School of Built Environment and Development Studies Faculty of Humanities

University of KwaZulu-Natal Howard College Campus South Arica

TOPIC:

EXAMINING PRACTICES AND TRADITIONS OF WASTE RE-USE AS AN ALTERNATIVE FEEDSTOCK IN THE POULTRY INDUSTRY IN KWAZULU-NATAL, SOUTH AFRICA

.

Thesis Submitted in Fulfillment of the Requirements for the Award of a Master's Degree in Development Studies

Presented by:

Karina Chetty

SUPERVISOR: PROFESSOR OLIVER MTAPURI
CO-SUPERVISOR: DR MARC KALINA

DATE: ……

SUPERVISOR'S SIGNATURE

……..

CO-SUPERVISOR'S SIGNATURE

…….……..

ABSTRACT

The overarching aim and the purpose of this case study was to examine the practices of the poultry industry's waste re-use as an alternative feedstock for enhancing the livelihood of Urban Farmers in KwaZulu-Natal, South Africa. In the study, the researcher relied on 13 in-depth interviews which required the participants to share their knowledge and experiences in the poultry industry. Qualitative methodology was used, with thematic analysis to analyze the data. Purposive and snowball sampling was the method of sample selection, and interviews and questionnaires were employed for data collection. A theoretical framework for discussing and studying indigenous knowledge as a theory of communication that fluidly operates within and outside of modernity, was adopted. This discussion is part of a continuance of public conversations on the path of indigenous knowledge in development studies, and communication research. The main findings were that there were many environmental concerns regarding poultry waste. These can be solved by proper waste management systems, which were shown by the different waste management re-use practices that were adopted over the years by the different poultry sectors in South Africa. The other finding was that using poultry by-products as fertilizers in soil proves to have a positive crop yield throughout the year and solves the disposal problems from poultry waste. One of the key conclusions was that poultry does not only serve as a healthy source of protein but is also economical for both farmers and consumers. This study showed that there are more female farmers that are integrated into the poultry farming sector. To minimize the negative impacts brought by the poultry industry, there needs to be proper waste management implementations, as known by the numerous sustainable re-use patterns.

DECLARATION

The Registrar, Academic University of KwaZulu-Natal
Durban
South Africa

I, **Karina Chetty** (Student number **213561282**), declare that the thesis titled: **Examining practices and traditions of waste re-use as an alternative feedstock in the poultry industry in KwaZulu-Natal, South Africa** is my original research.

This thesis has not been submitted for any degree or examination at any other university.

1. The graphs and other information entailed have been acknowledged.

2. This thesis does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:

    a. Their words have been reworded but the general information attributed to them has been referenced.

    b. Where their exact words have been used, then their writing has been placed in italics and inside quotation marks and referenced.

3. This thesis does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged, and the source being detailed in the thesis and in the References sections.

Sign Date

…….. …….

DEDICATION

I dedicate this study to my friends, family and those who helped me along this journey.

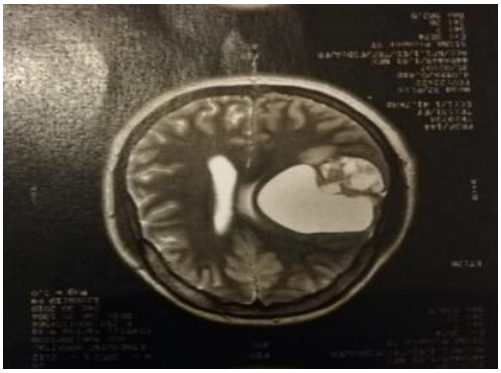
ACKNOWLEDGEMENTS

What this says on a spiritual level is that we can never really know what direction life will take, what changes those small butterfly flutters of intention and action might cause in our destiny. And at the same time, it also tells us that we can never truly know the mind of God. We can never fully understand the how, where, and when of anything, even something as simple as boiling water. We must surrender to uncertainty, while appreciating its intricate beauty.

Synchrodestiny: Harnessing the Infinite Power of Coincidence to Create Miracles (Deepak Chopra 2005:30)

On 29 December 2019, I found out that I had brain cancer, and the tumor was removed on 31 December 2019. Further tests and scans showed that there was a recurrent tumor in the surgical site. I required further urgent surgery to debulk this tumor on 1 June 2020. Due to the second surgery, I had developed 3-point palsy which affected my mouth, numbness in my left hand as well as impaired vision. During a routine scan in July 2022, another tumour was picked up and I had to undergo a third surgery to debulk the tumour on 10 August 2022. Thus, as a young Masters' student, this has truly been a challenging time for me. Through this trying time in my life, I have never given up hope and my faith in God. I would like to thank my friends and family for their unconditional love and support during this trying time.

To my mentor and supervisors, Professor Oliver Mtapuri and Dr. Marc Ronald Kalina, thank you for your time and patience in encouraging and guiding me when it seemed impossible. I will forever be grateful for your wisdom, guidance, and expertise. I would also like to acknowledge the contribution made by the research participants in the completion of this work.



MRI scan of the Ependymoma of my brain

ABBREVIATIONS

ANF	Anti-Nutritive Factors
AWMS	Agricultural Waste Management System
As	Arsenic
BSE	Bovine Spongiform Encephalopathy
CH4	Methane
COD	Chemical Oxygen Demand
CO	Carbon Monoxide
CO2	Biogenic Carbon Dioxide
Cu	Copper
DDGS	Distillers Dry Grains with Soluble
FAO	Food and Agricultural Organization
GFC	Grain Field Chickens
GDP	Gross Domestic Product
IKCS	Indigenous Knowledge Communication Systems
ITAC	International Trade Administration Commission of South Africa
K	Potassium
N	Nitrogen
NOx	Nitrogen Oxides
NPN	Non-Protein Nitrogen
NRC	National Research Council

NSP	Non-Starch Polysaccharides
Mt	Million tons
P	Phosphorus
Poultry CRC	Poultry Co-operative Research Centre
SADC	Southern African Development Community
SDG	Sustainable Development Goals
SFRB	Scavenging Feed Resource Base
SME	Small Medium Enterprise
SMB	Small and Medium Enterprises Survivalists and Micro-Businesses
SMMEs	Small, Medium and Micro Enterprises
UN	United Nations
WTO	World Trade Organization
Zn	Zinc

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Introduction

The agriculture sector is one of the best ways for an estimated 7.8 billion people (Worldometer, 2020), from around the world, to trade and produce their way out of poverty and inequality. It is consequently imperative to connect small-scale farmers to integrate and market them into a more commercial, formalized value chain (Louw, 2017). In South Africa, agriculture can be considered as a dual industry, with the commercial farmers at one end of the spectrum and the small-scale farmers at the other (Aliber, 2014). Even though a large percentage of these households cite the reasons for the participation in agriculture as 'obtaining extra food' (Louw, 2017), one can assume that the large share of all these farmers would also be persuaded to reap and gain the economic benefits that are associated with surplus trade and production (Louw, 2017).

The problem, which is specific to South Africa, but connected to the conception of livelihoods and poverty reduction, is transforming. Because of the history of segregation and apartheid, South Africa is plagued by a tremendously unequal income distribution source and is often associated with the marginalization of countless poor people, and the previously disadvantaged households from the mainstream economy. Due to this, South Africa's economic developmental policies are a broad-based industry path. At first glance, the poultry industry appears to be an idyllic platform to accomplish all that is proposed. This is premised on the dispute that chicken production does not involve large tracts of scarce land that have low entry costs and signifies a prevalent enterprise for new producers, more particularly at a subsistence level (Clauer, 2013).

Fertilizer by-products are impending for being recycled on the agricultural land. The beneficial use over land use is founded on their capacity to favorably alter the soil properties such as water holding capacity, organic matter content, soil tilth, cation

exchange capacity, plant nutrient availability, and soil reaction (pH). Poultry waste encompasses all the essential nutrients that include micronutrients; this has been well documented and offers a valuable source of plant nutrients, more especially to organic growers (Preusch, 2016).

Adding poultry manure to the soil not only helps to resolve the issues with disposal problems but also enhances the biological, physical, and chemical fertility of soils (Friend, 2018). Incessant cultivation of arable soils frequently results in the corrosion of the soil structure which leads to abridged crop yield. Adding poultry manure has shown to progress the richness of the cultivated soil by oxygen diffusion rate, the aggregate stability of the soil's cumulative organic matter content, and water holding capacity (Mahimairaja, 2015). The optimum usage of manure by- products necessitates knowledge of their composition, not only relative to favorable uses but also to environmental implications (Bolan, 2016).

Environmental concerns that are associated with land application of fertilizer by-products from intensive animal operations include leaching losses of nitrogen (N) in sub-surface groundwater and drainage. The contamination of surface water with soluble and particulate phosphorus (P), reduced air quality by emission of volatile organic compounds, greenhouse gases, and increased metals input (Williams, 2013). Upholding the eminence of the environment is an important deliberation when developing management practices to efficiently use manure by-products as a soil conditioner and nutrient resource in horticultural and agricultural production systems (Wolf, 2016).

Most environmental problems are associated with unsuitable practices of the appliance of manure by-products on land that has centered on the pollution of surface and groundwater with the two major nutrients, P and N (Wolf, 2016). Though manure by-products may also comprise other potential toxic trace elements such as zinc (Zn), arsenic (As), and copper (Cu), this still has received little attention (Bolan, 2016).

Poultry manure addition for example, is thought to be one of the main sources of arsenic (As) input to soils. In Delaware-Maryland-Virginia (Delmarva) Peninsula, along with the Eastern shore of the United States of America (USA), over 40 tons of Arsenic (As) was introduced per annum to the environment using Arsenic (As) compounds such as roxarsone, in order to control the coccidiosis in poultry birds in the United States (Christen, 2011). Conversely, it is important to know that (As) compounds are not normally used to control coccidiosis in countries like New Zealand and Australia. In order to counterbalance the environmental risks of fertilizer land application, (Edwards, 2019) pointed out that "to reduce the risk of offsite contamination, land application guidelines should be developed that considers the total composition of the manure by-products rather than only one component, for example, N or P concentration" (Bolan, 2016, p.6). The concentration of these trace elements in by- products and poultry litter can be reduced by controlling the quality of mineral additives and raw feed materials (Bolan, 2016).

1.2 The Poultry Industry in South Africa

According to STATSSA (2017), there are approximately 6 million households in South Africa which consist of the smallholder agricultural Africa's poultry eggs and meat that has grown at an astounding rate. Each year, Africa imports an additional two million metric tons of poultry products that are valued at close to US$3 billion to meet the domestic demand (Sandrey, 2013). In 2012, over two million tons of eggs and five million tons of poultry meat were consumed in Africa. African people have grown accustomed to consuming poultry and eggs due to this being a cheaper alternative, with consumption growing because of the rapidly increasing population (Smallstarter, 2019).

Around 800 000 to 850 000 chickens are slaughtered every week (Botha, 2018). When Phase 1 of this project is complete, the figure would possibly increase to 1.2

million chickens every week. Grain Field Chickens (GFC) is owned by VKB Agri Processors. The GFC workers' trustees own their own suppliers of chickens, abattoirs, and fowl houses (Botha, 2018).

GFC's main core values are based on good old business principles that are communication, respect, and honesty. In this business, quality and quality services are non-negotiable. GFC's main purpose is to form a business that is favored by suppliers in South Africa by forming an extension of product range and basic business principles. The GFC relies on creating value for the South African consumer, local job creation, and locally farmed produce (Botha, 2018).

1.3 Improving the Urban Economy and Reducing Food Insecurity

During 2014, China's poultry agriculture production output appreciated (Liu et al., 2017) which is estimated at 656.9 billion US$, whilst India is ranked second. Brazil formed around 100.9 billion US$. The BRICS countries had contributed to total more than 40% of the international agricultural significance (Liu et al., 2017). The increasing acknowledgment of agro-industrial waste usefulness and practicality has significantly been easing the extreme burden of food insecurity. This has also improved the economy due to the incredible management and utilization of poultry waste as an alternate substitute to synthetic fertilizer which is the main ingredient for improving production and soil output (Liu et al., 2017).

The rising recognition of urban agriculture's usefulness and practicality has been improving the urban economy and slowing down the problems of food insecurity. This is because of the implausible management and utilization of poultry waste as an alternative towards synthetic fertilizer as an ingredient for cultivating production and soil outputs (Redwood, 2009). Despite all these perceived benefits that are related to poultry waste operations, there has also been uncertainty and indecision about its suitability and quality to produce crops. This is most probably due to the

complexities of its nature which involves the multifaceted interactions amongst political, cultural, economic, biophysical, and social factors (Lebel, 2003).

There is likewise no conscious or mindful effort that has been made to clearly recognize the management and utilization techniques of poultry waste for urban agriculture. The problems that is associated with its organization, handling, farmers' perceptions, acquisition, and seasonal variations, as well as their implications on yield crops needs to be looked at (Adedayo, 2012). These concerns have brought about the necessity to focus its attention on the systems, techniques, and methods that are used for the management and utilization of poultry waste in urban agriculture and its influence on well-being and yields on urban farmers. By understanding the influences and drivers of poultry waste utilization and management techniques which extensively affect revenue generation and crop yield amongst farmers, we can pave the way for increased income and improving poultry waste activities for urban agriculture, poverty reduction, and urban food security (Adedayo, 2012).

Feedstock for anaerobic digestion to produce biogas originated from a vast range of industries and activities such as agriculture waste, food waste, agro-processing waste, and sewage. Agro- processing and agricultural wastes have received interest with respect to its high organic matter content and availability. Furthermore, the increased capacity in the amount of volume in waste from all these sectors is drastically accumulating because of the increase in the population food demand which is expected to upsurge from the current 54.96 million to 82 million by the year 2035 (Griffiths, 2013). The agro-processing and agricultural sector industry has revealed promising biogas potential likely in countries such as Ghana and Kenya; with 72% of the anaerobic digesters in Europe using agricultural livestock manure, energy crops, crop residue and agro-processing waste (Fischer, 2010).

The usage of anaerobic digestion technology for biogas production would also serve as a sustainable method intended for waste management. The method that is used to dispose of agro-processing and agricultural waste in South Africa poses an extreme

threat to human health hazards and the environment. For example, liquid waste, in the form of wastewater is released into freshwater bodies such as rivers and estuaries which then lead to water pollution (Mugodo, 2017). Alternative disposal methods which include wastewater treatment plants (WWTP), and irrigation systems can become very costly because wastewater needs to be treated to Chemical Oxygen Demand (COD) levels below 400 mg/L before it is disposed of (Mostert, 2010). Solid waste for instance is often dumped onto landfills that are applied or composted to the field and as a result, this had led to the emission of greenhouse gas releases into the atmosphere (Mittal, 2006).

Using indigenous knowledge has been seen by many people as an alternate means of promoting development in the more poor and underprivileged rural communities in many different parts of the world. By reviewing and studying the most recent work on indigenous knowledge, there remain several tensions and problems that have resulted in indigenous knowledge not being useful as expected. These include problems that are emanating from a focus on the factual; binary tensions between indigenous knowledge systems and western science; the problem with power relations and differentiation; the romanticization of indigenous knowledge, and the all too frequent de-contextualization of indigenous knowledge (Briggs, 2015).

1.4 Problem Statement

The poultry industry is currently facing numerous environmental problems. The major problem is the accretion of many wastes, especially litter and manure that is generated by intensive production. A layer of large-scale accumulation of many different types of waste may pose pollution and disposal problems unless economic and environmentally sustainable management technologies and solutions are evolved to help solve the countless environmental problems we face today (Tesfamariam, 2013). Most of the litter and manure that is produced by the poultry industry is still currently applied to agricultural land. When managed correctly, the land application is a feasible

way to recycle nutrients such as potassium (K), nitrogen (N), and phosphorus (P) in manure (Bolan, 2016).

Pollution problems could arise when fertilizers are applied under environmental situations that do not favor agronomic utilization of manure-borne nutrients (Sharpley, 2008). The constant sustainability, productivity, and profitability of the poultry industry would probably be reliant on the development of the best management practices to mitigate environmental consequences that are linked with water and air quality parameters. This has been greatly impacted by land application, and the formation of cost-effective innovative technologies which provides an alternative to land application of poultry wastes (Bolan, 2016).

Due to the poultry industry being one of the fastest and largest emergent agro-based industries in the world, this can be recognized as a cumulative demand for egg products and poultry meat. A huge problem that the poultry industry is facing is the large-scale accumulations of waste which include litter and manure. These would pose pollution and disposal problems unless economic and environmentally sustainable management technologies have progressed. Most of the litter that is produced in the poultry industry is presently applied to agricultural land as a source of soil amendment and nutrients. Nevertheless, environmental pollution that results from contaminant and nutrient leaching occurs when the poultry litter is not applied under the correct climate and soil conditions which do not favor agronomic utilization of the manure-borne nutrients (Szogi, 2016). Poultry litter in relation to environmental contaminants and nutrients, cost-effective innovative technologies for improving its value, fuel source and animal feed, soil amendment and its value as a nutrient source needs to be looked at. Poultry litter does provide a high source of phosphorus, nitrogen, and trace elements for crop production that is effective for improving biological and physical fertility, indicating that land application remains the focal option for the utilization of this valuable resource. The alternate use of litter as a fuel source and animal feed is limited by the contaminants and has higher moisture content. One of the best management

practices to mitigate environmental consequences are water and air quality parameters which are impacted by land application to retain the sustainability continued productivity and profitability of the poultry industry (Szogi, 2016).

1.5 Aim

The purpose of the study is to examine the practices of the poultry industry's waste re-use as an alternative feedstock for enhancing the livelihood of Urban Farmers in KwaZulu-Natal, South Africa.

1.6 Objectives of the Study:

- To examine the practices of poultry industry's waste re-use for enhancing soil quality by both large and small-scale farmers in KwaZulu-Natal.

- To determine the effectiveness of poultry industry's waste re-use in improving the crop production of urban farmers.

- To determine the effectiveness of poultry industry's waste re-use in enhancing the sustainability of urban farmers' livelihoods.

- To examine the social acceptability of re-used waste as feedstock for both producers and consumers in KwaZulu-Natal.

1.7 Main Research Question

How practices of the poultry industry's waste can be re-used as an alternative feedstock for enhancing livelihoods of Urban Farmers in KwaZulu-Natal, South Africa?

1.8 Questions Addressed:

- How do the practices of poultry industry's waste re-use enhance soil quality by both Large and Small-Scale Farmers in KwaZulu-Natal?

- How effective is poultry industry's waste re-use in improving the crop production of Urban Farmers?

- How effective is poultry industry's waste re-use in enhancing the sustainability of Urban Farmers' livelihoods?

- How socially acceptable is waste re-use as feedstock for both producers and consumers in KwaZulu-Natal?

1.9 The Rationale for and Significance of the Study

Eggs and poultry meat provide an affordable quality food product which is consumed by almost every ethnic population from around the world. Advances and progress in technology and knowledge over the past decades favor the intensification and growth of the production of poultry in developing countries where there is an increase in economic constraints and human populations. Matters that are associated with human health, environment, and the quality of life for people who live nearby and a distance from the poultry production operations waste management is a critical and crucial consideration for long-term sustainability. The growth of poultry production in much larger bird facilities located near peri-urban and urban areas, as well as for the smaller commercial systems is associated with the live bird markets, and for backyard flocks and villages located in rural areas (Williams, 2017).

Maintaining the eminence of the environment is a main concern when developing

management practices to efficiently use manure by-products as a soil conditioner and nutrient resource in horticultural and agricultural production systems (Sims, 2014). Most environmental problems are associated with the improper practice of land application of manure by-products that have centered on the contamination of surface or ground water with two major nutrients, P and N (Sims, 2017). Manure by-products could possibly contain other potentially toxic trace elements, like zinc (Zn), arsenic (As) and copper (Cu), and have received little attention (Bolan, 2016). To counterbalance the environmental risks of manure land application, Edwards (2010) stated that "to reduce the risk of offsite contamination, land application guidelines should be developed that consider the total composition of the manure by-products rather than only one component, i.e., N and/or P concentration" (Rysen, 2018, p.2). Conversely, the concentration of the trace elements in poultry litter and its by-products can possibly be reduced by regulating the quality of raw feed materials and decreasing the mineral additives in poultry diet (Rysen, 2018).

Sustainable poultry farming requires knowledge, but these are all comparatively straightforward skills that could be taught to the many rural individuals who have little to no formal education. Most rural people have some sort of knowledge of rearing poultry on a wide-ranging scale because it is a mutual practice for most of the rural people in that area to keep a few poultry running around in their backyard. The purpose is to get most of the Rural Farmers rearing poultry on a semi-intensive measure so that they would be able to supplement their dietary requirements and earn an income, ultimately resulting in the elevation of their living standards (Zinyemba, 2018).

Although the country is committed towards sustainable development, South Africa's main aim is to balance the broader social and economic challenges of an unequal and developing society and in doing so defend our natural and environmental resources. There is a need to eradicate the uncalled-for use of raw materials and the necessity to support waste prevention, resource efficiency and sustainable product designs. This can

be achieved by means of re-using products where possible; and trying to recover the value from products when they have reached their life span through energy recovery, recycling, or composting. Even though the elimination and abolition of waste in its entirety may not be feasible at all, it is possible over the systematic application of the waste management hierarchy to then reach a point from within the next coming decades where treatment, recovery, recycling, and re-use overtake the landfills as a preferred option for waste management (Newman, 2017).

1.10 Definition of key terms

Agricultural waste

Agricultural waste is defined as the residues, remains and deposits from the processing and growing of raw agricultural products or produce such as meat, crops, poultry, vegetables, dairy products, and fruit. These are the non-product outputs of processing and production of agricultural produce which may encompass materials that could certainly benefit man whose economic value remains less than the cost of processing, collection, and transportation for beneficial use (Nwakaire, 2016).

Agricultural waste, also known as agro-waste, is comprised of animal waste such as animal carcasses and manure. Whilst 20% of maize is canned, food processing waste is 80% while crop waste, like sugarcane bagasse; pruning; corn stalks; droppings; culls from fruits and vegetables, toxic and hazardous agricultural waste include herbicides, pesticides, and insecticides. The projected agricultural waste ascending is rare, but they are generally assumed to be contributing to a significant proportion of the total amount of waste (Nwakaire, 2016).

Agro-industrial wastes

Agricultural deposits and residue are rich in bioactive compounds. The deposits could be used as an alternative source to produce different products such as tempeh, biogas,

mushroom, and biofuel, as the raw material in numerous industries and research studies. The use of agro- industrial wastes as raw materials can drastically decrease the production costs and help reduce the pollution capacity from the environment. Agro-industrial wastes which are used for the manufacturing of animal feed, antioxidants, antibiotics, biofuels, vitamins, enzymes, and other chemicals through Solid State Fermentation (SSF). A variability of microorganisms is used in the production of valuable products through SSF processes. SSF and their effects on the formation of value-added products are discussed and reviewed in the literature (Sadh, 2018).

Waste re-use

Waste re-use means that any operation by which products are not waste is used again for the same purpose. In the poultry industry scrap and raw material are repurposed and reused for chicken coops.

Poultry Industry

Poultry Industry is a farming method that raises domesticated birds like chicken, turkey and geese to produce meat and eggs for food. Poultry – mostly chickens are farmed in large numbers to meet the high demands of consumers.

Livelihoods

The poultry industry is playing a huge role in socio-economic development and is a vibrant hub for creating employment opportunities and improving food security.

Feedstock

Feedstock is an essential, integral, and important part of the bio-refinery system. This is an ideal feedstock for bio-refinery that ought to be a non-food use for humans and animals. Poultry offers a higher product yield with wide market interest. Likewise, it is also easily available on a larger scale and must have a long-time storage capacity. It must possess a lower cost and uniform composition to offer economic feasibility. Moreover, to develop a more sustainable bio-based society, there should be a need for

prosperous implementation of the active bio-refinery with an eco-friendly and reliable processing unit feature (Ganti, 2019).

1.11 Qualitative Methodology: Indigenous Knowledge Theory

This qualitative study was conducted during the field entry phase from November 2019 to October 2020. It sought to establish appropriate methods of researching Indigenous Knowledge. As the principal investigator, I interacted with 65 people to carry out this study. These informants were from Ndwedwe a small rural community on the North Coast of KwaZulu-Natal.

65 people formed the sampling base and 14 people participated in this study. Participant selection was purposive and ongoing which is based on the potential data relevant to the purpose of this study (Vonga, 2014). This selection was gauged on the researcher's judgment of the person's knowledge on poultry farming. The 14 key participants included 10 Rural Farmers, 1 Small Medium Enterprise (SME) Farmer, 1 Feedstock Manufacturer, and 2 Industrial Poultry Farmers. I used observatory-conversational methods to access information from these participants and to generate data. Audio-recorded conversations by using open-ended questions were initially adopted to collect the data. I also used field notes and made observations of the context and non-verbal clues like pictures. English and isiZulu were used as the language of communication. IsiZulu was used because it is an indigenous language to South Africa and most of the participants in the rural area of Ndwedwe, KwaZulu Natal are Zulu-speaking. English was mostly used as the official language of communication since it is a medium of instruction in South Africa (Denzin and Lincoln, 2015).

1.12 Chapter Outline

Chapter One consists of the introduction and background to the study. It examines the practices and tradition of waste re-use as an alternative feedstock in the poultry industry

in KwaZulu- Natal, South Africa, and introduces the research problem statement and the objectives of the research.

Chapter Two presents the literature review. This theoretical literature review offers an understanding of the practices and traditions of waste re-use as an alternative feedstock in the poultry industry.

Chapter Three provides a detailed outline of the methodology of the study. This chapter explains the research design, sampling, and data collection methods. The data analysis techniques are also explained in this chapter.

Chapter Four discusses the data obtained from the field research and provides an analysis and interpretation of the results.

Chapter Five presents the research findings and discusses the results and presents the conclusions.

1.13 Conclusion

This first chapter has introduced the subject of the dissertation, with a brief background of the study, the poultry industry in South Africa, and focused on the need to improve the urban economy and reduce food insecurity. It offered the problem statement and definition of key terms and highlighted the rationale for the study; it also described the research aim, objectives, and questions guiding the study.

Chapter Two discusses the practices of the poultry industry's waste re-use as an alternative feedstock for enhancing the livelihood of Urban Farmers as it reviews literature on the poultry industry in South Africa.

CHAPTER 2: THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Background and Introduction

Chapter Two discusses the selected indigenous knowledge theory that is used in this study. It reviews the literature on The Sustainable Development Goals (SDG), and to check if livestock could possibly deliver. It also explores hunger, poverty, and agriculture as well as urban agriculture as a livelihood strategy to food security. It provides an overview of the South African poultry industry; COVID-19 disruptions to poultry production chain; alternative feedstock; manure-enhanced soil fertility and productivity; agricultural waste generation; utilisation and management; Agricultural Waste Management System (AWMS); typical poultry waste management options; chicken manure-enhanced soil fertility, and productivity to ensure that people are aware of the impact of waste on their health, well-being, and the environment. It also provides a theoretical framework, the indigenous knowledge theory, and the sustainable livelihood approach and a conclusion.

2.2 The Sustainable Development Goals (SDG)

The global meat industry is said to be a major contributor to climate change and environmental damage. Significant voices from animal rights groups in the west are questioning the enormity of animals that are sacrificed to produce the protein we need (Mitchell, 2018). However, in other parts of the world such as developing countries, substantial parts of the population are subjected to poverty, hunger and malnutrition and are incapable of accessing adequate animal-source foods. At the same time, through the United Nations (UN) the world's governments have agreed to work towards meeting the UN's Sustainable Development Goals, and to tackle the world's biggest global problems such as poverty, climate change, hunger and pollution, while driving forward economic prosperity for everyone (Mitchell, 2018).

Firstly, the SDGs are a set of 17 broad targets which the UN is calling for the world to meet by the year 2030. These goals include motivations to achieve "No poverty", "Good health and well-being", and "Zero hunger" for all. This has become a global rallying on all the sectors from business, civil society and governments. Key themes which are relevant in the poultry sector such as the eradication of malnutrition and hunger, lead to the injunction to deliver responsible production and consumption for the economies worldwide (Johnson, 2018). According to Jimmy Smith, the director-general of the International Livestock Research Institute, "The livestock sector is challenged by its environmental footprint and concern that consuming animal source foods leads to poor health. In many parts of the world too much produce is consumed, whilst many parts of the developing world ought to consume more, given the importance of animal-source foods in nutrition" (Smith, 2019, pp.10). Over the past ten years, the impetus had been shaping the future of livestock production to contribute positively and face these challenges to the SDGs. The global agenda for sustainable livestock has become one of the most imperative points for those people across the livestock sector to come together and promote a more sustainable practice (Johnson, 2018). A formation between the stakeholders in livestock- sector development, aims to be the place that brings together all sectors and future solutions, that includes academics and Small-Scale Farmers, local civil society organizations to industry and governments. Through the sector's sustainable development, this process is not very common for those with an interest in improving the sustainability of livestock (Johnson, 2018).

The Global Agenda works by heightening dialogue between the diverse nations which builds shared "action networks" to form a new approach towards sustainable livestock. It reassures a broader scaling and adoption of work and solutions to create an enabling environment that focuses on governments and policymakers' consideration of the need for sustainable strategies. With everyone from the vociferous Non-Governmental Organization (NGO), and campaigners to the largest global meat-trade associations, discussions are often lively. Nonetheless, the attention on convening across diverse

groups and views has led to innovative collaborations. An example would be that in face of multiple issues such as deforestation, which is a challenge for Farmer's livelihoods, and concerning issues regarding animal welfare, a group of Colombian Cattle Farmers, welfare NGO and academics demonstrated how some forms of cattle farming can essentially renew and protect the environment (Mitchell, 2018).

One of the most important participants in this process is the International Poultry Council (IPC), which represents most of the major poultry producers worldwide. Dr Anne-Marie Neeteson, chair of the IPC's Sustainable and Environmental Working Group, highlighted how far the poultry industry and production have come over the past 40 years in terms of working to progress the significant welfare and productivity problems such as livability and health (Neeteson, 2017). "Poultry is the major source of animal protein globally; we need and want to show where we contribute to society: from providing diverse, safe and healthy meats with a very good environmental footprint to improved welfare, continuous innovations, being a great entry into the poultry business and its importance for the viability of the regions" (Neeteson, 2017, p.1).

We are clearly at a turning point regarding the future of food and rebalancing how much animal protein the world eats. It's also important to know how and where meat products are consumed. Though, by addressing livestock on a shared Global Agenda, the impending for sustainability looks much brighter (Johnson, 2018).

2.3 Sustainable Development Goals (SDG)

Small-Scale Farmers produce most of the developing countries food. However, there are more poor people as compared to the rest of the population in these countries, yet there is not even enough food security for the urban poor. Even though most of the world's population will end up living in urban areas by the year 2030, farming practices would not be as small as they are today. In the near foreseeable future, dealing with hunger and poverty in substantial parts of the world is daunting as Small-Scale

Farmers and their families are faced to survive daily (Fletcher, 2017).

Policies and investment priorities should take note of the immense problems and diversity of opportunities that are facing Small-Scale Farmers. The resources on which they draw on, includes their choice of activities, and indeed the entire structure of their lives. These are often connected inseparably by the cultural environment, biological, economic and physical, which they find themselves in and which they have limited control over. However, while every Farmer is unique in their own way, those who share comparable conditions also share common priorities and problems that often transcend political borders or administratively (Fletcher, 2017).

2.4 Hunger, Poverty and Agriculture

Agriculture is reinforced by an apparition of a world without poverty and hunger. As most of these poor people usually reside in rural areas of developing countries and are often reliant on agriculture for their livelihoods, the main forms of eradicating the current situation of suffering should lie in the formation of a more dynamic rural community that is founded upon prosperous farming. An analysis of the agricultural system in which the rural poor work and live can provide more insight into how planned significances for the decline of hunger and poverty are now affecting so many lives. A Farming Systems Approach distinguishes the variety of the livelihoods of the fishing families, pastoralists, and poor farmers that delivers a framework to explore numerous paths that could propose an escape from poverty and inequality in a changing world (May, 2016).

Rural development depends on the everyday results of millions of individuals from both women and men. The challenge for civil society organizations, the private sector and governments is to deliver the incentives and institutional environment that would enable agricultural households themselves to attain poverty reduction and agronomic growth. Sadly, the best available current projections suggest only a very slow deterioration of poverty and hunger in these developing regions (May, 2016).

