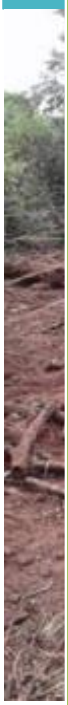
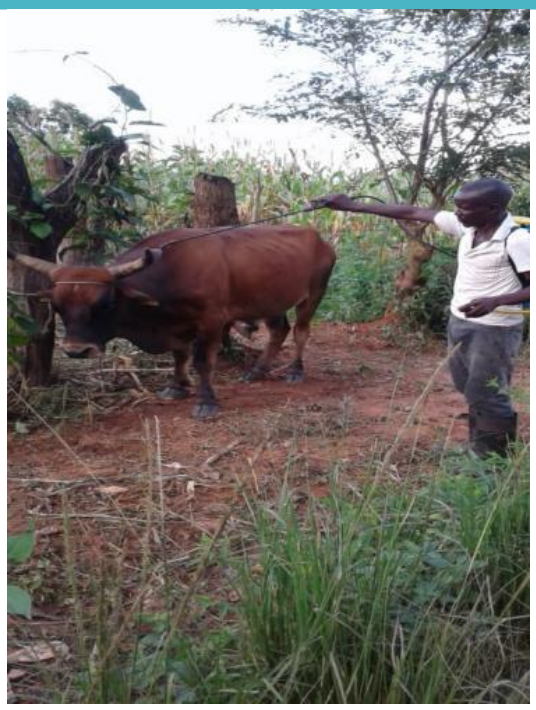
ON-MORINGA BASED CHICKEN FEED,BIOCHAR BASED NATURAL FERTILIZER AND ERTHNOVET TICK AND THEILERIOSIS CONTROL IN ZIMBABWE

PAPER #3



ZIMBABWE

Food and Agriculture Organization of the United Nations

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About LFSP: The Zimbabwe Livelihoods and Food Security Programme (LFSP), Agriculture Productivity and Nutrition Component (APN) is managed by the Food and Agriculture Organisation of the United Nations (FAO), with the aim of contribute to poverty reduction through increased incomes for a target 250,000 smallholder farming households. The programme is being implemented in four provinces covering 12 districts as follows: Mutasa, Mutare, and Makoni in Manicaland; Guruve, Bindura, Mazowe and Mt Darwin in Mashonaland Central; Kwekwe, Gokwe North, Gokwe South and Shurugwi in Midlands and Zvimba in Mashonaland West provinces. FAO is in partnership with three NGO consortia led by Practical Action, Welthungerhilfe and World Vision International, two Strategic Technical partners i.e. IAPRI for policy influence, HarvestPlus for biofortification, three Commercial Banks, 1 Wholesale Facility - the Zimbabwe Microfinance Fund (ZMF), 5 Microfinance Institutions (MFIs) and the USAID managed DCA Facility. To date the LFSP is funded for two phases to the tune of £72.4m.

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BACKGROUND

The Government of the United Kingdom through the Foreign, Comonwealth and Development Office has been supporting the Zimbabwe Livelihoods and Food Security Programme (LFSP), which aims at contributing to poverty reduction through increased incomes. The programme has targeted over 127,000 smallholder farming households in eight districts, and aims at addressing constraints to productivity, market participation, access to rural finance as well as the supply and demand of nutritious foods. The LFSP comprise of three main components managed by the Food and Agriculture Organization of the United Nations (FAO), Palladium, and Coffey. The FAO is managing the Agriculture Productivity and Nutrition (APN) component aimed at raising smallholder farm productivity by promoting adoption of improved and climate appropriate practices, access to finance and production and consumption of safe and more nutritious foods. Palladium is managing the Markets Development component whilst Coffey is responsible for overall programme monitoring, reporting and evaluation.

The implementation of the programme involves a number of partners ranging from international and national NGOs, private sector, CGIAR centres, financial institutions, research institutes and government. FAO and partners have succeeded to deliver a multi-faceted intervention that incorporates extension and advisory services, nutrition, community based micro finance, rural financial services, market development and access by smallholder farmers. Additionally, they have also managed to generate knowledge and evidence that has started to inform as well as influence the policy agenda. Given its relevant research experience and strength in outreach activities, the Indaba Agricultural Policy Research Institute (IAPRI), a non-profit Zambian company that works with public and private stakeholders in the agricultural sector, and partnering with the Michigan State University's Department of Agricultural Economics (MSU) was identified as a strategic regional partner to assist in implementing, strengthening evidence and analysis to influence policy and private sector investment in collaboration with programme partners. The specific roles of the IAPRI/MSU collaboration under this programme are as follows:

- To generate diagnostic and strategic policy research to fill key knowledge gaps in formulating and implementing agricultural and food security policies and strategies that promote smallholder agricultural growth and broader development objectives.
- To establish an information and knowledge support system to communicate research results for policy formulation, serving policymakers, development partners, private sector and other investors, analysts, and ultimately the farmers through a combination of the following:

  i) IAPRI/ MSU teaming up with MLWAFRR and local partners to form a research working group (for each thematic area) and collaborate with all relevant organizations in the implementation of the different studies

ii) Production of information packs in different formats, including working or background papers, policy briefs, infographics, documentaries, presentations and workshop reports and facilitate dialogue on the findings and policy recommendations.
iii) Support capacity building of partners (LFSP, MLWAFRR, reseachers and others) to use evidence and communicate the evidence within their networks.

The main objective of the policy research component of the programme is to integrate LFSP evidence and research findings into national policy formulation and implementation in order to create a policy environment that accommodates the operations of smallholder farmers. The approach and specific research themes and activities under this component are consistent with the objectives and focal areas of the ZIMASSET, the Comprehensive African Agriculture Development Programme (CAADP) process, and the Sustainable Development Goals (SDGs), and will complement the activities being done by various LFSP partners. In addition, capacity strengthening for policy research, analysis and outreach is an integral part of the approach for all the thematic areas. It is envisaged that in the long-run a policy environment that is conducive to private and public investments in the agriculture and food sector, shall contribute to a notable reduction in food and nutrition insecurity in Zimbabwe. The three key pillars for the implementation of the Programme are; 1) Short-term Policy Constraints Analysis; 2) Diagnostic and Strategic Policy Research; 3) Outreach for Policy Influence.

This paper is one of the key outputs of the Diagnostic and Strategic Policy Research

RESEARCH TEAM

Under the guidance of the Indaba Agricultural Policy Research Institute (IAPRI) Research Directorate, this research was undertaken by the following team members:

TEAM MEMBER	AFFILIATION	ROLE
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EXECUTIVE SUMMARY

INTRODUCTION

In Zimbabwe indigenous chickens contribute to food security. However the price of chicken feed has been escalating thereby reducing the viability of the poultry industry. This has led to the stagnation of the indigenous chicken production despite the proliferation of backyard hatcheries. The high cost of feed has triggered the need to explore the incorporation of non-conventional food stuffs such as leaf meals.

