

**SURVEY ON MANURE MANAGEMENT AND EVALUATION OF EFFICACY
OF INDIGENOUS MICROORGANISM IN MANURE DECOMPOSITION**

BY

PAULO HENRY SILAS MSANGI



**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN RURAL
DEVELOPMENT OF SOKOINE UNIVERSITY OF AGRICULTURE.
MOROGORO, TANZANIA.**


ABSTRACT

Agriculture provides rural and urban dwellers with extra income, food and offer employment to family members. However, intensive livestock raising is associated with concentration of manure a source of bad odour and threat to surface and ground water. Proper utilization of manure also requires adequate knowledge on handling, storage and application. Two studies were conducted; to survey on manure management at Mvomero district and to evaluate the efficacy of native bacteria (Indigenous Microorganism) in manure management. In study one a structured questionnaires, focus group discussion and physical observation were used. Thirty two dairy farmers were purposively selected and interviewed. Data collected were analyzed using SPSS (11.5) computer software. Study two was an experiment used to evaluate efficacy of different substrate sources for culturing indigenous microorganism (IMO), used on animal manure decomposition. To activate the native bacteria, ½ kg of three protein sources that are Moringa leaves, Leucaena leaves and Fishmeal and a combination of one kg of two energy sources (Cassava and Molasses) were used. Samples of cattle and pig manure were collected and subjected into sensory test. At the same time fifty samples of cattle manure were collected and sent to laboratory for determination of N, P, K and organic carbon. Data obtained were statistically analyzed using SAS (2004) computer software. Survey result showed that, there was under utilization of manure in the study area, due to a number of constraints. In study two, results showed that, there was no significant $P \leq 0.05\%$ difference on the quality of manure produced after being treated with IMO cultured using different substrate sources. Sensory test indicated that, there is significant difference at 0.05% and 0.01% on smell (odour emission) while there was no significant difference on texture. On the basis of these results, the use of IMO is recommended to improve manure

decomposition and reduction of bad odour emission. Furthermore, farmers should be educated on manure management to improve crop productivity.

DECLARATION

I PAULO HENRY SILAS MSANGI do hereby declare to the senate of Sokoine University of Agriculture that the dissertation is my own original work and has not been or concurrently being submitted for a higher degree award in any other university.

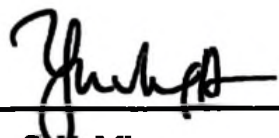


Paulo Henry Silas Msangi
(M.A. Candidate)

26 Nov. 2008

Date

The above declaration is confirmed:



Dr. S. H. Mbaga
(Supervisor)

26 NOV 2008

Date

ACKNOWLEDGEMENTS

I acknowledge with deep gratitude the help given to me by almighty Triune God for his guidance throughout my studies. I extend my thanks to the Ministry of Science, Technology and Higher Education for financial assistance through loan board for the whole period of my study.

Special thanks to my supervisor Dr. S.H. Mbaga for his tireless work in advising and guidance. It is his unforgettable work which made me to accomplish this work.

I am indebted to thank all workers of Department of Animal Science and Production for their tireless work in assisting me, my fellow students and all members of Development Studies Institute for their good cooperation.

I shall ever be grateful to my wife Anna Mchome whose help was of tremendous value to me, without her encouragement and support I could never have finish this work.

I sincerely thank my children who always prayed for me for the whole course, together with my relatives, friends and all who in one way or another contributed to completion of this work. May almighty Triune God bless them all abundantly.

DEDICATIONS

This work is dedicated to my beloved mother, the late Namwaka Silas Msangi and my beloved father Mr. Silas Paulo Msangi who without them I could not be where I am now. May God bless them.

COPYRIGHT

No part of this dissertation may be reproduced, stored in any retrieval system, or transmitted in any form or by any means without prior written permission of the author or Sokoine University of Agriculture in that behalf.

TABLE OF CONTENTS

ABSTRACT	ii
DECLARATION	iv
ACKNOWLEDGEMENTS	v
DEDICATIONS	vi
COPYRIGHT	vii
TABLE OF CONTENTS	viii
LIST OF TABLES	xi
LIST OF FIGURES	xii
LIST OF APPENDICES	xiii
LIST OF SYMBOLS AND ABBREVIATIONS	xiv
CHAPTER ONE	1
1.0 INTRODUCTION	1
1.1 OVERALL OBJECTIVE	3
1.2 SPECIFIC OBJECTIVES	4
CHAPTER TWO	5
2.0 LITERATURE REVIEW	5
2.1 ANIMAL MANURE	5
2.2 IMPORTANCE OF MANURE AS A FERTILIZER	6
2.3 LIVESTOCK AND SOIL FERTILITY	7
2.4 FACTORS INFLUENCING ANIMAL MANURE USE	7
2.5 MANURE USE IN RURAL AREA IN TANZANIA	8

2.6 URBAN AGRICULTURE	8
2.7 NUTRIENT CYCLING.....	9
2.8 WASTE COLLECTION AND DISPOSAL IN URBAN AREAS.....	10
2.9 THE USE OF NATIVE MICROORGANISMS AND ITS' CULTIVATION.....	10
2.10 COMPOSTING ANIMAL MANURE	12
2.10.1 Compost making.....	12
2.10.2 Important factors for manure composting	12
2.10.3 Decomposition of manure during storage.....	13
CHAPTER THREE.....	15
3.0 MATERIALS AND METHODS.....	15
3.1 LOCATION AND DESCRIPTION OF THE STUDY AREAS	15
3.2 STUDY 1: SURVEY ON THE GENERAL CONDITIONS OF LIVESTOCK KEEPING, ENVIRONMENT,.....	16
MANURE HANDLING AND UTILIZATION	16
3.2.1 The questionnaire administration.....	16
3.2.2 Focus Group Discussions (FGD).....	17
3.2.3 Physical observations.....	18
3.2.4 DATA ANALYSIS.....	18
3.3 STUDY 2: EVALUATION OF THE EFFICACY OF DIFFERENT SUBSTRATES SOURCES FOR CULTURING.....	18
INDIGENOUS MICROORGANISMS AND COMPARISON OF MANURE QUALITY UNDER	18
DIFFERENT IMO TREATMENT REGIMES.....	18
3.3.1 Study material	18
3.3.2 Collection and culturing of IMO	19
3.3.3 Measurements and data analysis.....	21
3.3.4 Sensory test.....	22

3.3.5 Descriptive analysis with scaling.....	22
CHAPTER FOUR.....	24
4.0 RESULTS AND DISCUSSION.....	24
4.1 SURVEY ON MANURE PRODUCTION, HANDLING TECHNIQUES AND UTILIZATION.....	24
4.1.1 Background of respondents	24
4.1.3 Source of income and labour.....	26
4.1.4 Livestock production	29
4.1.5 Livestock manure production and management.....	30
4.1.6 Gender and dairying.....	32
4.1.7 Manure disposal and utilization.....	34
4.2 THE EFFICACY OF DIFFERENT SUBSTRATES SOURCES FOR CULTURING INDIGENOUS MICROORGANISMS AND COMPARISON OF MANURE QUALITY UNDER DIFFERENT IMO TREATMENT REGIMES	37
4.2.1 Effect of treatments on decomposition of cow manure.....	37
4.2.2 Effect of treatments on sensory test.....	44
CHAPTER FIVE	50
5.0 CONCLUSION AND RECOMMENDATIONS.....	50
5.1 CONCLUSION.....	50
5.2 RECOMMENDATIONS.....	51
REFERENCES.....	52
APPENDICES.....	57
SECTIONB: MANURE MANAGEMENT	61
MANURE PRODUCTION	61

LIST OF TABLES

Table 1: Composition of fresh dung from different species of livestock	5
Table 2: Manure voided by different animals in kg/day	6
Table 3: Experiment to activate IMO.....	19
Table 4: Characteristics of the respondent	24
Table 5: Household characteristics of livestock keepers in Lusanga and Manyinga village.....	26
Table 6: Major source of income and labour.....	27
Table 7: Major crops cultivated by the farmer	27
Table 8: The acreages cultivated by each farmer for every crop	28
Table 9: Estimated crop production per hectors.....	29
Table 10: Livestock number per H/H at Lusanga and Manyinga villages	30
Table 11: Livestock manure production and management.....	32
Table 12: Responsible person on different activities during manure management.....	33
Table 13: Storage and utilization of manure	35
Table 14: Dairy animals' house.....	36
Table 15: Effect of cow dung decomposition time on N, K, P, C and C/N ratio	38
Table 16: Effect of various cow dung treatments on N, P, K, C and C/N ratio	39
Table 17: Least square means on effect of various treatments on cow dung and decomposition time on smell.....	45
Table 18: Least square means on effect of various treatments on pig dung and decomposition time on smell.....	46
Table 19: Effect of various treatments on cow dung and decomposition time on texture .	48
Table 20: Effect of various treatments on Pig dung and decomposition time on texture ..	48

LIST OF FIGURES

Figure 1: Effect of different cow dung treatments on N levels	40
Figure 2: Effect of different cow dung treatments on P levels.....	41
Figure 3: Effect of different cow dung treatments on K levels	42
Figure 4: Effect of different cow dung treatments on C levels	43
Figure 5: Effect of different cow dung treatments on C: N levels	44

LIST OF APPENDICES

Appendix 1: Questionnaire..... 57

Appendix 2: Focus group discussion..... 62

Appendix 3: ANOVA for N 63

Appendix 4: ANOVA for P 63

Appendix 5: ANOVA for K 63

Appendix 6: ANOVA for C 64

Appendix 7: ANOVA for C/N ratio 64

Appendix 8: ANOVA for sensory test smell..... 64

Appendix 9: ANOVA for sensory test texture 65

LIST OF SYMBOLS AND ABBREVIATIONS

AOAC	Association of Official Analytical Chemistry
C	Organic carbon
C/N	Carbon- Nitrogen ratio
DASP	Department of Animal Science and Production
g	Grams
GLM	General Linear Model
Ha	hector
HPI	Heifer Project International
i.e	That is
K	Potassium
Kg	Kilograms
MAFS	Ministry of Agriculture and Food Security
MALD	Ministry of Agriculture and Livestock Development
N	Nitrogen
P	Phosphorous
SUA	Sokoine University of Agriculture
t	Tones
Tsh	Tanzania shilling
URT	United Republic of Tanzania
°C	Degree centigrade
%	Percentage
>	Greater than
<	Less than
SES	Socio-Economic Status

IMO	Indigenous Micro-organism
DM	Dry Matter
NH₃	Ammonia
H₂O	Water
H₂S	Hydrogen Sulphide
CO₂	Carbon dioxide
ANOVA	Analysis of Variance

CHAPTER ONE

1.0 INTRODUCTION

Tanzania is a low-income country in east Africa, heavily depending on agriculture. Eighty percent of populations depend on agriculture, providing 84% of total employment, and it contributes about 60% of the country's foreign exchange (URT, 2002). Agriculture mainly is divided into two major section, crop and livestock production. However mixed arable-livestock farming systems are characteristic of many areas of Tanzania. Mixed farming systems involve complementary interactions between crops and livestock such as using animal traction and manure for cropping and feeding crop residues to livestock (Powell *et al.*, 1993). Many of these areas have high population density, hence a high demand for food that has led to continuous and intensive cultivation. Continuous cultivation of the land has resulted in accelerated soil nutrient depletion, decline in soil organic matter content, loss of physical structure and reduced crop productivity leading to serious threat to food security (Mnkeni, 1989).

In Tanzania there are 18 millions cattle, 12.6 million goats, 3.53 million sheep, 0.82 millions pigs, and 27.0 millions poultry (MAFS, 2002). Besides providing farm power, livestock make other contributions to the agricultural economy. Livestock thus serve to transform feeds into food and marketable products, adding value to farming enterprises, increasing income, and enhancing the biophysical and economic viability of agriculture (Powell *et al.*, 1993). Also contribute directly to sustainable agriculture by providing manure, which is a principle soil amendment available to large number of farmers (Rafiy, 2004).

Livestock industry is carried out not only in rural areas but also at urban and peri-urban areas. Livestock industry at urban and peri-urban areas started many years ago and still continuing and increasing. In Tanzania, UA has been described as the raising of animals such as dairy cattle, poultry, pigs, sheep and goats, and the growing of vegetables and field crops in areas designated urban by the United Republic of Tanzania under the Town and Country Planning Ordinance cap 378 of 1985 revised in 1991. The situation is observed in many towns in Tanzania and in other developing countries. Urban agriculture provides urban dwellers with extra income, food and offer employment to family members and youths. In Tanzania, it is a pre-occupation of most urban dwellers of all socioeconomic status dealing with raising both crop and livestock in the high, medium, and low-density areas (Mosha, 1991; Mlozi, 1996; United Republic of Tanzania, 2002). However, it has a negative effect on environment under poor management.