According to May, the population of developing regions of the world has doubled in the past four decades of the 20th century by approximately 5.1 billion. Currently around 60% of these people are categorized as rural individuals; of whom around 85% are agricultural. For the next 30 years, it is estimated that the developing region's population will continue to increase, though at a slower rate. Nevertheless, due to the result of increased urbanization, the total number of the rural population is essentially estimated to decline after 2020. Based on these estimates, the developing county's agricultural population by 2030 would possibly be slightly changed from its current level (May, 2016). Amid the influences that are forming uncertainty over the future population trends, two of these are notable. Firstly, the concerning interest regarding migration of people that are engaged in agriculture to urban areas. Secondly the prognosis for the HIV/AIDS pandemic in its uncertainty and the likelihood still subsists that it can decrease the rural population in several farming systems in Africa and other parts of the world. The migration rates reflect relative poverty rates in the rural and urban areas, henceforth they are affected by many aspects such as real exchange rates, international commodity prices, and urban employment growth (May, 2016).

2.5 Urban Agriculture as a Livelihood Strategy for Food Security

According to STATSSA (2012), more than 21% of the South African population currently finds it difficult in accessing sufficient and nutritional foods. In South Africa, 8% of the populations' only source of income is from some sort of social grant (Oxfam, 2014). In urban agriculture, there are many significant contributors to address the improvement of food security and poverty (Rogerson, 2016). Many people live in residential property that is less than 350 square meters and often have insufficient land to partake in urban agriculture (Crush, 2013). Policies have allowed urban residents to encourage urban agriculture by using vacant land and farms that are owned by municipalities, National Waste Management Strategy (NWMS) (Crush, 2013).

2.6 Overview of the South African Poultry Industry

The South African poultry industry is the largest agricultural sector that contributes more than 16% to the gross domestic product (GDP). This sector provides employment both directly and indirectly for approximately 108 000 people throughout its related industries and value chain (DTI, 2017). Some people believe that poultry meat remains an affordable source of protein as opposed to mutton, pork, and beef. Many people view poultry meat as a healthy alternative protein as compared to red meat. Over 935 million broilers were slaughtered in South Africa during 2016, which is just 3,1% less than the number of broilers that were slaughtered in 2015 (AFMA, 2018). The GDP value of South African agricultural products estimated at over R246 billion in 2016. The animal agricultural sector contributes a share of 47% (R117 billion) towards agricultural production. The slaughtered chickens are one of the largest contributors to the animal product categories, which contributed to more than R38 billion in 2016, whereas the eggs added another 10.12 Billion Rands (DAFF, 2018). The production of poultry meat has increased in South Africa over the past decades from 869 000 tons in 2001 to 1 704 000 tons in 2016. Currently, the total amount of consumption in South Africa has increased from 938 000 tons to 2 200 000 tons, through the gross per capita of consumption that shows significant growth from 21,48kg in 2001 to 40,04kg in 2017. This per capita consumption growth is much more than red meat – a total of 18,96kg in 2001 compared to 27,74kg in 2017 (DAFF, 2018).

Employment

The South African poultry industry employs approximately 14 500 people at the primary agriculture level, above 6 000 at the distribution level, and 27 600 at the secondary level. This sector also contributes to almost 60 000 jobs for the indirect employees in other supporting industries and an additional 18 137 jobs in the field crop sector (Motshekga, 2015).

Threats and Challenges

The South African poultry industry faces several momentous challenges that have stalled its growth and competitiveness potential. The foremost challenge relating to the poultry industry includes access to markets and finance, access to reliable supply and rising electricity tariffs, import penetration, exchange rate fluctuations, and rising feed costs (DTI, 2017). Brazil is the largest source of imported poultry to South Africa. A feedstock is by far one of the major production costs for the broilers that consist of approximately 25% soya bean meal and 60 to 70% maize. Due to this, production costs have fluctuated as grain prices decrease or increase in the South African market (AFMA, 2018). The price of feedstock has increased at a faster rate than exceeds the rate of increase that is experienced in poultry products (AFMA, 2018). The import of poultry meat has also been reported as the main source of threat for the local poultry producers. Honoring the many different trade agreements that South Africa forms part of, shows that the Poultry Farmers are at a disadvantage. Brazil is one of the major suppliers of South Africa's imported broiler meat claimed to be dumped onto the local markets (AFMA, 2018).

2.7 COVID-19 and its disruption to the Poultry Production Chain

At the outbreak of the COVID-19 coronavirus pandemic which broke out in December 2019, the whole world was plunged into a tailspin that left hundreds of thousands of people dead. The economy had suffered, and the poultry industry was not spared. Due to the lockdown, the number of deaths and workers infected by the virus, disruption to the supply chain has impacted largely to the demand in South Africa (Brockotter, 2020).

With the spread of this new and deadly virus, 'normal' is out of the question regarding the food supply chain. Within the first week of the outbreak, consumers were seen to be hoarding hand sanitizers, toilet paper, canned food, eggs, and meat products. A huge surge in demand for essential products to ensure that there was food on the table

left many supermarket shelves empty with suppliers struggling to keep up with the demand while trying to handle the virus themselves (Brockotter, 2020).

2.8 Challenges faced by Poultry Industry: Current Perspectives and Strategic Future after COVID-19

In the poultry sector, health, production, and poultry immunity are some of the several factors that test the future growth in the poultry industry. Types of products, safety, product quality, consumer confidence, the emergence and re-emergence of diseases would continue to remain one of the major challenges to the strategic future of the industry and current situation. Zoonotic and foodborne diseases are directly linked to poultry. Elimination, eradication, and control of zoonotic and foodborne pathogens present some of the major challenges in the poultry industry. Public health hazards from consuming foods with high antibiotic residues remain a critical issue. However, it is important to know that the chickens are not vulnerable to intranasal infection by the SARS-CoV-2 virus (Attia, 2020).

Nonetheless, the COVID-19 pandemic has affected transport, the economics of poultry farming, and poultry consumption. We should take into consideration the ethical, social dimension, economic and sustenance of the achievement of high environmental security. Farmers, veterinarians, and all the partners of the supply chain of poultry production need to be much more involved in the current situation and the future of the industry to ensure sustainable agriculture and fulfill human demands. Consequently, the current review explores these important tasks (Attia, 2020).

Reasonable production costs, high production, disease control, and product quality have been some of the new main goals of the poultry industry. Henceforth, welfare to humans necessitates continuous, efficient, and goal-oriented healthcare to control disease spread and decrease the application of antibiotics and meeting per capita consumption. These endeavors include the introduction of programs to control infectious diseases. They face constant changes in social and political conditions to

ensure the safety and security of foods and environmental defense issues, and address consumers' perceptions about animal welfare. Furthermore, the continuous increase in the costs of feedstock and food remains a more prominent issue. This occurrence of new and unanticipated diseases and the new legislation in several countries would likewise remain essential issues (Attia, 2020).

2.9 Alternative Feedstocks

In the future, the world's fossil fuel reserves will be depleted because these formations take millions of years to form. Some sources even forecast that petroleum oil could be exhausted by the year 2045. Conversely, fossil fuel obtainability could also be prolonged due to the reduction of overall consumption. The search for environmental, technical, and economic suitable alternative fuels which are used for a diesel engine is escalated with the increase of environmental consciousness and the decrease of global petroleum reserves particularly in the transportation sector (ACS, 2016).

Chicken Fat as an Alternative Feedstock: Biodiesel Production

Transitioning from the natural gas feedstock and petroleum as an alternative refers to a bio-based feedstock that is indispensable for the future sustainability of the Allied and Chemical industries. Developing a new energy-efficient process that would make use of all the bio-based and other feedstock will allow for industries to produce goods from a domestic resources intern that would substantially lower the carbon emissions. Strongly tailing this form of transition would eventually allow the Allied and Chemical industries to attain both national greenhouse gas reduction goals and important individual corporate sustainability goals without drastically impacting the feed and food supply. This transition would create a completely new manufacturing industry of conversion, feedstock supply, and preparation that would re-purpose a less competitive manufacturing facility which will revitalize many of the local economies. Furthermore, with refining base and chemical production on domestic raw materials, revitalized existing plants, and new domestic manufacturing plants would not be

vulnerable to transition overseas, thus impacting productivity, maintaining jobs, and ensuring production in South Africa (ACS, 2016).

2.10 Manure-Enhanced Soil Fertility and Productivity

Over the past few decades, agriculture from across the world has experienced climate change, farm size, vulnerability to urbanization, marketing strategies, increasing dependence on external non-renewable resources, economic and biological diversity, and volatile global markets. Researchers, government agencies, consumers, and producers have, consequently articulated an increasing interest in the economic viable alternatives which connect biological and ecological processes, diversification, and on-farm resources (Dinnes, 2012).

A primary approach is used to maintain soil fertility in concentrated cropping systems by using manure in modern and agricultural system to replace synthetic fertilizer (Dinnes, 2012). Advancements in technology and mechanization, the combined effects of costly government support programs, the use of agrochemical inputs to increase yields and the reduction of crop-rotation requirements and farm expenses is necessitated by numerous manure methods. The economic gains from the exchanges, conversely, have not been practiced consistently by all farmers. Larger costs could also be delayed shortly through over specialization, environmental degradation, farm consolidation, and government spending that is associated with reliance on current technologies and agricultural productivity growth (Cherr, 2006).

Chicken Manure-Enhanced Soil Fertility and Productivity

The increase in demand for chicken meat has prompted more Poultry Farming, which has consequential effects on the increased utilization of organic wastes, for example, chicken manure as fertilizer. Organic wastes comprise varying amounts of organic matter, water, and mineral nutrients (Edwards, 2012).

Though the use of organic waste matter as manure has been in practice for centuries throughout the world (Straub, 2007), there is still a need to assess the possible impacts of chicken manure on crop yield and soil chemical properties, by evaluating the critical application levels. Furthermore, the utilization and need for chicken manure has more use than any other animal manure such as kraal manure and pig manure, more because of the high content of potassium, nitrogen, and phosphorus (Warman, 2008). The escalating increase in the cost of inorganic fertilizers due to the increase in fuel price has also encouraged farmers to use chicken manure (Duncan, 2005). Likewise, organic waste is also being advocated for by different environmental organizations throughout the world in order to preserve the sustainable use of agricultural systems. Recently, studies have shown that a host of nutrient management practices have been undertaken by Smallholder African Farmers (Duncan, 2005). While the comparative adoption rates between mineral and organic nutrients differ by location, the occurrence of organic practices is often more used than mineral fertilizers (Dikinya, 2010).

Moreover, chicken manure is more favorably preferred amongst other animal waste by-products because of its high concentration of macro-nutrients (Duncan, 2005). Chescheir (2006) found an increase in the nitrogen levels from 40 - 60% and 17 - 38% to control for Cecil sandy loam soils and Norfolk sandy soils, respectively, resulting in the application of manure. The application of chicken manure to the soil enhances the concentration of water-soluble salts in the soil. Plants do absorb plant nutrients in the form of soluble salts, but excessive accumulation of soil salinity or soluble salts suppresses plant growth (Dikinya, 2010).

Recycling of Organic Wastes for Sustainable Soil Health and Crop Growth

A variability of waste is generated through many different agricultural and other activities in our daily lives. These include crop residues in the form of biomass of uncultivated plant species, husk, weed, forest biomass, straw, animal wastes and by-products from fish processing wastes, dung, bones, urine, and human habitation wastes such as sludge, garbage, and sewage are also used. Crop residue is plentifully generated

in larger quantities during crop cultivation. The accumulated waste left on the side of the field which is not disposed of creates major unpleasant odors (Chatterjee, 2017). Environmental problems such as pollution emanating from foul odour that is spread across vast areas forms a breeding ground for most of the mosquito vector and pathogenic microorganisms. Moreover, they are sourced from contaminated groundwater. Nonetheless, a potentially nutritious waste is recyclable organic matter and a good source of organic carbon. These massive inexpensive nutrient sources or otherwise unutilized organic waste can be used for recycling as valuable resources (Chatterjee, 2017).

Bearing in mind the growing deficiency of plant nutrients in crop fields, poor efficiency of chemical fertilizer, high cost of synthetic fertilizers, organic waste recycling for the plant nutrients supply is becoming more vital for replenishment of the plant nutrients, creating employment opportunities, sustaining soil health, and reducing the pollution problem. This is now being progressively recognized as a strategy for sustainable crop production. The organic waste had no adverse effects on biological activity, crop yield, or soil fertility. A somewhat stimulation by some properties creates more energy flow, balanced nutrients and reduce dependence on off-farm inputs, additional income is generated, ecosystem resilience is strengthened, and food security is increased (Peterson, 2003). Tandon (2015) states that a considerable proportion of nutrients are needed for aquaculture, forestry, horticulture, and agriculture could be encountered over appropriate recycling of several by-products and different types of waste. Over the past decades, we have witnessed a renewed interest in sustainable agricultural production by restoring and revitalizing the soil fertility rate and stimulating microbial activity to make the soil healthy and lively (Chatterjee, 2017).

Effect of Recycled Organic Waste on Soil Properties

The positive impacts of organic waste application on soils and the improvement of physical properties such as resistance to soil erosion, aggregation, total porosity, base exchange capacity, soil structure, aggregate stability, bulk density, water holding

capacity, hydraulic conductivity, soil temperature, soil resistance to penetration, and pore size distribution have been well documented (Aggelides, 2000).

Yaganoglu (2011) attributed the surge in water-holding capacity values in a plot that is treated with sewage sludge because of its high organic matter content. Through crop residue application with or without fertilizer, a small increase in the water-holding capacity is produced. The absence of substantial changes in soil water holding capacity and soil bulk density indicates that the changes in these properties are more likely to start to develop gradually after the start of organic waste application (Mubarak, 2000). The incorporation of the crop residues with or without inorganic fertilizer significantly increased water-holding capacity throughout the year, by the control and required fertilizer treatments. The practice of removal of crop residues and continuous cereal monoculture cropping has resulted in the deterioration of the biological, physical, and chemical properties of the soil (Giller, 2017).

2.11 Agricultural Waste Generation, Utilization, and Management

Agricultural waste is the non-product outputs of processing and production of agricultural poultry that contain materials that could be beneficial to man, but the financial values are much less than the cost of processing, collection, and transportation for beneficial use. The composition would depend on the type of agricultural activities and system in the form of solids, liquids, or slurries. Agricultural waste contains toxic and hazardous agricultural matter that uses herbicides, pesticides, and insecticides. Animal waste on the other hand is made from animal carcasses and manure. Whilst crop waste consists of sugarcane bagasse, corn stalks, droppings and culls from vegetables and fruit pruning, 80% of food processing waste comes from corn because only 20% of maize is canned. An expanding agricultural production system has naturally resulted in the increased quantities of agro-industrial by-products, livestock waste, and agricultural crop residues. There will be a substantial increase in the agricultural waste sector globally if developing countries like South Africa continue to

intensify the farming systems, with an estimated 998 million tons of agricultural waste produced yearly (Agamuthu, 2019). Organic waste can consist of 80% of the total solid waste that is generated in any farm (Brown, 2017).

Waste from Livestock Production

Livestock activity that includes solid waste such as organic materials and manure in the slaughterhouse; cage wash water and wastewater such as urine, maintaining sanitation in slaughterhouses and the bathing of chickens and odors add to poultry waste. The amount of pollution that is caused by livestock production is consequently much serious since most of the slaughterhouses are usually built in and around residential areas in South Africa. Air pollution from agriculture includes odor emanating from the cages resulting with the digestion process of livestock wastes, redundant foods, animal urine, and the putrefaction process of organic matter in manure. This non-reusable and untreated waste can generate greenhouse gases while causing water pollution and having a negative impact on the fertility of the soil. In poultry livestock waste, water volume consists of 75 - 95% of the total volume, while the rest includes many species of parasite and microorganisms, inorganic matter, and organic matter (Hai, 2010). These substances and germs can spread diseases to humans that cause many negative effects on the environment (Nwakaire, 2016).

Fertilizer Application

The utilization of animal manures for the use of fertilizers has had a great impact on input energy requirements at an agricultural level (Timbers, 2017). Nevertheless, fertilizer use of manures from the large confinements is connected to high energy costs, odor problems, distribution, risk of groundwater contamination, transport, and storage facility requirements. Timbers (2017) and Mokwunye (2000) describe poultry manure as containing high levels of phosphorus which has a positive effect on the productivity and growth of crops. It also becomes effective when used with mineral phosphorus fertilizer for agricultural use. The addition of manure to soil increases its

fertility rate because of the high nutrient retention capacity or exchange capacity; this improves the physical condition, the soil structure stability, and the water holding capacity (Obi, 2016).

Animal feed

In South Africa, the biggest problem with animal feed is that there is an insufficient amount of protein sources even though there are great efforts being made to find an alternative supplement (Leng, 2012). The crop residues have high fiber content and are low in fat, protein and starch. Consequently, using the traditional method of increasing livestock production with the use of supplementing pasture and forage with protein and grains cannot future meat protein needs. The use of protein and grain for human consumption would compete with the use for animal feed. There are many problems that may arise by utilizing residues to feed domesticated animals (Hussein, 2010).

2.12 Agricultural Waste Management System (AWMS)

Currently, agricultural waste management (AWM) for sustainable development and ecological agriculture has become a critical issue of concern for policymakers (Hai, 2010). The approach that has been taken towards agricultural waste management has been released into the environment with or without any treatment. It is important to consider waste as a potential resource rather than unwanted and undesirable. To avoid contamination of land, air, water, and to avoid the transmission of hazardous materials would require better use of incentives and technologies. Changes in attitudes and philosophy could lead to better approaches towards agricultural waste management. Organic wastes, especially manure that is generated by animals such as poultry, if left untreated or not properly managed can often result in significant degradation of air, soil, and water quality. The stagnant waste provides a medium in which diseases are transmitted and a breeding ground for flies and mosquitos. The unrestrained decomposition of organic wastes often produces gases, odorous as well as ammonia volatilization, which lead to acid rain (Wright, 2015).

AWMS consists of the six basic functions that are stated by (Smith, 2016). These are utilization, treatment, collection, transfer, production, transfer, and storage. Production is a function of nature and the amount of agricultural waste that is generated. The waste necessitates management if the quantities that are produced are adequate to become more of a resource concern. A comprehensive analysis of production includes timing, location, volume, and consistency. Collection refers to the preliminary gathering and generating of the waste from the point of deposition or origin. The AWMS plans should identify the method of labor requirements, collection, scheduling of the collection, location of the collection points, installation, management costs of the components, structural facilities or necessary equipment, and the effects collection has on the consistency of the waste. The storage function has to do with the momentary holding or containment of the waste. The storage facility of a waste management system still provides control over the timing and scheduling of these system's functions such as the application and treatment or the use of waste that can be pretentious by the weather or hindered by other operations. The waste management system should identify the type, location, required storage volume, storage period, estimated size, and installation cost of the storage facility; the impact of the storage on the consistency of the waste, and the management cost of the storage process (Obi, 2016).

The agricultural wastes are deposits from the processing and growing of raw agricultural products that are non-product outputs of processing and production and can contain materials that could be beneficial to man. These deposits are usually generated from numerous agricultural activities and that includes aquaculture, cultivation, and livestock production. When waste recycling is managed properly by expertise gained regarding agricultural waste management systems, this could be transformed into an advantageous material for agricultural and human use. The proper waste utilization would assist in the development of the agricultural sector in South Africa and provide viable biofuel resources for many people (Obi, 2016).

2.13 Typical Poultry Waste Management Options

Poultry Farms are a typical waste management system that shows the application of each component function of an AWMS. The poultry waste management systems are described as all-inclusive to the various waste management options for poultry production in South Africa (Smith, 2016).

Production

Waste is associated with the poultry operation that includes dead and manure poultry. Dependent on the systems, waste also includes waste feed, litter, and wash-flush water (Obi, 2016).

Collection

The manure that comes from the poultry operations is allowed to gather on the floor where it is then mixed with the litter. The manure from the litter pack forms a "cake" which is generally removed between flocks. The litter pack could be removed more frequently in order to avoid disease transfer between the flocks. In the layer houses, poultry manure that drops to the bottom of the cage is then collected in deep stacks and is removed by using a shallow pit that is located underneath the cages for the scraping, flushing, or belt scrapers that is positioned directly below the cages (Smith, 2016).

Storage

The litter from poultry operations is kept outside the housing facility or on the floors of the housing facilities. When it is removed, it is then placed directly into the fields for land application (Smith, 2016).

Transfer

The method that is used to transfer waste deposits is often determined by the total

solid content of poultry waste. Liquid waste can be conveyed through tank wagons, pipes, or gutters and the dried litter can be hauled, scraped, loaded as solid and then transported using trucks (Obi, 2016).

Utilization

Waste from the poultry facilities could be sold for agricultural land applications because of the high nutrient content of the litter. Additionally, poultry waste can be used for the feed supplement to livestock, buried directly as a fuel, production of methane gas, and re-used as bedding (Obi, 2016).

2.14 Chicken-Enhanced Soil Fertility and Productivity

Over the past decade, the agricultural sector around the world has experienced many changes in the economy. Biological diversity, farm size, marketing strategies, increased dependence on vulnerability to urbanization, external non-renewable resources, volatile global markets, and climate change add to this. Researchers, government agencies, producers and consumers, consequently, have shown an increased interest in economically viable alternatives that harness biological and ecological processes, diversification, and on-farm resources (Dinnes, 2012).

Crucial methods for the maintenance of the soil fertility in the intensive cropping systems where manure was used for centuries had been substituted by pest control inputs, synthetic fertilizer and weed control after the post-World War II developments of the agrochemical industry (Dinnes, 2012). Collectively, with technological advancements in mechanics, the use of such agrochemical inputs increased the yield output through the reduction of farm crop-rotation and expense requirement that necessitate manure techniques. The economic gain from the exchanges has not been experienced consistently by all Farmers. This is largely due to the costs that were also deferred to environmental degradation, farm overspecialization, consolidation, and government spending that is associated with reliance on the current technology (Cherr,

2006).

2.15 Impact of Waste on Health, Wellbeing, and the Environment

Awareness regarding the impact of waste on the environment, health and well-being, are very uneven across many different communities in South Africa. This is evidenced by the extent of littering. The objective of this goal is to create awareness regarding waste management issues and to improve the practical waste projects to the basic education curriculum. Anti-littering and waste awareness campaigns would be linked to the extended waste services and recycling infrastructure. This would be significant in separating waste from its source. For this reason, municipal campaigns have been implemented and designed in partnership with the local stakeholders, which include NGOs, civil society, labour and industries that form the basis of the strategy to create awareness regarding waste in South Africa (NWMS, 2011).

2.16 Theoretical Framework: Indigenous Knowledge Theory

This dissertation adopts a theoretical framework for discussing and studying indigenous knowledge as a theory of communication that fluidly operates within and outside of modernity. This discussion is part of a continuance of public conversation that is a path of indigenous knowledge in development studies, communication research as well as mainstream media (Manyozo, 2018)**.**

For development studies, an engaged consideration of indigenous knowledge first emerged in the 1980s, as a way of engaging and reaching out to traditional communities. Even though there was minimal attention given to indigenous knowledge in the past, it is now being taken seriously.

However, most of the scholarly approaches are governed by a western enlightenment-centric and reproduction of modernistic development discourses that would always be associated with indigenous people with primitive information while finding the notion

outside of modernity. Indigenous knowledge has been related to an absence of civilization and modernity especially when the discussion involves Asia, Latin America, Africa, and countries in the global south in general (Manyozo, 2018). Unfortunately, the history of this field has largely remained western- centric and ignores the others' history and place. Conversely, some of the social scientists have allowed reconsideration of the crucial role of indigenous knowledge within practices and theories of good governance and development (Sillitoe, 2002).

Indigenous Knowledge Communication Systems (IKCS)

Social science and oral literature have in general conceptualized indigenous knowledge as the way of knowing that accumulates and is generated by social groups over many generations who live in an environment by allowing the people to make sense of their world. Because of the peculiar attribute that has been entrenched in the local metaphysical infrastructures, indigenous knowledge has been presented as an antithesis to rational and scientific knowledge and frequently described as being oral (Manyozo, 2018).

Indigenous knowledge through oral and written texts has been created, modified, and shared across many generations through a series of covert and overt communicative performances and practices known as Indigenous Knowledge Communication Systems (IKCS). In pre-colonial countries such as Asia, Africa, and Latin America, indigenous knowledge communications comprised of songs, murals, tableau, paintings, written scripts, and many forms of social relations and organized behavior (Manyozo, 2018). Sillitoe (2002) defines communication systems as an organic developed "elaborate way" over how societies transmit non-technical and technical information amongst their members to educate, entertain, and inform them. For the traditionalists, IKCS refers to systems that can exist outside of innovativeness or those that could exist before the onset of mass media (Manyozo, 2018).

Indigenous practices could decouple us from the modern and current environmental

crises. There is a global concern in order to safeguard the increasingly dilapidating environment. However, environmental degradation must be combated to eradicate or minimize the threats to lessen its limits of the earth to meet environmental destinations, social, and needs (Kanene, 2016).

Indigenous Knowledge: A Natural Resource for Rural Farmers - A Guide to the Study

Indigenous agriculture is usually perceived as a method of farming for those of low socio- economic strata and poor people. However, these claims are misleading and not true. For centuries, indigenous agriculture has been a crucial part of many people's development and livelihood. This is not only within the limits of Africa but around the world. Nevertheless, South Africa has always been an anchor on traditional methods and indigenous agriculture for production, this production system results from the global increase in the use of modern technology (Quabe, 2020).

Strengths of using Indigenous knowledge

Indigenous knowledge is passed on through generations that people in each community have developed and acquired and this process continues to develop. This is founded on the experience, which is often tested over many centuries, the adaptation to local environments and cultures which changes the dynamic. The local people have intimate knowledge of many aspects regarding their daily lives and surroundings. Over the past centuries, people in the communities have learned how to survive in difficult environments and grow food. They knew how to breed different animals, which plants were poisonous and when to weed and sow, and the varieties of crops to plant. This knowledge can be useful in the control of diseases among humans, plants, and livestock. Indigenous knowledge has been passed from generation to generation usually by cultural rituals and word of mouth. This has been the basis for conservation, agriculture, food preparation, education, health care, and a wide range of many other activities that sustained society and its environment in South Africa for many centuries

(Atoma, 2011).

Limitations of Indigenous Knowledge

As with scientific knowledge, indigenous knowledge has some limitations, and it should be recognized. Indigenous knowledge is occasionally accepted as uncritical because of its naive notions of what they do naturally in harmony with the environment and its surroundings. There is much contemporary and historical evidence that indigenous people have committed many environmental 'sins' such as over-cultivation, over-grazing, or over-hunting of the land. It is deceptive to think of indigenous knowledge as continuously being 'sustainable', 'good,' or 'right' (Langill, 2019).

Indigenous knowledge systems can moreover be eroded by wider social and economic forces. The pressures that are put on indigenous peoples for them to integrate with much larger societies are often great. As they become more integrated into societies, the social structures that generate practices and indigenous knowledge could break down. Due to the growth of international and national markets, the imposition of religious and educational systems is impacted by various development processes that are leading more towards the 'homogenization of the world`s cultures (Grenier, 2018, pp33-47). Subsequently, indigenous practices, customs, know-how, values, and beliefs can be altered and the resulting knowledge base incomplete (Langill, 2019).

Why Was Indigenous Knowledge Chosen for this Study?

This theory was chosen because over the past few decades, development projects have not encouraged the active participation of the local people. The orthodox approach towards research has often been characterized by the control of outside development and scientists that are specialists in this field of study set project agendas and carried out information-gathering activities without any inputs from the local community members (Chambers, 2014). Not only have the local people not played an important part in the implementation or critical planning of these projects, but their

knowledge of local ecology and the structures of their political, social, and economic systems have been ignored as well. Many people often believe that this 'top- down' method has contributed to the failure of many development projects. The argument is that the lack of knowledge and community involvement could frequently lead to a lack of understanding, inappropriate project goals, and community apathy of ecological and local social systems (Langill, 2019).

How does Indigenous Knowledge Compliment the other Theories?

The theoretical framework is an imperative purpose of philosophy in education is to adapt and generate theories in order to augment and estimate education practice. However, philosophy delivers a policy for theoretical thinking to make education more accurate and relevant. This broad reflection about ideas, reality, and thoughts contributes towards a theory. A theory would occur when there is sufficient evidence that accumulates to support a hypothesis and theorizes or concludes. This inclusive inference on notions and pedagogical opinions can portray facets such as the cultural theory of education that reflects how learning occurs within the entirety of a specified culture, including all the realms of a given society. An inherent outcome of theories with more of a cultural context is practical in abstract and character in nature. The abstract nature and pragmatic of a theory define functionalism, preparations, holistic, perennials, and communalism are the bases of African thought which is perceived in this dissertation as indigenous knowledge systems (Mwinzi, 2015).

2.17 Sustainable Livelihood Approach

A livelihood encompassing assets, capabilities and activities are required for the means of living. Livelihoods and sustainability that can deal with and recuperate from stress and shocks, enhance, and maintain its assets and capabilities, provide sustainable livelihood opportunities for the next generation and subsidize the net benefits to other

livelihoods at the global and local levels in the short and long term (Chambers, 2012).

Underprivileged households would only be able to live a healthy and productive lifestyle if different livelihood strategies are adopted. A livelihood embraces the available resources to survive (Chambers, 2012). A household would expand its livelihood strategies by using its tangible and intangible assets. Tangible assets are the resources that are available; this would include money, water, food reserves, and land. Intangible assets are often perceived as help that the households receive through support from other organizations such as food, or family support (Chambers, 2012). Sustainable livelihoods must recover and cope with forms of shocks and stress (Scoones, 2018). The resilience aspect is significant towards coping and livelihood adaptation (Davies, 2016). If the households are not able to adapt or cope with shocks and stresses, they would unavoidably be more vulnerable and can struggle to achieve sustainable livelihoods. Consequently, households with a more diverse livelihood strategy would be more accepting of stresses and shocks and in addition they would be able to cope better in unfavorable circumstances. Diversified livelihood strategies result in more resilient households (Chambers, 2012).

With the vastness of the food insecurity problems, habitually the level of food security of the urban poor is not always apparent (Cruch, 2010). Households may adopt many livelihood strategies to advance their standard of living, provide an income, and be more food secure. Though urban agriculture has been supported as a livelihood strategy for food security, there has been limited research that is done to control the influence of urban agriculture on household food security (Moher, 2009). The different livelihood strategies are dependent on the assets, capabilities, and resources that people have (Scoones, 2018). These livelihood resources are the natural, social, human, and financial capital that influences livelihood strategies. The livelihoods outcomes indicate urban agriculture as a livelihood strategy (Chambers, 2012).

2.18 Limitations of Indigenous Knowledge

As with scientific knowledge, indigenous knowledge has some limitations and should be recognized. This is occasionally accepted as uncritical because of the naïve notions of what indigenous people do naturally and in harmony with the environment and its surroundings. There is much contemporary and historical evidence that indigenous people have committed many environmental 'sins' such as over-cultivation, over-grazing, or over-hunting of the land. It is deceptive to think of indigenous knowledge as being 'sustainable', 'good,' or 'right' (Langill, 2019).

Indigenous knowledge systems can, moreover, be eroded by wider social and economic forces. There are pressures put to integrate indigenous people into larger societies. As they become more integrated, the social structures that generate practices and indigenous knowledge could break down. Due to the growth of international and national markets, the imposition of religious and educational systems is impacted by various development processes that are leading more towards the 'homogenization of the world's cultures (Grenier, 2018). Subsequently, indigenous practices, customs, know-how, values, and beliefs can be altered and the resulting knowledge base incomplete (Langill, 2019).

2.19 Conclusion

Chapter Two offered a broad understanding of the poultry industry in South Africa and the indigenous knowledge theories that were used in this study. The concept of waste re-use as an alternative feedstock in the poultry industry is a complex issue, with indigenous knowledge theories trying to explain it. An overview of urban agriculture, Sustainable Development Goals (SDG), hunger, poverty, and agriculture were presented in this chapter. The chapter also reviewed the literature on the overview of the South African poultry industry; COVID-19 disruptions, poultry production chain, alternative feedstocks, manure-enhanced soil fertility, and productivity. Emphasis was placed on the agricultural waste concept, generation, utilization and management, Agricultural Waste Management System (AWMS), national waste management

strategy, typical poultry waste management options, chicken manure-enhanced soil fertility, productivity, and the need to ensure that people are aware of the impact of waste on their health, well-being, and the environment. Chapter Three will discuss the qualitative research mythology that was used in this research.

