Protection Measures

In general the quality of receiving waters can be preserved from agricultural wastes by stream standards or effluent standards. Although the ultimate goal is to raise the quality of the river or lake to the optimum for its best usage, it is sometimes easier to accomplish this by requiring each polluter to discharge only a given quantity of contaminant or a given concentration with a stipulated total volume of waste water [Nelson, 1983]. Many state agencies ascertain the best usage of a stream and assign certain quality standards to that water use. Any polluter found adding contaminants in such quantities as to contravene these standards is cited as a violator and must then abate the pollution. A more recent trend followed by some agencies is to establish the receiving water quality desired and attempt to maintain this quality by controlling each agricultural waste discharge to the minimum contaminant units per unit of production of per capital [Mckee and Wolf, 1963]. Table 5 illustrates the effluent standard system of New York State of American.

Table 11 : NEW YORK STATE CLASSES AND STANDARD FOR FRESH SURFACE WATERS

Best Use	Minimum Dissolved Oxygen mg/l	Coliform Bacterial Median No. 100 ml	pH	Toxic Wastes Deleterious Substances. Coloured wastes heated liquids odour Producing substances	Floating Solids, Settleable Solids and Sludge Deposits
Water used for supply and other Usage	[Trout] 4.0 [Non-Trout]	Not to Exceed 50	6.5 - 8.5	None in sufficient amounts or at such temperature as to be injurious to fish life or make the water unsafe or unsuitable	Non attributable to sewage industrial wastes or other wastes
Water of filtered water supply and other usage	[Trout] 4.0 [non-trout]	Not to exceed 5000	6.5 - 8.5		None which are readily visible and attributable to sewage industrial wastes or other wastes
Water and any other water except as a source of water supply	[Trout] 4.0 [Non-trout]	Not to exceed 2400	6.5 - 8.5		
Water and any other water except public supply and bathing	[Trout] 4.0 [Untrout]	Not applicable	6.5 - 8.5		None in sufficient amounts or at such temperatures as to be injurious to present fish life or impair the water for any other best usage
Water for municipal drainage and Industrial supply	3.0	Not Applicable	6.0 - 9.5		None in sufficient amount or at such temperatures as to present fish survival or impair the waste for agricultural purposes or any other best usage

: Nelson (1983).

Neutralisation

Adjustment of the reaction pH is required for many reasons in numerous

cases some of these are listed below.

- (1) protect sewer lines and plant structures from corrosion
- (2) reduce the demand for excessive chemicals for coagulation as a treatment method
- (3) provide optimum bacterial activity in biological treatment of agricultural wastes.

- (4) prevent odours which may emit at low or high pH values.
- (5) protect receiving water from detrimental effect of agricultural wastes with either less than 6.0 or greater than 9.5 pH values. [Nelson, 1983]. pH Values adjustment to correct values can be obtained by :
 - (1) adding acid (usually sulphuric) or base (usually sodium) hydroxide or lime.
 - (2) mixing acid wastes with alkaline waste in proper proportion
 - (3) acidifying with gas or compressed CO₂.
 - (4) acidifying with submerged combustion [burning of fuel under water].
 - (5) passing acid wastes through limestone beds. It should be noted that neutralisation costs money and should be used where; justified economically.

4.8 Use of secondary biological treatment :

A secondary biological treatment plant - if adequately sized - can best be utilized to treat a readily - decomposable, organic-laden industrial waste. Typical examples of these types, include dairies, canneries, slaughter houses, tanneries. Each of these wastes - as well as other typical organic wastes contain contaminants. Dairy wastes often turn acid extremely fast and the lowered pH can affect biological oxidation. Many canneries contain extremely alkaline wastes which when discharged in sludge beds can also hamper slaughter houses wastes containing sludge loads of grease and bloods which could hinder physical and biological processes, while tannery wastes contain chromium, sulfides, and lime, which are not compatible with normal sewage treatment. Proper treatment and plant operation, however, can remedy these problems (Nelson,1983). Mckee and Wolf [1963] noted that little would be gained if an industrial waste, such as from a dairy or textile mill, were treated in a municipal treatment plant consisting solely of primary treatment. Industry must make an assessment of the objectives of treatment required and then

examine the municipal plant available or being planned.

2.4.9 Biogas method

Three types of biogas generators have been constructed. The first types is constructed with a 2200-litre discarded oil drum which produces 0.2 - 0.3cm³ of biogas daily, enough to light a burner for 50 minutes. The gas is stored in a 16 meter floating drum inverted over the digester mixture. The second digester is family-sized and it is made from three 200 - litres drums welded together end to end. In this case biogas is stored in storage tanks made from open-ended 160 litres drums inverted over 200 litres drums filled with wastes [Odeyemi and Olaoye, 1984]. The third types of the biogas digester is much bigger semi-commercial non-moveable type made of concrete block with the gas stored in a fixed dome made of cement block on top of the fermentation chamber. It has the same design with the first biogas digester discussed above with except that the fermentation chamber which is much bigger is built with cement block and the gas storage chamber is non-floating, fixed dome. Each of the generator is fed with various mixture of agricultural waste material such as animal manure and other agricultural waste. The gas is used for cooking, heating and lighting while the post digestion slurry is used to manure and fertilize vegetable garden [CASSAD, 1996a]. Table 13 shows the relative biogas generation from different organic materials in Nigeria.

Table 6: RELATIVE BIOGAS GENERATION FROM DIFFERENT ORGANIC MATERIALS IN NIGERIA

ORGANIC MATERIAL	BIOGAS I/KG/DAY
Eupatorium Odoratum	256
Water Lettuce	108
Cow Dung	40
Sheep Manure	94
Goat Manure	200
Swine Manure	306
Poultry	312
Cassava Leaf	55
Sewage Sludge	65

Source: [CASSAD, 1996a]

2.4.10 Treatment Of Other Effluent And Water

In addition to manure there are other effluents for which provisions must be made designing and laying out from buildings. Liquor from silage can cause very serious pollution and great care must be taken to exclude it from the farm drains and to avoid the possibility of its seeping into streams of underground water supplies. Amount of liquor produced is directly proportional to the moisture content at the time of ensiling. The percentage of dry matter of material at the time of ensiling is shown in Table 7. It is clear that the problem can be greatly reduced by making high dry matter silage.

Table 7: PERCENTAGE DRY MATTER AND AMOUNT OF EFFLUENT

PERCENTAGE DRY MATTER OF MATERIAL AT THE TIME OF ENSILING	AMOUNT OF EFFLUENT PER TON OF SILAGE (GAL)
10 - 15	80 - 100
16 - 25	20 - 50
25	Virtually

Source: Peter (1983)

However, if there is a silage effluent discharge this should not be allowed to enter the farm effluent system if there is any chance that it may eventually reach a water course untreated. Silage effluent should be taken to a separate tank or blind ditch or preferably be diluted with water and spread back on the land from which the silage crop came.

Washing Down Water

- (i) **Cows:** The amount of washing down water required depends upon the system of housing and method of cleaning. Quantities of washing water used for alternative cow-housing and milking systems is shown in Table 8.