Research has established that inclusion of *Moringa* leaf meals at inclusion levels of 5 – 12 % gives normal chicken growth performance. The major ingredients in chicken feed formulation include cereals for carbohydrate supply and these include maize, sorghum or millet and protein sources such as sunflower or cowpeas. The production of these under smallholder agriculture has been hampered by poor soils, expensive fertilizers and the changing climate that has increased the frequency of droughts. The other source of protein for the rural farmers is beef. Beef production is currently under threat from the tick transmitted disease Theleriosis (January disease). Faced with these challenges, agro ecology promises to offer solutions that use natural processes, limit the use of synthetic inputs, promote closed cycles with minimum negative externalities, and stress the importance of participatory knowledge development. Therefore, the objectives of this assignment was to carry out a scoping exercise on the feeds used by the farmers to feed indigenous chickens and how they formulate the feeds. The assignment also sought to determine the major sources of natural fertilizers used by the farmers in crop production and hence explored the opportunity for use of biochar natural fertilizer. The assignment also sought to determine the botanicals used by farmers in tick control and explored the opportunity to introduce *Tephrosia vogeli* as an alternative for tick control in order to reduce mortality of cattle due to Theleriosis.

The scoping exercise found that farmers used mainly sorghum maize and millet for feeding the indigenous chickens. In terms of natural fertilizer usage, it found that farmers mainly used cattle manure for improving soil fertility in their fields. Farmers were not using ethno-veterinary products for tick control as they were solely relying on acaricides.

METHODS

Training was then carried out on these three agro-ecological practices across the ten districts that were covered by the LFSP programme. Demonstration trials were setup at ten households per district where each practice had its performance tested and compared to local practices in the 2020-21 season.

FINDINGS

The results showed that *Moringa* based chicken feed gave significantly higher chicken weights for the indigenous chicks, grower pullets and layers as compared to conventional farmers' feeding. As for broilers, the results showed that conventional feeding using industrially manufactured feeds gave significantly higher broiler weights compared to *Moringa* based chicken feeds due to growth promoters. The *Moringa* fed chickens maintained growth above expected normal growth curve for

broilers. Farmers also reported that *Moringa* fed chickens were more active, had reduced mortality and produced better tasting meat. For biochar based natural fertilizer, the results indicated that biochar based natural fertilizer gave significantly higher growth, chlorophyll content, nitrates retainance against leaching and higher yields compared to farmer practice across all the crops included in the study: maize, sorghum, sunflower and cowpeas. For tick control using *Tephrosia vogelii* the result showed that Tephrosia significantly reduced tick numbers on the cattle compared to farmers' conventional dipping which is inconsistent and not done on regular basis.
All the three agro-ecology practices have potential to increase production in the communal farming sector of Zimbabwe. The practices have a huge potential in easing the rural people's lives through improved production

RECOMMENDATIONS

From this assignment the following recommendations can be made

- *Moringa* based feeds should be promoted to other districts as it adds to the other agroecology practices, and has proved better and affordable when compared to other feeding regimes done by farmers
- Biochar based fertilizer gave better growth and yield and hence it should be promoted to other districts which did not participate in the demonstrations.
- Tephrosia should be successfully planted and maintained as it has potential to reduce tick infestations on cattle

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ACRONYMS

GDP	Gross Domestic Product
GOZ	Government of Zimbabwe
IAPRI	Indaba Agricultural Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
LFSP	Livelihoods and Food Security Programme
NAPF	National Agricultural Policy Framework

1. INTRODUCTION

Agriculture occupies a central place in the Zimbabwean economy for employment, incomes and poverty reduction. It contributes 15-18 percent of Gross Domestic Product (GDP), 23 percent to the total formal employment, and provides livelihoods to approximately 70 percent of the rural population (54 percent of which are women). There has been a special focus on the ability of agro ecology to tackle the challenges that are currently experienced due to climate change. There is an urgent need for a transformational change of food systems towards more sustainability. According to Lieppert et al., (2020) agro-ecological approaches favour the use of natural processes, limit the use of synthetic inputs, promote closed cycles with minimal negative externalities and stress the importance of local knowledge and participatory processes that develop knowledge and practice through experience as well as conventional scientific methods and address social inequalities. These approaches are uniquely placed to help countries deliver under climate change and the 2030 agenda for sustainable development. Building resilient ecological and sustainable agriculture and respective food systems are a fundamental part of the solution to tackle climate change.

In Zimbabwe, agriculture is based on crop production and livestock keeping which include chickens. Production of crops has been hit by climate change. Soil fertility has emerged as one of the biggest problems faced by farmers in crop production. Most fields have been over cultivated and are characterised by acidic pH in sandy soils. Zimbabwe has lost a lot of cattle due to January disease hence the need to find sustainable ways of managing the ticks which are careers of the disease. Whilst indigenous chickens are the most reared in rural areas their production has been hampered by expensive feeds. The prices of chicken feed have been escalating thereby reducing the viability of the poultry industry in Zimbabwe and the SADC region (Fivet 2013). Additionally, high mortality rates of 8-10%, morbidity, decreased preference for broiler meat due to higher fat content and lack of appealing colour have been reported. Productivity of indigenous chicken has remained static despite proliferation of backyard hatcheries. This project produced a low cost *Moringa* based indigenous chicken feed that resulted in increased production, reduced mortality and morbidly rates, and broiler chicken of normal growth rate and appealing golden brown colour.

Climate change has severe negative impacts on livelihoods and food systems worldwide, with future projections, seriously undermining current efforts to improve the state of food security and nutrition (Strohmaier *et al.*, 2016). In Zimbabwe, current food systems contribute to the degradation of ecosystems, biodiversity losses, and high greenhouse gas emissions which accelerate climate change. Smallholder farmers already often struggle to grow enough food because of depleted soils, water scarcity, crop and animal diseases and pests, and the onset of climate change impacts further exacerbates these already existing problems.

According to IPCC (2012) resilience is defined as the ability of a system to absorb the shock, maintain its function during the shock or the capacity to return to its functional state prior to the shock. Building on traditional knowledge and wider management options passed down through generations contributes to increased resilience. Zimbabwe produced a National Agricultural Policy Framework (NAPF) that requires intervention that directly respond to enhance the flow of investments to those areas that are critical to

generating and sustaining the growth of the agricultural sector with a decided focus on increasing agricultural productivity and production. The NAPF discusses the emerging challenges under nine pillars of which the scoping exercise targeted pillar 8 which focuses on sustainable green and resilient agriculture. Pillar 8 recognises the vulnerability of farmers to weather shocks and emerging shocks and emerging pests and diseases due to dependence on rain (World Bank, 2020, GOZ, 2020).