CHAPTER 3: METHODOLOGY

3.1 Introduction

Good research depends on a systematic way of collecting data, careful planning, analyzing and collating information. This research started by asking and forming questions that resulted in finding solutions to a problem. The research method that was used is qualitative research methodology. In this chapter, the researcher addresses the research design, sampling, and data collection methods. The ethical considerations are also explained in this chapter.

3.2 Research Design: Qualitative Research

Qualitative research methods deal with understanding and discovering perspectives, thoughts, and experiences of the participants (Harwell, 2011). As a result, qualitative research is regarded as exploratory that discovers the observer in the world of ideas, opinions, and thoughts. It comprises a set of material and interpretive practices that make the world perceptible which in turn transforms the world. They describe the world into which we live, through a series of illustrations and representations that include recordings, examine indigenous knowledge systems, memos, interviews, photographs, conversations, and field notes. At this level, qualitative research comprises a naturalistic, interpretive approach to the world at large. Therefore, this means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret and understand phenomena, in terms of what meaning people bring to them (Denzin, 2005).

This qualitative research is described as permitting a more comprehensive investigation of the topic that is of focus, in which information is collected and composed by the researcher through examining indigenous knowledge systems, interviews, ethnographic work, and case studies. Essentially in this methodology is the explanation of the interactions amongst participants and the researchers in naturalistic surroundings with

few limitations, resulting in a more open and flexible research process. These unique and distinctive interactions imply that there are different results which can be obtained from the same participant and that depend on who the researcher is because a researcher and participant in each and assumed situation form results (Harwell, 2011).

Indigenous knowledge is the knowledge that assists societies to make decisions on activities such as education and agriculture that are acceptable to their daily lives. Western-based knowledge and indigenous knowledge help to create development solutions that are culturally acceptable for the societies that are being helped. Over the past few decades, this type of knowledge has been overlooked and development solutions have been created that were not culturally acceptable or economically feasible for societies to be aided (Puffer, 2015). The knowledge that is the basis for environmental conservation, education, agriculture, and many other activities is known as indigenous knowledge. It is generally transmitted across generations by an oral tradition and is an aspect of every human community (Puffer, 2015).

In this study, the researcher collected data based on indigenous knowledge through interviews on practices of the poultry industry's waste re-use as an alternative feedstock for enhancing the livelihood of Urban Farmers. People in different regions of KwaZulu-Natal have unique cultural histories and traditions, which critically shape their views of their livelihood choices, environments, social behavior, health, and illness. In the end, the researcher can forge a common understanding between the participants (Sillitoe, 2016). This was ensured in this research through selecting the research sample through snowball sampling which was concerned with selecting information from participants (Patton, 2015). This study focused on Farmers from different sectors, such as the rural areas, SME farms, Industrial Poultry Farms, Feedstock Manufacturers, and consumers from all over KwaZulu-Natal, Durban.

A case study is an in-depth analysis of relationships bounded by some unifying factor of people and events. Here it investigated and explored the contemporary real-life

phenomenon through detailed contextual analysis of a limited number of people, conditions, and their relationships in the rural area of Ndwedwe, SME farms, Feedstock Manufacturers, and Industrial Poultry Farmers (Yin, 2013). It is necessary to obtain an in-depth appreciation of a phenomenon of interest, issue or event in its natural real-life context (Crowe et al., 2011).

3.3 Location of the Study: KwaZulu-Natal, South Africa

Figure 1: Map of KwaZulu-Natal in South Africa

Source: Google Maps (2017)

KwaZulu-Natal is one of South Africa's provinces that contains vast amounts of water and has a larger area of high-quality agricultural land compared to the other provinces and produces several agricultural products. KwaZulu-Natal covers such a small portion of South Africa's land area, but there is a significant percentage of the country's Small-Scale Farmers that are based here. Agriculture in KwaZulu-Natal is diverse and relates to the patterns of its landscape. Due to the fertile soils and reliable rainfall, the agricultural sector in KwaZulu-Natal has become very prolific and is known for farming different types of products, such as poultry and eggs. The province is known for its fertile soil and has a total of 6.5 million hectares of land for farming purposes of which 82% is suitable for extensive livestock production whilst 18% is

arable land (Adlam, 2021).

Poultry production is an imperative agricultural sector in South Africa. Many emerging farmers are opting for the poultry sector, but skills' training is critical. Currently, many Farmers' sales are from the informal sectors, the development of co-operatives could be more permeation of the formal marketing channels (Adlam, 2021).

Ndwedwe

Ndwedwe is a small rural town within the Ilembe District Municipality of KwaZulu-Natal Province in South Africa. It is the largest of four municipalities in the district and makes up a third of its geographic area. This municipality consists mainly of underprivileged African (black) communities whose livelihoods usually rely on subsistence farming (Municipalities, 2012). Ndwedwe, which is located comparatively close to major economic and urban developments, remains relatively poor, underdeveloped, and disadvantaged. Internal and external access is substantially limited compared to east-west roads, while north-south links are few and of very poor quality (Municipalities, 2012). Most of the Ndwedwe Municipality's detailed plans depend on the future strategies yet to be developed for the iLembe District Municipality. Nevertheless, the main short-term objectives that were identified for Ndwedwe are focused on the provision of basic services and infrastructure to a population that is severely lacking in most of these facilities (Municipalities, 2012).

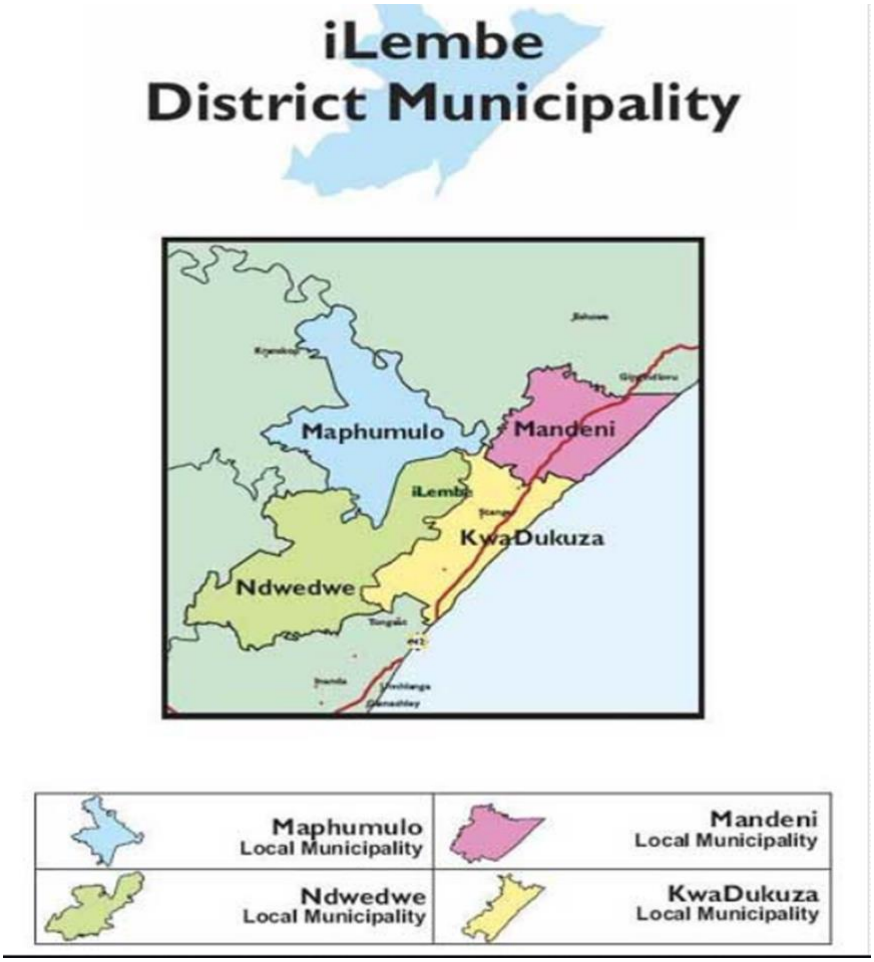


Figure 2: Map of Ndwedwe Local Municipality

Source: Google Maps, Ndwedwe Local Municipality (2017)

3.4 Sampling and Data Collection

Snowball sampling is often reflected as a type of purposive sampling. However, in this method, the informants, or participants with whom contact has already been made by using social networks to discuss the researcher with other people who could contribute or participate in the study. Snowball sampling is frequently used to recruit and find

"populations," or groups that are not easily accessible or available to researchers through various other sampling strategies (Denzin, 2017).

Grain Field Chickens (Large-scale farming)

Telephonic calls were made to find out more about the waste re-use and alternative feedstock within the large-scale poultry industry. The researcher interviewed two people in the Industrial Poultry Industry to understand the farming practices of Large-Scale Farmers.

QPro Feeds (Feedstock Manufacturer)

To find out more about the animal feed manufacturing process the researcher interviewed one person to understand the production of animal feed.

Shane Broody Farms (Small Medium Enterprise Farming)

To find out more about waste re-use and alternative feedstocks within the Small-Scale Poultry industry sector, the researcher interviewed one person to understand the farming practices of Small-Scale Farmers.

Ndwedwe (Rural, Household Farming)

The aim was to find out more about the waste reuse and alternative feedstocks within the Rural Poultry Industry. The researcher interviewed 9 people to understand the farming practices of Small-Scale Farmers in the rural areas.

Consumers in KwaZulu-Natal (Survey Interviews and Questionnaires)

Consumers were interviewed to find out what types of chickens they preferred: farm fresh chicken or industrial chicken. The researcher interviewed 22 people for the questionnaire and 29 people were interviewed for the survey to get an insight into consumer behavior.

Data Collection Methods Interviews

Interviews are often used on specific matters, opinions, beliefs, or views and to explore experiences. Accounts can be compared and explored alongside others, to improve an understanding of the fundamental outlines and principles. There are various types of grades to structure the interviews: open or in-depth, structured or semi-structured that is reliant on the characteristics of structuring interviews by the researcher (Choo, 2015). The researcher had formulated a topic list beforehand of the interview which had flexibility. As interviews are a form of communication amongst the researcher and interviewee, the skills and settings of the researcher are of significance. For example, the researcher could build a sense of trust such as developing rapport, the way of phrasing questions which gave the interviewee much opportunity to tell me more about their story and their body language gave me a perspective about their passion for farming. Moreover, it is also important to consider the type of transcription of audio tapes (Choo, 2015).

Unstructured Interviews

The researcher had used unstructured interviews, for they are flexible as questions could be changed and adapted, dependent on the respondent answers. The interviews at times deviated from the interview schedule. An unstructured interview creates qualitative data from the use of open-ended questions (Choo, 2015). This allows the respondent to talk in more depth by choosing their own words. This also helped me as the researcher to develop an actual sense of the interviewee's understanding of a situation. The researcher had also increased validity because it allows the interviewer to probe for a much deeper understanding, by asking for clarification and allowing the interviewee to steer the direction of the interview (McLeod, 2014).

Observation

The researcher had used observational methods which were to understand phenomena by studying people's accounts and actions in an everyday context. The researcher had used different types of observations, with various degrees of research participation, like non- participant observation and by using video recordings, the researcher saw what recyclable materials were used to build the chicken coops, and participant observation or ethnography. Ethnography, as the researcher was partaking by helping some of the households feed their chickens' feedstock, overtly or covertly, in people's daily lives for a week, watching what happens with the chickens and how the chicken lay eggs, how the chicken was cooked, listening to what is said, or asking questions through informal and formal interviews, and collecting data in Ndwedwe (Reeves, 2013).

Naturalistic Observation

This technique involved my observation and studying the precipitous behavior of the participants in their natural surroundings. The researcher had observed the difference between studying chickens in the poultry industrial areas and studying them in their natural habitat. By being able to observe the flow of behavior in its setting, studies have greater ecological validity (McLeod, 2015). The researcher observed the practices of the poultry industry's waste re-use as an alternative feedstock for enhancing livelihood for Urban Farmers in KwaZulu-Natal, South Africa.

Data Analysis

The researcher had used qualitative data which refers to non-numeric information that consisted of text documents and images, audio recordings and video, notes, and interview transcripts (Dudovskiy, 2017). Thematic analysis was a useful method for my research because it examines the perspectives of different research participants that I had interviewed, by highlighting the differences and similarities, and generating

unanticipated insights (Braun, 2006). As a researcher, thematic analysis was also useful for summarizing the main key features of a large data and to take a substantial well-structured approach to handling data, by helping to produce a much clearer analysis and an organized final report (King, 2004).

3.5 Ethical Considerations

This research involved several human participants who raised unique, complex, political, economic, legal, ethical, social, and environmental issues; thus, it considered ethical principles that govern research (David & Resnik, 2015). The significance of following ethical norms is to support the aim of the research such as avoidance of error, knowledge, and truth. This research observed ethical issues such as informed consent, confidentiality, the right to withdraw, voluntary participation, and anonymity. The participants have explained their thoughts on this research, and they were also informed that they were free not to respond to any question they felt uncomfortable answering, and that they had the right to withdraw at any point in time or at any stage during the research.

Credibility

The credibility of the participants' views or data is their representation and interpretation by the researcher. Triangulation is a system that is used to enhance credibility, which is a process that uses multiple sources to draw conclusions that involves using multiple data collection methods. The researcher had employed in-depth interviews in this study, and observations and questionnaires were used as methods of data collection (Polit & Beck, 2012).

Reliability

Reliability is the constancy of findings over similar conditions. There are many different constructions of meanings that are based on the individual's experience and

interpretations of the researcher in data gathering. Working on an audit trail is an approach to enhance the reliability of qualitative research. An audit trail consists of a collection of notes and materials such as interview transcripts, process notes, data analysis and drafts of the final report, which is used in the research process that documents the researcher's assumptions and decisions (Cope, 2014).

Conformability

Conformability is the researcher's ability to demonstrate capability by describing how interpretations and conclusions were established and demonstrated, the findings which were derived straight from the data. Nonetheless, the researcher documented the fieldwork findings in the form of questionnaires, thematic classifications, interview guides, and audio recordings of interviews (Polit & Beck, 2012).

Transferability

This refers to the extent to which findings are indiscriminate or applied to other groups or settings (Houghton et al., 2013). To make sure of transferability, the researcher has given a more detailed explanation of the research method that was used, and the settings and contexts studied so that the readers can get adequate information and judge the applicability of the study findings (Houghton et al., 2013).

Dependability

Dependability establishes the repeatability and consistency of the research findings. This can be safeguarded using overlaying the data collection methods and reporting on how the research was done; this comprised an explanation in detail of the analysis, implementation, data gathering, and research design (Houghton et al., 2013).

3.6 Conclusion

This chapter described the qualitative research methodology, research design, sampling, and data collection methods used, and what the researcher had observed while doing the research. The relevant participants were selected using the snowball and purposive sampling methods. Chapter Three also explained the thematic data analysis which was used to analyze the data and how the researcher observed the ethical norms and principles of qualitative research involving human participants. Chapter Four discusses the data presentation and analysis.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS

4.1 Introduction

Chapter Three consists of the research methodology that was used in this study and Chapter Four presents the analyses of the data that was collected during the study. Thematic data analysis was used to analyze the data; it was also useful for summarizing the key features of a large data set. The purpose of this study was to examine and identify practices of the poultry industry's waste re-use as an alternative feedstock for enhancing the livelihood of Urban Farmers in KwaZulu- Natal, South Africa. Several themes emerged during this data collection from the interview questions asked and the answers derived from the questionnaire. The major themes that derived from the research were:

(i) Waste re-use for enhancing soil quality by both large and Small-Scale Farmers.

(ii) The effectiveness of the poultry industry's waste re-use in improving the crop production of Urban Farmers.

(iii) The effectiveness of the poultry industry's waste re-use in enhancing the sustainability of Urban Farmers' livelihoods.

(iv) The social acceptability of waste re-use as feedstocks for both producers and consumers in KwaZulu-Natal.

The chapter ends with a discussion of the findings.

4.2 Profile of Participants

Six Interview Schedules were used and there were over 65 interview participants. This consisted of 10 household Poultry Farmers from Ndwedwe, one Feedstock Manufacturer, one Small-Scale Poultry Farmer, two Industrial Poultry Farmers, 28 surveys and 23 questionnaires. The survey was used to evaluate the experiences of

consumers regarding chicken consumption whilst the questionnaire was based on a set of questions to establish consumers' opinion about the poultry industry. The research was done on-site in Ndwedwe and due to the outbreak of COVID-19, President Cyril Ramaphosa on 23 March 2019 announced a lockdown in South Africa. Therefore, telephonic interviews were conducted with Small-Scale Poultry Farmers and Industrial Poultry Farmers. Surveys and questionnaires for consumers were done online. The research interviews were done with people in different sectors to further understand what practices of the poultry industry's waste can be re-used as an alternative feedstock for enhancing the livelihoods of Urban Farmers in KwaZulu-Natal, South Africa.

Table 1: Demographic profile of participants

Variable	Constant	Number	Percentage
Gender	Male	5	36%
	Female	9	64%
Highest Education Level	Primary	1	7%
	Secondary	7	50%
	Tertiary	3	21%
	Uneducated	3	21%
Marital Status	Married	12	86%
	Single	2	14%

Figure 3: Waste re-use for enhancing soil quality

4.3 Findings according to the Themes

The poultry industry is one of the fastest and largest growing agro-based industries in South Africa. Currently, there is a cumulative demand for poultry meat products that is mainly due to its acceptance by most societies in KwaZulu-Natal and its relatively low cholesterol content. The South African poultry industry is facing numerous environmental problems. One of the major problems is the accumulation of many wastes, especially litter and manure which is generated by intensive production that is voided by a layer of large-scale accumulation of waste. This would pose pollution and disposal problems unless economic and environmentally sustainable management technologies are evolved (Power, 2017). Most of the litter and manure that is produced by the South African poultry industry is currently applied to agricultural land, as shown in the following excerpt from one of the participants.

> *The benefit is that none of it is wasted, it all has a use or purpose so you don't have the problem of disposing of it, and so you don't need a dedicated site*

> *where you have to bury it or burn it or anything like that so you can use it. Either for feeding of other animals or as enhancement of the soils - that's the biggest benefits. Drawbacks are obviously something like mortalities; it has to be kept or frozen so they don't go off, I mean if it goes off it can make other animals sick… and the litter - there's certain medications that we can't use in the chickens, because it can be dangerous if that litter is fed to ruminants (*Industrial Poultry Farmer #1, February 2020, Male, Age 40).

This excerpt shows that the industrial poultry sector in South Africa has a more sustainable way of disposing of waste as opposed to burning it, which can be harmful to the environment. When managed correctly, the land application is a viable way to recycle the nutrients such as phosphorus (P), potassium (K), and nitrogen (N) in manure. A Small-Scale Poultry Farmer explained:

> *Fertilization of soil, putting stuff back into the soil or more so in the ruminant industry, not so much in the poultry industry itself* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

The Implications for Waste Re-use

The SME sector believes that waste re-use has to do with more of the ruminants' industry, which means that any animal or plant waste can be used to make fertilizer and not necessarily poultry waste.

Figure 4 shows the implications of waste re-use, where waste material is just dumped anywhere. The waste piles accumulate, and animals start to scavenge around them.

Figure 4: Rubble

Conversely, infliction and pollution problems occur when manure is applied under environmental conditions that do not favor agronomic utilization of manure-borne nutrients (Sharpley, 2015). The continued sustainability, productivity, and profitability of the South African poultry industry would more likely be dependent on the preparation of best management practices to mitigate environmental penalties that are associated with water and air quality parameters. These are impacted by the land application, and expansion of cost-effective innovative technologies that provide an alternative to land application of poultry wastes (Kelleher, 2012). In support of this idea, an Industrial Poultry Farmer said:

> *Some sort of extensive hazardous products we can't just discard, so you can't just dump it somewhere. We use external companies to collect that product and they got their ways to discard that product.* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

Poultry Litter Production

The quantity of poultry litter that is produced in an industrial broiler unit often depends on the litter (bedding material) management, the feed intake, and its digestibility. A variety of materials including paper clippings, cereal straw, wood shavings, and husk which is being used as bedding materials (Swain, 2018). A Small-Scale Poultry Farmer stated:

Just on the farming side, we obviously use products like wood shavings as bedding for chicken. Now the wood shavings will after 6 weeks have a lot of fecal material in it, which is Nitrogen rich and that is again used on farms as fertilizers (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Three common practices are implemented for litter management in the broiler units (Bernheart, 2016). This includes single-use litter, partial re-use, and multi-use litter. The single-use litter includes the total clean-out of the house after each replacement of the bedding material and flock. Partial re-use comprises the removal of litter from the brooding section for dispersal on the grower section of the house. New bedding material is then dispersed on the brooding segment. The partly spent litter is frequently composted for a few days to elevate its temperature to kill off any pathogens. Sometimes some of the spent litter is removed after each batch. An Industrial Poultry Farmer said:

> *Before the day-old chicks arrive, we would cover the whole surface area of the chicken house floor with about 50mm of good shavings to act as an insulator and to give the bird a warm footing to walk onto and to lie on. If they lie on cold cement, the birds will not start feeding and then they lose their reflex to swallow and they die. So, we use that as something to keep them warm and that product is used as a fertilizer for maze production and whatever later on, once*

their cycle is completed (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

With the multi-use of litter, only caked material is removed, and the house is disinfected (Sistani, 2017). The total amount of solids excreted by the birds is estimated from the dry matter digestibility of the diet. The broiler chicken in South Africa generally digests about 85 to 90% of the dry matter of the feed (NRC, 2014).

As the production rate increases, economic and sustainable tactics for managing poultry manure are required. Poultry manure has been traditionally treated as a waste product and was applied to pasturelands and surroundings to recycle nutrients which consisted primarily of potash (K), nitrogen (N), and phosphorus (P) (Lin, 2018). An Industrial Poultry Farmer stated:

Well, nothing goes really to waste, because everything goes into the poultry house. In the end of the cycle, we clean out the house completely and all that litter and poultry manure that's in the house either gets composted or it is fed to ruminants or its spreads to land that is going to be used as crop production (Industrial Poultry Farmer #1, February 2020, Male, Age 40).

In KwaZulu-Natal, poultry manure is frequently applied to meet the crop N requirement that results in excessive P application. Although the agronomic importance is very well established, the environmental aspects of poultry manure management have always been primarily focused on water quality (Harmel, 2016). With a more comprehensive assessment of poultry manure usage in KwaZulu Natal, the agro-ecosystems consider water quality, crop yield, and soil health as well as the economic impact of assimilating poultry manure into cropping systems in South Africa. Economic factors are of utmost importance as they are a primary if not the leading factor driven by farm-scale decision-making. A Small-Scale Poultry Farmer stated:

You see, faeces aren't the problem, because faeces are a natural product. You

> *know, as I say, one would just have to be careful where you have your operation because if it's on a site near a river, you know you are going to have a lot of run off. So those are all the things you need to take into consideration. But like I say to you, what happens is all the litter you know that chicken manure gets connected by the people working there and they take that and they put it back into the areas where they going to plant herbs and crops, so we don't really have any barriers in terms of… you know; for example, in a big farming operation, a big chicken abattoir operation, it could be barriers such as lack of municipal services. You know to get rid of waste, but that does not affect a Farmer farming free range who is selling their chickens' live* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

The effects of poultry manure on crop yield, when compared to inorganic fertilizer application are vast. The results depend on the cropping system, tillage, soil types, and method of application (Lin, 2018). Generally, poultry manure has a significant positive yield increase. An Industrial Poultry Farmer stated:

> *Okay, that's more on the abattoir side, the mortalities on the farms and the ones that die throughout the cycle obviously can't go into the human food chain. But that can go into the lion farms, predator farms, crocodile farms, where that can be used as food for them. Otherwise, that can go into composting which can then be used as compost; from the abattoir most of the bird is used. One thing that is not used is the feathers obviously but that goes a plant where they produce that into feather meal, that is not something we are directly involved with* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

Under no-till or strip-till practices, higher yields were observed from peanut, soybean, corn, and cotton crops when amended with the use of poultry manure, and the crop yield benefits were more pronounced with repeated applications (Hoover, 2019).

Figure 5: Indigenous chicken and the different breeds in Ndwedwe, KwaZulu-Natal

Indigenous Chicken in South Africa

In KwaZulu-Natal, there has been a research gap in the nutritional, genetic, and physiological aspects of indigenous chickens in South Africa over the past decade. These different breeds of chickens are well known to be culturally, economically, and socially important to the people, especially those from marginalized communities in Ndwedwe. Although these chickens are associated with poor productivity in terms of the number of eggs laid, most consumers prefer their flavorsome meat (Tlou, 2020). Indigenous chickens adapt easily to harsh environmental conditions which include organic production systems, extensive small-scale villages, and free- range chickens. These chickens are sometimes referred to as family chickens, village, backyard, traditional, and scavenging chickens (Tlou, 2020). The chickens in Ndwedwe are not injected with artificial hormones; they are much more affordable and can feed the entire family. The leftover bones are often used to feed the dogs or other animals and birds around that area.

Solid waste disposal in the rural areas in South Africa has been a lingering problem in rural areas causing grave environmental catastrophes (Elard, 2019). The illegal burning

and dumping of household food and solid waste are the most common disposal methods that are practiced in the rural areas of Ndwedwe, KwaZulu-Natal (IDP, 2012). These practices result in countless environmental problems such as severe air, land, and water pollution (Nkwachukwu, 2010).

People in Ndwedwe and rural areas generally discard their waste indiscriminately on verges of the road and any available open pit in their back yard irrespective of the impact on the environment (Kaundal, 2017). A Rural Farmer stated:

> *We don't have things where we can put our waste, so we dug a hole where we put all our waste. When that hole is full, we then burn it. There is no other way that I know except to dig a hole because we don't have things where we can put our waste in* (Rural Farmer, isiZulu Interview #10, November 2019, Female, Age 49).

Because of illegal dumping, this has been prohibited because of its adverse impact. Nonetheless, in the rural areas in KwaZulu-Natal, the practice is still very common, and even in some urban areas, this is mainly due to the lack of awareness, law enforcement, financial means, and awareness (Frantz, 2016). As stated by a Rural Farmer:

> *I feed the food to the chickens, I collect 2 litre bottles as you can see there and the remaining waste I burn it. Interviewer: What type of saving method do you use in your household? Like those 2 liter bottles why are you keeping them? Participant: We use the 2 liter bottles to store water or when I am making fire, I use it as an accelerant. Some people even buy them (Rural Farmer, isiZulu Interview #3, November 2019, Female, Age 34).* In most developing countries, this type of practice is much more common, because of the indiscriminate disposal of solid waste practices in the rural areas. A participant said, when asked about a specific place where you dispose and burn rubbish:

> *No, I dispose of it anywhere* (Rural Farmer, isiZulu Interview #9, November 2019, Female, Age 67).

This is not conducive for the environment or public health (Frantz, 2016), as poor waste management practices can have an adverse impact on a local and global scale (Elard, 2019). Though in the current generation that we live in, it is critical for waste to be avoided, or where it cannot be avoided, this must be recovered, reduced, recycled, or re-used. Only as a last resort should it be disposed of and treated safely (Uzair, 2019).

Inappropriate waste management has given rise to undesirable environmental problems to many people in South Africa and this has affected the living environment and lifestyles of future generations (Pingoud, 2019). Furthermore, due to the indiscriminate disposal of municipal solid waste that produces a significant amount of nitrogen oxides (NOx), methane (CH4), carbon monoxide (CO), and biogenic carbon dioxide (CO2), these are great contributing factors that cause pollution in the environment (Pingoud, 2019). As stated by a Small-Scale Farmer:

> *It's an environmental problem which has an impact on the finical side of things. You see… that would be one of the big challenges I think for all farming, not only chickens; in the country it would be for all farming. It's that climate change is making it increasingly difficult to be able to farm, its making it increasingly expensive and that increase cost is being passed over to the consumer. And because the consumer is paying more for meat they would eat less meat, so that is another challenge is that how do you get people to - you know - if you are trying to grow a business. How do you get them to eat more meat rather than eating less meat because if they are eating less meat, you've got a thinking market not a growing market? So, do you see how the whole circle is linked?* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

However, it is suggested that municipal solid waste be disposed of in engineered landfill sites that can eliminate or reduce the threat of methane productions (Pingoud,

2019). The problem of disposing of waste, gas, liquid, or solid waste has the perspective of polluting the water eventually. Polluted water directly affects the riverbeds, agriculture fields as well as soil, and it creates a secondary source of pollution (Uzair, 2019).

The burning of waste is a prevalent option for waste disposal in Ndwedwe, KwaZulu-Natal where there is no Durban Solid Waste (DSW) waste removal. A participant stated, regarding the collection of waste:

> *Leftover food - we give it to the chickens and other waste we put it in the waste bin. We throw it away, you see this one I was going to burn it, but it is wet I will burn it when it is dry* (Rural Farmer, isiZulu Interview #2, November 2019, Female, Age27).

The thermal treatment method is a manner that often uses heat to treat waste and is commonly used in rural areas of South Africa while causing smoke and other harmful emissions that are released directly into the atmosphere (Post, 2017). This type of waste treatment method "the burning of waste" produces ash as residues. The people in Ndwedwe, KwaZulu-Natal indiscriminately spread the ash to the veldt or garden. Traditionally, waste ash from the wood fires (potassium) that are used to cook food is used as fertilizers to enhance the quality of the soil (Post, 2017). The most frequently used final waste disposal practice in most rural areas in KwaZulu-Natal is to burn waste.

4.3.1 The effectiveness of the poultry industry's waste re-use in improving the crop production of urban Farmers

Poultry provides an important source of animal protein and is amongst the most intensively reared of all livestock species in South Africa. Poultry has an immense socio-economic benefit in terms of the production of meat, eggs and creating employment. This often constitutes some environmental risks to both animal and human lives air, water, and soil pollution. Hatchery wastes, such as poultry excrement, litter, and on-farm mortalities are some of the few waste products produced. If agro-industrial wastes are not used or

disposed of in an adequate form, it in turn would pose enormous pollution problems. Poultry waste and feathers are rich sources of amino acids and keratin proteins which can be converted into valuable products such as fertilizer, feather meal, biodegradable plastic, and biodiesel (Muduli, 2018).

Chicken Manure-Enhanced Productivity

Figure 6: Poultry manure used as organic Fertilizer

The utilization of poultry manure as an organic fertilizer is critical in improving crop production and soil productivity in South Africa (Oagile, 2010). An Industrial Poultry Farmer stated:

> *Nothing goes really to waste, because everything goes into the poultry house…at the end of the cycle we clean out the house completely and all that litter and poultry manure that's in the house, either gets composted or it is fed to*

ruminants or its spreads land that is going to be used as crop production (Industrial Poultry Farmer #1, February 2020, Male, Age 40).

The increasing demand for poultry meat has encouraged more chicken farming. There are consequential effects on the increase for the utilization of organic wastes, for example, chicken manure as fertilizers. Organic wastes do contain varying amounts of organic matter, water, and mineral nutrients (Edwards, 2017). Although the usage of organic wastes as manure has been in practice for centuries across South Africa, worldwide, and in current times (Omiti, 2019), there exists a need to evaluate the possible impacts of chicken manure on crop yield, soil chemical properties, and in the specific evaluation of critical application levels. A participant stated:

Well, the only waste on the farms is mortalities and the litter at the end of the cycle. That is exactly as I described earlier, it either gets to predator crocodile farms. Mortalities and the poultry litter either gets fed to ruminants or spread on lands (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

Furthermore, the utilization and need for chicken manure has surpassed the usage of other animal manure such as kraal and pig manure because of its high content of potassium, nitrogen, and phosphorus (Warman, 2016). The escalating price of inorganic fertilizers due to the increase in fuel price in South Africa has also encouraged the use of chicken manure (Place, 2015). Likewise, organic waste is also being supported by the different environmental organizations around the world in order to preserve the sustainability of agricultural systems. A participant stated:

The benefit is that none of it is wasted, it all has a use it purpose so you don't have the problem of disposing of it, so you don't need a dedicated site where you have to bury it, or burn it, or anything like that so you can use it either for feeding of other animals or as enhancement of the soils characters that's the

> *biggest benefits. Drawbacks obviously something like mortalities, it has to be kept or frozen so they don't go off, I mean if it goes off it can make other animals sick and the litter there's certain medications that we can't use in the chickens, because it can be dangerous if that litter is fed to ruminants* (Industrial Poultry Farmer #1, February 2020, Male, Age 40).