Table 8: **QUANTITIES OF WASHING WATER USED FOR ALTERNATIVE COW-HOUSING AND MILKING SYSTEMS**

SYSTEM	METHOD	GALLONS PER COW PER DAY	GALLONS PER 50 COWS PER DAY
Cowshed	Buckets	3 - 4	150 - 200
Cowshed	Power-House	12	600
Yards	Bucket	4 - 5	200 - 250
Yards	Power-House	12 - 15	600 - 750
Parlours	Buckets	-	50
Parlours	Power-House	-	200

Source: James (1981)

Assuming the use of Power-House for total cleaning, not just for washing down after removal of solid manure by other means, if the washing contain quantities of dung or urine, they should not be allowed to run directly into a ditch or water course. It may be possible to take them to a soaking or to a combination of settling tank and soak-away. If the manure is going to be handled in liquid form, they may be added to the main bulk of manure collected from the cows. A decision must depend on individual farm circumstances. Agricultural wash down water is classed as trade effluent for the "purposes of the rivers (Prevention of Pollution) Acts.

- (ii) **Beef Cattle and Poultry :** Only the wash down is likely to arise with

yarded beef cattle or with poultry are the occasion of a major clean out.

- (iii) **Pigs:** Some systems of pig housing use a minimum of straw bedding and this allows a discharge of effluent from the houses and manure store. This discharge can be greatly reduced by ensuring that the drinking appliances do not leak. The effluence from these buildings is highly polluted and should not be discharged directly to a water course. The effluent should be returned to the land or taken to a blind ditch system or barrier ditch system.
- (iv) **Other Clean Water :** The remaining main source of water is from milk coolers and will usually amount to about three gallons per gallon of milk cooled. Thus 50 cows averaging 900 gal per cow will add a further 500 gal of water per day. Plans must be made to exclude this water from the dung-urine mixture unless it is required for dilution purposes. It can often be re-used for cattle drinking or for washing down. The addition of clean waste water can be beneficial where agreement has been reached to discharge treated effluent to a stream. In such cases, entry to the flow should normally be made below the treatment point. (Ministry of Agriculture, 1973).

CHAPTER THREE

METHODOLOGY

3.1 DESCRIPTION OF STUDY SITES

The Teaching and Research Farms of the Federal University of Technology, Akure, (FUTA), the Federal College of Agriculture, Akure (FCAA), Jofa Farms, Irese, Fembo Nigeria Limited (Distillers of Ethanol) were the study sites visited for agricultural waste and water sampling analysis. FUTA, FCAA and JOFA Farms are located at Ilesha, Owo and Irese roads, respectively. Each occupies about six hectares of land. In all the farms, livestock wastes (effluents) are packed and deposited at 150, 250 and 200 metres away from FUTA junior Staff Quarters, FCAA Lecture rooms and offices and Jofa Store and offices, respectively. Table 15 shows the particulars of each of the farm in relation to numbers of livestock.

Table 9: PARTICULARS OF EACH OF THE FARM IN RELATION TO NUMBERS OF LIVESTOCK

S/NO.	LIVESTOCK	FUTA FARM	FCAA FARM	JOFA FARM
1.	Cattle	19	34	-
2.	Sheep	29	11	-
3.	Pigs	11	63	-
4.	Goats	6	6	-
5.	Poultry	700	1,350	22,000

Fembo Nigeria Limited (Distillers of Ethanol) is located at Kilometre four, Old Ondo Road, Akure. It has an effluent drainage system which include two pits, where the effluents are controlled before they are discharged into the nearby stream. Fembo Nigeria Limited occupies about ten hectares of land, to be developed for further operations in future. Its operations include, yeast preparation, fermentation process, distillation and rectification or cleaning of crude ethanol. Waste collection methods at FUTA, FCAA and JOFA include, manual scraping, free fall and flushing. Manual scraping involves moving the waste deposited by the livestock into an open field very close to the livestock house with the aid of scraper which consists of a flat metal plate that is pushed or pulled along

the floor for the purpose of moving (scraping) the loose materials lying on the surface. Free fall collection used by FUTA, FCAA and JOFA is accomplished by allowing their poultry waste to pass through a screened floor and to be deposited in a collection pit for final disposal. Flushing method involves cleaning poultry and piggery houses with the help of flushing gutters that were made to carry the waste. Fembo Nigeria Limited uses flushing method of collection to discharge their effluents (Molasses and washing water) through the drainage gutter to the pits and final deposition into the nearby stream.

Data gathered from questionnaires distributed to the management of the establishments visited are summarised in Table 10.

Table 10: SITUATION REPORT OF FARMS AND FEMBO NIGERIA LIMITED INVESTIGATED

	FUTA FARM	FCAA FARM	JOFA FARM	FEMBO NIG. LIMITED
Year Of Operation	13	41	6	6
Staff Strength	10	18	44	22
Types of Wastes Produced	Solid, Liquid Waste	Solid and Liquid Waste	Solid and Liquid Waste	Liquid Waste (Sludge or Vannase)
Names of Wastes Produced	Dungs, Fur, Bones and Feathers	Farmyard manure, bones, feathers and blood	Farmyard manure and feathers	Sludge (Vinnase) and Washing Water
Waste Source	Cattle, Sheep, goat, Pigs and Poultry	Farm Livestock	Poultry Birds	Molasses Distillation, Yeast and Fertilizer
Product From Waste	Beef, Mutton, Goat Meat, Pork, Chicken and Eggs	Beef, Chicken, Mutton, and Eggs	Chicken and Eggs	Ethyl Alcohol
Waste Handling Method	Collection, Packing and Deposition in an open field	Collection, Packing and deposition in an open field	Collection, Packing and deposition in an open field	Drainage and Pits Methods
Nuisance By Waste	Flies, Odour and Mosquitoes	Flies, Odour and Mosquitoes	Flies, Odour and Mosquitoes	Flies, Odour and Mosquitoes
Use of Receiving Stream	For domestic purpose	For Fish Pond Purpose	For Fish Pond Purpose	For Domestic Purpose
Importance of The Waste	Used as Fertilizers	Used as Fertilizers	Used as Fertilizers	Used as Fertilizers

3.2 SAMPLE COLLECTION

Samples of livestock waste were collected from FUTA, FCAA and JOFA Farms randomly for five consecutive times. Collected wastes were mixed up properly before laboratory analysis were carried out in order to determine Agricultural Waste parameters (such as dissolved oxygen, Biochemical oxygen demand, Nitrite, Nitrate, pH, Phosphorus, Total organic matter etc.) present in the samples, Fig. 4 below shows the collection procedures. Also collection of effluents (i.e. Sludge and washing water) generated by Fembo Nigeria Limited was achieved by putting bucket at the discharge point of the effluents, that leads to the drainage channel. Fig. 5 below shows the collection methods.

Raw material used for the production of ethanol (i.e. Molasses) is a waste (effluent) produced at Bacita Sugar Company, Jebba. Some quantity was collected for laboratory analysis. To determine the effect(s) of the parameters on the receiving stream, near Fembo Nigeria Limited, water samples were collected at both up and down stream for laboratory analysis as shown in Fig. 6. Some of the collected samples were filtered for laboratory analysis.