In Tanzania, the problem of environmental degradation caused by accumulation of animal manure is substantial. This problem of environmental degradation is increasing because farmers dispose off animal dung haphazardly and unplanned growth in urban human populations and peri-urban settlement. For instance, in the city of Dar es salaam, there were 3 318 head of dairy cattle in 1985 and the number increased to 9 081 in the year 1993 (Mlozi, 1996). Similar trend was reported in Mbeya and Morogoro cities suggesting, that herd increase is mainly an attempt to lessen the economic hardship that the urban dwellers endure (Mlozi and Hella, 2001). Also animals are kept to supplement the low income and provide food to the household.

These large concentrations of animals and the associated concentrations of manure have been targeted as a source of odors, a threat to surface and ground water and other factors related to the health and quality of life of people living in the area. The landless livestock

systems are increasingly located at or near urban areas. Considering poor sanitation in the urban areas and poor nutrient recycling to the soil at the farm areas there is a need to find the means to alleviate the condition.

It is also expected that, in rural areas farmers could utilize fully animal manure at their field to improve production and maintaining good environment. But most of the farmers pile animal manure around their houses with minimum utilization.

Therefore, to have a sustainable agriculture and improved animal manure handling, storage and utilization in both rural and urban areas, technologies that will accelerate the rate of animal manure decomposition thus improving manure handling and utilization are required. Appropriate technology which reduces odor emission during decomposition and storage time of animal manure will contribute in reducing the annoyance associated with accumulation of animal waste materials and improve the nutrient recycling.

Therefore this study seeks to evaluate the use of native bacteria for manure management.

Overall objective

The overall objective of this study was to improve manure handling, storage and utilization for improved crop productivity and reduction in odour emission.

The study was conducted with the following specific objectives:

Specific objectives

- i. To survey the general conditions of livestock keeping, its effect on environment, manure production, handling and utilization in the rural areas.**
- ii. To evaluate efficacy of different substrates sources for culturing indigenous microorganisms (IMO).**
- iii. To compare manure quality under different IMO treatment regime.**
- iv. To test the efficacy of IMO on rate of manure decomposition and odour emissions.**

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Animal manure

For centuries, animal manure was considered the only major external sources of nutrients used to maintain the nutrient level of soils. The type and quality of available manure depends upon the animal enterprise and the degree to which it is integrated into the farming system (Powell *et al.*, 1993). The nutrient composition of animal manure varies significantly with poultry manure being the richest followed by sheep/goats, cattle and swine (Bockman *et al.*, 1990). In addition, there is great variation within a given source of manure as affected by feed management, handling of manures, and mode of application to soils (Maccalla, 1975). This is particularly true for the N and K component of manure (Table 1).

Table 1: Composition of fresh dung from different species of livestock

Animal species	%N	%P ₂ O ₅	%K ₂ O	C/N
Chicken	1.5(1.2-3)	1.3(1.1-2.6)	0.8(0.6-2)	9-11
Sheep and Goat	0.7(0.6-1.2)	0.4(0.3-0.5)	0.25	20-25
Pig	0.5(0.4-0.6)	0.4(0.3-0.5)	0.4	19-20
Cattle	0.3(0.3-0.5)	0.2(0.18-0.2)	0.15(0.14-0.18)	20-26

Source: Mccalla, (1975)

Manure voided by different animal's species also varies between breeds, age, weight and diet (Table 2). Volume of manure produced at a dairy farm is composed of washing down water from teats, incidental spillage from drinking water and rainfall (Rynk, 2004).

Table 2: Manure voided by different animals in kg/day

Animal	Amount in kg/day
Dairy cow (normal weight)	44.5
Beef cattle	19.8
Sow	11.7
Fat pig	4.9
Poultry	0.1
1000 laying hens	144.0
Pig	
Baconer	7.4
Porker	5.4
Farrow sow	10.7

Source: Rynk, (2004)

2.2 Importance of manure as a fertilizer

Variety of claims have been made about the potential benefits of manure application as a means of sustaining soil fertility (Powell *et al*, 1995). The demonstrated benefits includes increase in PH, water holding capacity, hydraulic conductivity, infiltration rate and decreased bulk density. Manure is also seen as potentially important sources of nutrients, especially nitrogen (N), phosphorus (P) and potassium (K). In the longer term the recalcitrant components of the manure forms a reserve pool of mineralisable nutrients that will be available for plants up take in future season. Manure also has the long term effect of raising soil organic matter levels with all the concomitant benefits to soil fertility (McDonald *et al.*, 2002). These benefits are not invariable, however, and excessive manure application has also been shown to lead to problems of ground water pollution through leaching of nitrate (NO₃-N) from the soil (Lekasi, 2001).

Major limiting factors on manure management include labour, capital, poor implementation of appropriate technology and improper division of labour in the house

hold. These result to accumulation of manure, emission of odor, pollution of environment and annoyance to the people (Mlozi, 1996).

2.3 Livestock and soil fertility

The nutrients in plant materials that are consumed by animal are either digested or absorbed from alimentary tract for metabolism in the animal body or pass out as undigested waste products. Substantial quantities of the minerals absorbed are eventually excreted in the urine, but in each case, a small proportion is incorporated in animal tissue or secreted in milk. Thus each of the minerals is involved in a cyclic movement from soil to plant, plant to animal and back to the soil (Hodgson, 1990). Nutrients in urine are readily available to plants, while those in faeces or in plant materials only become available through the process of biochemical decomposition and mineralisation of the faeces or organic residues (Defoer *et al.*, 1998). Animal residues and/or waste products are broken down more readily than plant residues because they have been partially degraded by the microbes in the rumen. Therefore, the efficiency of the recycling process increases as the proportion of the plant material eaten increase (Hodgson, 1990).

2.4 Factors influencing animal manure use

Defoer *et al.*, (1998) have reported several factors that influence use of manure. Some of these factors include: the extent to which crop fields are scattered, the distance between cattle stalls and the crop field and the available means of transport and labour. The amount of usable manure that can be obtained from cattle depend upon factors such as the amount of feed, the method of feeding (pen rearing, kraaling the animal at night, free range) and the efficiency of collection of manure. It is estimated that one livestock unit (1LU=500kg live mass which consume 15kg DM per day) produces about 7 tones of recoverable fresh manure per year when stabled all day. This decline to two to three tones per year of usable

manure (that is 30-40% recovery), if the animals are stabled only overnight (Schleich, 1986).

2.5 Manure use in rural area in Tanzania

Mixed arable-livestock farming systems are characteristic of large areas of Africa. Smallholder dairy farmers in the high land of East Africa generally feed animals in stalls and collect manure in pits and store it (Bockman *et al.*, 1990). In Tanzania mixed arable-livestock system is practiced so as to solve the problem of declining land productivity. The amount and frequency of manure being applied to cropland is influenced by rainfall, cropping and livestock densities and the type of livestock being kept. Farmers tend to apply greater amount of manure and at a shorter intervals in areas of higher rainfall where cultivation densities are greater and cattle are more important than small ruminants (Powel, 1993). Rafiy (2004) reported that in highland areas, efforts should be directed to manure management because use of manure for crop production is already common.

2.6 Urban agriculture

Migration of people from rural to urban area is very high. At the same time urban agriculture is growing tremendously. UA is a global activity undertaken for different social, economic and cultural reasons (Mlozi *et al.*, 1996). In Tanzania, UA has been described as the raising of animals such as dairy cattle, poultry, pigs, sheep and goats, and the growing of vegetables and field crops in areas designated urban by the United Republic of Tanzania under the Town and Country Planning Ordinance cap 378 of 1956 revised in 1991.

AU has both positive and negative effect to the life of the people living in the area. Where there is crop-livestock integration there is a positive effect. Increased integration of the

livestock and cropping sectors has long been viewed as the most promising means for initiating improvements in agriculture productivity (Murwira, 1995).

2.7 Nutrient cycling

Nutrient cycling in plant/soil systems can be described as the functioning of biological components within a prescribed area, at a given cost and with acceptable risk that ensures the transformation of solar energy into animal and vegetable biomass to supply the needs of the population (Mugwira *et al.*, 1997). Fertilizers, particularly those containing nitrogen, require much fossil energy in their manufacture, this energy was increasingly expensive and, moreover, is a diminishing resource. The raw materials used to make fertilizer need to be mined. Although supplies are expected to last many decades, the reserves in economically workable concentrations do not have an infinite life. These considerations, plus a greater awareness of the need to protect the environment from the polluting effect of excess fertilizer and to avoid damage to the physical environment and landscape of the planet emphasize the need to improve the movement of nutrients from soil to plant to animals and back to the soil (Powel *et al.*, 1993).

Significant quantities of nutrients are transferred from rural to urban areas in the form of farm produce. Urban centres can, therefore, be major drains of on-farm nutrients. Nutrient cycling in urban areas is very inefficient. Virtually nothing is recycled except in some compound farms and home gardens in the lower density areas of urban centres where domestic animals such as sheep, goats, donkeys, horses and poultry are kept (Murwira, 1984).

Food such as grains, root and tuber crops, and fruits and forages are brought from farms in semi and fully processed forms for urban dwellers. Animals that have been raised on farms in rural areas are slaughtered and consumed daily in urban areas.

Major nutrients losses in urban areas are from: human wastes which consist of garbage, night soil, sludge, animal waste such as manure, litter and spoiled fodder, blood, hoofs and horns etc. It has been estimated that Sub-Saharan of Africa produced about 28.12million tons of N, 10.25 million tons P and 23.05 million tons of K as wastes (Murwira, 1984). Whereas the consumption figures for N, P and K for the period 1985/86 was about 6.2 million tones (Agboola and Akinifesi, 1991) this means that only 10% of the nutrients available for recycling are actually recycled.

2.8 Waste collection and disposal in urban areas

Waste collection and disposal is often seen as being the responsibility of the government or municipality. In many cases the municipality is unable to fulfill this role either due to financial constraints, lack of will or lack of organizational skills. In many cities, collection and separation of waste by the private or informal sector is seen as being too time consuming because of the content of the waste, often a mixture of organic and non-organic substances, such as plastic film. For there to emerge a successful organic waste reclamation process, it has been noted that it is of great help if the organic and non-organic waste is separated at source. It is here that the responsibility is thrown back onto the generator of the waste, the public. Many successful schemes are only successful because of community participation in the activities on a day-to-day basis. There are a number of good examples of community recycling or resource recovery schemes in developing countries. E.g. Biogas production, manure composting (Mosha, 1991).

2.9 The use of native microorganisms and its' cultivation

Native microorganisms are indigenous microorganisms commonly found in a given natural habitat. They have inhabited there for over hundreds of million years to support nature and to nurture animals, plants and even human beings. The bacteria have highest

acclimation to the environment and are readily available. Native microorganisms can be collected from the forest, by using different methods. The common and cheap method is by using attractive substrate to capture the indigenous micro-organism (Schleich, 1986).

Native bacteria are classified into two groups depending on air (oxygen) requirement .These groups are aerobic bacteria and anaerobic bacteria (Kirchmann, 1995). Aerobic bacteria can be collected from the forest by using the mixture of rice, wheat bran or maize bran. Anaerobic bacteria can be collected at any place by using the mixture of rice juice, diluted milk, yogurt or Soya bean paste kept in the bucket and left for few days to allow lactic acid bacteria to grow and multiply (Kirchmann, 1995).

Bacteria can be activated by supplying protein, carbohydrates, mineral and vitamins.

Bacteria after being multiplied can be used in agriculture and livestock industry by:-

- (a) Sprinkling into the saw dust to accelerate fermentation, therefore the saw dust can last for longer time.**
- (b) Sprinkling on the cattle bedding material**
- (c) Blend the bacteria and the compost heap at the compost storage fermentation will be accelerated**
- (d) In agriculture bacteria are used to produce "Bokashi (fermented organic material) manure.**
- (e) By sprinkling the bacteria on kitchen waste can help to make compost without odour thus maintaining good environment around the house (Njoroge, 1994).**

2.10 Composting animal manure

2.10.1 Compost making

Composting is the natural process of turning the organic material into valuable plant food called humus. On a farm, large amount of vegetation such as crop remains, garden weeds, kitchen and household wastes, hedge cuttings, garbage, etc are converted in a compost pile into humus (Raussen, 1997). When properly made and applied, compost becomes immediately available as a plant food without the need to be first broken down by microorganisms. When compost is applied, it does not cause excessive weed growth, as is sometimes the case for ordinary farm manure. This is because the process of manure-making compost generates heat, which destroys the germinating power of weed seeds.