These challenges are greater for smallholder food producers who are vulnerable to climate extremes such as droughts and floods. These shocks are being experienced in a production landscape in which soil is over-cultivated and acidic; disease outbreaks in cattle such as the January disease from ticks are prevalent; feed for commonly reared indigenous chickens in rural areas is expensive, and overall agricultural inputs are difficult to access and expensive when available. This makes meeting the country's production goals difficult. To meet the food requirements, Zimbabwe needs a fundamental shift in food production towards a highly adaptive, low carbon, resource-preserving type of agriculture that also benefits the smallholder farmers through improved access to food.

In addressing some of the aforementioned challenges in agricultural production, Zimbabwe produced a National Agricultural Policy Framework (NAPF) that requires interventions that directly respond to enhance the flow of investments to those areas that are critical to generating and sustaining the growth of the agricultural sector - with a decided focus on increasing agricultural productivity and production. The NAPF discusses the emerging challenges under nine pillars of which the project targeted Pillar 8, which focuses on sustainable green agriculture. Pillar 8 recognises the vulnerability of farmers to weather shocks and emerging shocks and emerging pests and diseases due to dependence on rain for production (World Bank, 2020, GOZ, 2020). There is an urgent need for a transformational change of our food systems towards more sustainability and resilience, and agro-ecology practices offer that opportunity. Agro-ecological approaches favour the use of natural processes, limit the use of synthetic inputs, promote closed cycles with minimal negative externalities and stress the importance of local knowledge and participatory processes that develop knowledge and practice through experience as well as conventional scientific methods and address social inequalities (Lieppert et al., 2020). These approaches are uniquely placed to help countries deliver their goals and the 2030 agenda for sustainable development.

Agro-ecology provides a feasible alternative towards more socially just, economically viable, and environmentally sustainable agriculture and food systems that improve the livelihoods and build the resilience of smallholder farmers. It is a holistic approach to integrated agriculture, based on ecological principles, as well as food and nutrition security, food sovereignty and food justice.

1.1 Project outputs and outcomes

Objectives

The project sought to produce and promote innovative cost effective and sustainable technologies on - farm *Moringa* based chicken feed, Biochar based natural fertilizer and Ethnoveterinary tick and Theileriosis control through;

(i) Setting up of chicken feed processing demonstration plots, tick and theileriosis control using Ethnoveterinary chemicals from tree parts common in the area and production of biochar and hot compost for use in field crop and horticultural production in ten districts

(ii) Establish sustainability and cost effectiveness of the agro-ecological practices

Overarching goal

The production and promotion of on - farm *Moringa* based chicken feed, Biochar based natural fertilizer and Ethnoveterinary tick and theileriosis control reduces production cost, promote sustainability through use of local resources and promote self-confidence and reliance. This brings resilience to the smallholder farming sector as they adjust and absorbs shocks resulting from the effects of climate change. Eventually, such practices promotes food security in marginal farming areas.

Sub objectives

a. To carry out a scoping exercise on the chicken feeds, organic fertilizers and botanicals for use in tick control that are used by the small scale farmers in the ten districts

b. Setting up of chicken feed processing demonstration sites, tick and theileriosis control using Ethnoveterinary chemicals from tree parts common in the area and production of biochar and hot compost for use in field crop and horticultural production in the ten districts.

c. The project assessed feasibility of the agro-ecology practices as evidence generation. This will inform policy formulation on sustainable of agro-ecology practices.

2. METHODOLOGY

2.1 CAPACITY BUILDING FOR FARMERS

Inorder to assess the effectiveness of using Moringa based chicken feed , Biochar natural fertilizer and the use of Tephrosia vogelii, extraction and application for tick control .The researchers developed and distributed training materials (facts sheets, posters and manuals for the three thematic areas) and include the following

- Moringa chicken feed fact sheet
- Biochar fertilizer making fact sheet
- *Tephrosia vogelii* growing , extraction ad application fact sheet

2.1.1 *Moringa* based chicken feed

The fact sheet covered the reasons for growing *Moringa* and the possible uses of *Moringa* in stock feeds. It also covered land preparation for *Moringa* planting, planting and crop management. The fact sheet includes growing *Moringa* from cuttings and seed, harvesting *Moringa* leaves, their drying, packaging and storage.The fact sheet covered preparation of *Moringa* based chicken feed. It first covers the reasons for

using *Moringa* based feed and *Moringa* leaf meal inclusion levels in chicken feeds. The raw materials used for making *Moringa* based chicken feed were also covered in the fact sheet. Also covered in the fact sheet was the general feed mixing guide and the composition for indigenous chicken diets for the various chicken groups of chicken diets using various materials.

2.1.2 Biochar natural fertilizer making

The fact sheet covered definitions of biochar and the good attributes of biochar. The fact sheet also covered how to make a pyrolysis machine under small scale agriculture in Zimbabwe using the locally available materials and how the biochar is made. Compost making process was also covered in the fact sheet. The materials needed in the making of compost were also covered in the fact sheet. Finally, the fact sheet covered the making of biochar natural fertiliser using a combination of biochar and cow manure or compost manure.

2.1.3 Growing *Tephrosia vogelii*, extraction and application for tick control

The fact sheet also covered land preparation, planting, leaf harvesting and application on livestock for tick control together with tree care and maintenance.

2.1.4 Training manuals

All the fact sheets were also complimented by three training manuals for *Moringa* based chicken feed, biochar manual and Tephrosia manual respectively. Also prepared are the posters for the three areas.

In the groups the following concepts were covered

a) Practical on feed formulation

b) Setting up demonstration on the comparison between the performance of *Moringa* based chicken feed and farmer's feeding materials

c) Making a pyrolysis equipment

d) Making biochar from biomass

e) Making biochar natural fertiliser

f) Planting *Tephrosia vogelii*

g) Extraction of acaricide from *Tephrosia*

h) Application of *Tephrosia* extracts to livestock

i) Development of monitoring and data collection tools

The lead farmers were divided into three groups and they did the practical on the various thematic areas in the field, cattle pens and chicken houses and they rotated to cover all the thematic areas.

2.1.5. Training methods

The methods used in the theoretical aspects was the lecture method and the participatory method. The lead farmers and extension staff were also trained on the practical skills.