Fig. 4: Collection Procedures of Livestock Waste



Fig. 3: Collection Method of Fembo Nigeria Limited

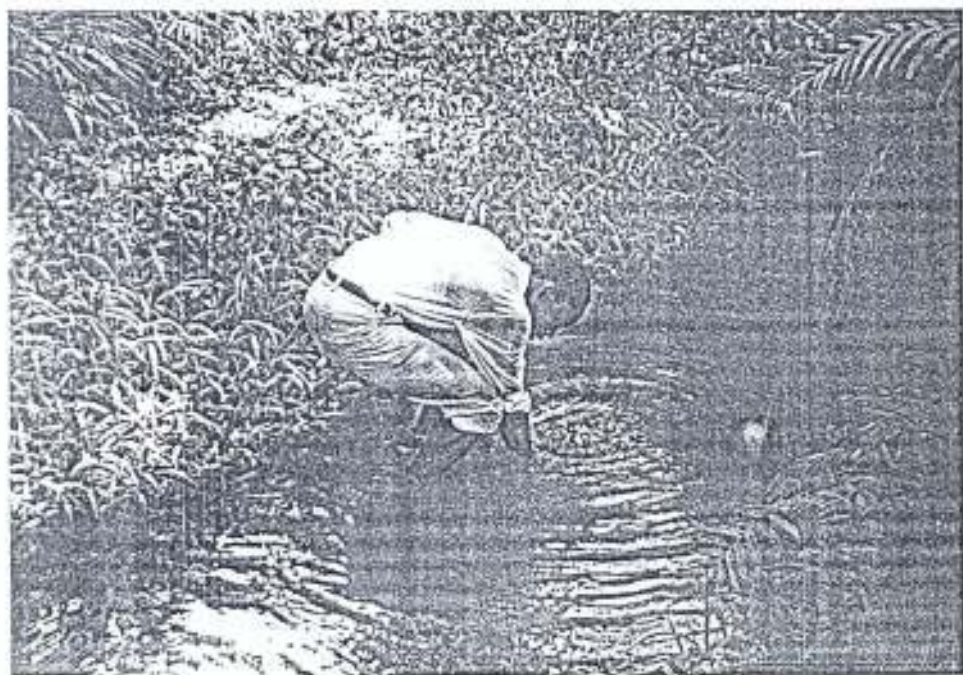


Fig. 6: Collection of Water Samples from the Receiving stream for Laboratory Analysis.

3.3 LABORATORY ANALYSIS OF AGRICULTURAL WASTE PARAMETERS.

Collected samples from FUTA, FCAA and JOFA Farms and Fembo Nigeria Limited were analysed in order to determine the impact of parameters present in the livestock wastes on environment. Pollution level of the stream near Fembo Nigeria Limited was put into consideration during the laboratory analysis.

Chloride Determined: Chlorides were determined using Palintest method. The Palintest Chloride test uses a tablet reagent containing a standardized amount of silver nitrate and potassium chromate as indicator. The test was carried out by adding tablets, one at a time, to a sample of effluent until the colour changed from yellow to brown. The result was calculated from the number of tables used in relation to the volume of the effluent sample taken.

Ammonia analysis: Ammonia laboratory analysis was determined using Palintest method. It was based on a Salicylate in the presence of chlorine to form a green-blue indophenol complex. Catalysts were incorporated to ensure completed and rapid colour development. The reagents are provided in the form of two tablets for maximum convenience. The test was simply carried out by adding one of each tablet to a sample of the water. The intensity of the colour produced in the test was proportional to the ammonia concentration. The colour was measured by comparison against colour standards using a Palintest comparator and disc.

Nitrite Determination: Palintest method was used for the determination of Nitrite (Nitricol). Nitrites in acid solution reacted with sulphanilic acid. The resulting diazo compound couple with N - (I - naphthyl) - ethylene diamine to form a reddish dye. The Palintest Nitrocol method featured a single tablet reagents containing both of these reagents in an acidic formulation. The test was simply carried out by adding

a tablet to a sample of the effluent under test. The intensity of the colour produced in the test is proportional to the nitrite concentration. The colour was measured by comparison against colour standards using a Palintest comparator and Disc.

Nitrate Determination: Nitrate (Nitratetest) was determined using Palintest Nitrates Method, Nitrate was first reduced to Nitrite, the resulting nitrite was then determined by a diazanium reaction to form a reddish dye. The reduction stage was carried out using the unique Zinc-based Nitratetest power, and Nitratetest Tablet which aids rapid flocculation after the one minute contact period. The test was conducted in a special Nitratetest Tube - a graduate sample container with hopper bottom to facilitate settlement and decanting of the sample. The

Nitrite resulting from the reduction stage was determined by reaction with Sulphanilic acid in the presence of N - (1-naphthyl) - ethylene diamine to form a reddish dye. The reagents were provided in a simple Nitricol tablet which is simply added to the test solution. The intensity of the colour produced in the test was proportional to the nitrate concentration and was measured by comparison against colour standards using a Palintest comparator and Disc.

Hardness determination: Hardness was determined using the Palintest hardness method. The test provides a simple method of checking effluent hardness. It uses a tablet reagent containing a standardised amount of EDTA

(ethylenediamine tetra acetic acid) with eriochrome black as indicator. The test was carried out by adding tablet, one at a time, to a sample of water until the colour changes from plum red to blue. The result was calculated from the number of the tablets used in relation to the volume of water sample taken. **Temperature, Conductivity, Turbidity and Salinity Determination:**

Water quality checker U - 10 machine was used for the determination of temperature, conductivity, turbidity and salinity level during laboratory analysis. 9071

Do₂ Metre was used for the determination of dissolved oxygen and Biochemical oxygen demand in the effluents. pH was determined with the aid of machine called pH Mettler Toledo. Graphimetric method was used for the determination of total suspended and total dissolved solids respectively. Moisture content was determined using the following relation:

$$\% \text{ Moisture Content} = \frac{\text{Loss in weight}}{\text{Weight of sample before drying}} \times 100$$

$$\% \text{ M.C} = \frac{W_2 - W_3}{W_2 - W_1}$$

where, W_1 = Weight of a clean weighing dish

W_2 = Weight of Sample and Dish

W_3 = Weight of Oven dried sample, cooled for about one hour

% M.C. = Percentage of Moisture content.

Nitrogen Analysis: Nitrogen was determined using a standard method that involved complete digestion of effluents using Electro Mantle digester, distillation of effluents with the aids of 2% borid acid (H_3BO_3), 0.198g bromocresol, 0.132g methyl red in 200 ml alcohol and 40% NaOH and tritration and calculation stage. Nitrogen was calculated using the following relation:

$$\% \text{ Nitrogen} = \frac{M \times T \times 0.04}{W} \times \frac{V_1}{V_2} \times 100$$

Where, M = Molarity of Acid

T = Titre Value

V_1 = Volume of Digest

V_2 = Volume of Digest Used

W = Weight of Sample

Phosphorus Determination: Phosphorus was determined using spectrophotometric analysis method (Vandodo Molybdate method). Phosphorus was calculated using the following relation:

$$\% P = \frac{A \times FV \times D}{\dots}$$

Where,

Wt

- A = concentration of sample as obtained from graph
FV = Final volume of sample extract or digest weight of samples used.
D = Dilution Factor
P = Phosphorus
Wt = Weight of sample

Organic Matter Determination: Organic matter (Total Organic Carbon) were determined using ash method procedure that involved the use of Muffle furnace. The mathematical relation below is used for the calculation of organic matter.

$$\% \text{ Ash} = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

$$\% \text{ Organic matter} = 100 - \% \text{ Ash}$$

- Where : W_1 = Weight of Empty Crucible
 W_2 = Weight of Crucible Plus Sample
 W_3 = Weight Crucible Plus Ash

Finally, metals such as Iron, magnesium, calcium, sodium, Potassium, and zinc were determined by Atomic Absorption spectrophotometer (AAS) at the wave length listed below :

Metals	Wavelength (nm)
Iron	248
Magnesium	285
Calcium	422
Sodium	589
Potassium	766
Zinc	214

It should be noted that all the methods of analysis were based on that set out by the "standard" methods for the examination of effluents from agricultural waste materials. (Ibitoye, 1995).