2.10.2 Important factors for manure composting

Carbon/nitrogen ratio (C/N)

Njoroge (1994) reported that an ideal initial carbon–nitrogen ratio (C/N) for starting a compost pile is 25-30:1. The C/N ratio tells how rich or poor compost mixture is (Njoroge, 1994). If the C/N ratio is very low then nitrogen is lost, and the compost will smell of ammonia. Addition of sawdust can reduce the loss of nitrogen (Jaiswal *et al.*, 1971). If the C/N ratio exceeds 35:1 the composting process will take place very slowly and little warming will occur. In order to maintain initial proper C/N ratio, compost must have a mixture of nitrogen –rich and carbon –rich materials.

Moisture content

For a compost to decompose well, it must contain enough water to enable its fungi and bacteria to develop (Mullar - Samann and Kotschi, 1994). The process of decomposition stops if water content falls to 12-15%, but water content as high as 40-45% may limit the compost development (Minich and Hunt,1979). Ideally, a compost heap should contain

initial water content of 50-60%. As a practical indicator, the compost should look like a squeezed sponge. Too much water causes compaction of compost materials.

Ventilation

Compost needs good ventilation so that oxygen can enter and carbon dioxide can escape (Mullar-Samann and Kotchi, 1994).

Temperature

A satisfactory temperature is the best indication of successful composting. Temperature required is 60°C to 70°C (Njoroge, 1994). This temperature destroys most disease pathogens and weed.

2.10.3 Decomposition of manure during storage

There are two main nitrogenous compounds found in manure, soluble and insoluble nitrogenous compounds (Miller, 1965). The insoluble nitrogen compounds are mostly in the form of proteins, which change very slowly during the rotting process. Briggs and Courtney (1993) reported that the soluble nitrogen occurs mainly in the form of urea ($\text{CO}(\text{NH}_2)_2$), which is rapidly hydrolyzed to ammonia carbonate,



The carbonate produced dissociates to give ammonium (NH_4). Much of this is lost through volatilization as ammonia gas (NH_3), some is oxidized by nitrifying bacteria to nitrite and then nitrate. Nitrate can be taken by plant or lost by leaching. The decomposition of urea is substantially reduced if pH is kept below 7.0. When pH is above 7, change of urea to ammonia carbonate take place very rapidly and may be almost complete within 3-4 days.

The solid fraction of manure contains considerable quantities of cellulose, hemicelluloses, lignin and other compounds that escaped digestion, thus this fraction represent the most resistant component of biological decomposition. The end products of this biological oxidation are carbon dioxide and water (Miller, 1965).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Location and description of the study areas

Two studies were carried out at Sokoine University of Agriculture (SUA) and Mvomero district in Morogoro region. SUA was selected purposely as on station site to meet the requirement of laboratory work and availability of experimental material. Here IMO collected were multiplied by using seven different substrates and were tested for their efficacy in manure decomposition.

Mvomero district and specifically Turiani division was chosen because dairy keeping is a recent phenomenon. As such general management not only of the animal, but also the efficient of manure handling technology is poor. Cases of manure being set on fire because of inadequate handling techniques or lack of knowledge on its usefulness have been observed (Mbaga, Unpublished). Here a survey on general management of livestock, environment, manure handling and utilization was done.

Turiani division

Turiani division is about 100 km, North of Morogoro Municipality along Kilosa, Handeni road. The division cover's 454 km² in Mvomero district and is found between latitude 5^o 5' and 7^o 4' and longitudes 37^o 10' and 31^o 31' E (Safari *et al.*, 2000). This area lies along the altitudes ranging from 380, to 520m above sea level. According to URT (2002) the division has a population of 90 129 people. The division is flanked by Nguru Mountains to the West and North while a large portion is flat land. The flat land becomes flooded during the rainy season. There are several rivers and streams which form many Valleys from Nguru Mountains.

The area experiences a bimodal pattern of rainfall. Long rains start at the end of February and lasts to the beginning of May while short rains fall during November and December. The area receives average annually rainfalls of about 1180mm. July to October is a dry period. Humidity is high during April and lowest during September. The mean temperature of the area range from 15⁰C to 29⁰C the population density is about 22.3 people per square kilometer.

The division comprises of five wards namely, Sangaji, Mtibwa Diangoya, Kanga, and Mhonda. The division headquarter is in Sangaji ward. A large Number of farmers in Turiani are involved in both crop cultivation and livestock keeping. The major crops cultivated are paddy and sugar cane as cash crops while maize and cassava are food crops. The livestock kept includes local and improved cattle breeds, goats, sheep, and poultry. Introduction of dairy cattle in Diangoya was started by two Non-Government Organizations (NGOs) namely, the Foundation of Sustainable Rural Development (SURUDE) and Heifer Project International (HPI) today known as (HPT). These organizations have been providing loans for purchasing improved dairy animals through Heifer in Trust (HIT) Scheme. SURUDE was supporting introduction of improved dairy cattle by providing in calf heifers on credits and free extension services. Diangoya ward was selected purposely to meet the requirement of the study and two villages Lusanga and Manyinga were randomly choosen.

3.2 Study 1: Survey on the General Conditions of Livestock Keeping, Environment, Manure Handling and Utilization

3.2.1 The questionnaire administration

Structured and semi-structured questionnaire was designed based on the objectives of the study. The questionnaire was pre-tested to check its reliability and validity in order to

make appropriate adjustments. Survey was conducted in the selected two villages (Manyinga and Lusanga) and 32 households' keeping dairy cattle were purposeful selected to observe general conditions of livestock keeping, manure handling and utilization. The survey mainly used questionnaire whereby 32 farmers were interviewed. The interview was complemented by focus group discussion and physical observation. The information obtained from this survey included the reason of keeping animals, use for bedding materials, limitation of manure production, methods of manure handling, and limitation of manure utilization (Appendix 1).

3.2.2 Focus Group Discussions (FGD)

Focus group discussion was organized, after the interviews. Twenty seven people in each village were selected purposely to form the three discussion groups. These groups comprised of nine village leaders, nine livestock keepers and nine neighbours of livestock keepers. Each group selected three people to form the secretariat. The secretariat composed of chairperson, secretary and facilitator. Secretariat was responsible to collect, record, summarize information presented by each group and to prepare the group report at the end of discussion. Each group was presented with questions and was requested to discuss them. After completion of an assignment one member of the group was requested to make presentation and the subject was open for discussion. Group meetings were conducted in each village and six topics were discussed. Topics were:

- 1. How do farmers dispose/ utilize animal manure?**
- 2. How do livestock keepers ensure good environment when they dispose/utilize animal manure?**
- 3. What are the opportunities and constraints available in manure management in the village?**
- 4. What strategies are employed to ensure nutrient recycling to the soil?**

5. Do you benefit from animal manure generated by your neighbor's livestock keepers?

Yes or no? If yes how? If no, why?

6. Have you experienced an annoyance due to odor emission or improper manure?

3.2.3 Physical observations

The direct observation on general management of livestock keeping, manure handling, storage, utilization and condition of environment were made when visiting the farmers. The observation results were noted down to verify and cross checking with the information that was gathered during group discussion and individual interviewing. The observation checklist and focus group meetings (appendix 1 and 2) which was prepared in advance, was used to ensure that observations and group meetings were made systematically.

3.2.4 Data analysis

Data collected using individual interviews, focus group discussion and physical observation was analyzed using Statistical Package for Social Science (SPSS) Windows 11.5 package of 1996. Descriptive analysis that is frequencies, means, percentages and cross tabulation were used. Data from the FGD was recoded, discussed and summarized used to improve the result obtained from the questionnaire.

3.3 Study 2: Evaluation of the efficacy of different substrates sources for culturing indigenous microorganisms and comparison of manure quality under different IMO treatment regimes

3.3.1 Study material

Major study material includes native bacteria (indigenous macro organisms) and animal manure. Other equipments includes: deep freezer, weighing scale, cool box, spade,

polythene bags and papers, substrate energy source (maize bran, cassava powder and molasses), protein sources (*Moringa oleifera*, fish meal and *Leucaena* leaves). Energy and protein sources were used for activation of the growth of microorganisms.

3.3.2 Collection and culturing of IMO

Indigenous microorganisms (IMO): These were collected from Kimboza catchments forest in Morogoro district. Soil of the natural forest rich of numerous microbes (bacteria, fungus, protozoa and worms) was collected using maize bran as a substrate. A pit measuring 50 by 50 cm length and width, 10 cm deep was dug at a well-drained ground. Maize bran was put in the dug hole and covered with soil and left for 10 days. Thereafter, macro organisms and the soil were collected. The collected soil substrate mixture was brought on station for subsequent experiment. *Moringa* leaves and *Leucaena* leaves were picked from SUA botanical garden and dried under shed for five days. Thereafter, by using grinding machine, dried leaves were grinded to form the powder. At the same time grinded Fish meal, Cassava powder and Mollases were purchased from Morogoro market.

To activate the native bacteria, ½ kg of three protein sources that are *Moringa* leaves, *Leucaena* leaves and Fishmeal and a combination of one kg of two energy sources (Cassava and Molasses) were used (Table 3).

Table 3: Experiment to activate IMO

	Moringa powder	Leucaena powder	Fishmeal	
Cassava	MC	LC	FC	M ₀
Mollases	MM ₀	LM ₀	FM ₀	C ₀

Where M= *Moringa* powder, L = *Leucaena* powder, F = Fishmeal, C = Cassava, M₀ = Mollases, C₀ = Control.

Note P=Protein sources and E= Energy sources

T1=Moringa oleifera leaves + Cassava powder + IMO+ Fresh cattle manure.

T2=Leucaena leaves+ Cassava powder + IMO+ Fresh cattle manure.

T3=Fish meal+ Cassava powder + IMO+ Fresh cattle manure.

T4= Moringa oleifera leaves + Mollases + IMO+ Fresh cattle manure.

T5 = Leucaena leaves+ Mollases + IMO+ Fresh cattle manure.

T6 = Fish meal+ Mollases + IMO+ Fresh cattle manure.

T7 = Mollases + IMO+ Fresh cattle manure

T8 = Fresh cattle manure only (control)

Each treatment mixture was kept in a plastic buckets, each containing one protein source and one energy source (CT1-CT6). T7 contained only molasses as energy source, while T8 was control Water was added to the mixture and left covered for 11days to allow extraction of protein and soluble energy. Then the indigenous macro organisms and the soil were added to the mixture and left for four days to allow the macro organisms to multiply. After four days the mixture in each bucket were diluted twenty times.

Four liters of the mixture was sprinkled on 50kg of cattle manure packed in seven polythene bags and allowed to decompose.

The same treatment as above was done using pig manure. Both experiment (cattle and pig manure) was carried out concomitantly. Cattle manure samples were subjected to both laboratory and sensory test while pig manure samples were subjected to sensory test only. Pig manure samples were not subjected to laboratory test due to financial constraints.

The experiment was used to evaluate the efficacy of different substrates sources for culturing indigenous microorganisms and comparison of manure quality under different IMO treatment regimes.

3.3.3 Measurements and data analysis

Cattle samples were collected weekly to evaluate the quality of manure produced at each treatment. Four samples of ¼ kg each were collected from a depth of about 30 cm in each bag of manure. The four samples were mixed together to form one representative sub sample of approximately ¼ kg each (in duplicate). Samples were packed in the plastic bags and stored in the deep freezer ready to be taken to the laboratory. Two samples of fresh manure were collected on the first day of the experiment (just before treatment), and eight samples in duplicate on the first week (sixteen samples), second week and third week respectively. Therefore, fifty samples of cattle manure were collected. In the laboratory samples were analyzed for N, P, K and organic Carbon content. During transportation the samples were preserved in a cool box with ice cubes to minimize any further decomposition and nutrient loss through volatilization.