In KwaZulu-Natal, a host of nutrient management practices had been undertaken by smallholder African Farmers (Place, 2015). While the comparative acceptance rates between mineral and organic nutrients vary by location, the incidence of organic practices is more frequently used than mineral fertilizers (Oagile, 2010).

Conventional agriculture has been impacted, due to the excessive use of pesticides, chemical fertilizers, and growth regulators that interrupt the soil's ecological balance and make the soil less favorable to plant growth. Plants become more susceptible to diseases and pests (Pujiastuti, 2020). An Industrial Poultry Farmer explained:

> *I don't think of the poultry industry, because we make use of environmental houses, so the environment defiantly influences the production of maize, and it has an effect on the possible poultry as well* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

This could lead to a decrease in quality and crop yield (Pujiastuti, 2020). For change to occur in the South African farming system, it needs to be a more sustainable one. Farmers need to look at alternative methods to increase food production and improve efficiency levels through different practices such as recycling of on-farm wastes as a soil conditioner, livestock and irrigation of crops, minimum tillage, crop rotation, and integrated pest management (Pujiastuti, 2020).

Figure 7: Arid land due to the excessive use of Fertilizers

Source: Google, Arid land due to the excessive use of fertilizers (2019)

Crop Varietal Innovations in South Africa

Figure 8: Compost pit, which is used as fertilizer for crops in Ndwedwe

One of the main factors for investment in crop varietal innovations in South Africa is the need to improve yield potential, tolerance and resistance to abiotic and biotic stresses, processing quality, and nutrition. An even greater investment in development and agricultural research, more particularly varietal innovations is essential to sustain and

increase agricultural productivity, as well as to address challenges such as increased weather variability, food security, poverty, adaptation to climate change, and the volatility of prices in global markets and water scarcity (Afr., 2021). A Small- Scale Farmer stated:

> *It's an environmental problem which has an impact on the finical side of things. You see as I say to you that would be one of the big challenges I think for all farming, not only chickens in the country it would be for all farming. It's that climate change is making it increasingly difficult to be able to farm, it makes it increasingly expensive and that increase cost is being passed over to the consumer. And because the consumer is paying more for meat they would eat less meat, so that is another challenge is that how do you get people to you know if you are trying to grow a business. How do you get them to eat more meat rather than eating less meat because if they are eating less meat, you've got a thinking market not a growing market? So do you see how the whole circle is linked* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Concerns to address increasing scarcities of water and land degradation remain the primary source of food shortage supply and the main source of declining growth in the agriculture sector. There is a need to increase agricultural production to meet the increasing demand of the growing population. Innovations such as crop varietal improvements need to focus beyond raising productivity to address additional challenges such as environmental protection, risk reduction, water scarcity, and improved product quality (Afr., 2021).

Grains and Maize in Poultry Diets

Figure 9: Chickens feeding on maize in Ndwedwe

Maize is one of the largest locally produced field crops and is the most important source of carbohydrates in the Southern African Development Community (SADC) region for human and animal consumption. South Africa is the main source of maize producers in the SADC countries, with the production rate at over 12 million metric tons a year over the past few decades. An industrial Farmer explained:

> *55% of the diet would be maize and then 25% of the diet will be soybeans and then we will put in some other animal protein source, something like fish meal animal by- product meal as a protein source. And in terms of the micro-ingredients, we will add minerals, vitamins in balanced fashion specific levels of those* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

It is estimated that around 6500 commercial maize producers are responsible for crops produced in South African, and over thousands of small-scale producers that are responsible for the rest (SAYA, 2019). An Industrial Poultry Farmer said:

> *Poultry companies are in maize productions per say, so all the feed will be bought some of these companies are integrated so they will have their own feed mills. But the feed mill would do the purchasing of all the ingredients here like this year err there is enough maize and soya in the country so we will buy locally but in years of drought we would also buy on the international market. The feed stuff price normally changes monthly, the biggest driver of the change and cost of feed relates to the grains and predominantly maize and soya. So as the maize and soya go up and down in terms of price, the price would be adjusted feed companies purchase their raw materials. The maize and soya a month ahead so the maize we would use in a months' time, they have already bought. So that is the shortest lead time we will have in terms of purchasing raw materials if we believe that there might be a drought on its way, we will hedge and buy forward. So, companies will tend to buy between 3-12 months ahead depending on forecast depending on how big the local crops would be* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

White maize is predominantly used for human consumption, while yellow maize is commonly used in animal feed production. White maize is usually grown in the Western Province of South Africa, while yellow maize is planted in the Eastern Province (SAYA, 2019). A Small-Scale Poultry Farmer explained:

> *Well, I normally plant crops like oats and barley and then you can also plant maize and a variety of herbs which is quite good for the chickens. Well herbs you can plant things like garlic well that's not really a herb; it's a vegetable but you can plant things like garlic, you can plant things like mint, you can plant parsley which is all really good more so things like mint. Because internal worms and*

that in the fowls they don't like the taste of mint, so it assists them you know. But your main feeding line would be like your grain type crop, and you can also plant lucerne, it depends on what does the best (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Maize is usually planted during late spring or early summer, with the optimal planting times being during November and December. Planting can start as early as October and extend to January. In a particular season, depending on weather conditions and rainfall determine the planting period of the maize as well as the length of the growing season. The momentous production upturn reflects the 35% increase in planting, which was urged by bumper yields, and higher prices. This was mainly due to the wetter conditions followed by the dry weather conditions that were experienced in the previous season. South Africa exported around 2,4 million tons of maize in the 2018 Financial Year and subsequently the net exporter, compared to previous years when an above-average volume of nearly 2,4 million tons had to be imported from other countries (SAYA, 2019). An Industrial Poultry Farmer said:

There is not really positives or negatives but the only negative we have is if we have droughts in South Africa, and remember we are a semi-desert country so our cost of production for maize and soya is significantly higher than Brazil, US and Ukraine - as an example - so that would be a negative the cost of raw materials in South Africa (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

The maize prices were stable in 2017 as upward pressure from a weaker rand currency and dry conditions during the start of the planting period for the 2018 maize crop were partly offset by forecasts indicating good seasonal rainfall prospects, as stated by the Small-Scale Poultry Farmer (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

It's an environmental problem which has an impact on the finical side of things… that would be one of the big challenges I think for all farming, not only chickens

> *in the country it would be for all farming. It's that climate change is making it increasingly difficult to be able to farm, its making is increasingly expensive and that increase cost is being passed over to the consumer. And because the consumer is paying more for meat they would eat less meat, so that is another challenge is that how do you get people to you know if you are trying to grow a business* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Additionally, the abundant national supplies have continued to exert downward pressure, keeping prices below their year-earlier levels (SAYA, 2019). In the rural parts of Ndwedwe, the Farmers usually feed their chicken maize meal. In the feedstock manufacturing sector, maize is one of the main ingredients in the mixture. The Feedstock Manufacturer stated:

> *So basically, soya bean meal, full fat soya, sunflower oil cake, we use maize, we use a bit of bran, then we got all the amino acids fining, we use a bit of choline and basically we put them in a pre-mix in as well, a bit of salt, lime stones, urea. So based on the raw materials that we can prepare and based on the prices sometimes we would sometimes use different raw materials* (Feedstock Manufacturer #1, February 2020, Male, Age 39).

Consumers' Thoughts on Feed

Chickens need a suitable mixed diet in order to stay healthy. Their diet consists of a mixture of leftover food such as mealies, vegetables, bread, and mealie-pap. Commercial chicken food is highly nutritious. Hens should be given a diet rich in calcium to produce healthy chick and eggs. They need to feed commercial layer rations which supply them with oyster shells, limestone grit, or small, regular quantities of bone meal (Voicu, 2020). Most consumers believe that the industrial poultry sector feeds their chickens Genetically Modified (GM) foods, whilst the Rural Farmers feed their chicken free-range organic foods.

Table 2: Consumers' thoughts on feed in Industrial and rural areas

Consumers thoughts on feed in the Industrial sectors in KwaZulu-Natal	***Consumers thoughts on feed in the Rural sector in KwaZulu-Natal***
Chicken feed, GM grown foods, steroids to make chicken bigger.	They let the chickens roam free and eat all the natural things like worms and seeds.
Feed	Crushed Mealies, Bird Seeds & Homemade Chicken feed
Chicken feed, includes selective seeds and dried corn	Seeds or corn
Probably some kind of chemical supplement.	Mealies or maybe beans.
Wheat	Wheat
Maize chicken feed	Maize chicken feed found in stores
A variety of processed chicken feed and grain.	Chicken are primarily fed mealie grain as well as leftover food. However, most of the time the chickens are left to roam about and source their own food in the veld.
Grain mixed with bulking materials	Grain
Feed	Possibly maize or feed
Mineral supplements, vitamin supplements and soybean oil meal	I think they feed their chickens corn, wheat and veggie scraps
Poultry feed with the necessary nutrients and supplements.	Wheat and corn or other crops grown in rural areas.
Genetically modified food to stimulate growth	Maize and seeds
Protein supplements such as soybean oatmeal, mineral supplements, and vitamin supplements	They are grain fed, also have corn and wheat and
Probably chicken seeds	Basically, anything they have – I mean people from rural areas can't even look after themselves
Grass, grain, seeds.	Grass, grain, seeds.
Bird feed	Maize meal

Crushed corn and normal corn and Processed feeds	They buy chicken feed, which often is corn
Chicken Feed - Grain or Grass Fed	Chicken feed and leftover scraps from the household
Genetically influenced mash and pellets	Maize and grain
Grain & wheat, vitamins & mineral supplements	Corn, veggie scraps
Chicken feed	Corn or other crops that Farmers grow
Protein feed	Grain, bird seeds, chicken flesh

Management Issues

There are different social and technical innovations that are required for the solid waste management sector in rural areas and large cities in KwaZulu-Natal (Bolton, 2016). A Rural Farmer had stated when asked about how they dispose of household waste:

> *I feed the food to the chickens, I collect 2 litre bottles as you can see there and the remaining waste, I burn it. We use the 2 litre bottles to store water or when I am making fire, I use it as an accelerant. Some people even buy them* (Rural Farmer, isiZulu Interview #4 November 2019, Male, Age 26).

Even though these dump sites signify the worst-case scenario in current waste management practices in terms of sustainability and environmental protection, they still occur in many other developed countries, more particularly in rural and peri-urban regions. Emerging and developed countries do not eradicate the wild dump issues. Although these sites are much smaller than the formal urban landfills and are scattered across the rural peri-urban regions, this is still a significant pollution source. Dumpsites should be mapped at the municipal level across all different regions in KwaZulu-Natal to assess their environmental impact (Stanisavljević, 2012). Monitoring illegal dumping activities is crucial either in high-income or developing countries as they affect water bodies, public lands, or roadsides (Mazza, 2015). The dumpsite is historically the basic

and convenient option in the waste management treatments that are used by human settlements across South Africa and the world along with river and ocean dumping practices (Mihai, 2017).

Due to the lack of finance and governmental policy, the difficulty in long-term planning and political issues in waste management, resistance to change, and social behavior is a setback. For instance, poor environmental awareness, poor waste management infrastructure, irregular waste collection services, the low market for recycled materials, separation of waste at source, lack of funds and low quality of waste management services, are all factors that contribute to the existence of open dumps nowadays (Taherzadeh, 2015).

The traditional recovery of household waste such as animal feed and home composting, has diverted a part of the bio waste portion from waste dumping into applications. The enhancement of home composting procedure across the rural communities in Ndwedwe is an environmentally friendly solution and would be cost efficient if it is correctly performed to avoid bio waste losses (Mihai, 2017). A Small-Scale Poultry Farmer said:

> *Well, in terms of management, the most important thing in terms of free ranging is that you need to make certain that you got crops planted for the chickens. Because if you haven't got crops you know, then you got to start buying feed and that can become expensive, so you also need to make certain that you got sufficient land to plant the crops and obviously a bit of water to irrigate the crops. Obviously, you have to look at you know sickness factors like lice outbreaks or flea outbreaks in chickens, and then they become dangers of erring diseases like in Newcastle. It's called Newcastle disease, if that gets into a chicken it can be fatal for all of them you know* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Recycling and reuse of various items such as metal, plastic bottles, construction material, and glass in the rural household also alleviates the potential amounts of waste

unrestrainedly disposed. The rural population of middle and low-income areas in Ndwedwe relies on solid fuels like crop residues for firewood, and dung as the energy source for domestic purposes (Mihai, 2017).

Agricultural wastes, for example, sawdust, stalks, wood, husks, and straws, are often disposed of by burning in open fields with exposure to fire hazards. Household wastes such as textiles, bio waste, and plastics, etc. are also prone to open burning practices. A Rural Farmer explained:

> *Yes, I do give it to the dog and sometimes chickens; you see today I gave chickens the maize meal scraps from yesterday. For other waste types there is a waste pit by the kitchen where I put all my waste and… usually burn it. When I want to burn the waste, I just throw in a burning coal into the pit because it deep for me. Here at home, I buy half sack of rice, I think I told you how many are we in this household? Yes, so I buy half sack of rice and maize meal this food lasts us a whole month. I put it in large containers, and I know how to save food, at home I grew up in a large family. I make breakfast for the children when they are going to school, but the boys want a full meal. I prepare a full meal for them also to eat after school, they all eat and I then cook again supper in the afternoon* (Rural Farmer, isiZulu, Interview #2, November 2019, Female, Age 27).

Waste that contains hazardous items like contaminated wood, solvents, plastic, batteries, e-waste, solvents, and oils, are often released into the atmosphere, groundwater, and soil. Some of the common hazardous substances that are used in the rural areas in South Africa include pesticide, chemical fertilizers, fungicide, cleaning agents used in animal husbandry, medical waste, chemicals used for fumigation, herbicide, and insecticide (Chandrappa, 2012). Such hazardous fractions should be managed, collected and separated from common household waste (Mihai, 2017). In a worst case, rural households in Ndwedwe do not have access to basic utilities such as waste management services, sanitation, and an improved drinking water source. The rivers are polluted by

waste dumping and agricultural waste (Epstein, 2019).

There are major gaps in the waste collection coverage between rural regions and larger cities across South Africa. A recent study shows that an estimate of 1.9 billion people lack waste collection services in the rural areas and the coverage rate of the rural population is under 50% in over 105 countries from around the world (Mihai, 2017). The amount of municipal waste that is uncollected and generated by the municipality in South Africa is more susceptible to be uncontrollably dumped or burnt, threatening public health, and polluting the local environment. Wastes contaminate the rivers and tributaries, coastal areas, and lakes; whereby ocean ecosystems and floating debris invade marine life. More particular plastic pollutions are non- compostable and micro plastics are a threat to large areas of oceans called "gyres" and marine wildlife is susceptible and not spared the effects of this debris carried by the currents (Mihai, 2017).

In Ndwedwe, proper access to formal waste collection services should be fortified to practice vermicomposting or home composting in order to acquire a more qualitative natural fertilizer. Having organic farms appears to keep soil healthy, produce good yields, maintain biodiversity, save energy, and reduce external costs (El-Haggar, 2017). The composting process may cover various bio waste sources such as agricultural, municipal, and sewage diverting fractions from open burning practices or open dumping practices.

4.3.2 The effectiveness of the poultry industry's waste re-use

The poultry industry in South Africa is rapidly growing and contributes to the direction of addressing the key national development goals. In addition to improving the standard of living of people through creating employment opportunities and alleviating poverty, poultry manure needs to be taken care of as a non-appropriate disposal or treatment can become risky for humans and the environment. A Small-Scale Farmer said:

> *You see, faeces aren't the problem, because faeces are a natural product. You*

know, as I say, one would just have to be careful where you have your operation because if it's on a site near to a river, you know you are going to have a lot of run off. So those are all the things you need to take into consideration. But like I say to you, what happens is all the litter you know that chicken manure gets connected by the people working there and they take that and they put it back into the areas where they going to plant herbs and crops, so we don't really have any barriers in terms of… you know; for example, in a big farming operation, a big chicken abattoir operation, it could be barriers such as lack of municipal services. You know to get rid of waste, but that does not affect a Farmer farming free range who is selling their chickens live (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

For instance, manure can contribute to the spread of diseases and in many cases pollute groundwater and soil resources if it is not properly handled. Waste is explained as something that is no longer used and needs to be disposed of. The poultry industry in South Africa produces large quantities of waste which includes wastewater and solid waste. The solid waste consists of feathers, feed, droppings, bedding material and hatchery waste that include dead hatchlings, infertile eggs, dead embryos, empty shells and sludge whilst abattoir waste include condemned carcasses, blood, and offal (Muduli, 2019). An Industrial Poultry Farmer said:

I wouldn't say re-use but maybe if there is a miss calculation or some of the food specs that's not, specifications that's not perfect. Those feed might be re-worked into new rashes, at I would guess about the inclusions about 5% just to not throw that away (Industrial Poultry Farmer #1, February 2020, Male, Age 40).

A question was asked regarding what consumers thought about the poultry industry's waste re- use in enhancing the sustainability of Urban Farmers' livelihoods. The responses are tabulated below.

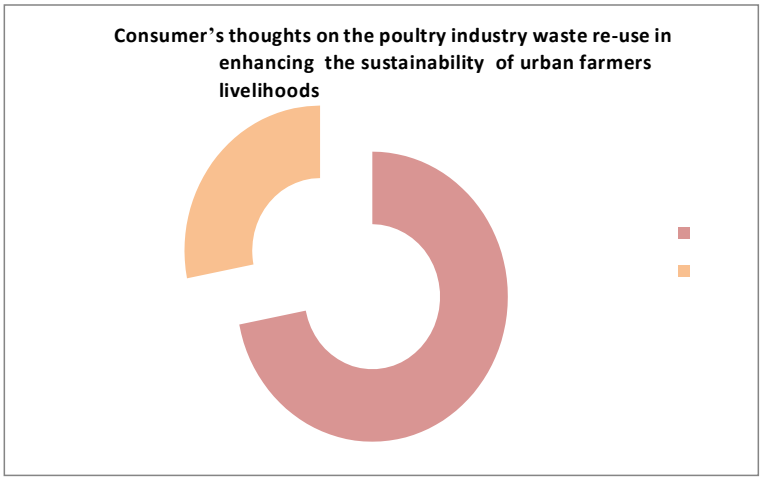


Figure 10: Consumer's thoughts on the poultry industry's waste re-use

The above graph shows that 70% of consumers agreed with the poultry industry's waste re-use to enhance the sustainability of Urban Farmers' livelihoods whilst 30% disagreed.

Legend

70% = Consumers Agreed
30% = Consumers Disagreed

Local Chicken Breeds of South Africa

Chicken plays an important role in improving the socio-economic status of many rural people in Ndwedwe, KwaZulu-Natal. A Rural Farmer said:

> *When you see that you have a lot of chickens, you sell them to make money. I do sell them when they are many; people do come and ask for chickens then I sell it to them. But I also eat them* (Rural Farmer, isiZulu, Interview #9, November2019, Female, Age 69).

Through a lack of coordinated disease control mechanisms, the absence of

conservation strategies, poor housing and feeding are some of the challenges that Rural Farmers in Ndwedwe, KwaZulu- Natal faces. A Rural Farmer stated:

> *That's why you need to build a coop for your chickens. So that you can keep them inside when you have planted something like beans, every morning you feed and give them water. It just that they do sometimes get sick from bird flu, and it is better when you have something that will help your chicken when that bird flu comes. The way I save the chicken feed? You save them yourself…That you know if you fed your chicken in the morning, you will feed it again in the afternoon giving you chicken food two times a day. That's the way I save. When you no longer going to eat the rice, I put in their feed and give it to them* (Rural Farmer, isiZulu Interview #7, November 2019, Female, Age 24).

Parasites in the intestines of chickens in rural areas are another problem that results in poor carcass quality and low weight gain (Mushi, 2018). Education level and market price, the inexperience of Farmers, access to extension services, and distance to the nearest market are factors that can affect the profitability of local chicken rearing (Natukunda, 2011). A Rural Farmer explained regarding feedstock:

> *Here in the rural areas because we farm maize we do give chickens that maize. When it's finished, we buy maize in stores. No, they don't have it in the local shops. I use any store where I can get chicken feed, even in the stores nearby.* (Rural Farmer, isiZulu Interview #1, November2019, Female, Age 42).

Despite all these challenges, rural chicken is a source of protein and income to a resource-limited local rural marginalized community in Ndwedwe. Rural chickens are more preferred over exotic chicken breeds because of their succulent meat. They are also much cheaper and more than 89% of consumers preferred to eat farm-fresh chickens in KwaZulu-Natal (Liswaniso, 2020). Henceforth, there is a great demand for farm-fresh chicken products such as meat and eggs which are pricey. It is estimated that rural chickens constitute more than 80% of poultry production in

Sub-Saharan countries (Desha, 2016). However, these figures display the necessity to increase poultry production (FAO, 2019). The mortality rate, and flock size amongst the farm chickens in African countries differ. In South Africa, studies have shown that the mean flock sizes of 12.9 to 29.98 chickens vary per household (Mengesha, 2011), while the mortality rate amongst the rural chickens in South Africa is high. According to a Rural Farmer:

> *With chicken it just that you have to be careful of the bird flu and they become fewer because they die. You have to have a way to deal and take care of the flu. The mongoose, it happens sometimes that they attack while the chickens are eating by the gate* (Rural Farmer, isiZulu Interview #9, November 2019, Female, Age 67).

Several reasons have been put forward which includes predation, malnutrition, diseases, and mismanagement (Selam, 2013). Consequently, the flock size is largely affected by theft, predator and diseases. The production quality of rural chickens which can lay around 20 to 80 eggs per year, is low when compared to commercial breeds that can lay up to 300 eggs per year. Low genetic potential and nutritional deficiency are factors that influence the low production of eggs. Henceforth, the genetic material necessity needs to be improved to enhance productive efficiency (Petrus, 2011).

Table 3: What Consumers look for when purchasing chickens

What consumers look for in chicken	Counts
Economic	14
Quality	15
Health and Safety	19
Accessibility	7
Freshness	18
Taste	11
Size	10

Legend

n = sample size n = 29

Figure 11: Protestors against poultry dumping

Source: Google, Protestors against poultry dumping. (2017)

Issues Regarding Poultry Dumping in South Africa

In the perspective of international trade, dumping is the export of poultry products at a price that is much lower than the price charged in the domestic markets, or below the cost of production. It permits the imports of products to advance in an unfair market share trade and it's reflected as a predatory practice (Fairplay, 2021). An Industrial Poultry Farmer explained:

> *The biggest challenge the industry faces is from other countries and the definition for me is dumping. And chicken dumping is when the country overproduces the product in their country, they maintain the price in their country and export the other over produced product to another country at a ridiculous low price and cause market disturbance in that country to get off set, so they export their problem; they do that to South Africa. The second form of unfair trade is where because of systems at port that is not as suffocated as in the EU, people are actually under invoicing the product to prevent paying the legal taxes, import taxes that they supposed to pay and that is causing harm to the industry, so that is one of the biggest problems in the industry* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

Dumping is not a fair competition or fair trade, nor is it fair to the consumers. This practice has shown that once the South African industries have been killed or crippled, importers from other countries can raise the prices to whatever level they think the market would be able to bear since they control the supply (Fairplay, 2021). After many years of neglect and the flood of a cheaper chicken import from Brazil and other European Union (EU) countries, the South African industry has been crippled leaving thousands of workers unemployed. This has a drastic ravaging effect on the country and creates distress amongst Poultry Farmers. Important inputs such as chicken feed, and other essentials have become very expensive for many of the farmers to ensure a profitable business (Karodia, 2017). According to these participants:

> *I think it's the attitude of the industry to be globally competitive, so we*

would be vigilant in identifying new technologies overseas, whether that be intellectual property or physical equipment. The industry transplants that to us, I think that's the one component of that. Chickens in Brazil, America and South Africa got different requirements by the country that produces chicken in 2000 or 1600 meters above sea level, they not designed to do that. So, we develop our own management practices to be able to get the full potential from chicken (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

...the biggest problem is diseases chicken companies, chickens' farms can control what happens between their four walls of a chicken house in the roof that they can't control the environment that they produce in and I'm referring to wild birds, I'm referring to back yard chicken. Outside birds would affect first, every season birds migrate from Europe to South Africa and bring with them diseases that are in Europe, US, Russia, and they would infect local birds and local birds will infect back yard chickens that are in the open and eventually they will infect the commercial chickens, so the diseases are a huge issue for us (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

Table 4: Consumer's thoughts on importing chickens from other countries

Some of those who agreed	Some of those who disagreed
Importing chicken should be nationalized so that consumption is cheaper, and duty free with no added tariffs on the international chickens.	Not acceptable. We are not sure of the quality of the imported chicken and whether they are fed with hormones, etc. and secondly, imported food is not good for our economy.
It is very important as we are going to consume the chicken, and if the chickens are injected with artificial agents which may be harmful to our body, then I would not want to consume that chicken. The chicken must be well taken care of and well fed and must be healthy for us to be confident to eat that chicken without getting sick	Sad situation for any country. Why import chicken from as far as Brazil?
It all depends on the conditions and how it is treated in the other countries e.g., health, safety, cleanliness etc.	I do not like the idea of importing chicken due to the risk of disease and it is always better to support local Farmers.

COVID-19 Impact on the Poultry Industry

The South African poultry industry is bracing itself for difficult times ahead, as many producers advise that there would be an enormous amount of chicken products that would be imported into the country after the COVID-19 pandemic. The issues pertaining to chicken dumping have plagued producers for many decades. While South Africa has been under lockdown for so many months, numerous businesses were not able to trade, and the poultry sector is no exception (Fairplay, 2021).

Challenges to the Poultry Industry in South Africa after COVID-19 Outbreak

It is critical to know that poultry is not vulnerable to intranasal infection by the SARS-CoV-2 (COVID-19) virus. However, the COVID-19 pandemic has affected the transport sector, the economics of poultry farming, and poultry consumption (Hafez, 2020). A participant stated:

> *It's the most important because of food quality, health and safety, the challenges of COVID-19, ensuring it is made more human consumption, lessons from COVID-19 forces people to be cautious about the health and safety of how it's produced* (Surveys #7, Question 8, April 2020).

To take into consideration the sustenance of the accomplishment of high environmental security, ethics, social dimensions, and economics, a participant said:

> *Due to COVID-19, it is not as welcoming. However, it's based on the health and safety protocols that are put into place* (Surveys #12, Question 9, April 2020).

Farmers, veterinarians, stockholders, and the partners of the poultry production supply chain need to be compliant in the strategic future of the industry in order to ensure sustainable agriculture and fulfill human demands. Consequently, the contemporary review must explore these important tasks (Hafez, 2020).

Reasonable production costs, high production, disease control, and product quality have been the most current goals of the poultry industry. Henceforth, welfare to humans and meeting per capita consumption necessitates continuous goal-oriented healthcare and efficiency to decrease the application of antibiotics and control the spread of disease (Cavani, 2019). These undertakings would include the launch of programs to ensure the safety and security of foods, constant changes in social and political conditions, and the biological aspects of the materials recycled determine its social acceptance. With the uptake of chicken consumption in South Africa, it probably is socially acceptable. A participant stated:

> *COVID did not impact my decision on buying chicken but rather the interruption of lockdown and the availability during this time. Also, the disruption in the domestic food supply and regulations definitely impacted the processing and distribution so the availability of fresh products was scarce. My preference is the fresh products rather than frozen chicken* (Questionnaire #20, Question 4, October 2020).

Due to the ongoing surge in the costs of raw material, the cost of food and feed becomes a prominent issue (Hafez, 2020). With the occurrence of new and unanticipated diseases, the new legislation in South Africa is important. In order to discuss environmental defense issues, control infectious diseases, and consumers perceptions about animal welfare should be addressed (Hafez, 2020).

In South Africa, poultry diseases remain the primary issues of the poultry industry and its future. The outbreak of any disease could turn into an epidemic and can have an extensive influence on the global trade of poultry products. A Feedstock Manufacturer explained:

> *So, basically now with the coronavirus there is this amino acids, that has come in from China and this has the effect on the supply and demand, the effect on prices. So… some is going up like maize is going down, but err amino acids is going up* (Feedstock Manufacturer #1, February 2020, Male, Age 39).

The increase in raw material and feeding costs as well as their obtainability would negatively influence the growth of the consumers and industries purchasing power, more particularly after the COVID-19 pandemic. A participant said:

> *China is a prime example of issues arising when we decide to mix ourselves with those abroad – COVID-19. We have chickens. Let's stick to our own chickens* (Surveys #24, Question 9, April 2020).

Furthermore, the increases in biofuel and biogas production would reduce the land available for feed for animal production and grain production. In turn, there would be elevated product prices and a marked increase in the cost of feeding for animal production. In the foreseeable future, the feed industry will have a responsibility to ensure that there is a good quality of feed material that is ecologically friendly and free from pathogens. Moreover, climatic change and limited water resources is also expected to adversely affect the strategic plan to meet per capita consumption in South Africa and poultry production costs (Anderson, 2017).

The effects of COVID-19 on Poultry Production: Emerging Issues in African Countries

Due to the uncertainty that surrounds COVID-19, virus transmission has created a significant fear among human-animal interaction, and the likelihood of infected humans transmitting the virus to animals. With the rising number of cases of the COVID-19 virus across the world, numerous measures that included self-isolation and social distancing have been established in order to limit the risk of transmission and ensure human safety.

Although there was preparation for global readiness of personnel and the health care systems, there are concerns that emanate on the issues such as the effects of global lockdowns and food security on the agricultural sector including the poultry industries. In South Africa, poultry production serves multi-faceted purposes that include food security, income generation, and nutrition. The containment of production operations would result in food shortages and a major economic crisis due to the ensuing fluctuation in demand and supply (Uyanga, 2021). A Feedstock Manufacturer's response is recorded already.

This generates a knowledge gap and interesting insight on the consequences of the COVID-19 outbreak on poultry production. With South Africa facing significant socioeconomic obstacles, it is important to devise measures that would support improving food security and nutrition in a routine that ensures the containment of the coronavirus (Uyanga, 2021). A Feedstock Manufacturer said:

> *Another welfare face feed manufacturing practices, the type of raw materials that you use err feasibility, and there is a lot of stuff that has changed over the past few years. I think the use of antibiotics as well* (Feedstock Manufacturers#1, February 2020, Male, Age 39).

South Africans Consumption of Poultry Products

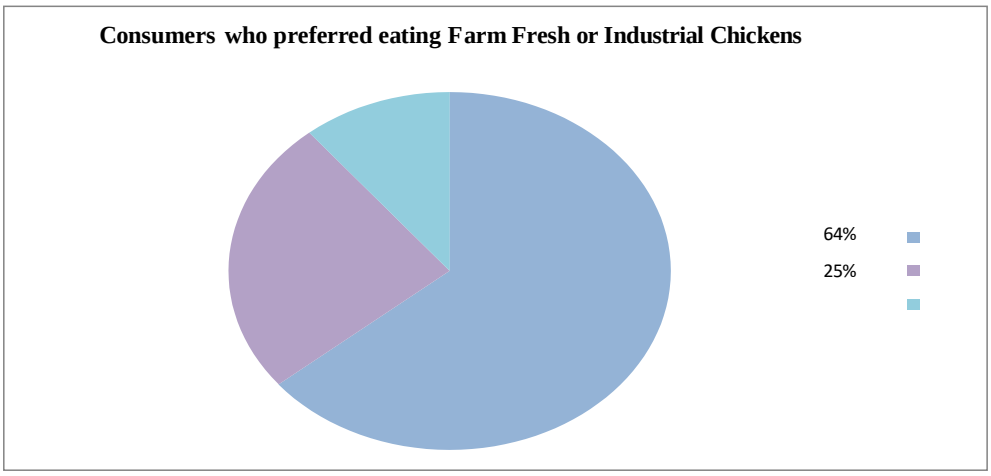


Figure 12: Preference of consuming farm fresh chicken or industrial chicken

Figure 12 shows that 64% of consumers preferred eating farm fresh chicken, 25% consumers preferred eating industrial chicken, and 11% consumers preferred eating both industrial and farm fresh chicken.