3.4 INSTRUMENTATION

The name range and accuracy of the various machines used for laboratory analysis are stated in Table 11:

TABLE 11 : INFORMATION ON VARIOUS MACHINES USED FOR ANALYSIS

S/NO	INSTRUMENT	PARAMETRES	RANGE	ACCURACY
1.	9071 DO, Metre	Dissolved Oxygen	0 - 19.9 mg/l	± 2% Full Scale Range
2.	9071 DO, Metre	Biochemical Oxygen Demand	0 - 19.9 mg/l	± 2% Full Scale Range
3.	9071 DO, Metre	Temperature	0 - 50C	± 0.3 C
4.	Water Quality Checker U - 10 Machine	Conductivity	0 - 100 mS/cm	± 1% Full Scale Range
5.	Water Quality Checker U - 10 Machine	Turbidity	0 - 800 NTV	± 3% Full Scale Range
6.	Water Quality Checker U - 10 Machine	Salinity	0 - 4%	± 0.1%
7.	pH Mettle Toledo	pH	0.00 - 14.00 pH	pH ± 0.01
8.	Electromante Range	Nitrogen	-	± 2%
9.	Muffle Furnace	Ash	-	± 1%

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 WASTE CHARACTERISTICS

In Tables 12-14 and Figures 7-12 are detailed the characteristics of wastes examined during this study. The results show that Total Organic Carbon (TOC) was generally high in all the wastes examined. The average organic matter for pig, cattle, sheep and goat, and poultry were 74%, 78%, 90% and 68% respectively. For Fembo Nigeria Limited and Bacita Sugar Company effluents however, the organic matter were 98.4% and 94.1% respectively. The Biochemical Oxygen Demand (BOD) which is an indication of the amount of oxygen required by bacteria to stabilize decomposable organic matter under aerobic conditions are generally high, ranging from 500mg/l to 710mg/l. Also, average dissolved oxygen of 1.4mg/l, 1.1mg/l, and 1.2mg/l were obtained from pig, cattle, sheep and goat and poultry wastes respectively. In addition, dissolved oxygen for Fembo Nigeria Limited and Bacita Sugar Company are 4.2 and 1.4mg/l respectively.

Results also show that the nature of hardness in the waste, with average Hardness in the range 100.5 - 200.5 mg/l respectively. It was discovered that Nitrate and Nitrite levels in the effluents was low and might not cause severe problem for receiving streams. Percentage nitrogen determined from the collected samples were small in quantity. Salinity was evaluated in order to assess the level of salinization of the effluents and to identify whether the waste can be used for irrigation purpose(s). The range of pH levels of 7.4 to 8.2 was obtained. This indicates using the waste for irrigation purpose(s) may not affect the salinity of the soil and the corrosion of irrigation pipe is limited since the waste has pH levels that is slightly acidic.