2.1.6. Practical skills imparted on farmers

The practical skills imparted on the farmers were:

a) Ability to prepare land and plant *Moringa* Oleifera

b) Ability to harvest sustainably *Moringa* leaves and process them for inclusion in the chicken feeds

c) Ability to formulate feeds for the various types of chickens

d) Ability to mix the various feed components in proper rations using person Square method

e) Ability to make a pyrolysis machine from various locally available material

f) Ability to make biochar using various types of biomass

g) Ability to make biochar based natural fertiliser

h) Ability to prepare planting stations for A vogelii and planting

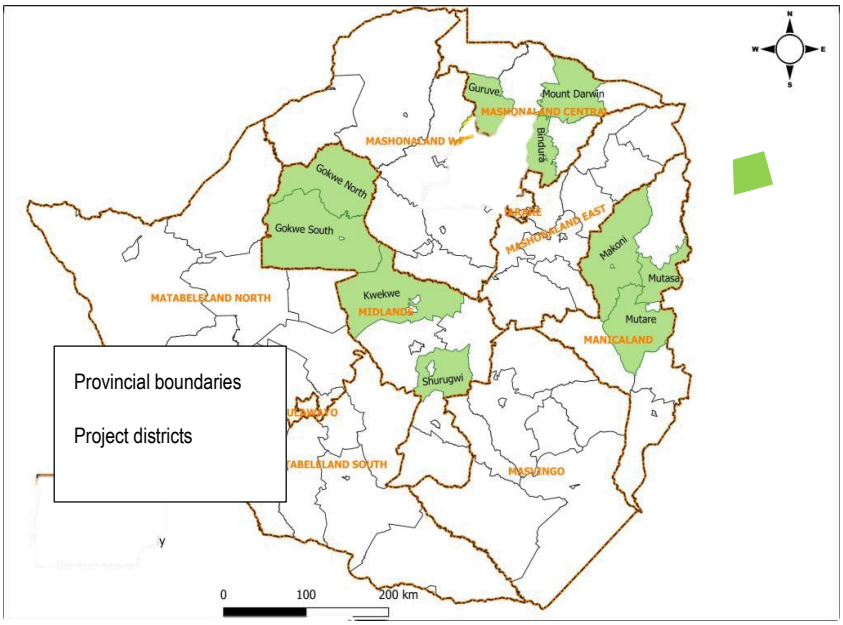
i) Ability to harvest in a sustainable manner the Tephrosia leaves

j) Ability to extract the Tephrosia extracts and apply on critical areas on the livestock body

2.2 Demonstration plot set up

The demonstration plot setting targeted the Zimbabwe Livelihoods and Food Security Programme's (LFSP) Provinces and 10 Districts. The figure below condenses the LFSP provinces and districts in which the demo plots were set up. The targeted provinces were Manicaland (**Makoni, Mutasa, Mutare)**, Midlands (**Kwekwe, Shurugwi, Gokwe South and Gokwe North)** and Mashonaland Central (**Guruve, Mt Darwin, Bindura)**. Therefore, the following figure highlight the specific location of the targeted districts.

Figure 1 Map Projects Districts Location



Source: LFSP (2014)

The demonstration set up exercise was carried out successfully from the 26th of November to 21st of December, 2020. The main objective of the demonstration set up was to determine the level of preparedness among farmers for implementing demonstrations in the three pillars of the project: *Moringa* based chicken feeds, Ethnoveterinary for tick control and Biochar based natural fertilizer. The exercise showed that the farmers were at different levels of preparedness with more than 80 % of the farmers showing that they were highly prepared to roll out the demos during the season. All the farmers either had the chicks, growers or layers for the *Moringa* demos or they had access to other members of the group that had the same. The project was able only to supply one pyrolysis piece of equipment per district but farmers showed their innovativeness by designing various types of the same equipment using locally available materials. More than 85 % farmers had planted their crop and Tephrosia seed as well as *Moringa* seeds by 20 December 2020. However, the poor germination percentage of Tephrosia was a major concern and the consulting team gave more seeds and seedlings so that adequate numbers of Tephrosia bushes could be reached for control of the ticks. More than 95 % of the farmers had prepared their cattle pens, identified the cattle to be used in the demos and tagging them. The demonstration set up period was also used to set up virtual groups on whatsApp for sharing of materials and concerns related to the demos. All the inputs had been delivered to the demo sites across the ten provinces by the 15th of December, 2020. The exercise was successful in determining the preparedness and offering technical assistance to the concerned farmers(see appendix for detailed farms were demonstration plots were set up).

The diversity of pyrolysis equipment made by farmers

The farmers learnt the principles for making pyrolysis equipment and they went on to make a diversity of the pyrolysis using different materials and of different types

A comparison of *Moringa* based chicken feed and conventional feed on four classes of chickens: chicks, growers, layers and broilers

Each of the ten farmers per district was given feed components to mix and make the chicken feed for all the four classes of chickens according to the training they had received. For road runners the *Moringa* based feeds were compared with farmers' way of feeding the chickens.

The road runners were fed in the morning and released to roam with other chickens. The chickens were weighed before the start of the demonstration plot and weighed as experiments progressed. The chickens were housed in different compartments depending on the type of feed they received. For layers, the number of eggs laid were recorded. For broilers the growth rates were also recorded. For data analysis t-tests were used to compare the effects of the two different feeds on the various classes of chickens.

Biochar and farmer practice

The Effects of biochar natural fertilizer on growth and productivity of maize, cowpeas sorghum and sunflower.

Ten farmers were selected per district and it was mainly those who had attended the training that had been offered. Each farmers had to set up a two plot demo per crop whose seed they had received. The seed received by various farmers across the districts are as shown in Table 1.

Table 1: Type of seed received by farmers across the districts

District	Cereal	Legume/oil crop
Gokwe South	Maize	Sunflower/cowpeas

Gokwe North	Sorghum	Cowpeas/sunflower
Kwekwe	Sorghum, orange maize	Sunflower/ cowpeas
Shurugwi	Sorghum/ orange maize	Sunflower/ cowpeas
Bindura	Maize	Cowpeas
Mount Darwin	Sorghum	Cowpeas
Guruve	Maize/ sorghum	Cowpeas
Makoni	Maize	Cow peas/ sunflower
Mutasa	maize	Sunflower/ cowpeas
Mutare	Sorghum	Cowpeas

The farmers were also trained on demonstration plots set up.

Moringa feed formulation demonstrations

Chickens were divided into three groups: day old chicks, grower pullers and those at point of lay. Farmers were taught on feed formulation and demo set up, where five chicks were put under *Moringa* feed and the other five under the farmer's normal feeding patterns across the three groups of chickens. Farmers also participated in developing the data collection tool which was used to make proper comparisons of the performance of these feeds under farmer conditions. A fowl run was divided into two and the chickens under *Moringa* were marked to identify them and note any difference that were seen on the performance of the chickens.