At the laboratory the cattle manure samples were dried by using oven drier at 105°C to constant weight. Dry matter obtained was used to determine the content of Nitrogen; Phosphorus, Potassium and organic carbon, (N P K C). Nitrogen content of cattle manure samples was determined using Kjeldahl method. To determine Phosphorous molybdate yellow colour method was used. Potassium was determined by atomic Absorption Spectrophotometer (AOAC, 1990). Organic carbon was determinate by Walkey- Black method (Juo, 1979) thereafter, carbon nitrogen ratio was calculated. The C/N ratio and NPK content of each treatment were evaluated, recorded and analyzed to determine the quality of the decomposed manure. Statistical analysis system (SAS 2004) soft ware was used to analyze the data. Probability of difference of SAS (2004) was used to separate the means and means are considered to be different when $P < 0.05$.

Model used (On Station)

$$Y_{ij} = \mu + T_i + D_j + (T \cdot D)_{ij} + e_{ij}$$

Where,

Y_{ij} is an observation on the manure receiving i^{th} treatment and j^{th} sampling period

μ = Overall mean

T_i = effect of i^{th} treatment ($i=1 \dots 8$)

D_j = sampling period ($j = 1, 7, 14, 21$ days)

$(T \cdot D)_{ij}$ = interaction effect of T&D

e_{ij} = Random error

3.3.4 Sensory test

During weekly sampling, samples of cattle and pig manure were collected in a bottle and labeled then immediately subjected to sensory test. Seven panelists were selected and trained on how to carry sensory test. Thereafter, they were requested to examine the odour and texture of the composted manure and provide a detailed descriptive evaluation of it. Data were recorded and analyzed using statistical analysis system (SAS, 2004).

3.3.5 Descriptive analysis with scaling

A preliminary discussion was held with the panelist. The major objective of the sessions was to familiarize with the modal of scaling and how they are going to score the samples during actual exercise. Also they agreed upon the sensory properties and terminologies to be used during the evaluation session. The panel members examined the odor and texture of the cattle and pig manure under decomposition, and provided a detailed descriptive evaluation of it. During actual evaluation sessions the panel members worked individually.

The scale used was an interval scale consisting of a horizontal line 15 cm long with anchor points of equal distance. A separate line was used for each sensory property (odour and texture) to be evaluated. (Lamund, 1977).

Each panelist recorded his evaluation by marking a vertical line across horizontal line at the point that best reflect his/her perception of the magnitude of smell or texture. After the panelist has completed their rating, the experimenter super imposed a grid by dividing the line into 150milimeter units, and assigned the number to each rating. Thereafter, the data was analyzed using statistical analysis system (SAS 2004).Analysis of variance (ANOVA) was carried out for data concerning manure handling (composting) using different substrate (T₁, T₂....., and T₈). Means among the treatments were compared using the Least Significance Different (LSD) test.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Survey on manure production, handling techniques and utilization

4.1.1 Background of respondents

The survey was done in two villages, Lusanga and Manyinga in Mvomero district. These villages were classified into peri-urban and rural according to farmer's opinion. Lusanga village was considered as rural, this might be because of its location being far from the major road while Manyinga is along the major road and closer to Turiani small town thus considered as peri-urban. Forty point six percent of the respondents were female and 59.4% were male (Table 4).

Table 4: Characteristics of the respondent

Village	Location	Sex of respondent		
		Male	Female	Total
Lusanga	rural	9*(64.3)**	5(36.7)	14(43.7)
Manyinga	peri-urban	10(55.5)	8(44.5)	18(56.3)
	Total	19(59.4)	13(40.6)	32(100)

*Numbers before the brackets are the no of respondents

** Numbers within the brackets are the percentage of respondents

Among the surveyed household 3.1% were female headed household and 96.9% were male headed household. All heads of household (100%) in the Study area had primary level of education. The average age of the farmers who were keeping dairy cows was 49yrs (range 40-60yrs).

Household characteristics in a study area have implications on social, economic activities, and availability of food (Mhite, 2000). In the study area household with 1-5 people were 28.1%, 67.5% had 6-10 people and 6.3% had 11-15 people respectively. Just over half of the household had 1-3 people with the ability to work, (56.3%) of the household has 1-3 people, (34.3%) household had 6-10 people, (6.3%) household had 11-15 people.

In thirty one household surveyed (96.9%) the head of the household were married while only one (3.1) household head was single, this might be because of the nature of livestock industry which is labour and capital intensive therefore, most single people do not afford to do it. Majority were aged between 46-55yrs (Table 5). This agrees with the information of the MAFS (2002) which indicated that more than 50% of the people engaged in agriculture are above 45years old. The result shows that most young people do not keep dairy animals. This could be due to the fact that, dairying needs high initial investments which they don't have and therefore, most of them are employed in sugar estate or engaged in small business. Nearly fifty percent of the farmers have the land size which is greater than ten acres. This is any indication that people in the study area has enough land for crop and dairy production, the later requiring rather small area given the herd size.

Table 5: Household characteristics of livestock keepers in Lusanga and Manyinga village

Variables	Responses			
Age of respondent		36-		
Range (age)	25-35	45	46-55	56&above
No. of respondent	6(18.8%)	6(18.8%)	13(40.6%)	7(25.8%)
Ability to work in the H/H				
Range(No. people)	1-3	4-6	7-9	10&above
No. in H/H	18(56.3%)	11(34.3%)	2(6.3%)	1(3.1%)
Household size				
Range	1-5	6-10	11-15	16&above
No of H/H	7(28.1%)	21(65.7%)	2(6.3%)	0
Marital status				
Married total	5(15.7)	6(18.8)	13(40.6)	7(25.8)
Single total	1(3.1)	0	0	0
Farm size				
Range in acres	1-10	11-20	21-30	31&above
No. of H/H	17(53.1%)	11(34.4%)	2(6.2%)	2(6.2%)

4.1.3 Source of income and labour

Their main source of income for respondents (dairy farmers) was crop production (87.5%) followed by dairy husbandry (6.3%). Very few were engaged in small business (3.1%) or being government employee (3.1%). Shem (1986) reported that zero grazed animals are labour intensive. Therefore, in these study areas 81.3% of the dairy farmers employ labour on casual labour bases (62.5%) and on temporary bases (12.5%). Casual labours are used to cut grasses during dry season as well as to tackle labour demand peaks especially during weeding period (Table 6).

Table 6: Major source of income and labour

Variable		No. of respondent	Percentage
Major source of income	Crop production	28	87.8
	Dairy production	2	6.3
	Business	1	3.1
	Employment	1	3.1
Do you employ labour	Yes	26	81.3
	No	6	18.8
Kind of employment	Permanent(yearly)	2	6.3
	Temporary(seasonally)	4	12.5
	Casual (daily)	20	62.5

The types of crops produced in the study area are represented in Table7. Respondent were requested to mention three main crops. Just nine point four percent of respondent mentioned maize as the only major crop, (37.5) mentioned rice and maize, (40.6%) mentioned sugarcane, rice and maize, and (12.5%) mentioned banana, rice and maize as the major crops.

Table 7: Major crops cultivated by the farmer

Crops	Number of farmers	Percentages
Maize	3	9.4
Rice, maize	12	37.5
Sugarcane, maize, rice	13	40.6
Bananas, maize, rice	4	12.5
Total	32	100.0

The acreages cultivated by each farmer for every crop are indicated in Table 8. Most of the farmers cultivate an average of one to two hectares for every crop. All respondents cultivate

maize (100%). This is an important food crop in the household. Extra maize produced was often sold to increase the household income.

Table 8: The acreages cultivated by each farmer for every crop

s/no.	Crop	Hectors cultivated	Number of farmers(=32)	Percentages
1	Maize	0.5-1.6	22	68.7
		1.7-3.2	6	18.9
		3.3-4.8	4	12.6
		Total	32	100.0
2	Rice	0.5-1.6	20	68.8
		1.7-3.2	6	20.6
		3.3-4.8	2	6.8
		>4.8	2	6.8
		Total	29	100.0
3	Bananas	0.5-1.6	4	100.0
		1.7-3.2		
		Total	4	100.0
4	Sugarcane	0.5-1.6	6	46.2
		1.7-3.2	5	38.5
		3.3-4.8	2	15.4
		>4.8		
		Total	13	100.0

Majority of respondents (69%) of their production per hector ranges between 6-10 bags for maize, 6-10 bags for rice, 31-40 tons of sugarcane and 1-1.5 tons of bananas respectively (table9). Regardless of this low maize and rice production, people still believe that their soil is fertile. Fertile soil was mentioned as one of the reason of not using organic and inorganic fertilizer. This observation agree with Hawassi (1997) that, little replenishment of plant nutrients in the soil due to increased cost of inorganic fertilizer have led to little maize yield in some parts of highlands in Tanzania. This was after Structural Adjustment Programme which removed subsidies on farm inputs in most countries of Africa.

Table 9: Estimated crop production per hectars

Crop	Bags or tons/hectars	Number of household (N =32)	Percentages
Maize	(bag =100kg)1-50	9	28.2
	6-10	19	59.3
	11-15	3	9.4
	16-20	1	3.1
	Total	32	100.0
Rice	1-50	1	3.4
	6-10	14	48.2
	11-15	13	45.0
	16-20	1	3.4
	Total	29	100.0
Bananas	(tons) 1-5	4	100.0
	Total	4	100.0
Sugarcane	(tons) 1-10		
	(tons)11-20	1	7.7
	(tons)21-30	4	30.8
	(tons)31-40	8	61.5
	TOTAL	13	100.0

Nb: Percentage based on total household producing the crop

4.1.4 Livestock production

The average herd size was two animal per household in both villages. They also keep other conventional animals as indicated in Table 10. Out of thirty two dairy farmers only five farmers had piggery units. Five farmers at Manyinga keep an average of seven pigs per household while at Lusanga none of the respondent kept pigs. Only three household out of thirty two keep indigenous goats. Eighty four percent of the dairy farmers also keep indigenous poultry.

The mean number of dairy cattle was 2.4 and 1.9 at Manyinga village and Lusanga village respectively. These small head composition was due to recently introduction of dairy cattle in the area. Cross bred dairy cattle produce 4-5 kg DM manure daily where local cattle produce 2-2.5 kg DM manure daily(Raussen, 1997). In order the H/H to produce 2-3 t DM

of animal manure per year which is enough to meet the requirement of one hectare of maize crop need to have two dairy cattle kept indoors. This was true if the animal manure is of high quality, containing 2.3 % of N, 1.1% P and 0.8 K. (Palm et al., 1997). The same herd size was reported at Njombe (Jackson 2005) where HPI project is operating.

Table 10: Livestock number per H/H at Lusanga and Manyinga villages

Livestock type	No. H/H	Livestock number	
		Mean \pm SD	Range
Dairy cattle			
Manyinga	18	2.4 \pm 2.1	1-8
Lusanga	14	1.9 \pm 1.1	1-4
Pigs			
Manyinga	5	6.8 \pm 5.8	2-13
Lusanga	-	-	-
Goats			
Manyinga	1	12	1-12
Lusanga	2	9	1-13
Poultry(Chickens)			
Manyinga	16	22.9 \pm 16.2	4-64
Lusanga	10	18.5 \pm 6.8	3-52
Poultry(Ducks)			
Manyinga	5	14.4 \pm 6.8	3-56
Lusanga	2	7 \pm 7.1	2-26

4.1.5 Livestock manure production and management

The results of manure production /handling are presented in Table 11. Ninety three percent (93.8%) of the respondent removes manure everyday and 6.2% remove after every week.

Manure is usually piled near by the cow shed. In dairy cattle management HPI (Heifer Project International) emphasized that farmers should clean the animal barn everyday.

Most dairy cattle are kept in barn with concrete floor and compacted ground. This has an implication on manure quality. According to Lekasi *et al.*, (2001) concrete floor results in high quality manure due to little leakage of urine. However, result shows that (71.9 %) of farmers were not aware of the importance of urine in manure production and do not use any means to trap it. Therefore, leaving the urine to dry or leading it to the open pit using an open trench, result to most urine N to get lost by volatilization and leaching (Rurselle, 1992).

Eight seven (87.3%) of dairy farmers do not use bedding material in the cowshed. This was because of presence of concrete floor in the animal barn in addition the farmers remove the manure from animal barn everyday. Generally farmers were not aware of importance of using bedding materials because even the leftovers of feeds were collected and set to fire. The reason behind was to reduce the bulkiness of the waste. But this action reduces the quantity and quality of manure. It has been estimated that 1kg of maize Stover's used for bedding can hold up to two litter of urine and lead to preservation of nitrogen in the manure (Raussen, 1997). Quantity and quality of manure also depend on conditions which it is stored and handled, which include housing, shedding, time of storage, and labour force available to accomplish the excise.