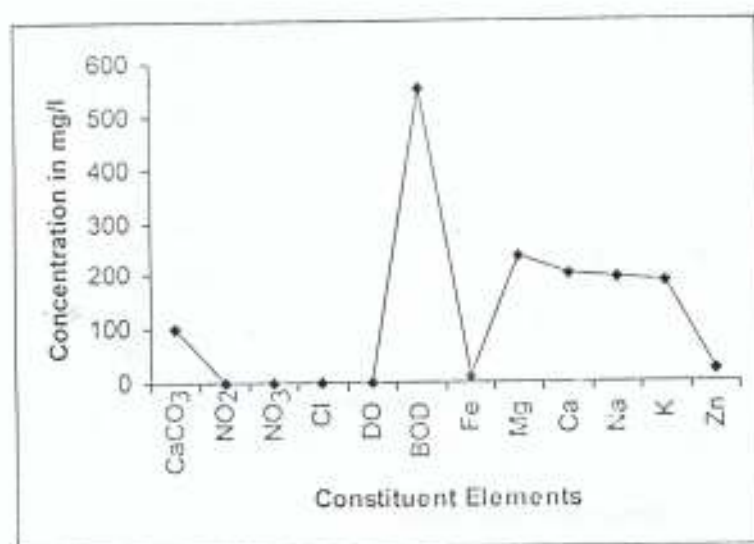


Figure 7: Characteristics of Pig Waste

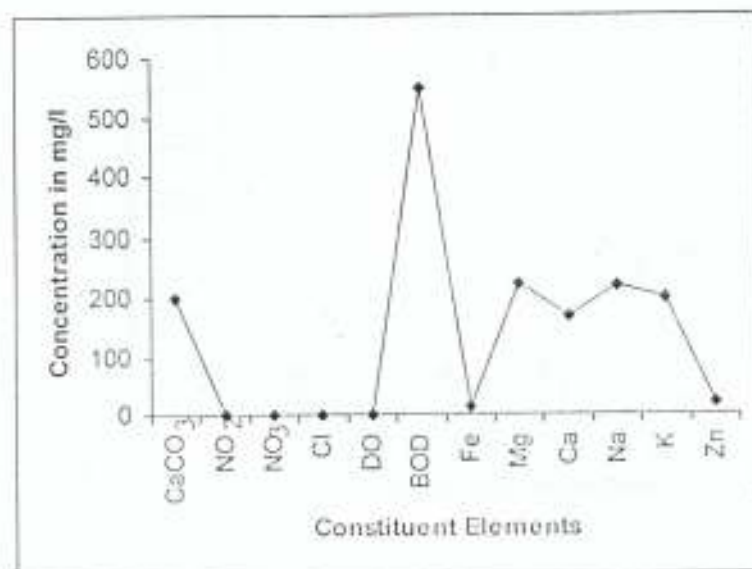


Figure 8: Characteristics of Cattle Waste

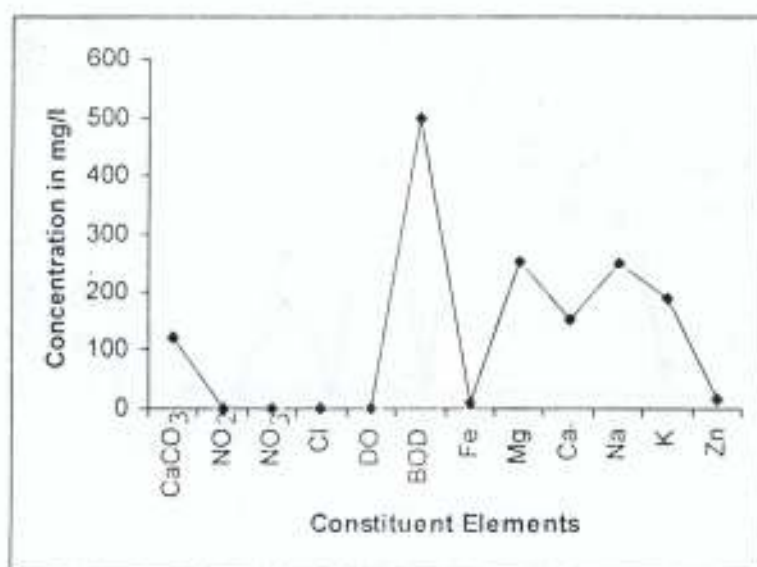


Figure 9: Characteristics of Sheep and Goat Waste

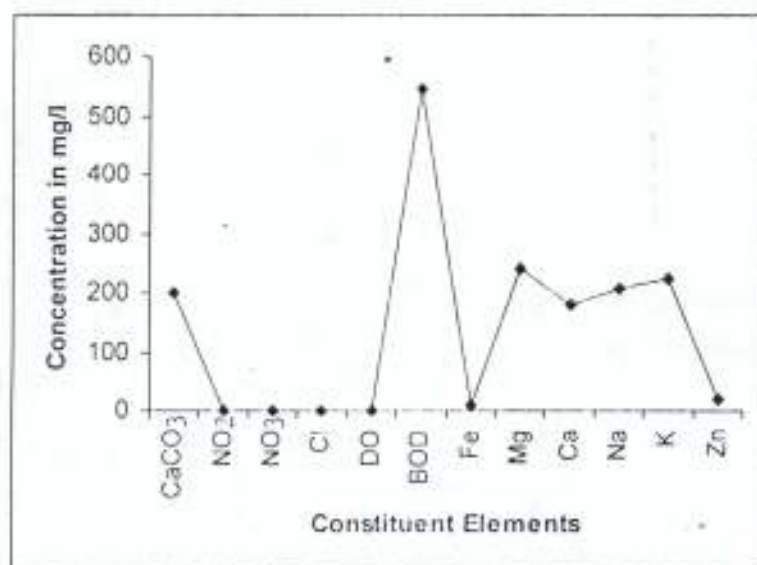


Figure 10: Characteristics of Poultry Waste

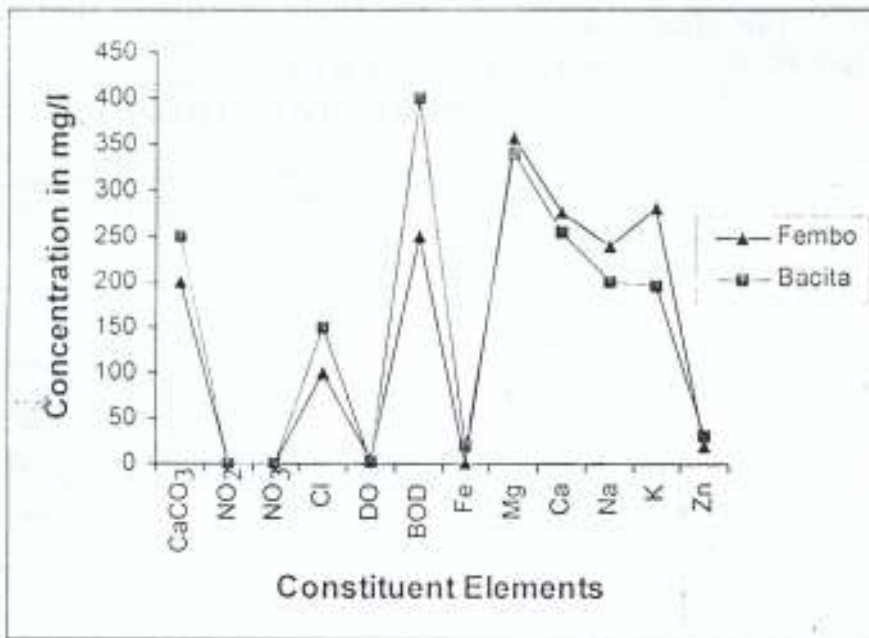


Figure 11: Characteristics of Fembo and Bacita Waste

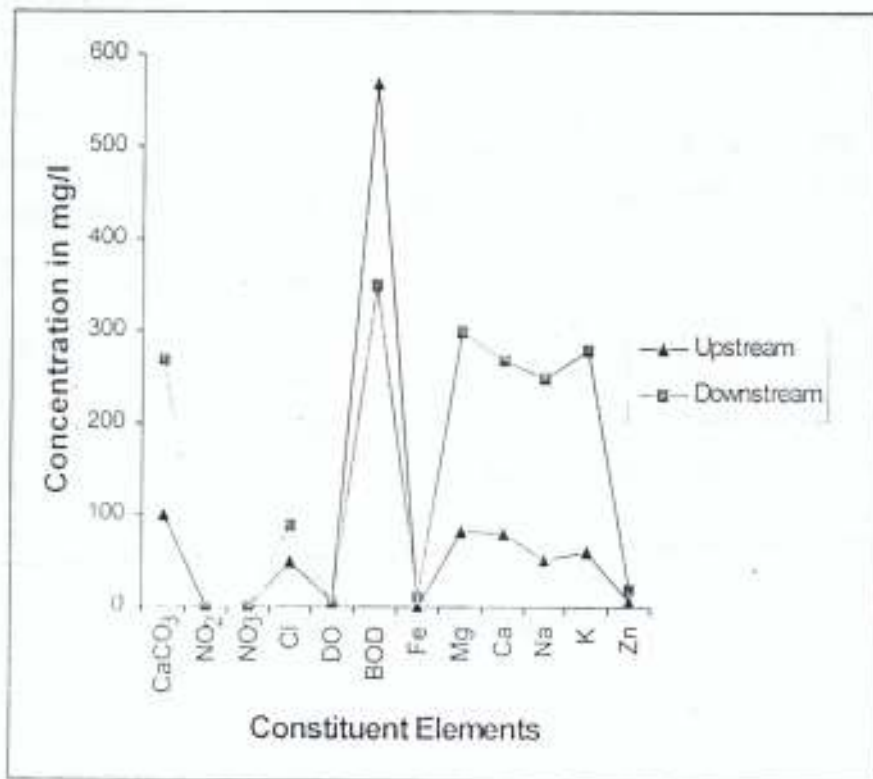


Figure 12: Characteristics of Fembo Waste on Receiving Stream

TABLE 12: CHARACTERISTICS OF PIG, CATTLE, SHEEP AND GOAT, AND POULTRY WASTES IN SOME SELECTED FARMS, AKURE, NIGERIA. CONCENTRATION IN mg/l EXCEPT WHERE OTHERWISE NOTED

CHARACTERISTIC S	PIG		CATTLE		SHEEP AND GOAT		POULTRY		
	FUTA FARM	FCAA FARM	FUTA FARM	FCAA FARM	FUTA FARM	FCAA FARM	FUTA FARM	FCAA FARM	JOFA FARM
Ammonia	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hardness	100	101	200	200.7	120	120.1	200	200.8	200.6
Nitrite	0.40	0.37	0.17	0.15	0.20	0.23	0.14	0.13	0.12
Nitrate	0.90	0.92	0.49	0.50	0.59	0.60	0.50	0.51	0.49
pH Value	8.1	8.1	8.1	8.1	8.2	8.2	8.1	8.1	8.1
Dissolved Oxygen	1.3	1.4	1.1	1.0	1.0	0.9	1.3	1.0	1.4
Biochemical Oxygen Demand	500	600	500	600	400	200	500	530	610
Temperature (°C)	24.9	24.9	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Salinity (‰)	0.40	0.39	0.50	0.49	0.39	0.40	0.50	0.49	0.52
Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phosphorus (%)	0.04	0.05	0.05	0.06	0.02	0.03	0.10	0.14	0.11
Nitrogen (%)	2.61	2.64	2.25	2.24	2.10	2.03	2.61	2.80	2.90
Total Dissolved Solid	2561	2495	2136	2134	967	966	2861	2891	2879
Total Suspended Solid	200	210	240	235	110	100	305	309	307
Ash (%)	25.85	25.87	22.34	22.32	10.28	10.31	31.59	31.61	31.65
Moisture Content (%)	8.67	9.12	14.33	14.31	8.10	8.00	9.63	9.59	9.23
Organic Matter (%)	74.15	73.94	77.66	77.68	89.72	89.69	68.41	68.39	68.35
Fe	10.74 9.94		12.11	12.12	11.20	11.21	10.14	10.10	10.12
Mg	233.05	235.25	222.28	223.26	250.98	251.42	240.59	240.89	240.78
Cu	200.13	200.03	170.95	170.91	155.74	150.52	180.64	180.59	180.75
Na	192.27	191.92	220.13	220.14	250.27	250.29	205.67	205.78	205.59
K	185.71	184.05	200.92	200.94	190.18	190.15	222.18	222.15	222.19
Zn	20.76	21.05	21.63	21.61	18.19	18.16	19.35	19.35	19.39

ND - not detectable

The presence of phosphorus was linked to the use of detergent for cleaning purpose and application of urea or fertilizer used as yeast during production of ethanol. The concentration of Nitrogen, Potassium, Phosphorus also confirmed the possibility of agricultural waste being good source of nutrient for crop growth. Total dissolved solids and suspended solids were determined for all the samples. The variation in waste characteristic as detailed in Tables 12-14 could be attributed to a number of factors viz: variation in the quantity of water used in flushing and cleaning of faecal matter, livestock number, and waste handling system/techniques.