Legend

1 = Prefer eating farm fresh chicken
2 = Prefer eating industrial chicken
3 = Prefer eating both farm and industrial chicken

By 2021, South Africa's poultry consumption for poultry products would decrease by 1 percent which would amount to 1.88 million tons. In 2020, poultry consumption is expected to remain stagnant at 1.94 million tons. South Africa is already in the recession period due to the coronavirus outbreak and lockdown, following consecutive negative economic growth of 2019. In 2020, South Africa has recorded a decrease in the Gross Domestic Product (GDP) since the recession which has begun at the start of the year. According to Stats SA 2021, the GDP growth for 2020 was recorded at -2%, following a

drop of 0.6% in 2019. South Africa's unemployment rate has increased to 30.1 percent in 2020 from 29.1 percent in the previous years and the above market expectations of 29.7 percent (STATSSA, 2021). An Industrial Poultry Farmer said:

> *I think the big impact on livelihoods is the fact that poultry is the most used protein source of all proteins that people consume in any developing country. Except maybe Nigeria and Ghana the first form of protein would be a chicken-based protein so if one want to look at food security and you want to look at nutriment of nutrient impact of people, you need a poultry industry without that industry the livelihood of a lot of people will deteriorate* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

South Africa is one of the main consumers of poultry products in the world. Chicken products are the most consumed meat in the country with a total per capita consumption of 33 kg in 2019 as compared to the beef per capita consumption of 17 kg (Makgopa, 2020).

The Pivotal Role of Women in Poultry Agriculture and Sustainability

Issues regarding gender disparities are overlooked and discussed in the field of politics and economics. The integration analysis of gender relations in sustainability and agro-economics in South Africa is important because of the benefits from the resources based on social relationships among business, control, and paradigm of access (Bagnol, 2019). Al-Rimawi (2012) states that female farmers play a critical role in decision-making with regards to farm management, waste re-use, and the activity of livestock production in Ndwedwe. It is not detached from the role of field extension which was provided by private parties or government. Most of the rural households in Ndwedwe have poultry and are maintained by children and women. Family-owned poultry business contribution to the family income is about 19-50% in the rural areas; therefore, poultry is reared traditionally and is most favorable to women (Lestari, 2017). The Rural Farmer participant stated:

> *When you see that you have a lot of chickens, you sell them to make money. I do sell them when they are many; people do come and ask for chickens then I sell it to them. But I also eat them. You cook them the way you like. Sometimes you make dumplings and chicken curry. We just cook the chickens and eat them with the children if we are craving for it; we either cook dumplings or chicken curry with it* (Rural Farmer, isiZulu Interview #8, November 2019, Female, Age 56).

> *Yes, it helps because sometimes there are things that need money urgently and when someone buys a chicken you get that money. I use yellow maize for big chickens and chicken mash for chicks. We used to in Verulam because there are many stores* (Rural Farmer, isiZulu Interview #8, November 2019, Female, Age 56).

Leading causes of failure for emerging Small and Medium Rural Poultry Enterprise

The challenges of Small and Medium Enterprises (SMEs) in the rural areas of South Africa especially the poultry sector in Ndwedwe struggle to survive day to day because of the lack of knowledge into the poultry business. A Rural Farmer stated:

> *It just that when I sell them, the money I make at the market it's too little. So that's why I stopped and now I just eat my chickens. They used to say they want them with R50, yoooh! Imagine R50.* (Rural Farmer, isiZulu Interview #1, November 2019, Female, Age 42).

Many of the Rural Farmers have little to no awareness of formal business management or sustainable waste management (Thwala, Pillay & Sargeant, 2001). The rural business management environment in South Africa lacks complexity because there are no costs for investments or competition. Most of the chickens they used as business stock had been purchased at very low prices, swapped, or inherited. A Rural Farmer stated:

> *Yes, because a lot of people bought them, and now other people know that they can buy chickens from this household. It's not something that usually happens, it happens only at that time* (Rural Farmer, isiZulu Interview #10, November 2019, Female. Age 49).

> *I farm chicken so that we can eat them but if a person come looking for a chicken with a certain color that I have, I sell it to them or exchange it with another chicken* (Rural Farmer, isiZulu Interview #6, November 2019, Female, Age 30).

The new informal businesses must make a profit too in order to thrive and survive. Many rural SMEs in Ndwedwe transformed from Survivalists and Micro-Businesses (SMB) because of the experiences gathered and successes in the rural settings. They have entered a more dynamic informal market that is possibly inexperienced owing to the lack of not having exposure to mainstream business with little or no formal business training. Like most SMEs that fail in South Africa in the first three years of inception (Rogerson, 2016), poultry SMEs also suffer a similar fate. The more formal markets in South Africa have tough competition and expensive overheads whilst rural business players are simple and few with ineffective and limited competition (Dzansi, 2014). Chicken Farmers of the indigenous chickens often inherit poultry stock at no cost. Moreover, breeding chickens are cheap and sustainable and more so because they are left to roam freely. As stated by a Small-Scale Poultry Farmer:

> *It is profitable as I say to you if you limit your feed cost; you know if you can limit your input cost. But if you got a buyer feeding out of the bag you know if you got to go to feed merchants and buy feeding then it becomes quite expensive and then it becomes a game of scale. You know the more chickens you keep the cheaper they get to run; you know Small Chicken Farmer should try to grow their own feeding because the cost of growing your own feeding vs buying feeding. If you buy chicken feed it works out to R6 a kg and you can grow your own feed about R1.50 a kg you see there is a big difference* (Small-Scale Poultry Farmer #1,

February 2020, Male, Age 62).

In the mainstream business industry sector, on the other hand, competition is an important business aspect. A small-scale Farmer had explained:

> *It's not really very competitive because it's a small-scale industry and it's not really looking or relying on a bulk market. You know for example if I was a very big farmer producing 10 000 chickens a day, I would need to have a contract with checkers or with spar or with Pick 'n Pay. So would a lot of the other competitors you know that would make my margins tight because I'm trying to come in at the lowest price. But because I'm a small operator it allows me to deal directly with the public. You know if I'm a big farm as I say to you producing 10000 chickens a day, I couldn't expect to sell them in ones, ones to like the man and lady in the street I need to get someone you know to take it off the agreement. But you know because I'm a small operator I can sell ones and twos to anybody on the street* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Managing a business can become very expensive for many SMEs, as some businesses must pay tax for the first time due to the registration conditions. As stated by the Small-Scale Poultry Farmer:

> *You know what else one will need to establish is a market because you can farm chickens and you can produce them but if you don't have a market then you know you got a problem. So, you obviously need vehicles if you are living far away, you know people can't drive out where you are to come and fetch the chickens then a vehicle and employ people to come and transport them to your markets. The most important things about any form of farming no matter it might be small-scale or large-scale is to have off take agreements with the certain customer* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Therefore, the investment costs and other business expenses for poultry SMEs are more likely going to delay entrepreneurial progress and activities. Usually, many of the entrepreneurs in KwaZulu-Natal would have great business ideas but would sometimes lack skills and business knowledge. Many of those Farmers who have the skills and knowledge would want to start having a big business or collaborate with other big businesses. Due to their lack of knowledge and skill, any complexities emerging, such as competition and extra expenses are likely going to strain their SMEs. The Small-Scale Poultry Farmer explained:

> *Well, you know there is not much established in terms of Small-Scale poultry let's call it organizations; you know it's done more on a sort of ad hoc basis. You know whereas big Farmers will have like a poultry producers' organizations, you know there is not one like that in South Africa that I know about. I'm not saying there isn't one but there may be one, but I don't know about it* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Profit Focus of Small Medium Enterprises

Certainly, there are many anticipated business difficulties for the rural poultry farmers in Ndwedwe. For sustainability, waste re-use, and growth, the profit-first approach is critical in any business. According to Agle et al, (2008), there are many factors, and in addition to profits, the direction chosen for the business by the decision-maker can influence the decision processes. Often the decision-makers choices in business can affect inclusive organizational attitude and ethics (Agle et al, 2008). A Rural Farmer said:

> *I wish to sell my chicken when they breed more chickens than the ones I have now* (Rural Farmer, isiZulu Interview #4, November 2019, Male, Age 26).

Appreciating profit considerations and influences of decision-makers in the SMEs enhances knowledge of leadership and management. Profit priorities and identifying

effects in making decisions can lead to the fundamental changes in leadership and management theory for many SMEs in South Africa Reference. A Small-Scale Poultry Farmer stated that:

> *Obviously helps my livelihood, you know it gives me an opportunity to make so extra money and its obviously used you know for important things like educating children and we also produce our own chicken meat so it saves us in grocery costs* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Agle, et al. (2008), contended that effective modern leadership necessitates leaders to understand the influences and their decision-making processes in generating profits. The decisions that are made by the managers or owners of the SMEs may reflect different influences and would affect the operations' effectiveness which could affect profits (Agle, et al. 2008). However, profit is a main principal concern of business. The rural poultry SMEs as well can only survive if they can make profits. A Rural Farmer said:

> *Yes, but I really don't sell them I just sell to people who want a certain chicken breed that I have. It depends on the chicken size. Sometimes I do sell it for R60 or below. No, I've never sold it for more than R60. The money that people give me when buying chickens, I sometimes use it to buy electricity* (Rural Farmer, isiZulu Interview #2, November 2019, Female, Age 27).

> *A cock? I didn't charge her a full price, I charged her R150. At the market it costs R200. Participant: Chicken price differ with the breed, black chickens' cost R200 and the white one they are cheaper. So, I didn't charge her a full price and I told her that I will reduce it with R50* (Rural Farmer, isiZulu Interview #1, November 2019, Female, Age 42).

Consumer's thoughts on the Price of Chickens

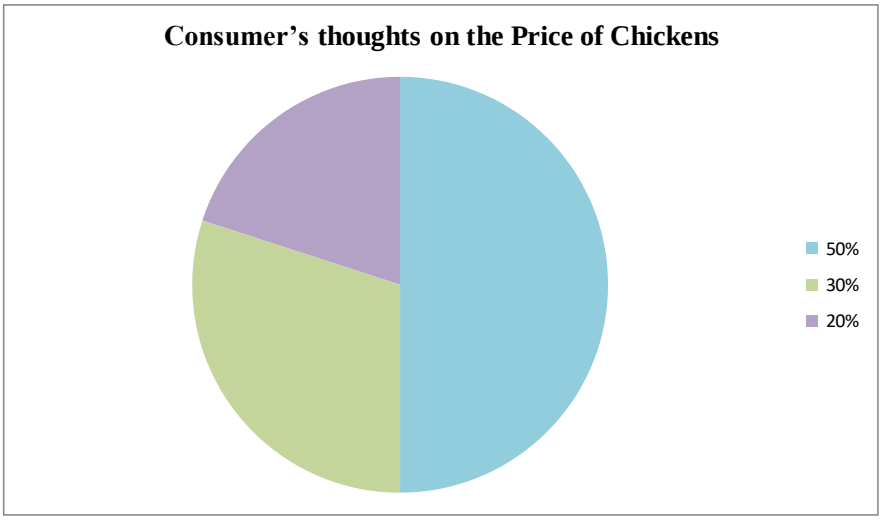


Figure 13: Consumers thoughts about prices of chicken in farm fresh and industrial chicken

The above bar graph showed that 50% of consumers agreed, 30% of consumers disagreed, and 20% of consumers were neutral.

Legend

50% = Consumers Agreed 30% = Consumers Disagreed
20% = Consumers that were Neutral

Table 5: Consumers' thoughts about the prices of chicken in farm fresh and Industrial chicken

Consumers that were Neutral	Consumers that Agreed	Consumers that Disagreed
I am not able to comment on the differences in price as I have not made comparisons	Farm fresh chickens are reasonably priced, with no added preservatives, as to opposed to industrial chickens that are more expensive due to additional production and maintenance costs being added	Not very happy about the price as the farm fresh chickens are higher. However, will pay for the quality of the chicken vs the price as nutrition and health are very high on my list
Industrial chicken may be more expensive because they seem larger in size; however, farm fresh chicken is cheaper. I have a neutral feeling towards the price since more chemicals and time is put into industrial chickens, hence cost more.	Value for money is important. I don't mind paying more for better quality, freshness, pre- packaged chicken. Farm fresh is more expensive but worth it.	The farm fresh chicken is substantially higher, and coupled with the current economic climate, it affects one's afford*ability*.
The price doesn't matter, farm fresh is slightly more expensive but at least I know what I'm paying for, and I have peace of mind.	Industrial is cheaper. Farm fresh is more expensive and therefore cannot be purchased as frequently.	Prices are a lot higher and I'm not sure if it is worth it.
The prices require revision.	I don't have a problem with price. I would rather pay for high quality than look for a bargain for low quality.	I feel you pay way more for one than the other.
Pricing is a secondary factor in my decision, I just buy what I want	fresh chickens have a fair price considering the quality, while industrial chickens are quite pricey.	Farm fresh is too expensive but industrial is cheaper.
	I feel like it is reasonable considering that these chickens are grain fed and kept well. I feel like industrial chicken is injected to grow which is not worthy to be expensive	You pay for the quality of chicken; I would rather pay extra and eat farm fresh chicken rather than industrial chicken.
	Farm fresh is slightly more expensive; however, quality is better	They are expensive
	Prices vary but we are prepared to pay for good quality chicken	Farm fresh is too expensive but industrial is cheaper
		Expensive

Table 6: Consumer's thoughts on chickens eating feedstock made from chicken bones, skin or any discarded off cuts.

Consumers that agreed	Consumers that disagreed
I really don't know how I feel about it, but as long as it does not harm the chicken and the consumer, I don't see any problem with it.	That's disgusting. It seems cannibalistic. I would not recommend that, nor would I like to eat chicken that were fed this.
It seems a bit bad feeding chicken food made from other chicken, but at the end of the day, the chicken is going to be killed and used as a source of food for humans. If the chicken is getting fed and is not starved, then there shouldn't be a problem.	It's not a good thing. They aren't meat to eat their own kind.
If this adheres to safety requirements and is not contaminated with bacteria. Preferred grains and wheat.	Feedstock has high chemical properties due to modification processes involved and will not be the ideal choice for me
Eating a chicken, fed on chicken feed, made with chicken feedstock, sounds unnatural and unethical. However, the modern world is rather… strange.	As a consumer, I would be uncomfortable with this, we would expect the highest quality for human consumption, taking into consideration alarming health defects that could possibly arise from this.
Ethically it doesn't sound right; however, if the off cuts were cooked well, it should not cause any health problems for the chicken. I don't mind if it is good for their nutrition.	It does not appeal to me personally and I feel that they should be fed proper feed instead of by-products.
If it's being made naturally then I don't see an issue.	It's not the most pleasant thought when thinking about what goes into them and what comes back to us on a plate.
I feel it's alright but at the same time I don't.	Disgusted and sad.
	As my answer in 4 above, it is not acceptable as it can lead to transfer of diseases to humans.
	It's like cannibalism. Imagine - we are eating human remains.
	I think that would pose ethical concerns.

Patterns of Re-Use

Specific patterns of re-use which manifest themselves across many different contexts, and within Ndwedwe suggests that these re-use practices are both diverse and widespread. Numerous waste items were identified as being re-used within these households like the chicken coops, which were made using scrap material such as old, rusted metal, chicken wire mesh, wooden planks, and other different types of material. Food waste is fed to livestock to cut down on the high cost of grain. Bamboo reeds are cut in half and used as walls for the chicken coops and kraal and are enclosures for which livestock are kept during the night, which in turn protects them from wild animals and theft. Many different objects can be re-used several times before it is finally discarded (Kalina, 2019).

This corresponds to what Appadurai (1988) identifies as 'regimes of value', or how certain items and materials circulate in specific socio-economic or cultural environments. In other words, the same items are transformed depending on demand and desire, power interaction, and reciprocal sacrifice in order to create value in particular circumstances (Appadurai, 1988). For example, in this research, discarded metal, bamboo reeds, chicken mesh, and plastic sheets were used to make chicken coops for household poultry farms in Ndwedwe. A Rural Farmer said:

Use normal chicken mesh and then you can use tar poles or arm poles and then you make the roosting areas out of corrugated iron roves. But in terms of free range, you got movable enclosures which can move because you are housing your chickens on lands, you actually planting crops for the chickens so as one crop areas get finished you will move your chicken coups the movable ones on to a new section (Rural Farmer, isiZulu Interview #4, November 2019, Male, Age 26).

Figure 14: Patterns of reuse in Ndwedwe

An Industrial Poultry Farmer stated:

> *Use for the foundation that is the same as the normal house and then the walls, is made from panels but it's like a kind of Polystyrene as well. I'm going to lie if I'm going to tell you what the [laugh]…it's between a plastic and a metal type of thing* (Industrial Poultry Farmer #1, February 2020, Male, Age 40).

Figure 15: Industrial farm chicken coops

Source: Google, Large-Scale Poultry Farmer. (2020)

Figure 16: Small-Scale Poultry Farmer's chicken coop

Source: Google, Small-Scale Poultry Farmer's chicken coop, (2017)

The Differences between Rural Farms, Small-Scale Poultry Farms, and Industrial Farm Coops

Rural sustainable poultry farming requires knowledge which are comparatively simple skills that are taught to rural individuals who have little or no formal education. Many rural people in Ndwedwe have some knowledge of building a chicken coop with the use of recyclable material (Bounds, 2018). They use scrap material such as bamboo reeds, corrugated iron, plastic sheets, and any type of materials that they find lying around, whereas in the Small-Scale Poultry Farms (SME), the farmers make the poultry coops out of chicken mesh wire and corrugated tin sheets. In the industrial poultry sector, a solid structure is made from either iron, brick, plastic, or timber to house the chickens.

The Purpose of a Chicken Coop

A chicken coop is a structure that keeps the chickens comfortable and safe which would eventually increase the flock's profitability and productivity in the rural areas. A Rural Farmer explained:

> *Then you can make nest for them where they will lay their eggs and not on the ground. When it lays eggs on the ground other animals like dogs eat those eggs. You will wait for the eggs to hatch; when they hatched you would take the chicks into a separate chicken coop if you built one for them with their mother. Then you give them food to eat* (Rural Farmer, isiZulu Interview #5, November 2019, Female, Age 70).

In South African, chicken coops have changed drastically over the past decade in both Small- Scale Poultry Farms and Industrial Poultry Farms. An industrial Farmer had this to say:

> *I think there are a lot of changes with regards to the housing, going from open housing to fully environmentally controlled houses, and vaccination processes have also changed to most of them happening in the actuary itself* (Industrial Poultry Farmer #1, February 2020, Male, Age 40).

The chickens need shelter to protect them from the cold and rain, and a place where they can sleep safely at night. Medium-size breeds of chicken hen need 1.5 square metres of space, and the other half is used for bantams and the roots are the right size and shape. The chicken coop needs to be well ventilated, and warm for the chickens to sleep, and it should also provide space for the hens to scratch around outside (SKIL, 2012). The Industrial Poultry Farmer stated:

> *If you talk about technology we get it predominantly from Europe, America, and Australia. Australia has got the same climate as us, so in terms of chicken houses, you will see that the design of chicken houses that we use is very similar to Australian chicken houses. It's fully automated houses, we control the temperature to plus minus 1 degree and the temperatures will differ day and night. We will not only look at temperatures we would also ventilate for oxygen pumping and Co2 content, moisture content so all of those parameter's feed into a computer program that works out what the right ventilation rate would*

be to optimize the requirement of the chicken. So that is if you just talk about the chicken house environment and if you talk about hachures and they are sourced from one of 3 suppliers from the world. We tend to use European technologies and we've got some of the best technology, we import some of the best technologies from Europe in terms of hachures (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

There is a high uptake of technology among Industrial Farmers. It is commercial and operated at a commercial scale aided by computers. In the case of Rural Farmers, the purpose of a chicken coop is to protect the chickens from predators and theft and prevent them from destroying the Farmer's crops. In the rural areas, the farmers use cheap scrap materials to build a stable structure that can withstand the elements and can last for many years. The next section looks at the impact of chickens on gardens.

Impact of Chicken in the Gardens

Chickens are unselective and voracious ground scavengers, and their sharp claws enable them to scratch the earth to find morsels such as seeds, grubs, and bugs. A question was asked regarding the problems they can cause to cultivated gardens. A participant said:

That's why you need to build a coop for your chickens so that you can keep them inside when you have planted something like beans. Every morning you feed and give them water. When I plant sugar beans, they usually dig it up. We don't have things where we can put our waste, so we dug a hole where we put all our waste. When that hole is full, we then burn it (Rural Farmer, isiZulu Interview #10, November 2019, Female, Age 49).

Chickens can dig shallow holes in a few seconds. These holes are adequate for dust baths but not conducive for growing vegetables or new seedlings. They like eating micro greens, seedlings and vegetables and they forage near recently turned dirt looking for worms (Fulghum, 2019).

Chicken Waste from Slaughterhouses

The processing of poultry necessitates a fair amount of water that is used to clean equipment, rinse, scald, and chill the bird carcasses and this process is referred to here as 'wastewater'. Naturally, there are specific amounts of organic "solid waste" as well, e.g., discarded poultry parts, feathers, and offal. This characteristic of waste would determine which method of disposal to use (Mass.gov, 2021). The Industrial Poultry Farmer explained:

> *The issue that impacts the industry is the resources, the ability to have water at slaughtering facilities and chicken houses you can imagine when we do not have water. Like in Standerton, one of the companies has been bringing water by truck 120 loads of water per day to be able to give water to the chickens, get the processing plant enough water to be able to slaughter…they spent R10 000 000 in the Standerton municipal water facility, to be able to ensure that there's always water so the whole issue around electricity and water increases our cost exponentially. Abattoir that slaughters one million birds per week, once there is a power failure that plant would stand at R100 000 an hour and it takes 3 hours to start up a plant to get everything to temperature before you can start to slaughter so those are the main distractors of profitability and efficiency in the industry* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

Solid waste is the only on-farm disposal selection for the poultry waste to be composted on the farm. There are various composting methods. The most common and simple methods are to produce a window or pile of carbonaceous material in which solid poultry waste is added. There are various composting methods, and the most common and simple methods are to produce a pile of carbonaceous material in which solid poultry waste is added (Mass.gov, 2021). In nature, microorganisms break down feathers, meat, and fat until it is completely decomposed, at which time the compost

can be spread onto a field. The Industrial Poultry Farmer stated:

> *Sometimes it relates to cost if one just looks at one example and that is the poultry by- product meal or the feather meal. Legislation overtime is changing that can't be used in certain types of animals they will, for example not allow one pork blood meal or carcass meal to be used in chicken and chicken not used in pork for concerns relating to viruses that might be taken and stuff like that. Now that obviously would have a cost impact on the industry so the biggest downside reusing overtime is higher specification and re-use of products that in general puts a higher level of increased cost of the product* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

> *Well, I think the first one is that in any type of production utilization of products is obviously a huge profit driver or a cost driver so you would want to utilize all the components of a carcass. Weather it is for human consumption, animal consumption or generation of energy, that forms part of the value chain whereby you need to optimize the total value chain and that's the benefits* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

Discarding options from on-farm wastewater would depend on whether they contain solids or if solids-free. Any wastewater that contains offal, feathers, fat, or any chicken parts is collected during processing and disposed of in a compost pile. Water that is used to rinse and scald the carcasses containing solids would be added to the compost pile (Mass.gov, 2021). The Industrial Poultry Farmer stated:

> *It's not a big issue because we slaughter so we don't consume. The waste in terms of that is negligible if we look at the chicken; the only products that aren't eaten on chickens would be the heads on certain cultures are useless. For human food or dog food or animal feed so very little of the carcass is actually wasted, the feathers and the blood would be the biggest components of the carcass that's not used for either human or animal consumption. So very little in terms of that if*

you talk about other resources like water and electricity and stuff like that, all the big companies have got processers to overtime increasingly use scarce resources. Water is typically cleaned through biological process not as much chemical processers as a biological process. Where they make use of different types of dams with fungi to do that and right at the end, they would use chlorine or chemicals to do the final treatment of the water. You would also find a lot of water from processing plants are recalculated water would not be used on food again, although it is of quality that you can, but it would be used for cleaning purposes. So, the water is very effectively used so we got standard I think we use less than 16 liters per bird that we slaughter and electricity wise. We will find that people might use feed exchangers and the one side of the abattoir you cool stuff, like you squeezing chicken and the other side of the abettor you create heat, broilers as an example and a lot of the energy will be re-used through pet exchangers (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

Feeding Game Animals

Most of the carnivores from game reserve obtain a commercially prepared diet that meets their nutritional needs. Their diet generally consists of meat, and they are fed during the week. Nonetheless, it is beneficial for these animals to eat turkey or chickens once a week. The bone-in uncooked poultry helps keep the animal's teeth clean and these animals often eat a variety (Ramirez 2010). One Feedstock Manufacture said:

That's more on the abettor side, the mortalities on the farms and the ones that die throughout the cycle obviously can't go into the human food chain. But that can go into the lion farms, predator farms, crocodile farms where that can be used as food for them. Otherwise, that can go into composting (cough) which can then be used as compost, from the abettor most of the bird is used, one thing that is not used is the feathers obviously but that goes a plant where they produce that into

feather meal, that is not something we are directly involved with. The only waste on the farms is mortalities and the litter at the end of the cycle. That is exactly as I described earlier, it either gets to predator crocodile farms the mortalities and the poultry litter either gets fed to ruminants or spread on lands. The benefit is that none of it is wasted, it all has a purpose so you don't have the problem of disposing of it, so you don't need a dedicated site where you have to bury it, or burn it, or anything like that so you can use it either for feeding of other animals or as enhancement of the soils characters that's the biggest benefits. Drawbacks obviously something like mortalities, it has to be kept or frozen so they don't go off, I mean if it goes off it can make other animals sick and ja the litter there's certain medications that we can't use in the chickens, because it can be dangerous if that litter is fed to ruminants (Feedstock Manufacturers#1, February 2020, Male, Age39).

Diseases and Overcoming Health Issues

Healthy chicken is the ones that have regular access to an optimal nutrient intake. While there are many drugs which are available for the improvement of chicken health, additives and supplements are greatly effective in supporting healthy functions and boosting the immune system (Bentol, 2020). One Feedstock Manufacturer said that:

> *Probably big pandemics like maybe influenza and infectious bronchitis. well for something like having influenza, bio security is the only thing you can do but for other disease vaccination is the corner stone as well* (Feedstock Manufacturer #1, February 2020, Male, Age 39).

Most of the common health issues can be avoided or mitigated by the improvement of diets that could minimize poultry stress. For some of the health afflictions and more severe diseases, antibiotics, vaccines, and other treatments may be required. However, even under these circumstances, the chickens would have a great chance of survival

if they were given the required portions of nutrients to sustain health (Bentol, 2020). The Small-Scale Poultry Farmer explained:

> *I'll say that rose humanely because they are allowed to walk around in open areas, they are raised without antibiotics, growth hormones and things like that. Obviously because of that it's a far healthier meat that humans are consuming, and another big factor is that it's not harmful to the environment in terms of having a lot of harmful by-products* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

> *We've got certain medication that you can buy to actually dip them, but then you can also use natural methods like I told you earlier by feeding them herbs. Which the lice don't like and then you also got very basic mechanisms like taking ash from fires and throwing them in an area where chickens can roll in because ash actually smothers the lice. So that would be like a holistic sort of an environmentally friendly outlet* (Small- Scale Poultry Farmer #1, February 2020, Male, Age 62).

Newcastle disease is an acute respiratory disease that can spread rapidly to chickens. A symptom of the disease depends on the infecting virus which has a predilection for nervous, respiratory, or digestive systems. This can affect both domesticated and wildfowl. The domestic poultry is much more susceptible to contracting severe symptoms (Bentol, 2020). A Small-Scale Poultry Farmer said:

> *It faces challenges such as livestock disease outbreaks, you know like I mentioned earlier you get a disease called Newcastle. Which if that got into the poultry stock of South Africa it would cause a lot of problems, and you know that is an airborne virus and it can be transmitted by wild birds and that so it's something that is a big danger* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Avian influenza is a disease that is caused by type A Orthomyxo viruses. They are more commonly spread and found by wild aquatic birds that infect domesticated poultry. Ruffled feathers, coughing and sneezing, nasal discharge, swelling, edema in the comb and wattles, diarrhea, and purple discoloration are symptoms of the bird flu (Bentol, 2020). The feedstock Manufacturer and Rural Farmer said:

> *Probably big pandemics like maybe influenza and infectious bronchitis. Well for something like having influenza , bio security is the only thing you can do but for other disease vaccination is the corner stone as well* (Feedstock Manufacturer #1, February 2020, Male, Age39).

Once spread, avian influenza is deadly.

> *With chickens, it's just that you must be careful of the bird flu and they become fewer because they die. You must have a way to deal and take care of the flu.* (Rural Farmer, isiZulu Interview #8, November 2019, Female, Age56).

Animal Health and Welfare

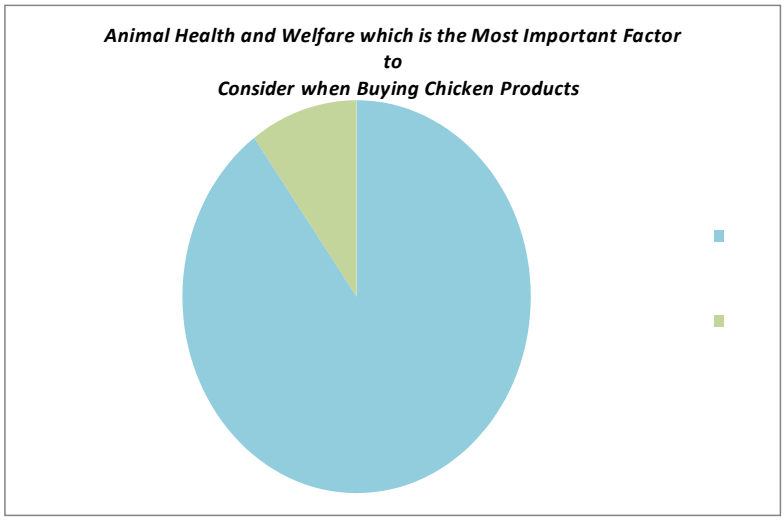


Figure 17: Consumers who agreed and disagreed on animal health and welfare

Legend

90% = Consumers Agreed 10% = Consumers Disagreed

The above pie graph shows that 90% of consumers agreed on the welfare of animal health, which is the most important factor to consider when buying chicken products. 10% of consumers disagreed on animal health and welfare which is the most important factor to consider when buying chicken products.

Table 7: Consumers thoughts on animal health and welfare

Consumers that Agreed	Consumers that Disagreed
Consumers want to stay clear from chickens that have antibiotics and hormones injected in them as this leads to hormonal issues and other health issues. The living conditions of the industrial chickens are disgusting and keeping animals in such close confinement enables to spread rapidly	It is not the most important factor. The health of the customer and sustaining the local economy is more important and if importing chickens is avoided.
It is important to follow proper standards and not have inhumane conditions while growing the chickens, however many people do not think about this aspect.	It affects the taste.
The health and welfare of the chicken determines whether it will get sold and determines whether the seller makes a profit, so basically that factor is important because people wouldn't eat chickens that have diseases.	Hormones & GMO have a negative impact on well-being.
It is very important as we are going to consume the chicken, and if the chickens are injected with artificial agents which may be harmful to our body, then I would not want to consume that chicken. The chicken must be well taken care of and well-fed and must be healthy for us to be confident to eat that chicken without getting sick.	I would not want to eat unhealthy chicken due to the spread of various diseases.
Animal health and welfare are the most important factors to consider when buying chicken products in order to avoid food poisoning such as salmonella infections.	
Well, we surely don't want to buy sick chickens or end up in hospital for eating sick chickens.	
The way a chicken is fed, they must not be force fed or injected. They must be free range and taste better.	
Chicken needs to be fed with healthy food to ensure they grow without the aid of enhancements as this will impact the health of humans ultimately.	
I think the environment that they are exposed to is important to consider, are they prone to diseases, water and soil pollution, they are bred under such conditions	

4.3.4 The Social Acceptability of Waste Re-Use as Feedstock for both Producers and Consumers in KwaZulu-Natal

Table 8: Socially acceptable waste is re-use as feedstock for both consumers and producers

Consumers that agreed with re-used waste as feedstock for both producers and consumers	Consumers that disagreed with re-used waste as feedstock for both producers and consumers
Can't really say because I am not knowledgeable when it comes to commercial Poultry Farming, but I know that people practicing subsistence farming, they do feed their chicken food leftovers and it is quite a common practice amongst them.	It seems disgusting. But if it works for the environment and the chickens, then good. As long as the chickens aren't poorly fed or treated.
I think in order to save costs and earn a living, the producers resort to re-used waste as feedstock. For the consumers, majority are usually in the dark or don't question what the chicken are fed and usually buy blind with cost as their only deciding factor. The more clued- up consumers will choose free range/grass fed or organic poultry. COVID-19 has not affected my decision, I still buy poultry products when I need it – however I still buy from Woolworths as I know they sell quality poultry and meat.	No, that's a bad idea. No nutrients are getting to the chicken because waste is what the chicken no longer needs.
COVID did not impact my decision on buying chicken but rather the interruption of lockdown and the availability during this time.	For certain consumers, it may not be socially acceptable to use re-used waste as feed stock; just the thought of it could put consumers off.
Also disruptions in the domestic food supply and regulations impacted the processing and distribution so the availability of fresh products was scarce. My preference is the fresh products rather than frozen chicken.	However, in this world and age, it is really important to do what is right for the environment. Producers will be willing to use the re-used waste provided that they are taught how to re-use the waste and if it means a saving in costs and enhancing their livelihoods, then producers would want to get on board.
As long as it does not greatly tamper with the general norms and customs, society usually quickly accepts and adapts.	Many might not accept this concept. How I feel about buying chicken during COVID, I'm okay with it; it hasn't changed my buying patterns.
I think at this point society will accept anything but only people who are strict about their chicken will not agree.	It isn't acceptable as many would question the health of the chicken because of re-used waste being used as feed.
It should comply with the legislation as there is always a concern about health and hygiene when it comes to consumers.	Not acceptable, more people want organic foods and poultry that is consuming nutritional food.
The biological aspects of the materials recycled determine its social acceptance. With the uptake of chicken consumption in SA, it probably is socially acceptable.	Not very acceptable, as it can lead to diseases which might be transferable to humans during consumption.
So long as the re-used waste is safe and nutritious.	This could give rise to environmental problems, i.e., soil and water pollution.
	I would think most people won't agree with regards to used waste.