Table 11: Livestock manure production and management

Activity	Number of respondent N=32	Percentage
Frequency of removing manure in the cowshed		
Every day	30	93.8
Every week	2	6.3
Total	32	100.0
Do you have any awareness on the importance of urine?		
Yes	9	28.1
No	23	71.9
Total	32	100.0
Do you use bedding material in your cowshed?		
Yes	4	12.5
No	28	87.5
Total	32	100.0
Reasons of not using bedding material		
Concrete floors	15	53.6
Importance not Known	13	46.4
Total	28	100.0
Type of bedding material		
Grasses	4	12.5

4.1.6 Gender and dairying

Women in the study area were involved in triple gender roles (reproductive, productive and community roles). In the farm women were involved in the production process but they do not have any control over the end products e.g. milk meat and manure utilization. On the aspect of manure production, handling and utilization, 53.1% of women are involved in cleaning the cowshed, maintaining clean environment, and storage of cattle manure. While 60.7% of the people involved in the utilization of manure and 57% of the

people involved in the selling or giving manure to the neighbours are men (Table 12). This situation implies that women have access but do not have control over this product

Table 12: Responsible person on different activities during manure management

Manure management	Frequency	Percentages
Cleaning of the cattle shed		
Wife	16	50.0
Husband	7	21.9
Son	3	9.4
Daughter	1	3.1
Attendant	5	15.6
Total	32	100.0
Person mostly store manure		
Wife	16	50.0
Husband	8	25.0
Son	2	6.3
Daughter	1	3.1
Attendant	5	15.6
Total	32	100.0
Utilization/carrying to the farm		
Wife	6	21.4
Husband	14	50.0
Son	3	10.7
Attendant	3	10.7
Relatives	2	7.1
Total	28	100.0
Giving manure to others		
Wife	10	37.0
Husband	15	55.6
Son	2	7.4
Total	27	100.0

To alleviate the situation gender sensitization should be emphasized. During discussion members agreed that, animal husbandry and manure production handling and utilization should be gender neutral and should be fully integrated into H/H dairying activities. Interventions should be made with reference to the gender needs. The challenge was the entry strategy in order to streamline gender issues in manure production, handling and utilization without forgetting animal production at large.

4.1.7 Manure disposal and utilization

Problem of manure utilization or disposal is a challenge to urban, peri-urban and rural areas, the situation is more critical at urban area where land is scarce. The challenge encompasses all residential areas from low density, medium density to high density.

Physical observation and responses of interviewers show that, 87.5% of the farmers pile the animal manure just beside the animal barns (Table13). During FGD. (Focus group discussions) participants pointed out that poor hygiene of the animal barn create unpleasant environment to neighbors, visitors and owners themselves. During the process of decomposition manure gives out a bad smell, attract flies and micro organisms. They said that, condition was worse during rain season creating annoyance to the neighbours and all people passing at those areas. They also pointed that, farmers loose the money because some of the milk has been rejected by customers/consumers. This might be because of milk taint as the milk has the ability to absorb the smell of the surroundings. Few farmers in the study area use animal manure at the nearby farms and gardens. They use the traditional mode of application by spreading on top of the soil without covering it. Data from the surveyed area shows that 100% of dairy animal farmers use animal manure to fertilize the pastures and crops by broadcasting. Also the survey shows that no body was having a biogas plant (Table 13).

Table 13: Storage and utilization of manure

Activities		Number of household N=32	Percentages	
pile out close to the cowshed	Yes	28	87.5	
	No	4	12.5	
	Total	32	100.0	
Utilize manure by spreading on the pasture plots	Yes	13	40.6	
	No	19	59.4	
	Total	32	100.0	
Utilize manure by spreading on the garden/farms	Yes	20	64.5	
	No	11	35.5	
	Total	31	100.0	
Mode of application to the pasture plots	Broadcasting			
	Yes	12	37.5	
	Mode of application to the garden/farms	Broadcasting	21	65.6
		Drilling	1	3.1
		Not using	10	31.3
Using to produce biogas		0	0	
Burn it	Yes	17	53.1	
	No	15	46.9	
	total	32	100.0	
Gift to the neighbours	Yes	18	56.3	
	No	14	43.8	
	Total	32	100.0	
Selling to others	Yes	0	0	
	No	32	100.0	

It was stated by members of FGD that, no program or training specific to manure production, storage and utilization has been carried out. Few farmers pointed out that, they learned manure management during farmers exchange visit in Njombe district. Also they were very much interested on animal traction which was quite new to them. Lack of skills on manure management and drought animal power resulted to poor utilization of organic

fertilizer at the distant farms and could contribute to low production of crops in the area. Farmers were also not aware that dairy breeds could be used on animal traction. To alleviate the situation farmers suggested that, use of animal power is inevitable as far as mixed farming is practiced in the area. They suggested that, animal power is required in the area, after the study tour in Njombe district where animal traction is practiced.

Table 14: Dairy animals' house

Dairy cattle house	Number of household	Percentage
With roof	31	96.9
Without Roof	1	3.1
Total	32	100.0
Type of the floor		
Concrete	30	93.8
Compacted Soil	2	6.3
Total	32	100.0
Time taken for manure (months) to decompose		
One month	1	3.1
Two to three	1	3.1
Four to five	19	59.4
More than five month	11	34.4

Majority of farmers keep the manure for more than four month (93.8%) to decompose before being ready for utilization. The time taken before utilization of manure can result to wastage and loss of nutrient.

Most of the dairy cattle are kept in the barn with concrete floor (93.8 %). This has an implication on the quality. According to Lekasi et al; (2001) concrete floor results in high quality manure due to little leakage of urine.

4.2 The efficacy of different substrates sources for culturing indigenous microorganisms and comparison of manure quality under different imo treatment regimes

4.2.1 Effect of treatments on decomposition of cow manure

Results for the effect of decomposition time on Nitrogen, Phosphorus, Potassium, Carbon and Carbon Nitrogen ratio are presented in Table 15. Results show that there was a significant ($P < 0.05$) increase in N, P, K and decrease in C: N ratio as decomposition time proceeded from day 1 to day 28. However, C started with high value which decreased after one week of decomposition which then slightly increased and decreased as decomposition time went on (Table 15). Result shows that cow dung decomposition time can influence the quality of cattle manure treated by IMO. Other factors influencing the chemical composition of cattle manure are; breed of the animal, diet of the cattle, and the conditions under which the manure is stored or handled (Van fassen and Van, 1987). Along the experimental time laboratory results showed any increase of Nitrogen, Phosphorus and Potassium. However, the Carbon and C: N ratio content was decreasing. The end products of this biological oxidation are carbon dioxide and water. Carbon dioxide is a volatile gas, it escaped during decomposition, result on total decrease of dry matter. According to Briggs and Courtney, (1993) this loss is necessary, and usually desirable to produce carbon nitrogen ratio that will benefit crops. Mineral nutrient will not be lost from manure unless they carried away by water. Some nutrients, like phosphorus, are relatively insoluble in water thus not easily leached, but others, like potassium, are easily carried away (Sperow and Keefer, 1975).

Table 15: Effect of cow dung decomposition time on N, K, P, C and C/N ratio

Day	N	P	K	C	C/N ratio
1	1.2	0.4	0.3	33.2	27.9
7	1.4	0.5	1.1	29.3	20.6
14	1.6	0.6	1.2	30.1	19.5
28	1.6	0.7	1.3	29.4	18.2
SEM	0.037	0.019	0.042	0.083	22.4
Significance level	*	**	**	*	*

*** = significant at $P < 0.05$, ** = significant at $P < 0.01$**

Table 16 shows the effect of cow dung treatments on N, P, K, C and C: N ratio. The extent on which treatment affected individual nutrient as decomposition time proceeded are demonstrated in Fig. 1, 2, 3, 4 and 5 respectively. Appendices III – IX shows the contribution of each source of variation on the respective nutrients. Generally, treatments did not influence N, P, C and Carbon: Nitrogen ratio (Appendix III, IV, VI and IX). Influence of treatment was observed on K only ($P < 0.01$) (Appendix V). However, decomposition time had an effect on all nutrients ($P < 0.001$) (Appendices III – IX).

Generally there were no significant different ($p < 0.05$) on the quality of manure produced after being treated by IMO cultured using different substrate. However, there were numerically different between the treatments. Result shows that cattle manure produced by T3 (IMO cultured using fish meal and cassava powder) had the same numerical value of N, as T1, T2, T6, T7, but higher when compared with the rest treatments (T5, T4 and T8 which had the least N). Also it has high P content than other treatments. This might be due to high protein content in fish meal and high content of carbohydrate in cassava powder.

Table 16: Effect of various cow dung treatments on N, P, K, C and C/N ratio

Treatment	N	P	K	C	C/N ratio
T1	1.5	0.5	1.0	32.1	21.7
T2	1.5	0.5	1.0	31.0	21.1
T3	1.5	0.6	1.0	30.4	20.0
T4	1.4	0.5	0.8	28.9	21.2
T5	1.4	0.5	1.2	28.6	19.8
T6	1.5	0.5	0.8	31.8	21.5
T7	1.5	0.5	1.0	31.5	20.8
T8	1.3	0.5	1.0	29.8	22.6
SEM	0.05	0.03	0.06	1.17	21.72

The Nitrogen level seemed to be at the same level at the commencement of the experiment for all treatments (Fig. 1). Variation in N levels started to be observed a week after, where higher N levels were observed in T1, T3, T4 and T7 respectively. It appears that, in the first week the rate of decomposition was very high and a lot of urea was rapidly hydrolyzed to ammonia carbonate (Briggs and Courtney, 1993).

The carbonate produced dissociates to give ammonium (NH_4). Much of this is lost through volatilization as ammonia gas (NH_3). In the second decomposition week N levels for all treatments with exception of T1 and T4 increased. In the fourth decomposition week N levels were nearly uniform when compared with previous weeks, and T4, T3 and T7 yielded lower N than the control (Fig. 1) this was an indication that cattle manure in treatment (T4, T3, and T7) decomposition was complete, and N was lost through volatilization as ammonia gas (NH_3) while T8 (control) the decomposition was still on process.

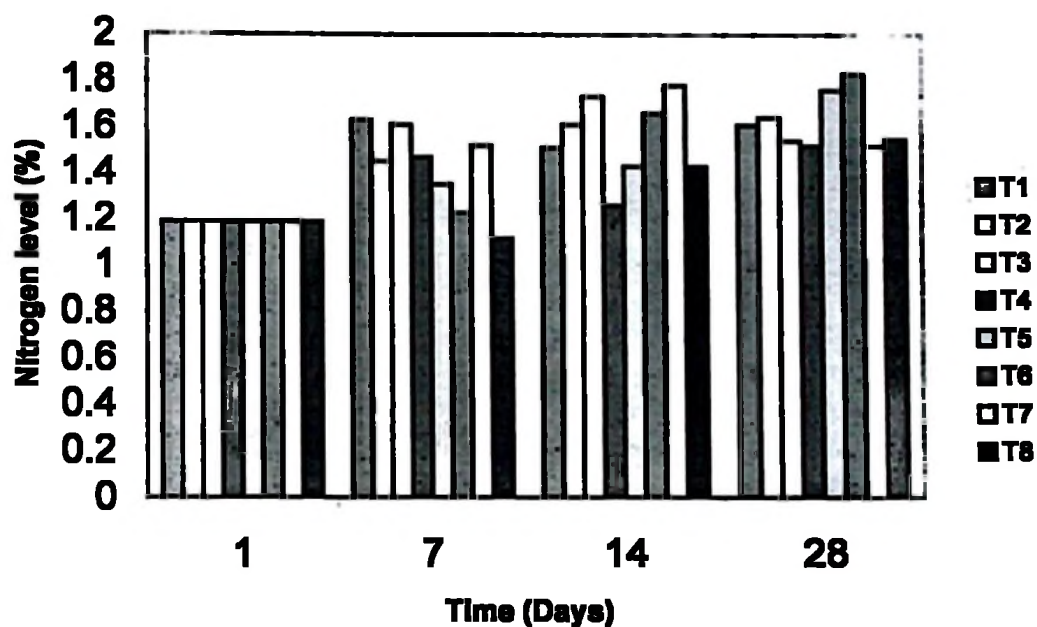


Fig. 1: Effect of different cow dung treatments on N levels

Figure 1: Effect of different cow dung treatments on N levels

Fig.2. shows the phosphorus (P) levels in various treatments at different decomposition time. All treatments had same level of P in day 1. Higher P levels were observed in T1 and T3 seven days after onset of decomposition. Treatments T3, T2, T7 and T6 showed to have high levels of P on the 14th day of decomposition. Low variations in P between treatments were observed in the 28th day of decomposition. Therefore, fourth week was the best time to utilize manure produced using any substrate in respect of phosphate (Fig. 2).