TABLE 13: EFFLUENT CHARACTERISTICS OF FEMBO NIGERIA
LIMITED CONCENTRATION IN mg/l EXCEPT WHERE
OTHERWISE NOTED.

CHARACTERISTICS	QUANTITY IDENTIFIED
Ammonia	ND
Hardness	200
Nitrite	0.60
Nitrate	1.00
pH Value	7.4
Temperature (°C)	24.0
Salinity (‰)	ND
Chloride	100
Phosphorus (%)	0.001
Nitrogen (%)	0.56
Dissolved Oxygen	4.2
Biochemical Oxygen Demand	250
Organic Matter (%)	98.4
Moisture Content (%)	97.3
Total Dissolved Solid	71
Total Suspended Solid	388
Ash (%)	1.7
Iron	0.6
Manganese	356.8
Calcium	275.9
Sodium	240.0
Potassium	280.1
Zinc	20.5

ND - not detectable



TABLE 14: EFFLUENT CHARACTERISTICS OF BACITA SUGAR COMPANY CONCENTRATION IN mg/l EXCEPT WHERE OTHERWISE NOTED.

CHARACTERISTICS	QUANTITY IDENTIFIED
Ammonia	ND
Hardness	250
Nitrite	1.0
Nitrate	1.0
pH Value	7.9
Temperature (°C)	24.7
Chloride	150
Salinity (‰)	ND
Phosphorus (%)	0.003
Nitrogen (%)	7.6
Dissolved Oxygen	1.4
Biochemical Oxygen Demand	400
Organic Matter (%)	94.1
Moisture Content (%)	27.9
Total Dissolved Solid	271
Total Suspended Solid	767
Ash (%)	5.9
Iron	20.2
Manganese	340.1
Calcium	255.1
Sodium	200.2
Potassium	195.2
Zinc	29.6

ND - not detectable

4.2 EFFECT OF AGRICULTURAL WASTE ON SOIL

The most economical and environmentally friendly way of disposing livestock wastes and dirty water is normally to apply it into agricultural land, to make the risk of water pollution as low as possible and get most from the nutrients. Although agricultural wastes improve the soil treatment when applied to the land, care must be taken to reduce the risk of polluting streams and groundwater. According to Maff environmental matter (1991), livestock waste and other organic wastes should not be applied within 50 metres of spring, well and borehole water source meant for human consumption, or to be used in farm dairies. The report noted that a longer distance may be needed in some cases.

Table 15 shows the permissible and the desirable criteria of some constituents or characteristics as required for soil and irrigation application.

Table 15: **CONSTITUENTS OR CHARACTERISTICS WITH PERMISSIBLE AND DESIRABLE CRITERIA**

CONSTITUENTS OR CHARACTERISTICS	PERMISSIBLE CRITERIA	DESIRABLE CRITERIA
Manganese	20 mg/l	< 2.0 mg/l
pH range	4.8 - 9.0	
Zinc	10.0 mg/l	< 10.0 mg/l
Nitrate Plus Nitrite (as N)	20 mg/l	< 10 mg/l

Source: Guideline and Criteria for water quality management in Ontario, Ministry of the Environment, Toronto, Canada. 1967.

Comparing the results obtained from laboratory analysis, it is discovered that Manganese and Zinc obtained were higher than the permissible criteria with the highest manganese of 356.8 mg/l from Fembo Nigeria Limited waste and highest Zinc of 29.6 mg/l from Bacita Sugar Company. To this end, the application to soil or for irrigation purpose necessitate prior treatment to meet desirable criteria. The

highest pH value of 8.2 obtained for sheep and goat waste fell within the acceptable limit. As shown in Table 15 are their direct application to soil for irrigation based on those parameters will do harm to the soil and irrigation equipment. Gasser et al (1980) had earlier observed that livestock wastes increase soil pH. It was therefore suggested that pH of livestock wastes must be determined before their application for effective monitoring of pH level in the soil.

The utilization of agricultural waste as soil nutrient by recycling it back through the soil, has been indentified as relatively simple, yet positive method of agricultural waste management. The best method of applying agricultural waste back to the land is referred to as surface application with immediate plough - down or injection into the soil. This will help to control odours and also reduce the loss of Nitrogen caused by volatilization. The high metal content specially Iron, Manganese, Calcium, Sodium, Potassium and Zinc of 20.2, 356 - 275.9, 240.0, 280.1 and 29.6 mg/l, respectively in the waste suggest careful management and correct application in the soil to achieve the much desired rapid plant growth and improvement of soil tilth. Excess application, on the other hand would decrease crop yields, cause an unbalanced soil chemistry and contaminate growth and surface water supplies. The correct application rate can be determined by carefully considering the following factors reported by James (1981) and reproduced in Tables 16 and 17.

Table 16: ANNUAL FERTILIZER CONTENT FOR VARIOUS ANIMAL WASTES

LIVESTOCK	N(Kg)	P ₂ O ₅ (kg)	K ₂ O (kg)
Pig	102	107	124
Cattle	91	50	122
Poultry	102	202	129

Source: James, A. M. (1981)

Table 17: NUTRIENT UTILIZATION OF CROPS

Crop	N (kg/ha)	P ₂ O ₅ (kg/ha)	K ₂ O(kg/ha)
Corn	208	90	240
Soyabeans	288	54	135
Wheat	140	56	124
Oats	170	62	170
Barlay	120	62	170
Alfalfa	505	90	170
Orchard Grass	337	112	421
Brome Grass	186	74	285
Tail fascue	157	73	208
Blue grass	225	62	202
Corn silage	225	90	275
Grain Sorghum	280	100	275

Source: James, A.M. (1981).

Application of agricultural wastes also involve the climatic condition characterized by rainfall, temperature and wind. These have significant effect on the chemical reaction and movement of wastes (nutrients) in the soil. Excessive amount of rainfall can cause leaching of the nutrient from the soil. Run-off may result in

pollution of ground and surface water supplies. Low rainfall rates can result in the accumulation of salt in the upper soil zone, reducing crop yield and disturbing the soil structure. Care must be taken in applying high sodium, manganese, calcium and potassium in wastes to soil because salts of sodium, potassium and lead to soil dispersion while sodium, potassium, calcium and manganese salts contributes to the salinity hazard. It is also better to apply agricultural wastes to the land at high temperature because high temperature stimulates plant growth and increases the microbial activity in the soil.

The physical properties of the soil including: texture, water holding capacity, infiltration rates and total exchange capacity must be considered before application of agricultural wastes to the soil. This will help to prevent leaching of nutrients from the soil, reducing its fertilizer value and possibly, contaminating groundwater supplies. Tight soils have slow intake rate and therefore retain more nutrients in the upper soil profile. Because of the slow intake rates, application rates of agricultural wastes should be carefully monitored to prevent run off from occurring.