Poultry Waste Management: An Approach for Sustainable Development

Globally, the poultry industry is increasing rapidly and is one of the contributors towards addressing the key national development goals, and in creating employment opportunities and improving the standard of living of people through poverty alleviation (Muduli, 2019). The Industrial Poultry Farmer explained:

> *The waste in terms of that is negligible if we look at the chicken; the only products that aren't eaten on chickens would be the heads on certain cultures are useless. For human food or dog food or animal feed so very little of the carcass is actually wasted, the feathers and the blood would be the biggest components of the carcass that's not used for either human or animal consumption. So very little in terms of that if you talk about other resources like water and electricity and stuff like that, all the big companies have got processers to overtime increasingly use scarce resources. Water is typically cleaned through biological process not as much chemical processers as a biological process. Where they make use of different types of dams with fungi to do that and right at the end, they would use chlorine or chemicals to do the final treatment of the water. You would also find a lot of water from processing plants are recalculated water would not be used on food again, although it is of quality that you can, but it would be used for cleaning purposes. So, the water is very effectively used so we got standard I think we use less than 16 litres per bird that we slaughter and electricity wise. We will find that people might use feed exchangers and the one side of the abattoir you cool stuff, like you are squeezing chicken and the other side of the abettor you create heat, broilers as an example and a lot of the energy will be re-used through pet exchangers* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

The problem that is often faced along with poultry production, is that the manure needs to be discarded, as disposal or a non-appropriate treatment could become risky for

both humans and the environment (Muduli, 2019). The Feedstock Manufacture said:

> *Sometimes, it relates to cost if one just looks at one example and that is the poultry by- product meal or the feather meal. legislation overtime is changing that can't be used in certain types of animals they will, for example does not allow one pork blood meal or carcass meal to be used in chicken and chicken not used in pork for concerns relating to viruses that might be taken and stuff like that. Now that obviously would have a cost impact on the industry, so the biggest downside re-using overtime is higher specification and re-use of products that in general puts a higher level of increased cost of the product* (Feedstock Manufacturers#1, February 2020, Male, Age 39).

For example, manure can contribute to the spread of diseases and can pollute groundwater resources and soil if it is not properly handled. The definition of waste is anything that is no longer useful to anyone and needs to be disposed of. Moreover, waste can also be defined by the place and type in which it is produced, such as mining, industrial, agricultural, and household. It is a fact that the poultry industry produces large amounts of waste which include wastewater and solid waste (Muduli, 2019).

The solid waste consists of feed, sludge, bedding material, hatchery waste and abattoir waste (Muduli, 2019).

Figure 18: Chicken Litter - Nutrient- Rich Fertilizer

Source: Google, Chicken Litter - Nutrient-Rich Fertilizer. (2021)

Poultry Litter Management

The poultry litter contains bedding material that is mixed with waste feed, feathers, manure, and spilled water which is often accumulated throughout the production cycle. Bedding material primarily consists of high carbon content biomass which contributes to the energy content of litter that is produced (Reardon, 2011). The Feedstock Manufacturer said that:

> *Sustainability - you will always have by-products when you slaughter chickens, so obviously it's you don't have to use fish meal, stuff like that. You can use by-products, so the natural resources of fish population err defiantly the sustainability is better by using our products* (Feedstock Manufacturer #1, February 2020, Male, Age 39).

Materials that are used include rice or peanut hulls, wood shavings, shredded paper, sawdust, and straw (Kelleher, 2012). Because of the high plant nutrient levels, it is regarded as a valuable source of organic fertilizer which provides the plant nutrients such as potassium (K), nitrogen (N), and phosphorus (P). Applying poultry litter residues to the crop soil would increase the organic matter and as a result, this would improve the soil's tilt and water-holding capacity. One of the main risks that are related to the agricultural field is the disparity of P and N in poultry manure. These two nutrients in the poultry litter are not the same amount as required by crops. A soil analysis is imperative to regulate the suitable balance of K-N-P and Ca for the preferred crop and though poultry litter comprises many valuable macronutrients that are found in numerous expensive commercial fertilizers, the K-N-P ratios may not be preferably suited towards the soil nutrient needs (Reardon, 2011). There are several waste management practices for litter that include land application as an organic fertilizer (Muduli, 2019). The Small-Scale Poultry Farmer said:

> *Those are the dangers you know you can free range if you can plant crops to*

free range quite successfully if you live in an area with high rain fall. But the problem in South Africa is that we are becoming a water scarce society, so it's becoming increasingly difficult to be able to plant your own feeding if you haven't got water like a big dam you know to irrigate the feeding that you want to plant (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Figure 19: Multi-batch litter

Source: Google, Multi-batch poultry litter, used as compost. (2019)

Litter Re-use

One of the solutions to dealing with spent or used litter is to re-use it for subsequent consignments. There are many cost-saving benefits gained from using spent litter with a new bedding material for each batch. There is also an advantage in that the subsequent multi-batch litter makes for enhanced quality compost. There is also a higher proportion of nutrients from larger proportions of the chicken excreta to bedding material in the litter. If there are any concerns regarding the carryover of disease organisms in the re-used litter, methods are being devised to reduce the pathogen load that is developed under the Poultry Cooperative Research Centre (PCRC). This includes the Litter Heat Map model to optimize and predict temperatures in the litter that is being pasteurized by heaping, and the standard procedures for in shed

pasteurization of litter between batches (Muduli, 2019).

Poultry waste in livestock feeding

In many countries including South Africa, poultry litter has been used in the diets as livestock feed for brooding cows, lambs, wintering cattle, poultry, lactating cows, swine, and ewes (Muduli, 2019). Poultry waste that is used for animal feeding is obtained primarily from laying hens and in broiler operations. Poultry litter is also used as feed for livestock. Cage layer waste is used by ruminants that are a source of supplemental protein (Muduli, 2019). A participant was asked where they sell their feedstock. He said:

> *We got internal poultry company called grain field chickens which slaughter about a million chicks a week and the main suppliers are KFC, Pick 'n Pay, Checkers so we produce mostly 80% of our feed goes to our own broiler houses which is grain field chickens* (Feedstock Manufacturer #1, February 2020, Male, Age 39).

> *So, the two feed mills, the one in Freed is the mono gastric feed mill and we produce for Layers, and we produce for broilers and figs as well. Then the feed company or the feed mill in Bethlehem is both ruminants in meaner gastric and mean produce, basically everything except for horses, so sheep beef dairy, err swine broilers, and layers everything except horses* (Feedstock Manufacturer #1, February 2020, Male, Age 39).

According to Chaudhry, amino acid nitrogen of the cage layer waste ranges from 37- 40% of total nitrogen and around 40- 60% of the total nitrogen that is in poultry excreta exists in the form of Non-Protein Nitrogen (NPN). Uric acid is one of the major NPN sources in poultry and is degraded to ammonia by the rumen microbes. The minim inclusion of poultry waste in ruminant feeds is 20%. Choi (2016) recommended that adding broiler litter to beef cattle rations at a level of 20% or higher

usually meets the animal's needs for phosphorus, crude protein, and calcium. Feeding corn silage to which poultry litter has been added at a level of 30% is beneficial. Moreover, Bowen, (2018) perceives poultry waste-fed levels above 35% that usually covers almost all the total protein requirement of sheep and contributes considerably towards the energy of the total ratio. The only issue regarding feeding processed poultry waste to sheep is the level of toxicity that is derived from the excessive copper level in poultry diets (Muduli, 2019). An Industrial Poultry Farmer explained:

> *Sustainability you will always have by-products when you slaughter chickens, so obviously you don't have to use fish meal, stuff like that. You can use by-products so the natural resources of fish population defiantly the sustainability is better by using our products* (Industrial Poultry Farmer #1, February 2020, Male, Age 40).

Jordon (2012) measured the body conditions of sheep that are fed urea, dried poultry waste, or soybean as winter supplements and concluded that feeding a supplement containing dried poultry waste results in performance which is like that of conventional supplements containing soya bean meal. Therefore, poultry litter could be incorporated into animal feeds. Poultry waste is one of the major pollutants and should be disposed of properly. Poultry feathers can be treated biologically or chemically with microbes to improve the nutritious significance of feather wastes which can be used as animal feed (Jordon, 2012). A Small-Scale Poultry Farmer said:

> *Well, the fact would be the global awaking to the importance of rather raising animals in a free-range manner rather than raising them in factories farms* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

They can also be biologically converted into organic fertilizer, biodiesel, feed supplements, and biodegradable plastic. Composting reduces pathogens and is used as fertilizer or soil conditioner or fertilizer. Poultry litter contains arsenic, chlorine, manganese, magnesium, nitrogen, copper, phosphorous, calcium, ferrous, sodium, and

carbon. This is a good source of fertilizer and methane gas produced from poultry litter which is converted into electricity by using patented technology (Muduli, 2019). Overall, poultry wastes could be efficiently utilized if it is properly treated to reduce the effects and a range of value-added products like biodegradable plastic, animal feed, fertilizer, bone meal, electricity, and biodiesel, which can be produced (Muduli, 2019). A Small-Scale Poultry Farmer said:

> *I don't think it's really chanced much, the only big change is that people have become more aware of the healthy side of eating free range meat, well you can call it chicken, beef or mutton or whatever. Ja, you know there has been a big awakening about the dangers of the overuse of antibiotics and growth hormones and that sort of thing and the meat that we eat. So, I think the major change is that there has been more awareness about the values of it* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Figure 20: Meat and bone meal chicken feed

Source: Google, Meat and bone meal chicken feed. (2017)

Meat and Bone Meal in Poultry Diets

The slaughter by-products are often routinely recycled for use in animal feed. They are rendered down to produce an economical and nutritional feed ingredient. The by-products that are used in feeds include foetus, organs and inedible parts, meat trimmings, and certain condemned carcasses. It is imperative to note that hide

trimmings, horns, stomach contents, hair, manure, hoofs, and blood are not used in the production of meat meals (Jacob, 2016). An Industrial Poultry Farmer said:

> *That is for the customers, they require us not to use that. The customers we require to supply fresh chicken to, they don't want us to use any of that. Not free range because they are all within enclosed houses* (Industrial Poultry Farm #1, February 2020, Male, Age 40).

> *So, you are talking about PBY Poultry By-product and blood meal and stuff like that? Okay, obviously you can use it, but it's regulated by *ASMA so there's certain stuff you can use and there is certain stuff you can't use. You can't use species, own species, so you can't use blood meal for own ruminants, but we can use that into the poultry feed, but all of these processes are very much regulated with *ASMA* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

When there are bones added to the meat meal, it is considered a bone and meat meal (Jacob, 2016). There are numerous types of bone and meat meals. The high-quality bone and meat meal usually contain a minimum of 50% protein content. A lower quality bone and meat meal is available and contains a minimum of 45% protein content. Bone and meat meal is a great source of protein. In poultry diets, bone and meat meals are usually limited to less than 5% of the diet content because of the high lysine, calcium, and phosphorus content of the meal (Jacob, 2016). The Feedstock Manufacturer said:

> *So basically, what we do is reject the low protein or pellet quality if it is bad, we will formulate that into another formula, if we know what that formula was. If there was a contamination and we are not sure about the content, then we will throw that in about maximum 2%.*

> *We implemented better classification and identification system. So, it is easier for us to classify and to put it into groups, and therefore we can use it in the*

larger quantities when we reuse it. In other practices we are putting in, is to fill everything together and take err big representative sample then we can sell it as feedstock, or we can formulate that back. I think that the basic practices with all the feed mills do, so it would just depend on the procedures, but mainly it goes back it would be formulated back into another rations stuff that is expired and stuff that is really not reusable would be written off, but yeah it is main practice for old feed (Feedstock Manufacturer #1, February 2020, Male, Age 39).

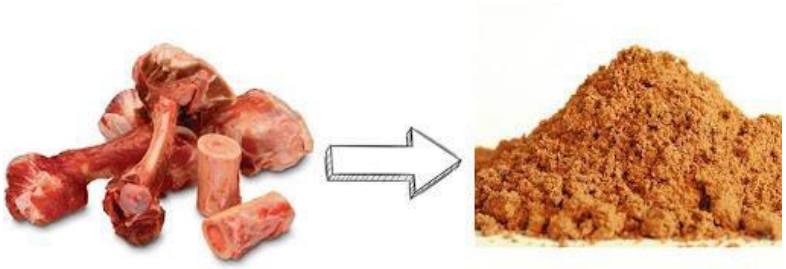


Figure 21: Discarded meat offcuts turned turned into bone meal for chicken feed stock

Source: Google, bone meal for chicken feed stock. (2021)

Renewable Feedstocks

Renewable feedstocks are bound to eventually replace sources of fossil origin such as coal, oil, and gas, both as raw materials and fuel for the chemical industry in South Africa and other countries. Lubricants are combined with the crucial performance features in transportation and industries with substantial economic value. The conversion from mineral oil-based lubes towards a biodegradable lubricant from renewable raw materials is an ongoing process. Bio lubricants originate from vegetable oils, plant polymeric carbohydrates, and wax esters. Plant biotechnology and chemical sciences are crucial for disciplines in designing an environmentally acceptable lubricant for a much wider diversity of applications. Important factors in the bio lubricant value chain are end-users and regulators, vegetable oil milling facilities, and

the lubricant manufacturing industry (Bart, 2013). The feedstock Manufacturer stated:

> *Opportunities is to establish mitigations but there is a lot of practices or opportunities err the only one I think you could make sure that the procedure manufacturing procedure are a bit better. We have standard operating procedures that minimizers worked but there would always be reworks at waste being, there would always be waste and reworks at the feed factory* (Feedstock Manufacturer #1, February 2020, Male, Age 39).

Thriving Chickens under Scavenging Condition

The chickens in Ndwedwe are an imperative source of high-quality protein for the ever-increasing urban and rural population of KwaZulu-Natal and provides the Rural Farmers with an additional income. The chickens in Ndwedwe are in general robust, survive on little and adjust to fluctuations in feed availability and adapt to rural environments. The chickens have a natural tendency to scavenge for their food resources such as discarded or leftover food that is on the ground. There has been a renewed interest in animal products that come from an organic system. The known importance of rural chickens is in providing socio-cultural values, meat, and cash income to the rural people (Kassim, 2018).

The Scavenging Feed Resource Base (SFRB) is defined as a feed resource that is available at the farm level which consists of the household refuse and entirely materials that are accessible in the immediate environment at that time and the scavenging birds use as feed. The major feed source for chickens are plant materials available in the backyard, insects, green leaves, seeds, and worms (Mwalusanya, 2016). According to Ologhobo (2012), bran, grains, and household food leftovers are infrequent sources of supplementary feed in purely free-ranging systems. A Rural Farmer said:

> *We feed them a lot in the morning so that they don't trouble us during the day. We always put water in the container for them, but we do give the*

chickens some scraps when we washing the pots. The chicken feed we only give it to them in the morning. Interviewer: Where do you buy or how do you buy your chicken feed? Participant: I buy the chicken feed in the stores. (Rural Farmer, isiZulu Interview #2, November 2019, Female, Age 27).

The SFRB for chickens varies vastly with location, season, and climate (Kassim, 2018).

The Feed Ingredients used in the Poultry Industry

The feed ingredients for poultry diets are a selection of nutrients which are devoid of toxins or are anti-nutritional. The main nutrients that are needed to supply the dietary ingredients which are vitamins, minerals, and amino acids are contained in proteins. Poultry requires energy, which is obtained from starches, proteins, and lipids (PHA, 2021). The Feedstock Manufacturer said:

So basically, what we do is reject the low protein or pellet quality if it is bad, we will formulate that into another formula, if we know what that formula was. If there was a contamination and we are not sure about the content, then we will err threw that in about maximum 2% (Feedstock Manufacturers#1, February 2020, Male, Age 39).

Feed ingredients are generally classified into miscellaneous raw materials such as roots and tubers, protein meals, feed additives, fats and oils, cereal grains, minerals (PHA, 2021). The Feedstock Manufacturer stated:

*Okay, so basically**,** it's a big factory we mix them, and it goes into conditioner process, where we put steam then we sterilize it and we can make basically bulk feed, so bulk loaders and then bags. So basically, soya bean meal, full fat soya, sunflower oil cake, we use maze, we use a bit of bran, then we got all the amino acids, met fining, we use a bit of choline and we put them in a pre-mix-*

ins as well, a bit of salt, lime stones, urea. So based on the raw materials that we can prepare and based on the prices sometimes we would sometimes use different raw materials (Feedstock Manufacturer #1, February 2020, Male, Age 39).

Cereal Grains used in Poultry Feedstocks

Cereal grains are Distillers Dry Grains with Soluble (DDGS) and cereal by-products. Cereal grains are mainly used to satisfy the energy requirements of poultry. The predominant feed grain in South Africa is corn, even though there are different types of grains used in other countries. For instance, in South Africa corn is by far the most imperative energy source for all poultry feed. In addition to the cereals, their by-products such as DDGS, wheat bran, and rice bran are used widely in poultry feed. The by-products of cereal are typically high in non-starch polysaccharides (NSP) and fiber which is poorly utilized in poultry (Brooker, 2020). The Feedstock Manufacturer said:

In terms of feedstock, the only big drivers that you would find globally is that they try to move away from animal by-product meal or feather meal as it's called, but there aren't really other sources other than the ones that I've just mentioned to you. So, the grain is quite big a big portion of the raw materials and there not really replacement for that. The cheapest grains in Southern Africa and places like America and South America the diet would be maze and soya. And if we talk, we talk about Eastern Europe and Western Europe, the Northern part, then they will use wheat, but wheat is too expensive for South Africa (Feedstock Manufacturer #1, February 2020, Male, Age 39).

Protein Meals used in Agriculture and Waste Re-use

Protein is provided from both animal and vegetable sources, such as fish and abattoir processing by-products, legumes, and oilseed meals (Brooker, 2020).

Vegetable Protein Sources

The vegetable protein sources generally come as cake or meal, which is the by-product of oilseed crops. The main oilseed crops include sesame seed, sunflower, copra, rapeseed, canola, soybean, linseed, peanut, and palm kernel. After the oil is extracted, the residue that remains is used as a feed ingredient (Brooker, 2020). This is how a vegetable feed is made for poultry feedstock and how planting fresh vegetables can help cure the issues regarding parasites. The Small-Scale Poultry Farmer explained:

> *Well, I normally plant crops like oats and barley and then you can also plant maze and a verity of herbs which is quite good for the chickens. Well, herbs you can plant things like garlic well that's not really a herb, it's a vegetable but you can plant things like garlic, you can plant things like mint you can plant parsley which is all really good more so things like mint. Because internal worms and that in the fowls they don't like the taste of mint, so it assists them you know. But your main feeding line would be like your grain type crops and you can also plant lucerne, it depends on what does the best* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

This shows the cost-effective methods that Farmers used to solve the poultry health requirements.

Waste Re-use

Many legumes and oilseeds contain anti-nutritive factors; some of these can be destroyed by heat and are used in heat-treated meals. The new cultivars of some

legumes and oilseeds have been developed and are naturally low in Anti-Nutritive Factors (ANF), allowing high levels of the unprocessed grains to be included in the poultry diets without any ill-effects (Brooker, 2020). The Small-Scale Poultry Farmer explained:

> *...you could use food waste in that, you know you could use let's say you could go to bakeries and get old bread and you could dry the bread out and turn it into crumbs and you could feed that to chickens. But the problem with that is that you are not certain of what contaminants are inside that feeding. They could be too much salt, they could be too much sugar, and they could be mold in it if its old bread which you know is harmful to animals. So that is a danger, so you could use that, but it's got its risk if you like to call it that* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Animal Protein Sources

The main animal protein source that is used in the poultry diets are bone meal and meat, fish meal, feather meal, blood meal, meat meal, and poultry by-product meal. Though the production of animal protein for the use of human consumption has been marred by controversy, domestic and worldwide consumption of protein will come from poultry. With the increase in animal protein productions, there would be an increase in demand for feed and demand for ingredients that are high in energy and protein (PHA, 2021).

The animal industries evolved as a means of adding value such as variety, availability, and higher nutrient level. These ingredients are of marginal food value for humans who include grains that are damaged by harvest or storage conditions or of poor quality, as well as recycled by-products of meat, egg production, milk, and vegetable oil. Around 50% of the live market is made up of ruminants and 30% of it is poultry by-product (PHA, 2021). An Industrial Poultry Farmer and the Feedstock Manufacturer said:

> *55% of the diet would be maize and then 25% of the diet will be soybeans and then we will put in err some other animal protein source, something like fish meal animal by- product meal as a protein source. And in terms of the micro ingredients, we will add minerals, vitamins in balanced fashion specific levels of those* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

> *These by-products are available, rendered, and ground as a feed source I wouldn't say re-use but maybe if there is a miss calculation or some of the food specks that's not, specifications that's not perfect. Those feed might be re-worked into new rashness, at I would guess about the inclusions about 5% just to not throw that away* (Feedstock Manufacturer #1, February 2020, Male, Age39).

Animal protein meals are usually defined by those that are specifically used in poultry diets which include bone and meat meal, from ruminants' meat that excludes bone and swine meat, fish meal, poultry by-product meal and feather meal (PHA, 2021).

> *If you got a big enterprise that produces a lot of by-products, you can obviously generate enough volumes to put it back into your own feed, so that's the competitiveness advantage you got over other guys that doesn't have a big abattoir that doesn't slaughter their own chickens* (Feedstock Manufacturer #1, February 2020, Male, Age 39).

There are specific limitations that are now assigned to these products regarding inputs that are used and a reassurance of the minimum nutrient levels. For example, bone and meat meals are made from ruminants and should be free of hide, hair trimmings, and wool. The products are rendered, which is a bio secure process that yields a finished ground product high in protein which has no resemblance to the raw product, fa extracts, evaporated water, and minerals. The products are marketed with guarantees as to minimum calcium levels, protein, and phosphorus (PHA, 2021). An Industrial

Farmer explained in terms of the alternatives considered in terms of feedstock:

> *In terms of feedstock, the only big drivers that you would find globally is that they try to move away from animal by-product meal or feather meal as it's called, but there aren't really other sources other than the ones that I've just mentioned to you. So, the grain is quite big a big portion of the raw materials and there not really replacement for that. The cheapest grains in Southern Africa and places like America and South America the diet would be maze and soya. And if we talk, we talk about Eastern Europe and Western Europe the Northern part then they will use wheat, but wheat is too expensive for South Africa* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

Many challenges are associated with the use of animal protein sources. Food safety is one of the utmost concerns that people have regarding the recycling of animal protein meals back to animals as feed ingredients. This is based on the variant Creutzfeldt-Jakob disease in humans and the prion disease variant Bovine Spongiform Encephalopathy (BSE) which is known as mad cow disease. Most importantly for the poultry production, even though researchers were unable to demonstrate the transfer of prions to poultry (Moore, 2011), there were no symptoms of the disease detected in birds for up to five years after the direct challenges. The prions that are associated with BSE which are not destroyed by the traditional methods of rendering can cause diseases with BSE contaminated bone and meat meal (Moore, 2011). An Industrial Poultry Farmer said:

> *It's not a big issue because we slaughter so we don't consume. The waste in terms of that is negligible if we look at the chicken; the only products that aren't eaten on chickens would be the heads on certain cultures are useless. For human food or dog food or animal feed so very little of the carcass is actually wasted, the feathers and the blood would be the biggest components of the carcass that's not used for either human or animal consumption. So very*

> *little in terms of that, if you talk about other resources like water and electricity and stuff like that, all the big companies have got processers to overtime increasingly use scarce resources* (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

There are still many concerns regarding the use of animal protein meals that are responsible for food-borne pathogen contamination, for example, salmonella. Usually, these bacteria are destroyed by possible recontamination and rendering which is frequently negated by the pelleting of manufactured feeds. If poultry acquires salmonella, it is more likely to be from an environmental source rather than feed. Animal protein meals may be contaminated with high levels of pesticides, heavy metals, and dioxins; though, meals are regulated and monitored to minimize this contamination (Moore, 2011).

The important issue is the variability in available nutrients from animal feeds which can be absorbed and retained by the bird. Maintaining a diet that is balanced with all nutrients, more particularly phosphorus and calcium should be incorporated. Animal protein meals provide essential amino acids which are a good source of minerals and energy. Animal protein meals have a long history in poultry nutrition. The utilization of this valuable feed ingredient is vital in minimizing the loss of economic value and nutrients in the production of safe, high-quality poultry meat, eggs, and by-products (Moore, 2011). The Feedstock Manufacturer explained:

> *There is a lot of that happening, I mean it starts with the feed the first one is that in terms of feed if its incorrectly manufactured or there is a quality issue on poultry feed per say. That product is then re-used in pigs, pigs are more tolerant to deviation in specification of the feed, all dust and all spilt feed in feed mills are used for pigs. But nothing of that is wasted, in terms of poultry production I've mentioned to you the feather meal obviously when we sault the poultry birds we create feathers, blood, fat in the process that is not sold as*

meat obviously those products are all utilize. So in terms of fat, we will have fat traps that would take the fat out of the abettor the fat is then cleaned and used in animal production again, the blood meal is then created again as a protein source from the blood in the abettor , that is used in dog food and then the feather meal… feathers are not very collectable and digestible so what will happen is that we will put it through a processor cooking of about 1100 degrees centigrade for 4- 6 hours…which will be done under pressure and that will increase the digestibility of feathers from 9 % to about 80% and that is used for animal feed again (Feedstock Manufacturer #1, February 2020, Male, Age39).

Ethical, Humane, and Conscientious Waste Re-use

In South Africa, modeling humane and ethical animal stewardship is crucial for the highest good quality that is needed. KwaZulu-Natal has many communities and cultures where the Farmers either need or choose to use animal by-products as food or raise them as by-products. Consumers are becoming more conscious about what they eat and there is a trend of people moving away from traditional industrial farming methods to choosing organic farming methods. Farmers are becoming aware of this trend and are raising chickens that are free range or organic (Lin, 2018). The Small-Scale Poultry Farmer said:

Well, the negative, I don't really think there is a negative because I say as long as the re-use stock has been processed you know in a hygienic manner and is being done properly, then I only see positives (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

Well, I'll say that raised humanely because they are allowed around in open areas, they are raised without antibiotics, growth hormones and things like that. Obviously because of that it's a far healthier meat that humans are consuming,

> *and another big factor is that it's not harmful to the environment in terms of having a lot of harmful by-products* (Small-Scale Poultry Farmer #1, February 2020, Male, Age 62).

I formed a questionnaire, which was done on consumers of poultry regarding their thoughts on chickens eating feedstock that is made from chicken bones, skin, or any discarded offcuts. 26% had no problem-consuming poultry products that feedstock was made from chicken bones, skin, or any discarded offcuts. Ethically it does sound right; however, if the offcuts were cooked well, it should not cause any health problems to the chicken.

> *I really don't know how I feel about it, but for as long as it does not harm the chicken and the consumer, I don't see any problems. It seems a bit bad feeding chicken food made from other chicken, but at the end of the day, the chicken is going to be killed and used as a source of food for humans. As long as the chicken is getting fed and is not starved, then there shouldn't be a problem'. On the other hand, 74% of consumers disagreed with the idea of consuming poultry products that are made from chicken feedstock (Questionnaire #27, Question 5, October 2020).*

> *As a consumer, I would be uncomfortable with this, we would expect the highest quality for human consumption, taking into consideration alarming health defects that could possibly arise from this'. 'It does not appeal to me personally and i feel that they should be fed proper feed instead of by-products'. 'It's not the most pleasant thought when thinking about what goes into them and what comes back to us on a plate'. 'I think that would pose ethical concerns' (Questionnaire #27, Question 5, October 2020).*

4.4 Discussion of Research Findings

4.4.1 Waste Re-use for Enhancing Soil Quality

The objective of the study was to examine the practices of the poultry industry's waste re-use for enhancing soil quality by both large and Small-Scale Farmers in KwaZulu-Natal. From the study, it was established that the South African poultry industry is currently facing numerous environmental problems. One of the major problems is the accumulation of many wastes, more especially litter and manure, which is generated by intensive production that is voided by a layer of large-scale accumulation of waste (Power, 2017).

This research shows that most of the poultry manure in the South African poultry industry is applied to agricultural land. When managed incorrectly, this proves to be very disruptive to the soil. Multiple practices are used which consist of adding waste from poultry agriculture to the soil, such as re-used products such as wood shavings as bedding for chickens. The wood shavings would have a large amount of fecal and after 6 weeks, it becomes nitrogen-rich and that is used again on farms as fertilizers. With the multi-use of litter in the industrial poultry sector, nothing goes to waste, because everything goes into the poultry house. At the end of the cycle, litter is removed, and gets composted or is fed to ruminants or spread to land that is going to be used for crop production. Moreover, more on the abattoir side, the mortalities on the farms and the ones that die throughout the cycle obviously cannot go into the human food chain. However, that can go to lion farms, predator farms, and crocodile farms to feed them. What is not used can be made into compost. Feathers go to a plant where they produce feather meal. These methods have been very beneficial for crop production and enhance soil quality.

Many Rural Farmers in Ndwedwe burn their plastic waste in a pit because there is no proper refuse removal system to dispose of it. This has proven to be an environmental

hazard to public health. Poor waste management practices can have an adverse impact on the soil and agriculture.

4.4.2 The Effectiveness of Poultry Industry's Waste Re-use

The utilization of poultry manure as an organic fertilizer is critical in improving crop production and soil productivity in South Africa (Oagile, 2010). The objective of the research was to identify the effectiveness of the poultry industry's waste re-use in improving the crop production of Urban Farmers. The results showed that nothing goes to waste because everything that goes into the poultry house and at the end of the cycle is cleaned out and composted. The organic waste does contain wavering amounts of organic matter such as water and mineral nutrients; this is very favorable for the soil and crop production. Feedstock Manufacturer #1 had this to say:

> *So basically, stuff like dedication, narratives and so on the sort of extensive hazards products we can't just discard, so you can't just dump it somewhere. We use external companies to collect that product and they got their ways to [cough] to discard that product.* (Feedstock Manufacturer #1, February 2020, Male, Age39).

According to Industrial Poultry Farmer #1:

> *The advantage is that none of it is wasted it all has used its purpose so you do not have the problem of disposing of it, so you do not need a dedicated site where you have to bury it, or burn it, or anything like that so you can use it. Either for feeding of other animals or as enhancement of the soils characters that's the biggest benefits. Drawbacks something like mortalities, it has to be kept or frozen so they don't go off, I mean if it goes off it can make other animals sick and the litter there are certain medications that we can't use in the chickens, because it can be dangerous if that litter is fed to ruminants.* (Industrial Poultry Farmer #1, February 2020, Male, Age 40).