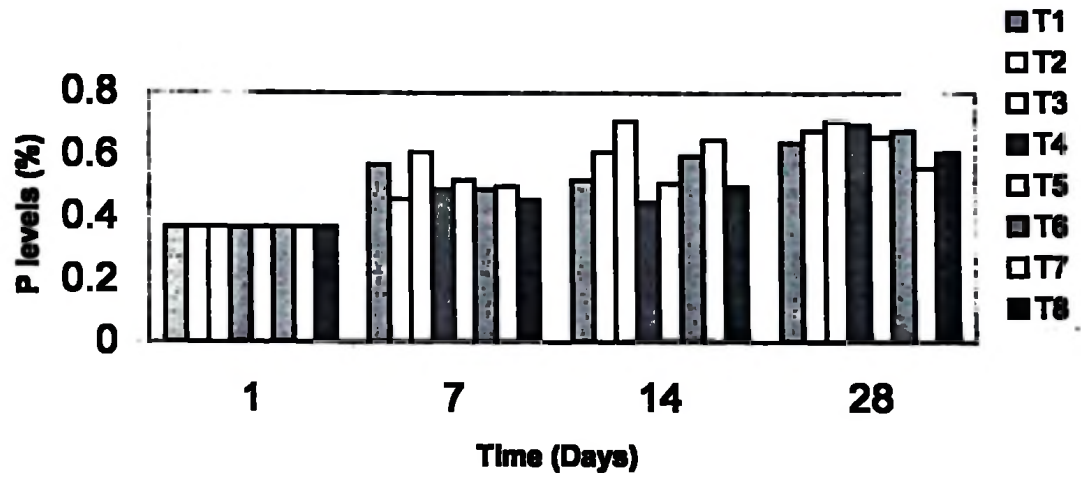


Fig. 2:Effect of different cow dung treatments on P levels

Figure 2: Effect of different cow dung treatments on P levels

Potassium levels in different treatments are demonstrated in Fig. 3. At the start of the decomposition experiment all treatments had a K level of about 0.26%. However, a rapid increase in K was observed a week after decomposition which proceeded up to the 2nd decomposition week. In the fourth week a rapid decline of K especially in T4 and T3 was observed.

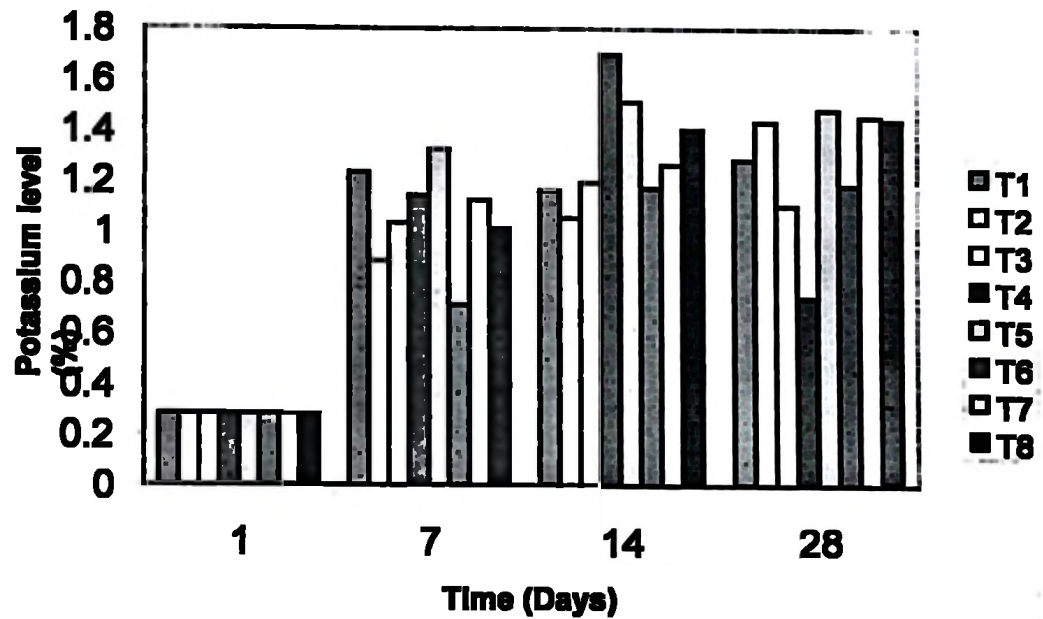


Figure 3: Effect of different cow dung treatments on K levels

Figure 4 demonstrates the carbon content in various treatments. With exception of T6 carbon seemed to decline as the experimental time went on. However, extent of decline varied between treatments.

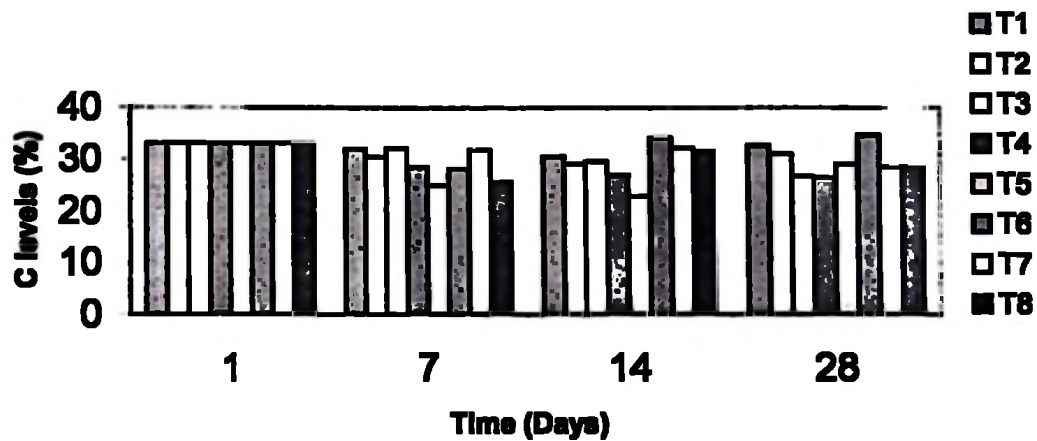


Figure 4: Effect of different cow dung treatments on C levels

The Carbon: Nitrogen ratio as decomposition time went on for all treatments is shown in Fig. 5. Similar C: N ratio was observed on the first day of decomposition. In the 7th day a rapid decrease in C: N ratio was observed in T2 while C: N ratio in other treatments decreased at a lower percent. The C: N ratio in T5 was similar to that of the control in the 14th day of decomposition. In the 28th decomposition day T7 showed similar C: N ratio to that of the control while T1 had C: N ratio which was higher than the control (Fig. 5).

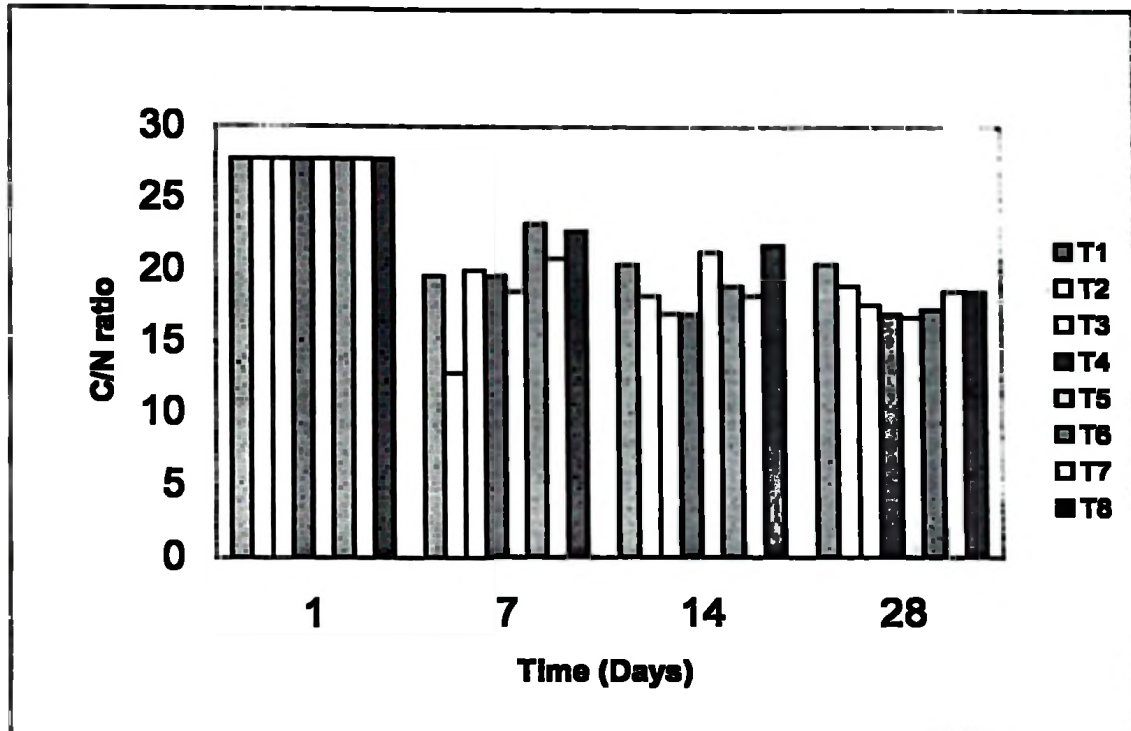


Figure 5: Effect of different cow dung treatments on C: N levels

Although there was no statistical ($P < 0.05$) difference on the quality of manure produced after being decomposed using different substrate, result shows that cattle manure produced by using IMO had a high numerical value of N, and low C/N ratio than control. Therefore any combination of substrate (energy and protein combination) can be used to culture the IMO and be used to decompose manure. Availability and the price of ingredient will determine the type of substrate which can be used to culture IMO.

4.2.2 Effect of treatments on sensory test

The effect of treatments on cow and pig dung decomposition as assessed by sensory test are presented in Tables 17 and 18 for smell and 19 and 20 for texture respectively. Analysis of variance (ANOVA) showing the extent at which treatment, decomposition time and panelist influenced the results are presented in Appendices VI and VII respectively.

Generally, treatments, panelist and decomposition time significantly ($P<0.01$ and $P<0.05$) influenced the sensory test smell (Appendix VI). For the texture evaluation only panelist and decomposition time had a significant ($P<0.05$) influence on the texture of the decomposed cow dung (Appendix VII).