4.3 IMPACT OF AGRICULTURAL WASTES ON RECEIVING STREAM

The condition of the stream receiving Fenbo Nigeria Limited waste is as shown in Table 18 and Fig. 12. When the characteristics of the stream before and after the discharge of effluent are compared, pollution by effluents appear to be severe with respect to concentration. Table 19 shows the water quality criteria for public surface water supplies, as recommended by the World Health Organisation (1971). This table was abstracted for comparison purposes.

Table 18: **CONDITION OF THE STREAM NEAR FEMBO NIGERIA LIMITED CONCENTRATION IN mg/l WHERE OTHERWISE NOTED**

CHARACTERISTICS	CONDITION AT UP STREAM	CONDITION AT DOWN STREAM
Ammonia	ND	ND
Hardness	100	270
Nitrite	0.02	0.52
Nitrate	0.03	1.00
Temperature (°C)	24.0	24.0
Salinity (‰)	ND	ND
Chloride	50	90
Dissolved Oxygen	6.5	4.5
B . Oxygen Demand	570	350
Organic Matter (%)	63	50
Moisture Content (%)	99.93	99.96
Total dissolved solid	102	224
Total suspended	60	100
Turbidity	10	15
Ash (%)	37	50
Nitrogen (%)	0.06	0.09
PH Value	6.4	8.2
Phosphorus (%)	5	9
Fe	0.65	10.34
Mg	82.1	300.3
Ca	80.7	270.4
Na	53.1	250.2
K	60.6	280.2
Zn	7.1	18.8

ND - Not detective.

Table 19: WATER QUALITY CRITERIA FOR PUBLIC STREAM
(CONCENTRATION IN Mg/l UNLESS OTHERWISE STATED)

CONSTITUENT CRITERIA	PERMISSIVE CRITERIA	DESIRABLE CRITERIA
Temperature	29°C	Pleasant Tasting
Calcium	200	75
Chloride	250	< 25
Hardness	500	500
Iron	0.01	1.0
Manganese	0.05	Absent
Nitrate Plus Nitrite	10.00 (as N)	Virtually absent
pH range	6.0 - 8.5 units	
Phosphorus (Phosphate)	Not encouraged	
	It stimulates growth	
	Of algae which interfere	
	With treatment process	
Sodium	200	50
Zinc	5.0	Virtually absent
Turbidity	7	5

Source: WHO (1971)

The presence of metals (specifically Calcium, Iron, Manganese, Potassium, Sodium and Zinc) at high concentration beyond permissible and desirable criteria, was an indication that effluents of Fembo Nigeria Limited require treatment before discharge into nearby stream. It is also advisable to educate the people who are using the stream for domestic purposes to avoid it, because some of these metals though essential for life at low concentrations are toxic at higher levels.

The results also shows reduction in dissolved oxygen at the down stream and

after the discharge of effluents into the stream (i.e 6.5 mg/l to 4.5 mg/l). The depletion of dissolved oxygen is an indication of the synthesis of the high organic waste as it is passed into the stream and a possibility of pollution. The Ministry of the Environment, Toronto (1967) report noted that when the level of DO are low in stream, problems will occur in photosynthetic activities. Low DO can also cause septicity and corrosion. Comparison of Biochemical Oxygen Demand (BOD) obtained during laboratory analysis as shown in Table 18 and Figure 12, with the standard required by Higgen and Burns (1975). in Table 20 revealed that the stream is polluted. This calls for improvement of this stream before usage by man and animals. The pH value, Nitrite, Nitrate, Chloride and Hardness obtained from laboratory analysis of Fembo Nigeria Limited waste, when compared water quality criteria for public stream in Table 19 shows that the parameters mentioned above fall in between permissive and desirable criteria.

Table 20: CLASSIFICATION OF STREAMS ACCORDING TO BOD

QUANTITY CLASS	BOD(O_2 ABSORPTION IN mg/l PER 5 DAYS
Very Clean	1
Clean	2
Fairly Clean	3
Doubtful	5
Polluted	10



Source: Higgen and Burns (1975)

4.4 AGRICULTURAL WASTE TREATMENT AND RE-USE

In all the establishment visited, there are no record of waste quantity, and no treatment of any kind is administered to the waste before disposal. Therefore, suggestion of the following environmentally acceptable agricultural waste disposal methods and treatments that are suitable to the field observation are stated below:

4.4.1 STORAGE PIT

Storage pit method of agricultural waste treatment is one of the methods which FUTA, FCAA and JOFA Farms visited can use for waste treatment because, it is possible to store Agricultural waste in storage pit (such as large underground tanks or earthen ponds) until such time that it can be field spread as a fertilizer and soil conditioner. James (1981), reported that the facility is highly effective as waste management system where flushing gutters, are used as a means for collection and transportation.

Therefore, it is one of the suitable method of Agricultural waste treatment that can be used in FUTA, FCAA and JOFA Farms because of the presence of flushing gutters as means of collection and transportation of wastes in the farms visited. Also the availability of land in the farms make the method suitable to them. The use of earthen pond for storing agricultural effluents is encouraging due to its relatively low cost when compared to other systems. Earthen pond is easy to maintain and structure becomes obsolete (James, 1981).

4.4.2 STABILIZATION PONDS

Waste stabilization ponds are particularly well suited for the treatment of agricultural wastes which are high in organic matter or total dissolved solids (James, 1985). From the results obtained in Tables 12-14, it was discovered that organic matter and total dissolved solids of the samples analysed range between 68.4 to 98.4 percent and 71 - 2,561 mg/l respectively. It is then justified to use waste

stabilization ponds as system of agricultural wastes treatment. The method is also economical and requires very little attention. The mean pH of the wastes analysed is 8.0, it is within the pH level of 7.5 to 8.5 stipulated by Oswald (1968) in his report on level of pH required for effective performance of waste stabilization ponds. Cooper et al (1965), reported that if pH falls below 6.7, odour production increases rapidly. It can be corrected by adding hydrated lime at the rate of 0.005kg per 1000m² of pond surface.

4.4.3 ACTIVATED SLUDGE PROCESSES

According to James, (1981), activated process, when properly designed and operated are free from offensive odours and are capable of producing clear, non putrescible effluent with reduction in settleable solids and BOD₅ levels of 90% or better. Since the motive behind treating agricultural wastes in this study include those things stated in James (1981) report above, the method if applied to agricultural effluents treatment in the establishments visited will go a long way in environmental protection, as a result of reduction in range of settleable solids (71 - 20891mg/l) and Biochemical Oxygen demand of 200 to 610mg/l. The method has ability to control the degree of treatment and the flexibility of effluents quality with varying strength. Pasveer, (1963), stated that, when properly designed, activated sludge can achieve BOD removal as high as 95%. Hence since the removal of BOD causes reduction or removal of nuisance the waste generated, the method is better specially for FUTA, FCAA and JOFA farms, in order to ameliorate nuisance created by Agricultural wastes in their environment.

4.4.4 ANAEROBIC DIGESTION

With anaerobic digestion, there is reduction in bulk of Agricultural wastes requiring ultimate disposal, conversion without creating air pollutants, and the production of valuable by-products in form of:

- i. methane gas as a source of energy.
- ii. a stable sludge as a source of fertilizer and soil conditioner.

The above make the method suitable for agricultural effluents treatment for all the establishments surveyed. If implemented, there is assurance of environmental protection of their various locations. The range of temperature obtained (24° - 25°C) during the samples analysis in Table 12 - 14, falls in between temperature of 20° - 50°C recommended by Maly and Fedrus (1971) and makes the method acceptable for agricultural waste treatment. The pH range of 7.4 to 8.2 obtained in the results, meet up with effective pH range of 7.0 and 9.2 reported by James (1981). If any one of these environmental control parameters is suddenly altered, the digester becomes imbalanced and the gas production may be severely reduced or stopped completely (Mohanrao, 1974).