Figure 2: Moringa and farmer based fed indigenous chickens

2.8 Biochar natural fertiliser demo

For Biochar natural fertilizer, the farmers were taught on the set up of four demonstration plots per lead farmer. The outline they were taught is shown in Figure 2

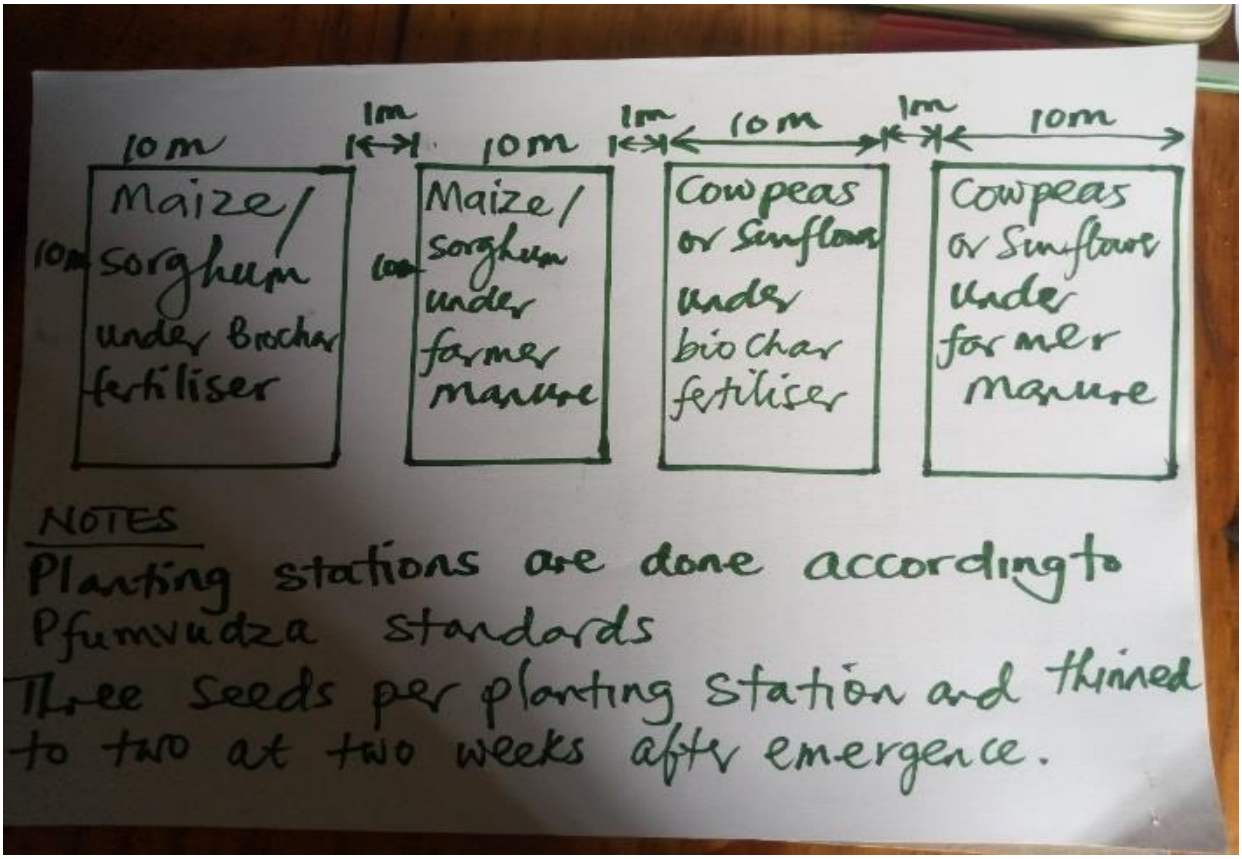


Figure 3 Biochar natural fertiliser demo set up

The farmers were trained on biochar natural fertiliser demonstration set up where they needed to make 4 plots of 10*10m each as shown in figure 1. One plot was having maize or sorghum with biochar whilst the other one had the same cereals with cattle manure. The third plot had a protein source such as cowpeas or sunflower on Biochar natural fertiliser whilst the last demonstration plot had the same protein source but under cattle manure. The farmers were also taught on the simple principles of experimentation so that any variation realised was attributed to the correct source. It was explained to farmers that it was a joint exercise between farmers, implementing agents and researchers to validate the usefulness of these technologies.

2.9 Tephrosia demos

The farmers were also taught on how to set up the cattle demos where a farmer was supposed to select three cows across ages and apply Tephrosia above the normal dips that cattle receive to a set of cattle under Tephrosia. The other three cattle selected across the ages had no extra tick control method applied to them except the normal dips. The farmers were also taught data collection to make proper comparison between those on Tephrosia and those not on Tephrosia

Figure 4 Tephrosia demo set up

2.10 Participatory development of monitoring tools

2.10.1 *Moringa* chicken feed demonstrations

The monitoring tools that were developed by both farmers and researchers were

1. Chicken weight
2. Mortality rates for chicks
3. Growth rates for pullets
4. Number of eggs for layers
5. General condition of the birds
6. Activeness
7. Vigour in feeding

2.10.1 Biochar natural fertilizer demonstrations

During the training there was also farmer and researcher participatory development of monitoring tools. Farmers participated actively in the development of monitoring tools. On biochar natural fertiliser farmers and researchers cited the following as monitoring tolls to determine the effectiveness of Biochar natural fertiliser

1. Crop growth rate
2. Leaf colour
3. Stem girth
4. Days to flowering
5. Wilting
6. Size of cob for maize and size of head for sorghum
7. Flower numbers for cowpeas
8. Head size for sunflower

2.10.1 Tephrosia demonstrations

During the training there was also the development of monitoring tools for th tephrosia demonstrations

1. Tick counts
2. Livestock body condition
3. Number of animals that dies due to tick related diseases

Each farmer had two plots for each crop: one had biochar natural fertilizer whilst the other had manure only. Biochar natural fertilizer was made by mixing biochar and manure in 1:1 proportions. Land preparation was done by digging planting holes using hoes. Biochar natural fertilizer was applied at a rate of 200g per planting hole. Manure was applied at half the rate to ensure that the only difference between these plots were that one had biochar whilst the other did not have biochar. Weeding was done at 3 weeks after crop emergence.

Top dressing was done using liquid manure fertilizer. The liquid fertilizer was made by dipping a sack full of chicken manure in a drum for a period of four days and using the leachate as liquid top dressing.

2.3 DATA COLLECTION AND ANALYSIS

Moisture content was measured using soil moisture metre TDR350 (Spectrum Technologies). Chlorophyll content was measured using a Chlorophyll metre (Apogee Instruments, MC-100 Chlorophyll meter). For both the biochar applied and manure applied plots.Nitrates were measured using the Horiba nitrate meter mad by LAQUAtwin. Two standard solutions were of 2000ppm and 150ppm were used to calibrate the nitrate meter. Soil samples were collected from a 10cm depth using a Dutch auger. A small quantity of soil was taken and mixed with a fixed quantity of water and shaken for three minutes until nitrates dissolved in water. The Horiba nitrate meter was used to determine the quantity of nitrates in the solution in parts per million.

Plant height, leaf number, and stem girth were also measured to determine the growth of the crops. The data from all samples were subjected to t-tests to determine the differences between biochar applied plots and manure applied plots at 0.05 probability level.