Therefore, several nutrient management practices need to be undertaken by Smallholder and Industrial African Farmers.

The traditional recovery of household waste such as animal feed and home composting, has diverted a part of the biowaste portion from waste dumping into applications. The enhancement of home composting procedure across the rural communities in KwaZulu-Natal is an environmentally friendly solution and cost-efficient but it should be correctly performed to avoid bio-waste losses (Mihai, 2017).

According to Small-Scale Poultry Farmer #1:

> *Well, in terms of management, the most important thing in terms of free ranging is that you need to make certain that you got crops planted for the chickens. Because if you haven't got crops you know, then you got to start buying feed and that can become expensive, so you also need to make certain that you got sufficient land to plant the crops and a bit of water to irrigate the crops (*Small-Scale Poultry Farmer #1, February 2020, Male, Age 62) .

Maize is one of the largest locally produced field crops, and it is consumed by both animals and humans. Industrial Poultry Farmer #2, stated:

> *Poultry companies are in maze production per se, so all the feed will be bought some of these companies are integrated so they will have their feed mills. But the feed mill would do the purchasing of all the ingredients here like this year there is enough maize and soya in the country so we will buy locally but in years of drought, we would also buy on the international market. The feedstuff price normally changes monthly, the biggest driver of the change and cost of feed relates to the grains and predominantly maize and soya. So as the maze and soya go up and down in terms of price, the price would be adjusted in the feed most of the feed companies will purchase their raw materials. The maze and soya a month ahead so the maze we would use in a month, they have already bought. So that is the shortest lead time we will have in terms of*

purchasing raw materials if we believe that there might be a drought on its way, we will hedge and buy forward. So, companies will tend to buy between 3-12 months ahead depending on forecast depending on how big the local crops would be. (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

South Africa exported around 2.4 million tons of maize in the 2018 Financial Year and is subsequently a net exporter; the change in the previous years was when an above-average volume of nearly 2,4 million tons had to be imported from other countries (SAYA, 2019).

4.4.3 The Effectiveness of the Poultry Industry's Waste Re-use and Sustainability of Urban Farmers

The other objective of the research was to analyze the effectiveness of the poultry industry's waste re-use in enhancing the sustainability of urban Farmers' livelihoods. The research established that there are issues regarding gender and these disparities are often overlooked. The field of politics and economics are addressing these issues. The integration analysis of gender relations in agro-economics in South Africa is important because of the benefits from the resources based on social relationships between raising many out of business, control, and paradigm of access (Bagnol, 2019). Al-Rimawi (2012) States that female Farmers play a critical role in decision-making relating to farm management and the activity of livestock production in Ndwedwe. It is not detached from the role of field extension which was provided by private parties or government. Most of the rural households in Ndwedwe have poultry and is maintained by children and women. Family-owned poultry business contributed to the family income of between 19-50% in the rural areas; therefore, the poultry is reared traditionally and most favorable to women (Lestari, 2017). Most of the women in Ndwedwe farm chickens to feed their families or sell their chickens to earn an income. This has been proven to be beneficial for the development of female Rural Farmers in the agricultural sector. Therefore, the rural chickens are a source of protein and income

to a resource-limited local rural marginalized community in Ndwedwe.

Dumping

In the perspective of international trade, dumping is the export of poultry products at a price that is much lower than the price charged in the domestic markets, or below the cost of production. It permits the imports of products to advance in an unfair market share trade and it is reflected as a predatory practice (Fairplay, 2021). This has proven to be a major challenge in the agricultural sector in South Africa, as it causes price fluctuation and unfair trade. Another problem in the poultry sector is diseases, which the Farmers cannot control. Industrial Poultry Farmer #2, had this to say:

> *Well, I think the big impact on livelihoods is the fact that poultry is the most used protein source of all proteins that people consume in any developing country. Except maybe Nigeria and Ghana the first form of protein would be a chicken-based protein so if one wants to look at food security and you want to look at nutriment of the nutria impact of people, you need a poultry industry without that industry the livelihood of a lot of people will deteriorate* (Industrial Poultry Farmer #2, February 2020).

South Africa is one of the main consumers of poultry products in the world. Chicken products are the most consumed meat in the country with a total per capita consumption of 33kg in 2019 and 7kg for eggs as compared to the beef per capita consumption of 17kg per year (Makgopa, 2020).

4.4.4 Patterns of re-use

From the study, it was established South African households is in the specific patterns of re-use which manifest across many different contexts, and within Ndwedwe, analysis suggests that these re-use practices are both diverse and widespread. Numerous waste items were identified as being re-used within these households for the

chicken coops, which included scrap material such as old, rusted metal, chicken wire mesh, wooden planks, and other different types of material that were manipulated to make chicken coops. Food waste is fed to livestock. Bamboo reeds are cut in half and are repurposed as walls for the chicken coops and kraal. This enclosure is meant to protect livestock during the night from predators and theft. Many different objects are re-used several times before they are finally discarded (Kalina 2019).

Similarly, Small-Scale Poultry Farmers make a structure out of normal chicken mesh and tar poles or arm poles to secure the structure. In terms of free-range, there are movable enclosures for housing chickens on lands, planting crops for the chickens so that as one crop area gets finished, the chicken coups are moved to a new section. Industrial Poultry Farmers "use for the foundation that is the same as the normal house and then the walls, is made from panels but it's like a kind of polo styling as well. I'm going to lie if I'm going to tell you what it's between a plastic and a metal type of thing".

There is a critical role that indigenous knowledge plays in poultry agriculture, which shows that it is in association with biodiversity, healthy lifestyles, nature conservation, and environmental well-being. Therefore, the rationale behind this correlation is that indigenous agriculture in its very nature creates a living environment that is productive, nonaggressive, and sustainable (Quabe, 2020).

The finding shows that numerous reuse methods are used in the South African poultry sector, to reduce the amount of waste that is admitted into the environment. The results show that scrap materials were predisposed to make the chicken coops, and scrap materials have many purposes in agriculture, more especially in the rural areas. The chicken coop protects and keeps the chickens comfortable, therefore, this would increase the flock's productivity and profitability; by using re-used materials, these methods are economical and sustainable.

4.4.5 The Social Acceptability of Waste Re-Use

The findings of this study showed that globally, the poultry industry is increasing rapidly and is one of contributors towards addressing the key national development goals, and in creating employment opportunities and improving the standard of living of people through poverty alleviation. The problem that often comes along with poultry production is the manure that needs to be discarded, as disposal or inappropriate treatment could become a hazard for both humans and the environment (Muduli, 2019). Feedstock Manufacturer #1, February 2020 said:

> *Sometimes it relates to cost if one just looks at one example and that is the poultry by- product meal or the feather meal…legislation over time is changing that can't be used in certain types of animals they will, for example, not allowing one pork blood meal or carcass meal to be used in chicken and chicken not used in pork for concerns relating to viruses that might be taken and stuff like that. Now that obviously would have a cost impact on the industry so the biggest downside reusing overtime is a higher specification and re-use of products that in general puts a higher level of the increased cost of the product* (Feedstock Manufacturer#1, February 2020, Male, Age 39).

The slaughter by-products are often routinely recycled for use in animal feed. They are rendered down to produce an economical and nutritional feed ingredient. The by-products that are used in feeds include fetuses, organs, meat trimmings, and certainly condemned carcasses. It is imperative to note that hide trimmings, horns, stomach contents, hair, manure, hoofs, and blood are not used in the production of meat meals (Johnson, 2018). Industrial Poultry Farmer #2, February 2020 said:

> *It's not a big issue because we slaughter so we don't consume. The waste in terms of that is negligible if we look at the chicken; the only products that aren't eaten on chickens would be the heads on certain cultures are useless. For human food or dog food or animal feed, so very little of the carcass is wasted,*

the feathers and the blood would be the biggest components of the carcass that's not used for either human or animal consumption. So very little in terms of that, if you talk about other resources like water and electricity and stuff like that, all the big companies have got processers to overtime increasingly use scarce resources. Water is typically cleaned through biological process not as much chemical processers as a biological process. Where they make use of different types of dams with fungi to do that and right at the end, they would use chlorine or chemicals to do the final treatment of the water. You would also find a lot of water from processing plants are recalculated water would not be used on food again, although it is of quality that you can, it would be used for cleaning purposes. So, the water is very effectively used so we got standard that is used less than

16 liters per bird that are slaughter and electricity wise. People might use feed exchangers and the one side of the abattoir to cool stuff, like squeezing chicken and the other side of the abettor you create heat, broilers as an example and a lot of the energy will be re-used through pet exchangers (Industrial Poultry Farmer #2, February 2020, Male, Age 56).

4.4.6 Chicken Health

Based on the findings of this research, modeling humane and ethical animal stewardship is crucial and for the highest good quality that is needed. KwaZulu- Natal has many communities and cultures. The farmers either choose to use animal by-products as food or raise them for by- products.

Healthy chickens are the ones that have regular access to an optimal nutrient intake. While there are many drugs available for the improvement of chicken health, additives and supplements are greatly effective in supporting healthy functions and boosting the immune system (Bentol, 2020). Most of the common health problems can be mitigated by the improvement of diets that contribute to poultry stress.

4.4.7 The Economy in the Poultry Industry

Finally, the research found that the South African meat imports focus specifically on the three factors that have the most effects on meat imports in this country: taste, technology, prices, or scale. Primarily, the estimated amount of demand shifts amongst the several types of meat in relation to their own scale, elasticity, prices, and cross-prices determines the patterns of consumer demand for the substitution effects and different meats. The estimated elasticity could be used to analyze the implications of the South African policy changes and the reforms which affect the meat trade. Nonetheless, with South Africa's growing economy this would normally lead to expanding consumer demand for chicken products, and more likely, to higher imports. The expanding supply can have an offset expanding demand. Alternatively, the attempt to expand the South African soybean and corn markets can be unsuccessful and this would lead to higher meat imports from more competitive world markets, higher domestic feed prices, and higher cost of production for domestic meat producers. Therefore, the formal analysis of the role of government policies would affect the domestic exports and supply of the grave feed commodities (Taherzadeh, 2015).

4.5 Conclusion

The chapter presented and analyzed the data collected during the study through questionnaires and interviews. The data revealed that all the poultry agricultural sectors in South Africa implement some sort of waste re-use as an alternative feedstock for enhancing the livelihoods of Urban Farmers in KwaZulu-Natal. This is shown by the different methods of farming in different sectors. The poultry sector is significant to the South African economy, as poultry is the most consumed protein in Africa. This diverse product has created many employment opportunities and its by-products that are used as different alternatives in the environment. The data showed the consumers'

thoughts when it comes to consumption, the poultry industry, and this indicated how consumer's thoughts differ. It further revealed that social, economic, and environmental factors also play an important role in Farmers' lives when it comes to the poultry sector. Chapter 5 will discuss the findings of this study and give some insights and recommendations.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The main aim of this study was to examine the practices of the poultry industry's waste re-use as an alternative feedstock for enhancing the livelihood of Urban Farmers in Ndwedwe, a small rural community in KwaZulu-Natal, South Africa. The focus was on investigating what practices of the poultry industry's waste can be re-used as an alternative feedstock for enhancing the livelihoods of Urban Farmers in the province. Chapter 5 presents the summary of all the chapters in this thesis. The research findings are discussed, and appropriate recommendations are then given. Limitations of the research together with areas suggested for future research are presented in this chapter. Finally, the summary of this study as well as conclusions are presented.

5.2 Summary of the Study

This dissertation was divided into five chapters. Chapter one introduced the study by providing its background, the research problem statement, objectives of the research as well as the research questions. In this chapter, insight into what practices of the poultry industry's waste can be re- used as an alternative feedstock for enhancing the livelihoods of Urban Farmers in all the poultry sectors in KwaZulu-Natal, South Africa. The different poultry industries in South Africa, and how this sector is improving the urban economy and reducing food insecurity, are explained and what prompted the interest to undertake this research.

Chapter Two discussed the selected indigenous knowledge theory that is used in this study. It reviews the literature on the Sustainable Development Goals and asks: could livestock possibly deliver? Hunger, poverty, and urban agriculture as a Livelihood with Strategy to Food Security, and an overview of the South African poultry industry and the impact of COVID-19 and its disruption to the poultry production chain. Chicken

manure-enhanced soil fertility and productivity. This was to ensure that people are aware of the impact of waste on their health, well-being, and the environment. Theoretical framework, indigenous knowledge theory, and sustainable livelihood approach was reviewed in this chapter.

Chapter Three presents the research methodology that was used in this study. This chapter gave a detailed description of how the extensive field research was done in Ndwedwe and due to COVID 19 pandemic; interviews had to be conducted telephonically. This included a detailed explanation of the data collection methods, research design, sampling of participants, and study area that was used in this research. Ethics and ideologies were experiential in the research which is also explained in this chapter (Mawire, 2017).

The research procedures that were undertaken were explained in Chapter Three, and data and research was analyzed and presented in Chapter Four. Thematic data analysis was used in analyzing the data that was collected during the research.

The concluding chapter discusses the conclusions of the study, its recommendations, and the limitations that were observed in the study.

5.3 Implications of the Policy

The findings of this study showed that all the poultry agricultural sectors in South Africa implement some sort of waste re-use as an alternative feedstock for enhancing the livelihoods of Urban Farmers in KwaZulu-Natal. This is shown by the different methods of farming in different sectors, such as the highly fertile and nitrous soil that is made from animal by-products, which contributes towards healthy plant growth. Chicken coops are made from scrap material in the rural areas, and leftover poultry carcasses are used as dog and wildlife feed. The poultry sector is significant to the South African economy, as poultry is the most consumed protein in Africa. This diverse product has created many employment opportunities and its by-products are

used as different alternatives in the environment. Consequently, South Africa's economic developmental policies are a broad-based industry path, which is then categorized by greater participation of historically disadvantaged and poor people, and marginalized regions and businesses, by the mainstream economy (Clauer, 2013).

5.4 Implications for Practice

The problem that affects the poultry sector in South Africa is that there are large amounts of waste, more especially litter and manure that are generated by intensive production. A large accumulation of poultry waste can prove to be detrimental to the environment, and if not disposed of properly. To counterbalance this, chickens should be fed a healthy diet. This can be corrected if there are economic, environmental, and socially sustainable management technologies and solutions to help solve these problems.

5.5 Conclusions Derived from the Findings

Based on this study, it can be concluded that there are many different types of waste re-use practices in South Africa. Manure is used in a modern agricultural system as a replacement for synthetic fertilizer, pest control inputs, and weed eradication, after the development of the agrochemical industry (Dinnes, 2012). Using poultry by-products as fertilizer proves that this method of farming is very sustainable and fertile for the crops. Many people believe that poultry meat is a much cheaper source of protein compared to other sources of meat products. This is beneficial for enhancing the Farmer's livelihoods as more people tend to favor poultry products because of their nutritional value and affordability. As shown in this study, there are many waste re-use practices across all the sectors in KwaZulu-Natal, and all prove to enhance the Urban Farmers' livelihood in South Africa.

5.6 Realization of the Objectives

Objective 1: ***Waste Re-use for Enhancing Soil Quality by Both Large-Scale and Small-Scale Farmers***

This objective was realized because the South African poultry industry is currently facing numerous disposal problems regarding waste in KwaZulu-Natal. Mainly by-products, litter, and manure that lead to a large-scale accumulation of waste, which can be detrimental to the environment if not disposed of properly. When managed correctly, poultry waste can be very useful to the environment, such as providing soils with high nutrition and being extremely fertile so plants can grow.

Objective 2: ***The Effectiveness of the Poultry Industry's Waste Re-use in Improving the Crop Production of Urban Farmers***

This objective was achieved because the research showed that the utilization of poultry waste as an organic fertilizer is important for the nutrition of the soil and in turn would lead towards a healthy crop yield. Organic waste does contain wavering amounts of organic matter such as water and mineral nutrients which is very favorable for the soil and crop production. It is a cost- effective way to provide nutrition to the soil and crops.

Objective 3: ***The Effectiveness of the Poultry Industry's Waste Re-use in Enhancing the Sustainability of Urban Farmers' Livelihoods***

This objective was realized because the study found out that there are vast amounts of female Farmers in the agricultural sector in KwaZulu-Natal. They provide economic stability in their household, agricultural management, and food. The dumping of chicken products in South Africa seems to pose a problem for economic fluctuations in domestic markets. Analysis suggests that these re-use practices are both diverse and widespread.

Numerous waste items were identified as being reused within these households for the chicken coops, which included scrap material such as old, rusted metal, chicken wire mesh, wooden planks, and other different types of material that were manipulated to make chicken coops. Food waste is fed to livestock, and bamboo reeds that are cut in

half are repurposed as the walls for the chicken coops and kraal, to protect them from predators and theft. These types of re-use forms in layers and many different types of objects may be re-used several times before it is finally discarded (Kalina, 2019).

Objective 4: ***The Social Acceptability of Re-used Waste as Feedstocks for Both Producers and Consumers in KwaZulu-Natal***

This objective shows that the poultry industry is growing rapidly throughout the world, because it is economical, nutritious, and it improves the livelihood of both Farmers and consumers. The slaughter by-products are often routinely recycled for use in animal feed, and this provides nutrition for the soil and healthy crop growth.

5.7 Recommendations

The poultry industry is currently facing numerous environmental problems. The major problem is the accretion of numerous wastes, especially litter and manure that is generated by intensive production. A layer of large-scale accumulation of many different types of waste may pose pollution and disposal problems unless economic and environmentally sustainable management technologies and solutions are evolved to help solve the countless environmental problems we face today (Tesfamariam, 2013). Pollution problems could arise when fertilizers are applied under environmental situations that do not favor agronomic utilization of manure-borne nutrients (Sharpley, 2008). Because the poultry industry is one of the fastest and largest emergent agro-based industries in the world; this can be seen as a cumulative demand for egg products and poultry meat. To solve these problems, proper waste management strategies need to be implemented.

This would include diversity within the poultry sector, where women and people of all ages would participate and share their knowledge in agriculture. This seems to be a major concern for developing countries like South Africa and the SADC regions, where women in different race groups are marginalized and are not recognized in this industry. This study show that many women contributed significantly to subsistent and

commercial farming, but this is not enough compared to their male counterparts.

Proper disposal of poultry waste and by-products should be done sustainably. Based on the research findings, it showed that the ruminants are disposed of in a sustainable way and used as fertilizers that are highly nutritious for the soil and plants and in turn produce a successful yield. Furthermore, the chicken carcasses are sent to game farms and are fed to animals such as lions and crocodiles. This shows that poultry is a diverse product and is beneficial for everyone in the poultry sector.

Poultry is one of the most consumed sources of protein in South Africa and is very affordable for consumers. The poultry industry contributes significantly to South Africa's GDP, as millions of people are employed in this industry.

5.8 Suggestions for Further Research

Poultry is the most consumed protein in South Africa, and the fastest and largest emergent agro- based industry in the world which can only be recognized as a cumulative demand for egg products and poultry meat. There is a need to carry out more research on the poultry industry's waste re-use as an alternative feedstock for enhancing the livelihood of Urban Farmers in KwaZulu-Natal, South Africa. The rising recognition of urban agriculture usefulness, practicality and practicability has been improving the urban economy and slowing down the problems of food insecurity. Because of the implausible management and utilization of poultry waste as an alternative towards synthetic fertilizer, waste re-use as an ingredient for cultivating production and soil outputs be further researched (Redwood, 2009). This research would give policymakers and environmentalists more information on how waste re-use is an alternative feedstock for enhancing the livelihood of Urban Farmers.

5.9 Conclusion

This chapter looked at the findings of the research and one of the main findings was that there were many environmental concerns regarding poultry waste. This can be solved by proper waste management systems, which were shown by the various waste management re-use practices that were adopted over the years by the different poultry sectors in South Africa. The other finding was that using poultry by-products as fertilizers in soil proves to have a positive crop yield throughout the year and solves the disposal problems from poultry waste. One of the key conclusions is that poultry does not only serve as a healthy source of protein but is also economical for both Farmers and consumers. This study showed that there are more female Farmers that are integrated into the poultry farming sector. In order to minimize the negative impacts brought by the poultry industry, there needs to be proper waste management implementation, as shown by the numerous sustainable re-use patterns.

REFERENCES

ACS, (2016). Sustainable U.S. Manufacturing: Chemical and Allied Industries. Alternative Feedstocks. Washington, DC: ACS publications.

Adedayo, V. (2012). Poultry Waste Management Techniques in Urban Agriculture and its Implications: A Case of Metropolitan Lagos, Nigeria. *Asian Journal of Agricultural Sciences*, 4 (4), 258.

Adlam, G. (2021, April 30). Agriculture. KZN Top businesses portfolio. https://kzntopbusiness.co.za/site/agriculture.

AFMA, (2018, April 20). Fair play movement. Overview of the South African poultry industry. https://fairplaymovement.org/overview-of-the-south-african-poultry-industry.

Afr, (2021), A historical assessment of sources and uses of wheat varietal innovations in South Africa. *South African Journal of Science*, 113(4), 3.

Agamuthu, P. (2019). Challenges and opportunities in Agro waste management. Tokyo, Japan.
An Asian perspective. Inaugural meeting of First Regional 3R Forum in Asia.

Aggelides, G. (2000). Effects of compost produced from town waste and sewage sludge on physical properties of loamy and clay soil. *Bioresource Technology*, 7(1), 253-259.

Agle, B. et al. (2008). Dialogue: toward superior stakeholder theory. *Business Ethics Quarterly*, 18(2), 153-190.

Aliber, A. (2014). Should subsistence agriculture be supported as a strategy to address rural food insecurity. *Agrekon*, 48(4), 434.

Al-Rimawi, A.S. (2012). The role of Jordanian women Farmers in livestock production with implications to agricultural extension education. *Journal of International*

Agricultural and Extension Education, 9(1), 14.

Anderson, S. (2017). A Draft Risk Assessment of Campylobacter spp. in Broiler Chickens. *Activities on Risk Assessment of Microbiological Hazards in Foods*, 9(3), 26.

Appadurai, A. (1988). The Social Life of Things. Cambridge: Cambridge University Press. Atoma, V. (2011). The Relevance of Indigenous Knowledge to Sustainable Development in Sub-Saharan Africa. ajol.info. https://www.ajol.info/index.php/ijotafs/article/view/76093.

Attia, Y.A. (2020, August 26). Frontier sin. Frontiers in veterinary science. https://www.frontiersin.org/articles/10.3389/fvets.2020.00516/full.

Bagnol, B. (2019). Gender issues in small-scale family poultry production: experiences with Newcastle Disease and Highly Pathogenic Avian influenza control. *World's Poultry Science Journal*, 65(2), 231-240.

Bart, C.J. (2013). Biolubricants. Chicago: Woodhead Publishing Series in Energy.

Bentol. (2020, December). *6 common chicken problems you can eliminate with quality nutrients.* https://www.bentoli.com/chicken-problems-common.

Bernheart, M. (2016). Compaction of poultry litter. *Bioresource Technology*, 101(1), 234.

Bolan, N.S. (2016). Uses and management of poultry litter. *World's Poultry Science Journal*, 66 (4), 955-962.

Bolton, A. (2016), management of solid waste. CRC Press, 23.

Botha, C. (2018, August 20). Grain Field Chickens (Pty) Ltd (GFC). VKB. https://www.vkb.co.za/index.php/en/agri-processors/grain-field-chickens.

Bounds, M. (2018). Poultry Farming: Lessening poverty in rural areas. *South African Journal of Agricultural Extension*, 46(1), 59-70.

Bowen, B. (2018). Biosecurity on Poultry Farms from On Farm Fluidized Bed Combustion and Energy Recovery from Poultry Litter. *Sustainability*, 2(7), 2135-2143.

Briggs, J. (2005). The use of indigenous knowledge in development: Problems and challenges.
Progress in Development Studies, 5(2), 99-114.

Brockotter, F. (2020, July 24). Poultry world. COVID-19 disrupts poultry production chain https://www.poultryworld.net/Meat/Articles/2020/7/COVID-19-disrupts-poultry- production-chain-617386E/.

Brooker, A. (2020). *Poultry hub.* https://www.poultryhub.org/the-race-to-find-an-alternative-to- antibiotics-in-poultry-feed.

Brown, N. (2017). Environmental review of national solid waste management plan. Environmental Consultancy Group, 23.

Cavani, C. (2019). Advances in research on poultry and rabbit meat quality. *Italian Journal of Animal Science*, 8(2), 741-750.

Chambers, R. (2014). Participatory Rural Appraisal (PRA): Analysis of Experience. *World Development, 52*(9), 1253- 1268.

Chambers, R. (2012).Sustainable rural livelihoods. *The Institute of Development Studies*, 43(2), 89.

Chandrappa, R. (2012). Solid Waste Management. Springer, 10.

Chatterjee, R. (2017). Recycling of Organic Wastes for Sustainable Soil Health and Crop Growth. *International Journal of Waste Resources*, 7(3), 9.

Chaudhry,Z. (2017). Combustion of chicken litter in a fluidised bed combustor."

The Second International Mediterranean Combustion Symposium, 82(6), 687-692.

Cherr, C.M. (2006). Green Manure Approaches Crop Production: A Synthesis. *American Society of Agronomy Journal*, 5(8), 302-319.

Chescheir, GM. (2006). Laboratory methods for estimating available nitrogen in manures and sludges. *Agricultural Wastes*, 1(3), 175-195.

Choi,J.M. (2016). Developing a Slowrelease Nitrogen Fertilizer from Organic Sources. *Journal of the American Society for Horticultural Science*. 121(4), 629–633.

Choo, E.K. (2015, May 14). Qualitative research: Amsterdam UMC. http://www.emgo.nl/kc/qual-data-collection/.

Christen, K. (2011). Chickens, manure, and arsenic. *Environmental Science and Technology*, 55 (3) 2037-2047.

Clauer, P.J. (2013). A small-scale agriculture alternative: Poultry. Virginia cooperative extension. Petersburg: Virginia State University.

Cope, D.G. (2014). Methods and meanings: credibility and trustworthiness of qualitative research. *In Oncology nursing forum*, 41(1), 32.

Crowe, S., Cresswell, K., Robertson, A., Huby, G., Avery, A. and Sheikh, A. (2011). The case study approach. *BMC medical research methodology*, 11(1), 100.

Crush, J. (2010). The Invisible Crisis: Urban Food Security in Southern Africa. *Research Gate, 3*(2), 4.

Crush, S.J. (2013). Urban food insecurity and the new international food security agenda. *Research Gate*, 28(4), 18.

DAFF, (2018). Economic review of South African agriculture for the year ended.

Department of Agriculture, Forestry and Fisheries, 17(3), 15.

David, B & Resnik, J.D. (2015). What is Ethics in Research & Why is it Important? *National Institute of Environmental Health Sciences*, 24(1), 48.

Davies.J.B. (2016). Reasons and causes: understanding substance users' explanations for their behavior. Glasgow: John Wiley & Sons, Ltd. Human Psychopharmacology, 39-48.

Denzin, N. K. (2005). The SAGE handbook of qualitative research. California: Thousand Oaks.

Denzin, N., & Lincoln, Y.S. (2015). The discipline and practice of qualitative research. (Eds.), The Sage handbook of qualitative research (pp. 1–32). Thousand Oaks, CA: Sage.

Denzin, N.K. (2017). Handbook of Qualitative Research. London, England: Sage Publications.

Dikinya, O. (2010). Chicken manure-enhanced soil fertility and productivity: Effects of application rates. *Journal of Soil Science and Environmental Management*, 1(3), 46-54.

Dinnes, D.L. (2012). Nitrogen management strategies to reduce nitrate leaching in tile-drained midwestern soils. *Agronomy Journal*, 94(14), 153–171.

DTI, (2017). The Department of Trade and Industry. Department of trade and industry 2016/17 annual report.

Dudovskiy, J. (2011, May 14). Qualitative Data Analysis. research-methodology. http://research-methodology.net/about-us.

Duncan, J. (2005). Composting chicken manure. WSU Cooperative Extension, King County Master Gardener and Cooperative Extension Livestock Advisor, Washington

State University, Pullman, 48.

Dzansi, D.Y. (2014). Social responsibility of SMMEs in rural communities, Unpublished doctoral thesis. Pretoria, South Africa: University of Pretoria.

Edwards, D.R. (2012). Environmental impacts of on-farm poultry waste disposal: A Review. *Bioresource Technology*, 4(10), 9-33.

Edwards, D.R. (2017). Environmental impacts of on-farm poultry waste disposal. *Bioresource Technology*, 41(1), 12.

Edwards, J.H. (2010). Chemical, physical, and biological characteristics of agricultural and forest by-products for land application, Land Application of Agricultural, Industrial, and Municipal By-products. *Soil Science Society*, 7(6), 1-62.

Edwards, J.H. (2019). Biological characteristics of agricultural and forest by-products for land application. *Land Application of Agricultural, Industrial, and Municipal By-products*, 6(5), 12.

Elard, G. (2019). Earth Link and Advanced Resources Development in association with Golder Associates Africa. *Environmental and social impact assessment*, 15(9), 112.

El-Haggar, H. (2017). Sustainable Industrial Design and Waste Management. Academic Press, 20.

Epstein, E. (2019). Disposal and Management of Solid waste. CRC Press, 14.

Fabian, E. E. (2013). Agricultural composting: A feasibility study for New York farms. New York: Cornell.

Fairplay, (2021, February 22). Anti-Dumping duties essential to stop chicken dumping. http://fairplaymovement.org/anti-dumping-duties-essential-to-stop-chicken-dumping/.

FAO, (2019, December 12). Africa sustainable livestock 2050. *Food and Agriculture Organization of the United Nations*, https://www.fao.org/in-action/asl2050/en/.

Fletcher, R. (2017). Decoupling: A Key Fantasy of the Post-2015 Sustainable Development Agenda. *Globalization*, 1(3), 17.

Frantz, A, (2016). A comparative study of municipal waste disposal practices and management in the Breede River District Council and the Cape Metropolitan Area. Unpublished MA thesis, 12.

Friend, A.L. (2018). Poultry litter application to Loblolly pine forests: Growth and nutrient containment. *Journal of Environmental Quality*, 35(3), 35.

Fulghum, L. (2019,May 27). Community chickens. https://www.communitychickens.com/will-chickensdestroy/#:~:text=Chickens%20Will%20Destroy%20Your%20Garden,At%20least%20a%20little%20bit.&text=Chickens%20also%20love%20to%20peck,they%20walk%20and%20lay%20down.

Ganti, S. (2019). Systems Analysis Frameworks for Biorefineries. Science direct, 325(45), 77- 92.

Giller, K.E. (2017). Building soil nitrogen capital in Africa. *Replenishing soil fertility in Africa*, 41(7), 46.

Grenier, L. (2018). Working with Indigenous Knowledge. *A Guide for Researchers*, 2(1), 33-47.

Griffiths, H. (2013, June 20). Biogas. E.E. Publishers. http://www.ee.co.za/wpcontent/uploads/legacy/.

Hafez, M. (2020, August). *Frontiers in veterinary science.* https://www.frontiersin.org/articles/10.3389/fvets.2020.00516/full.

Hai, H. (2010). Under the Framework of joint Project on Asia Resource Circulation Policy Research Working Paper Series. Institute for Global Environmental Strategies supported by the Ministry of Environment.

Harmel, R. (2016). Effects of annual Turkey litter application on surface soil quality. *Soil science*, 176 (5), 227-236.

Harwell, M.R. (2011). Research Design in Qualitative/Quantitative/ Mixed Methods.
Opportunities and Challenges in Designing and Conducting Inquiry, 5(3), 148.

Houghton, C., Casey, D., Shaw, D. and Murphy, K., (2013). Rigour in qualitative case-study research. *Nurse researcher*, 20(4), 12-17.

Hussein, S. D. A. (2010). The Utilisation of Agricultural Waste as One of the Environmental Issues in Egypt (A Case Study*). Journal of Applied Sciences Research*, 6 (8), 1116-1124.

IDP, 2012. Review of uThukela District Municipality. Unpublished report, Ladysmith: Unpublished report.

Jacob, J. (2016, April 18). Small and backyard Poultry
https://poultry.extension.org/articles/feeds-and-feeding-of-poultry/feed-ingredients-for-poultry/animal-by-products-in-poultry-feeds/meat-and-bone-meal-in-poultry-diets.

Johnson, R. (2018, October 10). The Sustainable Development Goals: Can livestock deliver? https://thepoultrysite.com/articles/the-sustainable-development-goals-can-livestock-deliver.