4.4.5 COMPOSTING

The method is fit for Agricultural waste treatment because the pH of 7.4 - 8.2 obtained from the samples analysed are within the guide level of 6.0 - 9.0 reported by James (1981), for better performance. Composting method of treatment can handle high total dissolved solid and organic matter wastes such as Agricultural wastes studied in this work.

The suggested methods of Agricultural wastes treatment above can be applied to wastes or effluents treatment, but the choice now based on establishment concern, waste characteristics, quantity of waste or effluent generated, available space and cost availability.

4.4.6 RE-USE

The re-use of Agricultural wastes serves as another means of waste treatment and management. Therefore, various Agricultural wastes studied can be re-used as follows:

- i. Utilization as a soil nutrient by the farmers that have their farms very close to the investigated establishments.
- ii. From the study conducted it was stated that poultry wastes are used for feeding fish in FUTA, FCAA and JOFA fish ponds. Also, outsiders owning fish pond were usually coming to the farms to collect the wastes as feed for their fish.
- iii. Application of the waste to the land as manure is highly practised in FUTA, FCAA and JOFA farms. Fembo Nigeria Limited wastes, is not left out.
- iv. Fembo Nigeria Limited waste can be used for irrigation purposes, or sewage farming.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The result obtained from the study, revealed that Agricultural waste has effect on soil and receiving stream. Agricultural waste has high polluting strength with mean values of 174.1 mg/l of hardness, 97.5 mg/l of chloride, 76.4% of organic matter, 10.0 mg/l of iron, 247.5 mg/l of manganese, 190.2 mg/l of calcium, 206.6 mg/l of sodium, 202.7 mg/l of potassium, and 19.7 mg/l of zinc. The effluent has 8.0 as mean value of pH from the results obtained in the analysis. The laboratory analysis carried out confirms the pollution of receiving stream at the downstream and the presence of high concentrations of metals such as iron, manganese, calcium, sodium, potassium and zinc at the values of 10.34, 300.3, 270.4, 250.2, 280.2 and 18.8 in mg/l, respectively. The depletion of dissolved oxygen (DO) from 6.5 mg/l to 4.5 mg/l and reduction of biochemical oxygen demand (BOD) from 570 mg/l to 350 mg/l are further evidence of stream pollution.

As shown in the study, the method(s) used in all the establishment visited are not as standard as expected. This resulted into environmental nuisance which include: odour, flies and mosquitoes. These can be effectively managed if correct or accurate treatment(s) suggested in the study is applied to Agricultural wastes, with adequate attention. Though the Agricultural waste has its impact on environment, it is also beneficial to farmers as manure, feed for livestock, e.t.c. if properly managed and utilized.

Since the subjection of untreated waste to receiving stream which are sometimes used for domestic purpose is very high and human access to the stream is very difficult to control, it is thus necessary to check the effect of Agricultural waste on soil, stream and the environmental impact in general. To achieve this objective, the following recommendation are hereby made:

- i. Farms and industries that generate Agricultural wastes capable of damaging our environment should adhere strictly to the Federal Environmental Protection Agency (FEPA) regulations concerning Agricultural waste treatment principles.
- ii. All farm and industry staff and contractors on the farm and industry who handle, store use, spread or dispose of Agricultural wastes that could pollute water should know about the causes and results of water pollution.
- iii. All storage facilities for Agricultural waste should be regularly checked for leaks and damage.
- iv. Government should organise symposium and workshop for staff of farms and industries dealing with Agricultural waste through FEPA on how to treat and manage their wastes.
- v. Government should establish code of Good Agricultural practise for the protection of our environment with a highlight on the main risks of causing damage to the environment.
- vi. It is advisable not to apply Agricultural wastes as fertilizer to the fields likely to be subjected to flooding.
- vii. The grass surrounding the Lagoon should be closely mowed to prevent the breeding of flies and mosquitoes. Pesticides can be applied where this is a problem.

- viii. Agricultural wastes should not be applied to fields next to a water course, spring or borehole where the surface is severely compacted.
- ix. Proper maintenance and frequent inspection are essential if the Lagoon is to operate according to plans.
- x. Methanogenic bacteria are very sensitive to sudden temperature changes and therefore digestion temperatures should be maintained at a constant level to ensure operational stability.
- xi. Whenever possible, plough the waste under shortly after it is applied. This will help to prevent run off and eliminate odour problems.
- xii. Do not spread Agricultural waste on the fields, when the wind is blowing toward populated area.
- xiii. Residents should be advised not to make use of the waste effluent receiving stream for domestic purpose without treatment. They should be educated as to how water from the receiving stream could be treated before use.



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APPENDIX I

EVALUATION OF TREATMENT AND ENVIRONMENTAL IMPACT OF AGRICULTURAL WASTE IN ONDO STATE

SECTION A

1. Name and Address of the company or Farm:.....
2. Person interview and Rank:.....
3. Date of interview:.....
4. Establishment Date of the Company or Farm:.....
5. No. of Employees:.....

SECTION B

1. Types of waste produced by the Company or Farm:.....
2. Waste handling method(s):.....
3. Type of Raw Material used:.....
4. Product of the raw material:.....
5. Quantity of Waste available per hour:.....
6. The amount of space available for waste treatment at the site or company:.....
.....

SECTION C

1. Source of the waste:.....
2. Drainage plan (Yes or No):.....
3. Is the waste above (effluent) used for any purpose?
4. Any attempt to recycle the waste? (Yes or No)
5. What is the frequency of intermittent discharges?

SECTION D

Briefly state the environmental impact of the waste been generated.

.....
.....
.....

CHARACTERISTICS OF PIG WASTE (AVERAGE VALUE) IN mg/l

CHARATERISTICS	AVERAGE VALUE
CaCO ₃	100.5
NO ₂	0.8
NO ₃	0.9
Cl	ND
DO	1.4
BOD	550
Fe	10.3
Mg	234.2
Ca	200.1
Na	192.1
K	184.9
Zn	20.9

ND - not detectable

APPENDIX IIB

CHARACTERISTICS OF CATTLE WASTE (AVERAGE VALUE) IN mg/l

CHARATERISTICS	AVERAGE VALUE
CaCO ₃	200.4
NO ₂	1.01
NO ₃	0.5
Cl	ND
DO	1.05
BOD	550
Fe	12.1
Mg	222.8
Ca	170.9
Na	220.1
K	200.9
Zn	21.6

ND - not detectable



APPENDIX IIC

CHARACTERISTICS OF SHEEP AND GOAT WASTE (AVERAGE VALUE) IN mg/l

CHARATERISTICS	AVERAGE VALUE
CaCO ₃	120.1
NO ₂	0.9
NO ₃	0.6
Cl	ND
DO	1.0
BOD	500
Fe	11.2
Mg	251.2
Ca	153.1
Na	250.3
K	190.2
Zn	18.2

ND - not detectable

APPENDIX IID

CHARACTERISTICS OF POULTRY WASTE (AVERAGE VALUE) IN mg/l

CHARATERISTICS	AVERAGE VALUE
CaCO ₃	200.5
NO ₂	1.0
NO ₃	0.5
Cl	ND
DO	1.2
BOD	546.7
Fe	10.1
Mg	240.8
Ca	180.7
Na	205.7
K	222.2
Zn	19.4

ND - not detectable