Table 17: Least square means on effect of various treatments on cow dung and decomposition time on smell

Treatment	Day 7	Day 14	Day 28
CT1	79.9 ^{ab}	72.7 ^{ab}	65.7 ^{ab}
CT2	60.9 ^{bcde}	49.7 ^{cd}	60.0 ^{ab}
CT3	71.1 ^{abcde}	63.9 ^{abc}	68.0 ^{ab}
CT4	36.9 ^{cd}	36.5 ^d	42.3 ^b
CT5	32.4 ^e	38.7 ^d	69.4 ^{ab}
CT6	69.1 ^{abcde}	32.4 ^d	71.6 ^{ab}
CT7	85.7 ^{abc}	45.7 ^{cd}	63.1 ^{ab}
CT8	115.6 ^{ab}	89.7 ^a	94.6 ^a
Sign. Level	*	**	*

Note: C=Cattle manure, 1 – 30 = No smell at all, 31 – 60 = Slightly smelling, 61 – 90

Moderate smelling, 91 – 120 = Strong smelling, 121 – 150 = Very strongly smelling

Means bearing the same superscripts in the column are not statistically ($P<0.05$) different

* = significant at $P<0.05$, ** = significant at $P<0.01$

Table 18: Least square means on effect of various treatments on pig dung and decomposition time on smell

TREATMENT	Day 7	Day 14	Day 28
PT1	93.1	91.9 ^a	75.7 ^a
PT2	99.4	116.4 ^a	112.3 ^a
PT3	74.7	37.2 ^c	66.0 ^b
PT4	69.2	37.6 ^c	54.1 ^b
PT5	86.1	61.2 ^b	65.0 ^b
PT6	81.7	81.9 ^{ab}	73.0 ^b
PT7	66.6	64.4 ^b	73.6 ^b
PT8	78.1	75.6 ^b	71.0 ^b
Sign. Level	NS	**	*

Note: P= Pig manure, 1 – 30 = No smell at all, 31 – 60 = Slightly smelling, 61 – 90

=Moderate smelling, 91–120 = Strong smelling, 121 – 150 = Very strongly smelling

Means bearing the same superscripts on the column are not statistically ($P<0.05$) different

***= significant at $P<0.05$, ** = significant at $P<0.01$**

Results in Table 17 show that control treatment (CT8) had significantly higher smell evaluation score than the rest of cow dung treated with other treatments for the entire decomposition time (day 1-28). This is an indication that other treatments responded to the effect of IMO. However, CT8 did not differ statistically ($P>0.05$) from that of treatments CT1, CT6, and CT7, respectively in the first decomposition week. Cow dung treated with CT5 and CT4 had significantly ($P<0.05$) lower sensory evaluation score than the rest of the treatments. In the second decomposition week control treatment (CT8) improved and attained better smell than that of the first week and did not differ from that treated with CT1 and CT3 respectively. Cow dung treated with CT4, CT5, CT6, CT7 and CT2 respectively had lower sensory evaluation scores which did not differ statistically from

one another ($P>0.05$). In the twenty eight day decomposition higher scores were observed in all cow dung treatments which did not differ statistically from each other. The trend expected was the score to decrease; instead the score increased in the third week. Increase of score may be was due to the change of members of the panel who participated in sensory evaluation therefore, failed to compare the score with that of the previous week. However, cow dung treated with CT4 persistently continued to have lower sensory evaluation scores than the rest of cow dung in other treatments hence the best performance in reducing the smell of decomposed cattle manure ($P<0.05$) (Table 17).

Table 18 shows the effect of different treatments on the pig dung decomposition. It shows that there were no significant different between the treatments in the first decomposition week. Pig dung treated with PT2, PT1 and PT6 had highest sensory evaluation scores ($P<0.001$) which did not statistically differ from one another. Pig dung treated with PT3 and PT4 had significantly lower sensory evaluation scores than the rest of the pig dung in other treatments ($P<0.01$) in the second decomposition week. Higher scores were observed in the fourth decomposition week. The trend expected was the score to decrease; instead the score increased in the fourth week. Increase of score might be due to the changes of panelist who participated in the excise after former panelist being away. However, PT2 and PT1 had highest scores compared to the other treatments (Table 18).

Generally T4 in both cattle and pig manure had lower score (slightly smelling). In consideration of N, P, K and C/N, Treatment 4 had higher N, equal P, lower K, and lower C/N than the control (Table 15). Therefore, *Moringa oleifera* leaves and Molasses can be used to culture IMO which can be used to reduce the smell of animal manure.

Table 19 and 20 shows the mean scores of cow and pig dung treatments on texture. The results show that there were no significant differences on the texture of the decomposed

manure of different treatments. However, in day 28 cow dung and pig manure treated with CT4 and PT4 had numerically lower scores than the rest of the treatments (Table 19 and 20

Table 19: Effect of various treatments on cow dung and decomposition time on texture

Treatment	Day 7	Day 14	Day 28
CT1	81.9	80.7	68.1
CT2	63.4	62.2	69.6
CT3	67.1	67.7	58.0
CT4	69.2	70.6	49.0
CT5	80.7	72.7	65.6
CT6	81.7	81.9	72.0
CT7	66.6	64.4	73.6
CT8	78.1	75.6	71.0
Sign. Level	NS	NS	NS

Note: 1 – 30 Very fine, 31 – 60 = Fine, 61 – 90 Coarse, 91 – 120 = Very coarse, 121 – 150 = Extremely coarse.

Table 20: Effect of various treatments on Pig dung and decomposition time on texture

Treatment	Day	Day 14	Day 28
PT1	91.1	91.6	64.6
PT2	91.1	103.6	84.3
PT3	91.1	78.2	67.0
PT4	75.9	75.6	64.0
PT5	74.7	110.4	72.0
PT6	72.4	90.2	90.0
PT7	89.9	70.1	77.6
PT8	89.9	75.1	83.71
Sign. Level	NS	NS	NS

Note: 1 – 30 very fine, 31 – 60 = fine, 61 – 90 course, 91 – 120 = very course, 121 – 150 = extremely course.

R^2 (Appendix 8&9) indicate that only 40 and 25% respectively of the result was due to parameters measured. Other 60% perhaps was due to change of panelist or different moisture content.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the result obtained from the study it can be concluded that:

- i. Insufficient knowledge on how to manage manure, location of large farms far away from animal shade, labour, required during transportation and manure application were identified as the major limitations of manure production, management and utilization in Turiani division.**
- ii. There was no statistical ($P < 0.05$) difference on the quality of decomposed manure produced by different treatments; therefore any combination of substrate (energy and protein combination) can be used to culture the IMO. Availability and the price of ingredient will determine the type of substrate which can be used to culture IMO.**
- iii. IMO can effectively be used to reduce odour emission and improve texture of livestock manure.**

5.2 Recommendations

- i. There also a need to plan and conduct training specific on manure handling, management and utilization. The emphasis should be on proper use of IMO and its importance in increasing productivity and maintaining good environment in the area.**

- ii. Gender and livestock industry should be streamlined in the whole process of the planning cycle on livestock management with special emphasis on manure production, storage and utilization.**

REFERENCES

- Agboola, A.A and Akinifesi, P.K. (1991). Soil fertility management for the humid tropic of Africa. In: *Soil and water management for sustainable productivity*. Second African Soil Science Society Conference Proceedings. 22-27 November, 1991 Cairo, Egypt pp 106-110.
- AOAC (1990). *Association of Official Agricultural Chemists*. Official methods of Analysis. 15th Ed. 2200 Wilson Boulevard, Arlington. Virginia, USA. pp 69-88
- Bockman, O.C, Kaarslad, O, Leie, L.H and Richards, I. (1990). *Agriculture and Fertilizer*. Agriculture Group, Norsk Hydro a.s. Oslo, Norway, 245pp.
- Briggs, D. and Courtney, F. (1993). *Agriculture and Environment*. Longman Ltd. Uk. 166pp.
- Burke, L. M. and Lashof, D.A. (1990). Green house gas emission related to agriculture and land use practices, In: *Impact of carbon dioxide, trace gases and climate change on global agriculture*. ASA Special publication 53 ASA (American society of agronomy) Madison, Wisconsin; USA pp. 27-43.
- Defoer, T., Bubeleman, A; Toulmin, C., Cater S. and Ticheler, J. (1998). *Soil fertility management in Africa*. Resource guider for Participatory Learning and Action Research part 1. pp 1-59.
- Hawassi, F.G.H. (1997). Effect of fertilizer subsidy removal of fertilizer use on maize production in Mbinga district. Dissertation for award of Msc degree at Sokoine University of Agriculture. Morogoro Tanzania, 80pp.
- Hodgson, J. (1990). *Grazing management science into practice*. John Wiley and sons inc., 605, Third Avenue, New York, NY 10158. Longman Group UK Limited. pp 110-112.

- Jackson, H.L. (2005). **Assessment of Livestock Manure Production, Management and Utilization in the Southern Highland of Tanzania. Dissertation for award of Msc Degree at Sokoine University of Agriculture 108pp.**
- Jaiswal, P.L; Wadhvani,A.M; Jain,M.K and Chhabra. (1971) ***Handbook of Manure and Fertilizers***. India council of Agriculture research, 2nd ed ; New Delhi, 396pp
- Juo, A.S.R. (1979). ***Methods of Plant and Soil Analysis***. Manual series no.1. International Institute for Tropical Agriculture, Ibadan, Nigeria, 65pp.
- Kirchmann, H. (1995). Losses, plant uptake and utilization of manure nitrogen during production cycle. ***Acta Agriculture Scandinavia***. Supplement 24.pp76-92.
- Lamund,E. (1977). ***Laboratory methods for sensory evaluation of food***. Food research institute Ottawa ont. Research branch Canada department of agriculture publication, Ottawa 278pp.
- Lekasi, J.K; Tanner,J.C; Kimani, S.K. and Harris, P.J.C.(2001). ***Manure Management in the Kenya Highlands***. Practical and Potential, Second edition. Emmersons, Farmer Ward Road, KENILWORTH, KU.35pp.
- MAFS (2002). **Tanzania main land: Basic data agriculture sector 1994/95-2000/01**
- MALD (1996). **Ministry of Agriculture and Livestock Development, Kilimo/FAO fertilizer program: *National fertilizer reports*, 100pp.**
- McCalla, T.M. (1975). Use of animal waste as a soil amendment. In: **FAO: *Organic Material as Fertilizer***. Rome. 88pp.
- McDonald, P., Edward, R..A., Greenhalgh, J. F. and Morgan, C.A (2002). ***Animal nutrition***. 6th Edition Ashford Colour Press Ltd. Gosport.693pp.
- Mhite, A.R. (2000). **Analysis of households. Coping strategy against seasonal food insecurity: the case of Kilosa district. Dissertation for award of MSc at Sokoine University of Agriculture, Morogoro, Tanzania. 121pp.**

- Miller, C.E. (1965). *Fundamentals of Soil Science*. National Academy Press USA, 364pp.**
- Minich, J and Hunt, M. (1979). *The rodale guide for composting*. Emmaus, Rodale Press, USA 405pp.**
- Mlozi, M.R.S. (1996). Urban agriculture in Dar es salaam: Its contribution to solving the Economic crisis and damage it Does to the Environment. *Development Southern Africa* 13(1): 47-65.**
- Mlozi, M.R.S. (1997^a). Tanzania urban and peri-urban livestock farming and the environment. In: *Proceeding of the 24th scientific conference of the Tanzanian society of animal production*, Arusha Tanzania 5-7 august ,1997. pp 43-57.**
- Mlozi M.R.S. (1997^b) Impacts of Urban Agriculture in Dar es salaam, Tanzania. *The environmentalist* 17: 115-124.**
- Mlozi M.R.S. and Hella J. (2001). Urban agriculture: *Linkage Between Poverty Alleviation and Damage on environment*: Research Report submitted to the Tanzania commission for science and Technology, Dar es salaam, Tanzania.152pp.**
- Mnkeni, P.N.S. (1989) A Review of Soil fertility and fertilizer use research and recommendations in Tanzania. In: *Proceeding of East and Southern African Management and Evaluation Workshop*. (Edited by Ssali,H; Williams,L.B). Nairobi Kenya. 27-29 May 1987. 129pp.**
- Mosha A. (1991). Urban Farming Practices in Tanzania. *Review of Urban and Rural planning in Southern and Eastern Africa*. Arusha Tanzania.1: 83-92.**
- Mugwira, L.M. and Murwira,H.K. (1997) Use of cattle manure to improve soil fertility in Zimbabwe: past and current research needs CIMMYT maize programme and natural resources group. *Network Research Results working paper no.2*: 1-129pp.**

- Muller-Samann, K.M and Kotschl, J.P. (1994). *Sustaining Growth. Soil fertility management in the tropical smallholdings*. Margraf Verlag. Germany.460pp
- Murwira, L.M. (1984). Relative effectiveness of fertilizer and communal area manure as plant nutrient sources. *Zimbabwe Agriculture Journal* 81:81-89.
- Murwira, H.K. (1995). Ammonia Volatilization from Zimbabwe cattle manure before and after application to the soil. *Tropical Agriculture Journal* 72:267-274.
- Njoroge, W. J. (1994). *Field Notes on Organic Farming*. KIOF, Kenya 24 pp
- Palm, C.A., Myer, R.J.K and Nandwa, S.M. (1997). Combined Use of Organic and Inorganic Nutrient Sources for Soil Fertility Maintenance and Replenishment. in: *Replenishing Soil Fertility in Africa* (Edited by Buresh, J.R., Sanchez, P.A and Calhoun) Madson, Wisconsin, USA. 193-217 pp.
- Powell, J.M; Fernandez-River S and Hofa S. (1993) Effects of sheep diet nutrient cycling in mixed farming system of semi arid West Africa. *Agriculture Ecosystem and Environment* 48:263-271
- Powell J.M; Fernandez-Rivera, S; Williams T.O and Renard C. (1995) Livestock and Sustainable Nutrient Cycling In Mixed Farming Systems of Sub-Saharan Africa. Volume II: Technical paper. *Proceedings of an international conference*. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia, 22-26 November, 1993. 3- 568pp
- Rafiy, S; (2004). Management and utilization of animal manure as resources for crop production under two major grazing systems in Tanzania. [<http://www.developmentgateway.org>] site visited on 29/8/2006.
- Raussen, T. (1997). *Integrated soil Fertilizer Management on Small-scale farms in eastern province of Zambia*. English press Ltd. Nairobi, Kenya. 87pp
- Rynk, B. (May 2006). Composit: Education and Resources for Western Agriculture. ([http:// www. Este.use.edu/compost/index.htm](http://www.Este.use.edu/compost/index.htm)) site visited 16/05/2006