3.RESULTS AND FINDINGS

3.1 Scoping Study results

Following the scoping exercise the consultants identified the various types of botanicals which are used by farmers and which will be compared to *Tephrosia*. Various botanicals were reported to be used by farmers except Mutare district that reported that they never use botanicals. On fertilizers, the most common manure used was cattle manure and it is the one that will be compared with Biochar in all the districts except Bindura, where compost from kitchen waste will be used. . Various types of feeds which are currently used by farmers will also be compared with *Moringa* feeds. Most farmers indicated that they prepared their own feed to feed indigenous chickens.

The scoping exercise also showed that the farmer had the necessary structures to carry out the chicken trials which is now limited to the indigenous chicken as broilers could not get takers.The scoping study also showed that farmers kept a diversity of livestock that included cattle, donkeys, goats and sheep with goats having the highest number in livestock ownership .

The most common source of natural fertiliser used by farmers was cattle manure which had a percentage of 90 % (Table 2.5). None of the farmers used biochar before in the surveyed districts hence this would become a new type of fertiliser.The knowledge on biochar was not found amongst the farmers. Only 11 % of the farmers indicated that they had some knowledge on biochar. All the farmers who participated in the survey indicated that they were willing to participate in the biochar based natural fertiliser .The main method used for tick control in ten districts was the use of acaricides. Farmers reported that they do not use ethno-veterinary products for tick control.

3.2 Findings from Demostration plots

3.2.1 *Moringa* chicken feeds and its effects on chicken growth

The germination percentage of *Moringa* seeds was above 80 % and most of the farmers had *Moringa* on their homesteads. The major challenge was trying to protect them from animals because their leaves are good and nutritious food for animals like goats, cattle and chickens. However most of the farmers managed to protect their trees from the roaming animals.

Figure 5: Some of Moringa plants at farmers' homesteads

Effects of Moringa feeds on growth of indigenous chicks

Moringa based chicken feed proved to be a superior feed to the farmers' feeds for indigenous chickens.

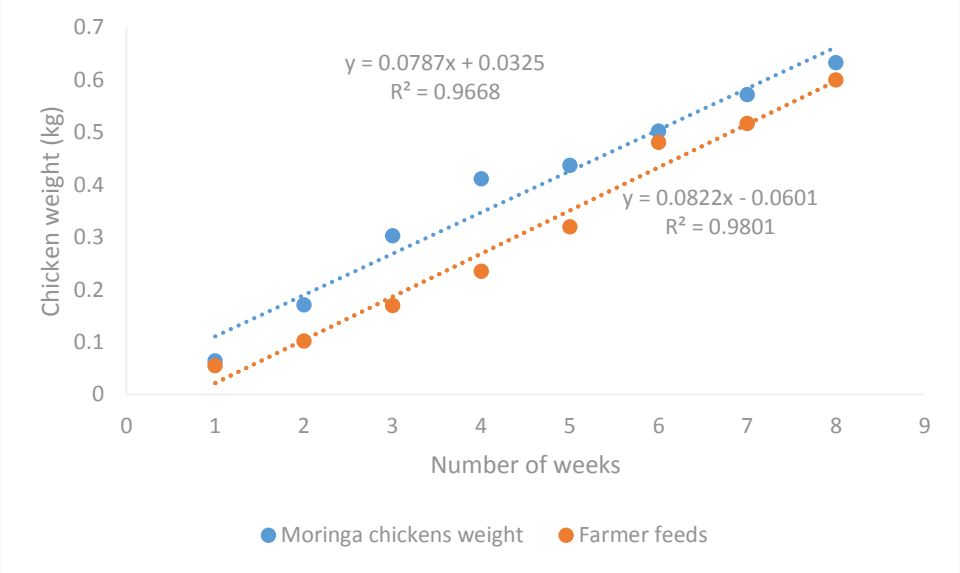


Figure 6 The relationship between chicken weight and number of weeks

The results from the demonstration showed that at every level across the growth period *Moringa* based chicken feeds gave significantly higher ($P<0.05$) chicken weight compared to the farmers' ways of feeding (Figure 6.1; Figure 6.2).

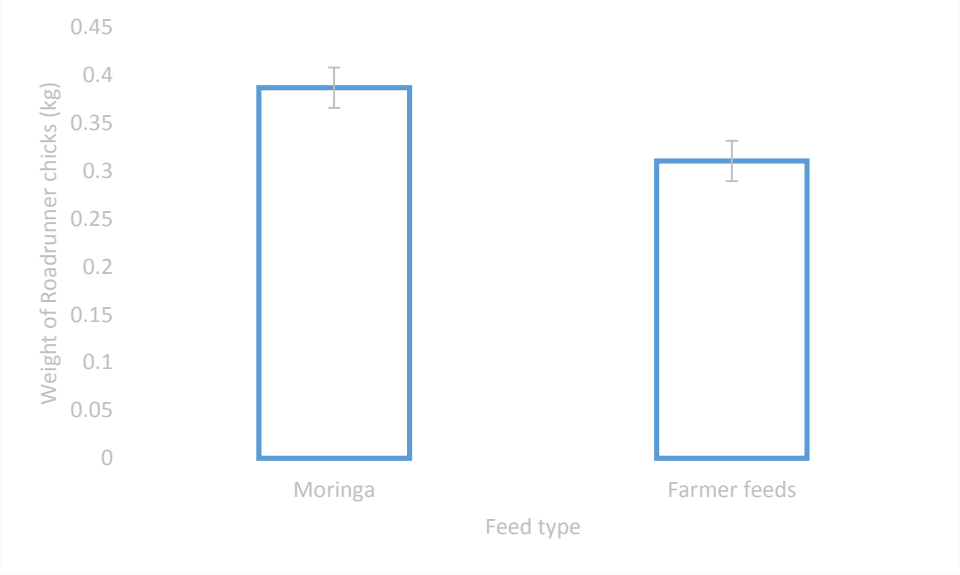


Figure 7: The effects of two different feeds on weight of the chickens

Grower pullets

The grower pullets showed that the *Moringa* based feed gave significantly higher chicken weight compared to farmers' feeds (Figure 7 and Figure 8)