Jordon, D. (2012). Effect of corn processing on degradable intake protein requirement of finishing cattle. *Journal of animal science,* 5(6), 78.

Kalina, M. (2019). Conceptualising re-use in African households: perspectives from Chembe, Malawi. South African Research Chair in Waste and Climate Change.

Kanene, K.M. (2016). Indigenous practices of environmental sustainability in the Tongaat community of southern Zambia. *JAMBA*, 8(1). 331.

Karodia, A.M. (2017). The South African Poultry Industry is in Dire Straits and is Facing Collapse: Is it a Management and Political Issue. *International Journal of Research Studies in Agricultural Sciences*, 3(5), 12-24.

Kassim, H. (2018, February 15). Med crave. https://medcraveonline.com/IJAWB/effects-of- soybean-and-maize-bran-supplementation-on-carcass-yield-of-local-chickens-under- scavenging-condition-in-mkwinda-epa-lilongwe-malawi.html.

Kelleher, (2012). Advances in poultry litter disposal technology. *Bioresource Technology*, 83(1), 27-36.

Kelleher, B.P. (2012). Advances in poultry litter disposal technology. *Bioresource Technology*, 4(2), 63.

King, N. (2004). Using templates in the thematic analysis of text. *Essential guide to qualitative methods in organizational research*, 20(1), 257–270.

Langill. S. (2019). Indigenous Knowledge A Resource Kit for Sustainable Development Researchers in Dryland Africa. *People, Land and Water Program Initiative, IDRC*, 32(4), 6.

Lebel, J. (2003). Health: An Ecosystem Approach. Canada, Ottawa: Published by the International Development Research Centre.

Leng, R. A. (2012). Practical technologies to optimize feed utilization by ruminants. Rome:
A. Speedy and P. L. Pugliese.

Lestari, S. (2017). The role of gender on Poultry Farms. *International Journal of*

Management and Applied Science, 3(1),3.

Lin, Y. (2018). Influence of poultry litter on crop productivity under different field conditions: a meta-analysis. *Agron*, 110 (3), 807-818.

Liswaniso, S. (2020). Quality Characteristics, Phenotypic correlations and Principal Component Analysis of Indigenous Free Range Chicken Eggs in Lusaka; Zambia. *International Journal of Environmental & Agriculture Research (IJOEAR)*, 6(1), 29.

Liu, Xuyi & Zhang, Shun & Bae, Junghan, 2017. *The nexus of renewable energy-agriculture- environment in BRICS, Applied Energy, Elsevier, 204*(16), 489-496.

Louw, M. (2017). Broiler production in South Africa: Is there space for smallholders in the commercial chicken coup. *Development Southern Africa journal, 34*(5), 564-574.

Mahimairaja, S. (2015). Agronomic effectiveness of poultry manure compost. *Communications in Soil Science and Plant Analysis, 26*(11), 16.

Makgopa, M.(2020). *Poultry and Products Annual.* Poultry and Products, Pretoria: Public Distribution.

Manyozo, L. (2018). The Context Is the Message: Theory of Indigenous Knowledge Communication Systems. *Journal of the European Institute for Communication and Culture, 12*(1), 394.

Mass.gov. (2021, March 2021). https://www.mass.gov/lists/march-2021-massachusetts-official- state-agency-resources-related-to-covid-19.

May, J. (2016). Poverty and inequality in South Africa. *Centre for Social and Development Studies*, 16(5), 782-812.

Mazza, A. (2015). Illegal dumping of toxic waste and its effect on human health. *International Journal of Environmental Research and Public Health*, 12(6), 68.

McLeod, S. (2014). The Interview Method: simply psychology.

https://www.simplypsychology.org/interviews.html .

McLeod, S. (2015). Observation Methods. Simply psychology. https://www.simplypsychology.org/observation.html.

Mihai, F. (2017, June 30). Introductory Chapter: Rural Waste Management Issues at Global level. https://www.intechopen.com/books/solid-waste-management-in-rural-areas/ introductory-chapter-rural-waste-management-issues-at-global-level.

Mitchell, L. (2018, May 15). The poultry site. The Sustainable Development Goals: Can livestock deliver? https://www.thepoultrysite.com/articles/the-sustainable-development- goals-can-livestock-deliver.

Mittal, G.S. (2006). Treatment of wastewater from abattoirs before land application-a review. Bioresource Technology, 97(9), 1119-1135.

Moher, D. (2009). Preferred reporting items for systematic reviews and meta-analyses. *Journal Pmed* , 6(7), 89.

Mokwunye, U. (2000). Meeting the phosphorus Needs of the soils and crops of West Africa: The Role of Indigenous Phosphate rocks. *IITA*, 36(12), 209-224.

Moore, A. (2011). Four plant defensins from an indigenous South African Brassicaceae species display divergent activities against two test pathogens despite high sequence similarity in the encoding genes. *BMC Research Notes*, 4(1), 459.

Mostert, F. (2010). Fruit waste as a renewable energy source for a clean development mechanism project in South Africa, Stellenbosch: University of Stellenbosch.

Motshekga, A. (2015, September 25). gov.za. South African Government. https://www.gov.za/speeches/minister-angie-motshekga-sapa%E2%80%99s-annual- national-conference-25-sep-2015-0000.

Mubarak, A. (2000). Effect of incorporation N accumulation of white clover in the hill farming system of Azad Jammu and Kashmir. *Common Soil Science Plant Anal*, 40(36), 1546– 1565.

Muduli, S. (2018). Poultry waste management: An approach for sustainable development

International Journal of Advanced Scientific Research, 4(1), 08-14.

Muduli, S. (2019). Poultry waste management: An approach for sustainable development.

International Journal of Advanced Scientific Research, 4(1), 8.

Mugodo, K. (2017). Biogas Production Potential from Agricultural and Agro-Processing Waste in South Africa. *Springer Link*, 8(4), 2383–2392.

Municipalities, (2012). Ndwedwe Local Municipality (KZN293). Municipalities OF South Africa. https://municipalities.co.za/overview/1073/ndwedwe-local-municipality.

Mushi, E.G. (2018). parasites of indigenous chicken. *Journal of the South African Veterinary Association*, 71(4), 247.

Mwalusanya, N.A. (2016). Nutrient status of crop contents of rural scavenging local chickens.

British Poultry Science, 43(1), 64-9.

Mwinzi. J.M. (2015). Theoretical Frameworks and Indigenous Knowledge Systems. *International Journal of Education and Research*, 3(2), 8.

Hoover, N.L. (2019). Long-term impact of poultry manure on crop yield, soil and water quality, and crop revenue. *Journal of Environmental Management*, 252(15), 3.

Natukunda, K. (2011). Indigenous chickens of the Kamuli Plains in Uganda: II. Factors affecting their marketing and profitability. *Livestock Research for Rural*

Development, 23 (10), 23.

Neeteson, A. (2017, September26). International Poultry Council. IPC Adopts Sustainability Principles. https://internationalpoultrycouncil.org/2017/09/26/ipc-adopts-sustainability- principles/.

Newman, A. (2017). National Waste Management Strategy. *Waste Service Delivery*, 9(4), 12.

Nkwachukwu, O.I, (2010). Issues of roadside disposal habit of municipal solid waste, environmental impacts and implementation of sound management practices in developing country "Nigeria". *International Journal of Environmental Science and Development, 1* (79), 409.

NRC, (1984). Nutrient Requirements of poultry. Washington: National Academy Press, 12. NRC, (2014). Nutrient Requirements of Poultry: Ninth Revised Edition. National Research Council. *National Academy Press*, 3 (1), 20.

Nwakaire, J.N. (2016). Agricultural waste concept, generation, utilization and management. *Nigerian Journal of Technology (NIJOTECH)*, 35(4), 957 – 964.

NWMS. (2011). National Waste Management Strategy. Environmental Affairs, 75.

Oagile, D. (2010). Chicken manure-enhanced soil fertility and productivity: Effects of application rates. *Gaborone: Department of Environmental Science*, 1(3), 46-54.

Obi, F. O. (2016). Agricultural waste concept, generation, utilization and." agricultural and bio resources engineering department. *Nigerian Journal of Technology (NIJOTECH)*, 35(4), 957 – 964.

Ologhobo, A.D. (2012). The dilemma of animal feeds and indigenous poultry in Nigeria. *African Journal of Agricultural Research*, 1(3),86.

Omiti, P. (2019). Soil fertility maintenance in Eastern Kenya: Current practices, constraints and opportunities. Kenya: Carmasak.

Oxfam. (2014). OXFAM annual report 2014 - 2015. Oxfam.

Patton, M. Q. (2015). Qualitative research & evaluation methods: Integrating theory and practice (4th ed.). Thousand Oaks, CA: Sage.

Peterson. S.O. (2003). Recycling of sewage sludge and household compost to arable land: fate and effects of organic contaminants, and impact on soil fertility. *Soil and Tillage research*, 72(2), 139-152.

Petrus,N.P. (2011). Characterisation and Production Performance of Indigenous Chickens in Northern Namibia Regions. Namibia: DAAIT.

PHA. (2021, April 20). *Poultry hub Australia.* https://www.poultryhub.org/all-about-poultry/nutrition/feed-ingredients.

Pingoud, V. (2019). Starch grain and phytolith evidence for early ninth millennium. *Proceeding of National Academy of Science*, 106(13), 5019-5024.

Polit, D.F., & Beck, C.T., 2012. Nursing research: Generating and assessing evidence for nursing practice. Philadelphia, PA: Lippincott Williams and Wilkins.

Post, S. (2017). Solid waste management in Jamaica: An investigation into waste reduction strategies. Houghton: Unpublished MSc (Civil engineering) thesis, 21. Power, N. (2017). Land Application of Agricultural, Industrial, and Municipal By products. *World's Poultry Science Journal*, 16(2), 674.

Preusch. S.W. (2016). Nitrogen and phosphorus availability in composted and uncomposted poultry litter. *Journal of Environmental Quality*, 31(6), 2051-2057.

Puffer, P. (2015). The Value of Indigenous Knowledge in Development Programs Concerning Somali Pastoralists and Their Camels. Iowa: CIKARD Associate Iowa State University.

Pujiastuti, E.S. (2020). The effect of chicken manure and beneficial microorganisms of

EM-4 on growth and yield of kale (Brassica oleraceae acephala) grown on Andisol. *Earth and Environmental Science*, 205(1) 74.

Quabe, Q. (2020, July 21). indigenous knowledge is a natural resource for Rural Farmers. Foodformzansi. https://www.foodformzansi.co.za/indigenous-knowledge-is-a-natural- resource-for-rural-Farmers/.

Ramirez, C. (2010, August 18). *Lions, tigers, jaguars...and chicken.* https://blog.zoo.org/2010/08/lions-tigers-jaguarsand-chicken.html.

Reardon, T. (2011). Rural nonfarm employment and incomes in Latin America: Overview and policy implications. *World Development*, 29(3), 395-409.

Redwood, M. (2009). Wastewater Use in Urban Agriculture: Assessing Current Research and Options for National and Local Governments. Tenure and land markets for urban agriculture, 34(2), 17.

Reeves, S. (2013). Ethnography in qualitative educational research: AMEE Guide No. 80. Research Gate, 35 (8), 4.

Rogerson, C. (2016). Resetting the policy agenda for urban agriculture in South Africa. *Journal of Public Administration*, 22(2), 183-198.

Rysen, V. (2018). Trace elements in poultry litter: prevalence and risks. Trace Elements in Animal Production Systems, 32(2), 535.

Sadh, P.K. (2018, January 02). Bioresources and Bioprocessing.
https://bioresourcesbioprocessing.springeropen.com/articles/10.1186/s40643-017-0187

Sandrey, R. (2013). BRICS: South Africa's way ahead, Western Cape, Stellenbosch: Tralac publications, 33.

SAYA, (2019). SOUTH AFRICA YEARBOOK 2017/18 Agriculture. DAFF, 12.

Scoones, I. (2018). Sustainable Rural Livelihoods: A Framework for Analysis. Institute of Development Studies, 47.

Selam, M. (2013). Causes of village chicken mortality and interventions by Farmers in Ada'a District, Ethiopia. *Academic Journnals*, 4(6), 88-94.

Sharpley, A. (2008). Impact of animal manure management on ground and surface water quality.
Animal Waste Utilisation: Effective Use of Manure as a Soil Resource, 173-242.

Sharpley, A. (2015). Nitrogen and phosphorus forms in soils receiving manure. *Soil Science*, 7(18), 159.

Sillitoe, P. (2002). Globalising Indigenous Knowledge. *In Participating in Development: Approaches to Indigenous Knowledge*, 15(4), 108–138.

Sillitoe, P. (2016). Introduction: Indigenous Knowledge in Development. *Journal for Applied Anthropology in Policy and Practice*, 13(3), 12.

Sims, J.T. (2014). Poultry Waste Management: Agricultural and Environmental Issues. *Advances in Agronomy*, 52(23), 1-83.

Sims, J.T. (2017). Nutrient management for intensive animal agriculture: policies and practices for sustainability. *Soil Use and Management*, 21(10), 141-151.

Sistani, K. (2017). Effects of drying method and rearing temperature on broiler manure nutrient content. *Communications in Soil Science and Plant Analysis*, 14(12), 32.

SKIL. (2012, February 02). How to build a chicken coop. https://www.skil.co.za/step-by- step/how-to-build-a-chicken-coop.html.

Smallstarter, E. (2019, April 18). Poultry Farming. Smallstarter. https://www.smallstarter.com/browse-ideas/poultry-farming/.

Smith, J. (2019). How external factors (e.g., climate change, conflicts, socioeconomics,

trading patterns) will impact veterinary services and the adaptations required. ILRI, 32(5), 10.

Smith. V. (2016, June 10). Agricultural waste management field handbook. http://www.info.usda.gov/ viewerFS. aspx?hid=21430.

Stanisavljević, N. (2012). Methane emissions from landfills in Serbia and potential mitigation strategies: A case study. *Waste Management and Research*, 6(1), 103.

Stats SA. (2017, December 12). Yearly Archives: 2017. Statssa. http://www.statssa.gov.za/?m=2017.

STATSSA, (2012). Bulletin of statistics. *Statistics South Africa*. 46(2), 1-158.

Straub, D. (2007). A hot issue-chicken manure. *A Journal of Organic and Sustainable Agriculture*, 9(6), 3483-3495.

Swain, (2018). Effect of different types of litter material for rearing broilers. *Poultry Science*, 23(40), 56.

Szogi, A.A. (2016). Uses and management of poultry litter. *Centre for Environmental Risk Assessment and Remediation*, 12(2), 5461-5465.

Taherzadeh, M.J. (2015). Factors affecting the development of waste management. Routledge: *Earthscan*, 1(3), 67.

Tandon, l.S. (2015). Recycling of crop, animal, human and industrial wastes in agriculture. *International Journal of Agronomy*, 17(2), 55.

Tesfamariam, E.H. (2013). Land Application of Agricultural, Industrial, and Municipal By-Products. *Soil Science Society of America*, 39(4), 4.

Thwala,J.D, Pillay,A.L & Sargeant,C. (2001). The Influence of Urban/Rural Background, Gender, Age & Education on the Perception of and Response to Dreams among Zulu South Africans. *South African Journal of Psychology*, 30(4), 1-5.

Timbers, G. E. (2017). Agricultural Biomass Wastes: Utilisation routes. *Canadian Agricultural Engineering*, 3(3), 84-87.

Tlou, G.M, (2020). Local Chicken Breeds of Africa: Their Description Uses and Conservation Methods. *MDPI*, 10(12), 2257.

Uyanga,V. (2021). Coronavirus Disease 2019 (COVID-19) and Poultry Production: Emerging issues in African Countries. *World's Poultry Science Journal* , 77(1), 22.

Uzair, M, (2019). Effect of industrial waste on seed bank and growth of wild plants in Dhabeji area, Karachi, Pakistan. *Pakistan Journal of Botany*, 41(4), 166.

Vonga, M. (2014). Exploring Methodologies for Researching Indigenous Knowledge of Plant Healing for Integration into Classroom Science: Insights Related to the Data Collection Phase. *African Journal of Research in Mathematics, Science and Technology Education*, 18(2), 164–175.

Warman, P.R. (2008). The effect of fertilizer, chicken manure and dairy manure on Timothy yield, tissue composition and soil fertility. *Journal of environmental quality*, 56(38), 78.

Warman,P.R.(2016). The effect of fertilizer, chicken manure and dairy manure on Timothy yield, tissue composition and soil fertility. *Agricultural Wastes (Agric Wastes)*, 18(4), 289-298.

Williams, C.M. (2013). Management and utilisation of poultry wastes. *Environmental Contamination and Toxicology*, 77(2), 165.

Williams, C.M. (2017). Poultry waste management in developing countries. *Poultry Development Review*, 15(9), 46.

Wolf, D.C. (2016). Poultry Waste Management: *Agricultural and Environmental Issues.*

Advances in Agronomy, 52(20), 1-82.

Worldometer, (2020, October 28). World population. https://www.worldometers.info/world- population/.

Wright, R.J. (2015). Executive Summary. Usda. https://www.ars.usda.gov/is/np/agby-products/agbyexecsummary.

Yaganoglu, A.V.(2011). Effects of sewage sludge application on some physical and chemical properties of a soil affected by wind erosion. *Journal of Agricultural Science and Technology*, 13(5), 757-768.

Yin, R.K. (2013). Case study research: Design and methods. Sage publications.

Zinyemba, O. (2018). Poultry Farming: lessening poverty in rural areas. *S Afr. Jnl. Agric. Ext, 36* (1), 12.

GOOGLE SOURCE

Google Maps. (2017). https://www.google.com/search?q=Map+of+KwaZulu-Natal+in+South+Africa&sxsrf=AOaemvJbBwaXivQeGTg4zM1RhXQWfis_QA:1639377902845&source=lnms&tbm=isch&sa=X&ved=2ahUKEwi-lLTMluD0AhVGilwKHa8FCgIQ_AUoAnoECAEQBA&biw=1584&bih=683&dpr=1#imgrc=jI_F5A28kwslZbM.

Google Maps, Ndwedwe Local Municipality. (2017). https://www.google.com/search?q=ndwedwe+local+municipality&tbm=isch&chips=q:ndwedwe+local+municipality,online_chips:ilembe+district:WSBejnkE4yU%3D&hl=en&sa=X&ved=2ahUKEwjyyJKUluD0AhUBlBoKHfyYBLwQ4lYoCHoECAEQIg&biw=1567&bih=683#imgrc=7s_acp0AJx-r0gM.

Google, Protestors against poultry dumping. (2019).

https://www.google.com/search?q=,+Protestors+against+poultry+dumping&sxsrf=AOaemvKmfp_EGokhqU8J81ilgzc2RFsF4Q:1639377417784&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiczI7llOD0AhWzolwKHQ8oDKMQ_AUoAnoECAEQBA&biw=1584&bih=740&dpr=1#im grc=PbrLHt7wD0UmEM.

Google, Small-Scale Poultry Farmer's chicken coop. (2017).

https://www.google.com/search?q=sme+chicken+coop&tbm=isch&chips=q:sme+chicken+coop,online_chips:broiler:duy9RcyLEgo%3D&hl=en&sa=X&ved=2ahUKEwj4zaDNk-D0AhUUcxoKHbt1BJ0Q4lYoAnoECAEQFg&biw=1567&bih=683#imgrc=jmVJ6-rpkGG8BM.

Source: Google, bone meal for chicken feed stock. (2021)

https://www.google.com/search?q=Meat+and+bone+meal+chicken+feed.&sxsrf=AOaemvLY4l vHCvV4kvcJ3Z-Q0RUkJnwKQ:1639375439989&source=lnms&tbm=isch&sa=X&ved=2ahUKEwj1wYO2jeD0 AhUsREEAHWb5DIUQ_AUoAnoECAEQBA&biw=1584&bih=740&dpr=1#imgrc=fSOZiJM D-vuMUM

Source: Google, Meat and bone meal chicken feed. (2017)

https://www.google.com/search?q=Meat+and+bone+meal+chicken+feed.&sxsrf=AOaemvLY4l vHCvV4kvcJ3Z-kQ0RUkJnwKQ:1639375439989&source=lnms&tbm=isch&sa=X&ved=2ahUKEwj1wYO2jeD 0AhUsREEAHWb5DIUQ_AUoAnoECAEQBA&biw=1584&bih=740&dpr=1#imgrc=JabshSLJ GyvxwM

Source: Google, Multi-batch poultry litter, used as compost. (2019)

https://www.google.com/search?q=chicken+litter+used+as+compost&tbm=isch&ved=2ahUKE wj7zorOkeD0AhUJw4UKHdSpCv8Q2-cCegQIABAA&oq=chicken+litter+used+as+compost&gs_lcp=CgNpbWcQDDoHCCMQ7wMQ JzoICAAQsQMQgwE6BQgAEIAEOggIABCABBCxAzoLCAAQgAQQsQMQgwE6CggjEO8 DEOoCECc6BAgAEEM6BwgAELEDEM6CggAELEDEIMBEEM6BAgAEB46BggAEAgQ HjoECAAQGFDFDFj7rwFgsPgBaAFwAHgAgAHIA4gBpjeSAQgyLTE5LjUuMZgBAKABAa oBC2d3cy13aXotaW1nsAEKwAEB&sclient=img&ei=tOa2YfukComGlwTU06r4Dw&bih=740 &biw=1584#imgrc=W6EHK9hlacrsJM&imgdii=dHCK9T_HwxYDVM

Source: Google, Chicken Litter - Nutrient-Rich Fertilizer. (2021)

https://www.google.com/search?q=Chicken+Litter+&tbm=isch&ved=2ahUKEwiUpuvfkeD0Ah UIXxoKHbQ-A-4Q2-cCegQIABAA&oq=Chicken+Litter+&gs_lcp=CgNpbWcQAzIHCCMQ7wMQJzIFCAAQgAQy BQgAEIAEMgUIABCABDIFCAAQgAQyBQgAEIAEMgUIABCABDIFCAAQgAQyBAgAE B4yBggAEAgQHjoKCCMQ7wMQ6gIQJ1DLD1iMNWDzPGgBcAB4BIABoQOIAYoTkgEH Mi0yLjIuM5gBAKABAaoBC2d3cy13aXotaW1nsAEKwAEB&sclient=img&ei=2ea2YdTVGIi- abT9jPAO&bih=740&biw=1584#imgrc=w7UQRWtPoaEYHM

Google, Arid land due to the excessive use of fertilizers. (2018).

https://www.dhakatribune.com/bangladesh/nation/2019/12/09/overuse-of-chemical-fertilizers- threatens-kushtia-soil-fertility.

APPENDICES

Interview Schedule 1: Industrial Poultry Farmer

1. What types of feedstock's have you used?

a. Where are they sourced?

b. How are they sourced?

c. How has prices changed?

d. What alternatives have you considered?

2. What re-use practices have you used regarding feedstock?

a. What are the benefits? Negatives?

b. What else have you considered implementing?

c. What else is established in the industry?

d. Industry trends around food waste or agro-industrial waste?

e. What are the barriers for re-use?

f. In your view, what are the opportunities?

3. What other waste re-use practices do you utilize?

a. What are the benefits? Negatives?

b. What else have you considered implementing?

c. What else is established in the industry?

d. What are the barriers for re-use?

e. In your view, what are the opportunities?

4. How has the SA poultry industry changed over the past decade?

a. What domestic or international factors have driven change?

b. What challenges does the industry face?

5. What are the challenges for sustainability within the industry?

a. Financial?

b. Environmental?

c. Re: international competitiveness?

6. The feasibility of various forms of agro-industrial and food waste as alternative feedstocks, including impacts on

d. Competitiveness

e. Sustainability

f. Livelihoods

Interview Schedule 2: Small-Scale Poultry Farmer

1. What types of feedstock's have you used?

a. Where

b. How are they sourced?

c. How has 8prices changed?

d. What alternatives have you considered?

2. What re-use practices have you used regarding feedstock?

a. What are the benefits? Negatives?

b. What else have you considered implementing?

c. What else is established in the small-scale poultry industry?

d. Industry trends around food waste or agro-industrial waste?

e. What are the barriers for re-use?

3. What other re-use waste practices do you utilise?

a. What are the benefits? Negatives?

b. What else have you considered implementing?

c. What else is established in the small-scale poultry industry?

d. What are the barriers for re-use?

e. In your view, what are the opportunities?

4. How has the South African small- scale poultry industry changed over the past decade?

a. What factors have driven change? (Domestic)

b. What challenges does the industry face?

5. What are the challenges for sustainability within the Small-Scale industry?

a. Financial?

b. Environmental?

6. The feasibility of various forms of agro-industrial and food waste as alternative feedstocks, including impacts on

a. Competitiveness

b. Sustainability

c. Livelihoods

Interview Schedule 3: Household Poultry Farmers

1. What types of feedstock's have you used?

a. Were

b. How are they sourced?

c. How has prices changed?

d. What alternatives have you considered?

2. What re-use practices do/have you used regarding feedstock?

a. What are the benefits? Negatives?

b. What else have you considered implementing?

c. What else is established in the household Poultry Farmers?

d. Industry trends around food waste or agro-industrial waste?

e. What are the barriers for re-use?

3. What other re-use practices do you utilyse? (Waste)

a. What are the benefits? Negatives?

b. What else have you considered implementing?

c. What else is established among the household Poultry Farmers?

d. What are the barriers for re-use?

e. In your view, what are the opportunities?

4. How have the South African household Poultry Farmers industry changed over the past decade?

a. What factors have driven change? (Domestic)

b. What challenges does the industry face?

5. What are the challenges for sustainability within the household Poultry Farmers industry?

a. Financial?

b. Environmental?

6. The feasibility of various forms of agro-industrial and food waste as alternative feedstocks, including impacts on

a. Competitiveness

b. Sustainability

c. Livelihoods .

Interview Schedule 3: Household Poultry Farmers (IsiZulu)

Imibuzo

1. Uwenzani ngezinkukhu zakho?

a. Uyazidla?

b. Bangaphi abantu obondla ngezinkukhu zakho emndenini wakho?

c. hloboluni lwezidlo oziphekayo ngalezinkukhu zakho?

d. Wanelisekile ngohlobo lwezinkukhu zakho?

2. Uyazihengisa na izinkukhu zakho?

a. Obani abathenga lezinkukhu ozidayisayo?

b. Inani lazo lithini?

c. Lishintshe kanjani inani othengisa ngazo izinkukhu zakho?

d. Kungabe uthengisa nofuya izinkukhu kusize kanjani emnothweni wakho?

3. Hlobo luni lokudla owondla ngazo ezinkukhu zakho?

a. Uthenga kuphi noma kanjani ukudla kwezinkukhu zakho?

b. Yikuphi okukuhlekelayo nokuzuzayo?

c. Izinhlobo ziphi ozisebenzisayo ukonga ukudla kwenzikukhu zakho? Iziphi izingqinamba obhekana nazo uma usebenzisa loluhlobo lokonga?

d. Iziphi izinhlobo lokondliwa kwezinkhu okukhona kodwa ongasebenzisi? Uma kukhona, indaba ungazisebenzisi?

e. Kukhona ukudla owawusebenzisa kwezinkukhu ngaphambilini kodwa ungasasebenzisi? Indaba ungasebenzisi?

4. Ulahla kanjani udoti wakho kwasekhaya?

a. Uyilahla kanjani inkuna yakwakho? Uzilahla kanjani izibi zakho zasendlini?

b. Iziphi izinhlobo zokonga ozisebenzisayo?

c. Ikuphi olahlekelayo noma ozuzayo ngalelohlubo lokonga?

d. Ikuphi okunye oke ukucabanga ukwenza?

5. Ishintshe kanjani imfuyo yakho eminyakeni edlulile?

a. Iikhule kanjani ifuyo yakho yezinkukhu?

b. Iziphi izingqinamba ezivelile?

6. Zidalwe yini lezingqinamba? Kungabe izimbangela zangaphakathi noma ezangaphandle?

a. Imaphi amathuba avelile ngokufuya ezinkukhu?

b. Adalwe yini lamathuba? Kungabe izimbangela zalamathuba zingaphakathi noma zingaphandle?

c. Uzicabanga noma uzibona njengeingxenye yebhinizisi lokuthengisa izinkukhu?

Interview Schedule 4: Feedstock Manufacturers

1. What types of feedstock's do you manufacture?

a. Where

b. How are they sourced?

c. How has prices changed?

d. What alternatives have you considered?

2. What re-use practices do/have you used regarding feedstock manufacturing?

a. What are the benefits? Negatives?

b. What else have you considered implementing?

c. What else is established in the feedstock manufacturing industry?

d. Industry trends around food waste or agro-industrial waste?

e. What are the barriers for re-use?

3. What other re-use waste practices do you utilise?

a. What are the benefits? Negatives?

b. What else have you considered implementing?

c. What else is established in the feedstock manufacturing industry?

d. What are the barriers for re-use?

e. In your view, what are the opportunities?

4. How have the South African feedstock manufacturing industry changed over the past decade?

a. What factors have driven change? (Domestic)

b. What challenges does the industry face?

5. What are the challenges for sustainability within the industry?

a. Financial?

b. Environmental?

c. Re: international competitiveness?

6. The feasibility of various forms of agro-industrial and food waste as alternative feedstocks, including impacts on

a. Competitiveness

b. Sustainability

Interview Schedule 5: Consumer Survey

Chicken Consumption Survey	Yes/ No
1. Is freshness the most important factor considered when making purchases?	
2. Does economics play a large part in a consumer's purchasing decisions?	
3. Is Animal health and welfare important when raising a chicken?	
4. Do you consider taste as the most important thing to when buying chicken products?	
5. A fair number of consumers look for specific brands of chicken when making purchases?	

6. What food do you think that chickens eat?

_____

7. What is your perception of consuming chicken that eats reused waste, such as biomass (grass clippings, leaf and yard waste)?

_____

8. How do you feel about eating chicken that has been fed with different feedstocks?

_____

9. Do you prefer to eat farm fresh chicken or industrial chicken?

_____

10. How do you feel about eating chicken that has been fed with different feedstocks?

_____

11. Do you prefer to eat farm fresh chicken or industrial chicken?

_____

12. Do you prefer to eat farm fresh chicken or industrial chicken?

_____

13. What do consumers look for in chicken?

_____

14. How do you think animal health and welfare is the most important factor to consider when buying chicken products?

_____

15. How do you feel about importing chickens from other countries, for example: Brazil?

_____

16. How do you feel about the prices of chicken in farm fresh chicken and industrial chicken?

_____

Interview Schedule 6: Consumers (Questionnaire)

1. What do you think that the Farmers in the rural areas feed their chickens?

   _____

2. What do you think Farmers in the industrial sector feed the chickens?

   _____

3. How effective do you think that the poultry industry's waste re-use in enhancing the sustainability of urban Farmers' livelihoods?

   _____

4. How socially acceptable is re-used waste as feedstocks for both producers and consumers?

   _____

5. How do you feel about chickens eating feedstock that is made from chicken bones, skin or any discarded off cuts?

   _____

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

SARCHI Chair
WASTE AND CLIMATE CHANGE

To: UKZN RIG Office
Westville Campus

Durban, 05 Nov. 2019

RE: GATEKEEPERS LETTERS FOR KARINA CHETTY, SIMLINDILE ZUMA, AND SNEGUGU NGCECE

To the Research Ethics Committee,

This letter has been written on behalf of my M.A. in Development Studies students Karina Chetty (213561282), Simlindile Zuma (214566415), and Snegugu Ngcece (215013557). They have applied to conduct field research at households that are beneficiaries of the SANEDI 'Working for Energy' Programme in Ndwedwe, KwaZulu-Natal. SANEDI is a state-owned enterprise under the Ministry of Energy and Mineral Resources. UKZN currently has a MoU with SANEDI to conduct research at these sites. The relevant gatekeepers for access are myself, as the project coordinator of the UKZN-SANEDI partnership, and Mr. David Mahuma, the Director of the 'Working for Energy' Programme. Municipal officials were engaged during initial steps, but SANEDI holds the right of access to these sites, and, as a parastatal, is the primary gatekeeper from within the South African state. I ask that you please process these students ethical clearances with due haste, and do not hesitate to contact me with any questions at 071-708-093 or at kalinam@ukzn.ac.za.

Sincerely,

Dr. Marc Kalina
Senior Research Scientist
South African Research Chair in Waste and Climate Change
School of Engineering
University of KwaZulu-Natal