- Safari, J. Lekule, F.P., Sarwatt, S.V., Mollel, E.L. and Makauki, A.F. (2000).** A study of some aspects of dairy management practices of farmers in Morogoro rural district. A study of SURUDE, and HPI. Beneficiaries in Turiani Division. In: *proceedings of the 27th scientific conference of the Tanzanian Society of Animal Production* (Edited by Mbagu S.H. et al.) 3-5 August 2000, Dar Es Salaam Tanzania. pp18-27.
- SAS (2004) Statistical Analysis Instituted System. SAS/ STAT user's guide Release 8.01 Ts Level OIMO. Statistical Analyzing Institute, INC. Carry NC. USA. 1 028pp.**
- Schleich, K. (1986).** The use of cattle dung in agriculture. *National resources and Resourses Development* 23:53-87.
- Shem. M.N. (1986).** Dry season feeding practice in smallholders farms in Kilimanjaro region- Tanzania. Dissertation for award of MSc Thesis Degree at University of Guelph. Total No of pp 4.5.pp
- Sperow, B.C. and Keefer, R.F. (1975).** *An Introduction to Soil Science Applied to East Africa, Morgantown.* West Virginia USA. 350pp
- SPSS (1996).** SPSS for windows. Advanced Statistics.SPSS (statistics package for social science). Release 6.0 Published by SPSS Ins. 660pp.
- URT (2002).** United Republic of Tanzania population census (<http://www.tanzania.go.tz/census/report.htm>) site visited on 22/7/2007.
- Van fassen H.G and Van D.J.K. (1987).** Manures as a sources of nitrogen and phosphorus in soils. Animal manure on grassland and fodder crops: Fertilizer or waste? *Development in plant and soil sciences* 30:27-45.
- Van Soest, P.J. (1982) *Nutritional Ecology of the Ruminant.* O&B books, Corvallis, Oregon, USA. 374PP.**

APPENDICES

Appendix 1: Questionnaire

BACKGROUND DETAILS

Village/ areas

District

Farm classification 1=Urban, 2=Peri-arban, 3=Rural []

Name of respondent.....

Role of respondent 1= Head of the household, 2=Attendant, 3=Relative,
4=Other household member (specify)..... []

Sex of respondent 1=Male, 2=Female []

Date of interview

SECTION A: GENERAL INFORMATION

CHARACTERISTICS OF THE FARMER AND HOUSEHOLD

A1: Householder name

A2: Sex of the householder 1=Male, 2=Female []

A3: Martial status of the householder 1=Single, 2=Married,
3=Divorced, 4=Widow, 5=Separated 6=Other specify..... []

A4: Education level 1=Primary school, 2=Ordinary level, 3=Advanced level,
4=Higher education, 5=Adult education 6=Illiterate []

A5: What is your age? (Years)

A6: How many people are in your household? (Number)

A7: How many people living in the house are able-bodied adults? > (15yrs) number
.....

A8: How much land do you have? (Acres)

A9: What is your main source of income?
1=Crop farming, 2=Dairy farming, 3=Other Livestock farming
4=Trading/commercial activities, 5= External assistance, 6=others (specify) []

A10: Do you employ labor at any time of the year? 1=Yes or 2=No []

A11: If yes, what type of labor do you employ in your farm?

1=Permanent (>6month), 2=Temporary (1-6months), 3=Casual (on daily bases) []

CROP PRODUCTION

A12: Which crop (3main) do you cultivate?

<i>s/no</i>	<i>Crop</i>	<i>hactors</i>	<i>Yield/hactors</i>
1			
2			
3			

A13: Do you ever use commercial fertilizer? 1=Yes 2=No []

If yes which crops?

<i>S/no</i>	<i>Crop</i>	<i>Rate of app.(Kg/ha)</i>	<i>Frequency of app. 1=often 2=occasionally</i>
1			
2			
3			

If no why?

- 1.....
- 2.....
- 3.....

A14: Do you often apply animal manure to your farm? 1=Yes 2=No []

If yes which crops?

<i>S/no</i>	<i>Crop</i>	<i>Rate of application (t/ha)</i>	<i>Frequency of application 1=often,2=occasionally</i>
1			
2			
3			

If no why?

- 1.....
- 2.....
- 3.....

A15: If not using neither commercial fertilizer nor animal manure, how do you maintain soil fertility?

- 1.....
- 2.....
- 3.....

LIVESTOCK DETAILS.

A16: How many cattle do you own? (Number) []

A17: When did you start keeping dairy animals (Year) []

A18: How did you get your first animal?

1=Bought using your own money, 2=Bank loan, 3=Gift from relatives/friends []
4=others (specify).....

A19: How many are local (Number) []

A20: How many are crosses (Number) []

A21: How many of the following animals do you have on your farm?

Animals	Adult (breeding age +)	Young stock (<breeding age)	Total	Purpose 1=Cash, 2=Food 3=Both 4=Others(specify)
Pigs				
Goats				
Sheep				
Donkeys				
Chickens				
Others eg.rabbits,ducks, guinea etc				

A22: Have you ever received training on dairy management? 1=Yes 2=No []

If yes give the details in the table below

Organizer&venue	Financial contribution to the course 1=Free, 2= Partial, 3= full	Year	Course content

A23: Did household member attend any manure production, handling and utilization training course in the last five years? 1=Yes or 2=No. []

If yes give the details in the table below

Organizer&venue	Financial contribution to the course 1=Free 2=Partial 3=full	Attendant 1=Husband 2=Wife 3=Son 4=Daughter 5Attendant 6=Relatives 7=Others	Year	Course content

A24: What constraints in relation to manure management do you face? (list them and rank them in ascending order)

Constraints	Rank

SECTIONB: MANURE MANAGEMENT

MANURE PRODUCTION

B1: How often do you remove manure from the cowshed?

1= every day

2=every week

3=after two weeks

4=others (specify)

[]

B2: Do you place beddings to animal barn? YES OR NO

[]

If no why 1.....

2.....

3.....

If yes what type of bedding material do you use?

1.....

2.....

3.....

4.....

5.....

B3: How were you dairy animal housed?

1 Cowshed with roof

2 Cowshed without roof

3 Kraal/boma

[]

B4: What challenges do you face in manure production?

1.....

2.....

3.....

4.....

5.....

MANURE HANDLING

B5: How do you handle manure?

1. Pile outside

2. Pile under-shed

3. Composite making

4. Others (specify).

[]

B6: Who do the following farm activities?

Activities	1=Husband, 2=Wife 3=Son 4=Daughter 5=Attendant 6=Relatives
Cleaning cowshed /sanitation	
Manure handling	
Manure disposal /utilization	
Selling of manure	

B7: How long do you need to store the manure before it is applied in the farm?

1 Month

1-2 Month

2-4 Month

>4 Month

[]

MANURE DISPOSAL/UTILIZATION

B8: How did you dispose of manure in 2006?

Pile out close to the cowshed

1=Yes or 2=No

[]

Put on pasture plots

1=Yes or 2=No

[]

If yes, 1=dug in or 2= spread on the surface of the field

[]

Put onto the garden

1=Yes or 2=No

[]

If yes, 1=dug in or 2= spread on the surface of the field

[]

Turn into biogas

1=Yes or 2=No

[]

Burn it

1=Yes or 2=No

[]

Give to neighbors (free)

1=Yes or 2=No

[]

Sell to others

1=Yes or 2=No

[]

Leave it in the pile

1=Yes or 2=No

[]

Others (specify.....)

Appendix 2: Focus group discussion

Members: Livestock keepers, Livestock neighbors, technical

Topics discussed:

- 1. What are the opportunities and constraint available in manure management?**
- 2. What strategies employed to ensure nutrient recycling to the soil?**
- 3 How do you ensure good environment when you dispose/utilize animal manure?**
- 4. What are the challenges related to manure disposal and utilization?**
- 5. Do you benefit from animal manure generated by your neighbor's livestock keepers? Yes or no?**
If yes how?
- 6. Have you experienced an annoyance due to odor emission or improper manure disposal?**

Appendix 3: ANOVA for N

SV	DF	SS	MS	F- value	Pr >F
Day	3	2.21	0.74	31.17	0.0001
Treat	7	0.28	0.04	1.71	0.1340
Day * Treat	21	0.98	0.05	1.97	0.0319
Error	40	0.94	0.02		
Toss	71	4.41			

 $R^2=0.786$

Coeff.. Var=10.586

N mean=1.451

Appendix 4: ANOVA for P

SV	DF	SS	MS	F- value	Pr >F
Day	3	0.85	0.28	44.58	0.0001
Treat	7	0.07	0.01	1.65	0.1501
Day * Treat	21	0.12	0.01	0.93	0.5617
Error	40	0.25	0.01		
Toss	71	1.30			

 $R^2=0.805$

Coeff.. Var=15.197

P mean=0.525

Appendix 5: ANOVA for K

SV	DF	SS	MS	F- value	Pr >F
Day	3	11.31	3.77	124.59	0.0001
Treat	7	0.77	0.11	3.65	0.0039
Day * Treat	21	1.18	0.06	1.85	0.0462
Error	40	1.21	0.03		
Toss	71	14.47			

 $R^2=0.916$

Coeff.. Var=18.453

K mean=0.943

Appendix 3: ANOVA for N

SV	DF	SS	MS	F- value	Pr >F
Day	3	2.21	0.74	31.17	0.0001
Treat	7	0.28	0.04	1.71	0.1340
Day * Treat	21	0.98	0.05	1.97	0.0319
Error	40	0.94	0.02		
Toss	71	4.41			

 $R^2=0.786$

Coeff.. Var=10.586

N mean=1.451

Appendix 4: ANOVA for P

SV	DF	SS	MS	F- value	Pr >F
Day	3	0.85	0.28	44.58	0.0001
Treat	7	0.07	0.01	1.65	0.1501
Day * Treat	21	0.12	0.01	0.93	0.5617
Error	40	0.25	0.01		
Toss	71	1.30			

 $R^2=0.805$

Coeff.. Var=15.197

P mean=0.525

Appendix 5: ANOVA for K

SV	DF	SS	MS	F- value	Pr >F
Day	3	11.31	3.77	124.59	0.0001
Treat	7	0.77	0.11	3.65	0.0039
Day * Treat	21	1.18	0.06	1.85	0.0462
Error	40	1.21	0.03		
Toss	71	14.47			

 $R^2=0.916$

Coeff.. Var=18.453

K mean=0.943

Appendix 6: ANOVA for C

SV	DF	SS	MS	F- value	Pr >F
Day	3	169.35	56.45	5.13	0.0043
Treat	7	113.91	16.27	1.48	0.2028
Day * Treat	21	198.55	9.45	0.86	0.6379
Error	40	440.35	11.01		
Toss	71	922.15			

 $R^2=0.522$

Coeff.. Var=10.827

C mean=30.646

Appendix 7: ANOVA for C/N ratio

SV	DF	SS	MS	F- value	Pr >F
Day	3	0.0038	0.0013	52.32	0.0001
Treat	7	0.0003	0.00004	1.56	0.1748
Day * Treat	21	0.0005	0.00002	1.0	0.4865
Error	40	0.001	0.00002		
Toss	71	0.0056			

 $R^2=0.825$

Coeff.. Var=10.360

CNR mean= 22.500

Appendix 8: ANOVA for sensory test smell

SV	DF	SS	MS	F- value	Pr >F
Panelist	6	48641.32	8106.89	5.94	0.001
Day	2	10140.77	5070.39	3.72	0.0257
Treat	15	145630.62	9708.71	7.2	0.0001
Day * Treat	30	29080.62	969.35	0.71	0.8687
Error	250	341031.08	1364.12	3.3	
Toss	303	574524.41			

 $R^2=0.406$

Coeff.. Var=49.62

N mean= 74.43