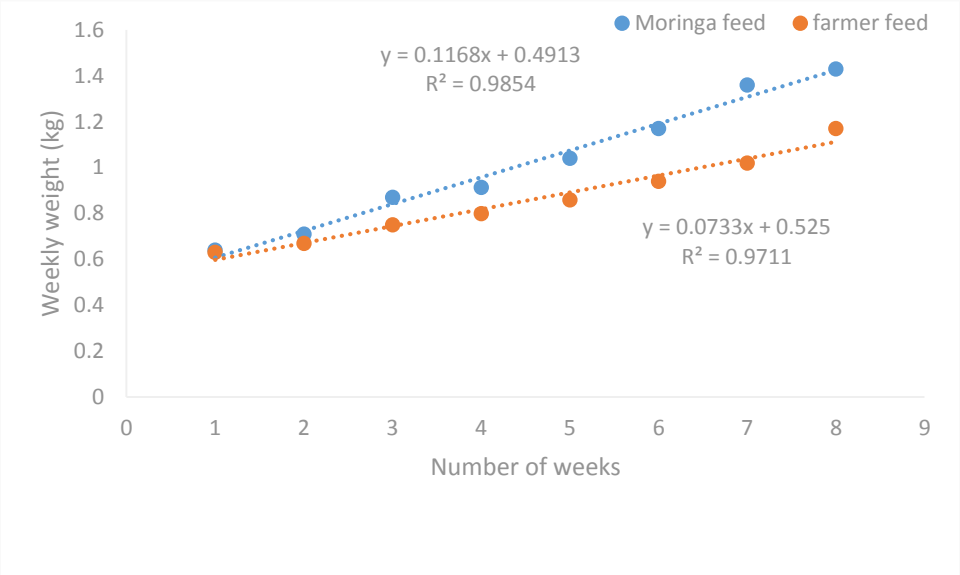


Figure 8: Growth of indigenous chicken under two feeding regimes

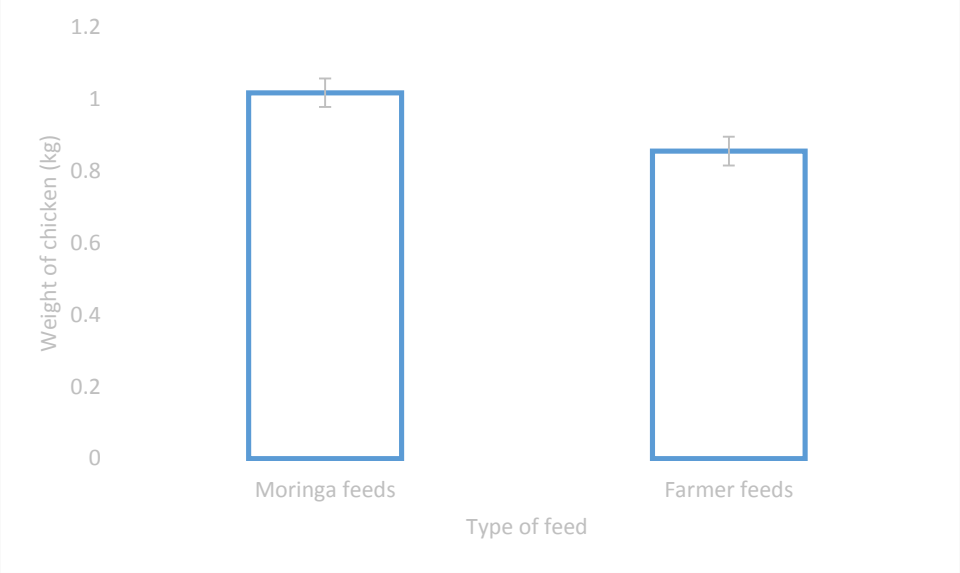


Figure 9: Effects of Moringa feeds and farmer feeds on the weight of chickens.

Broiler under *Moringa* feeds

For broilers, the results indicated that conventional feeds gave a significantly higher weight compared to *Moringa* feeds (figures 7 and 8). However the two growth curves for conventional and *Moringa* based feed

were both above the expected normal growth curve for broilers illustrated in table 6.1 below. *Moringa* based natural feed had no growth promoters added to it.

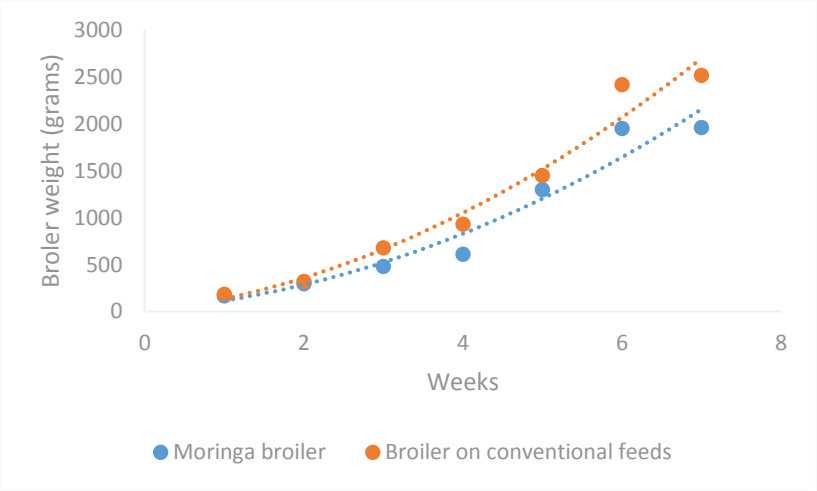
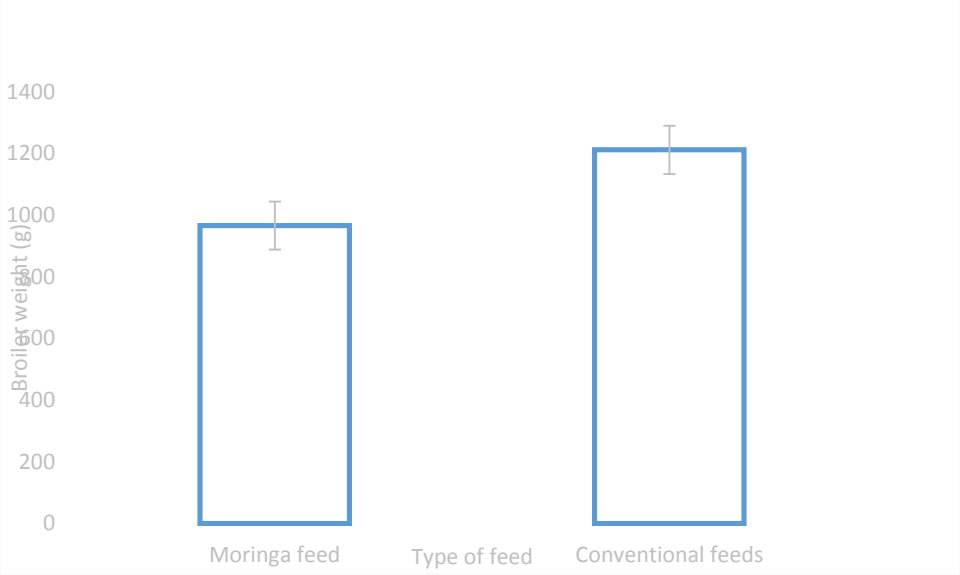


Figure 10: The growth curve of broilers

Table 2: .Expected normal weekly growth rate for broilers

Week -0	**Expected Weight (Kg)**
1	**0.126**
2	**0.268**
3	**0.52**
4	**0.82**
5	**1.18**
6	**1.57**
7	**1.96**

8	**2.35**



Conventionally Fed

Broiler demo at Headlands - Makoni district

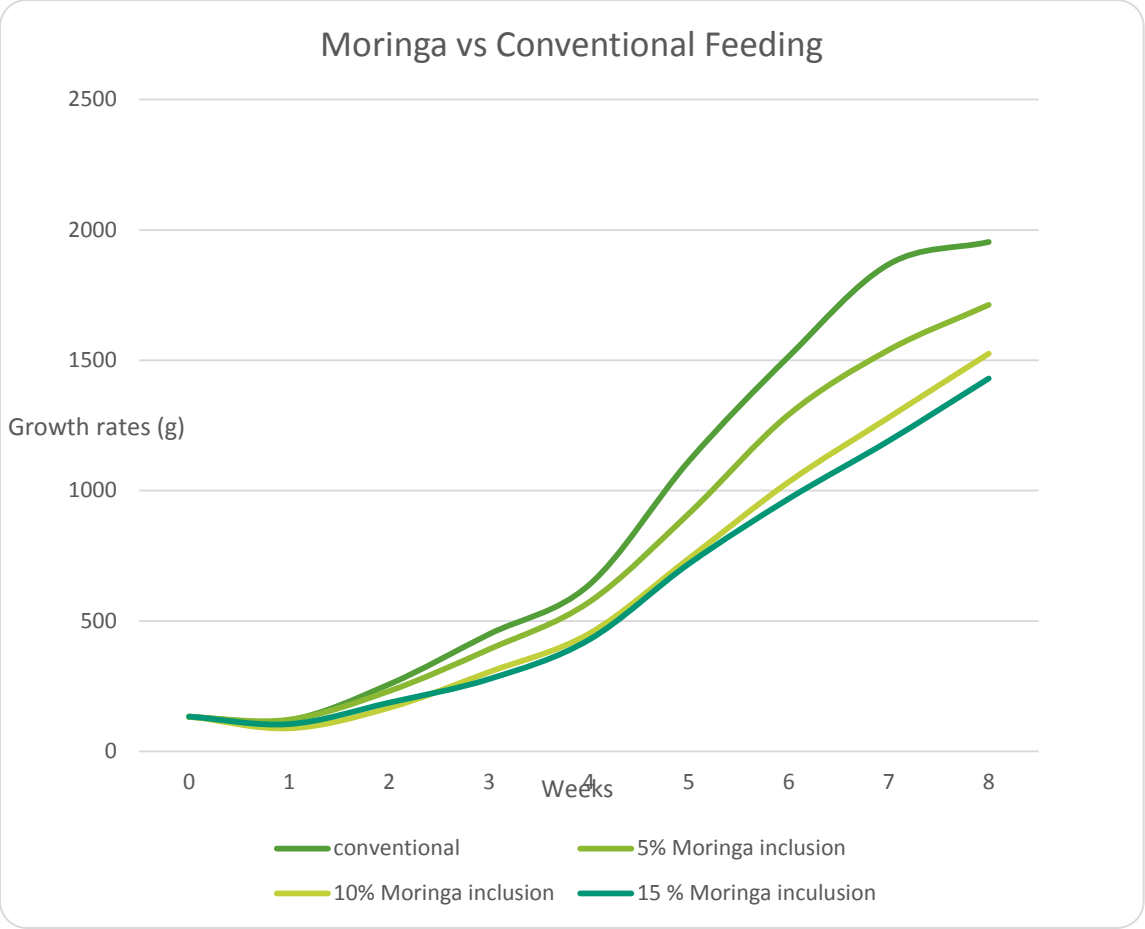


Figure 11 The effects of Moringa feeds and conventional feeds on broiler weight

3.2.3 Effects of biochar natural fertilizer on soil moisture content

The results showed that biochar natural fertilizer application lead to significantly higher soil moisture content compared to plots that used manure only (Figure 11)

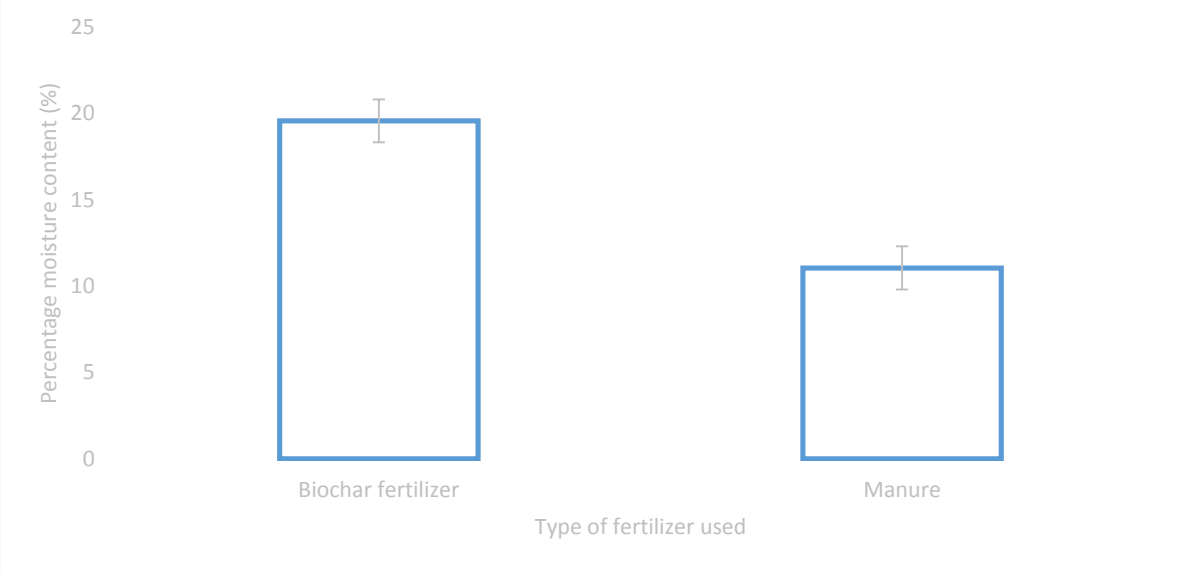


Figure 12: Effects of biochar natural fertilizer and manure on soil moisture content

The results indicated that biochar natural fertilizer gave a significantly ($P<0.05$) higher soil moisture content compared to manure only. This can further be reinforced by Picture 12.

Figure 13: Differences between biochar natural fertilizer and manure under moisture stress conditions in Zhombe

[on the right is maize with biochar natural fertilizer and on the right is the maize with manure on a sunny day.]

The results confirm the assertion that biochar has higher moisture holding capacity and assists plants to have more available water to it in time of drought. Therefore, it is a product that can assist in averting disasters in crop production that are brought about by mid season droughts. Biochar natural fertilizer can assist to take through the crop across the mid-season drought periods which are normally common in most areas in Zimbabwe.

Effects of biochar natural fertilizer on nitrate content of the soil

The 2020/21 season received quite large quantities of rainfall and a lot of leaching of nitrates is anticipated to have taken place especially because nitrates are highly leachable under high rainfall regimes.

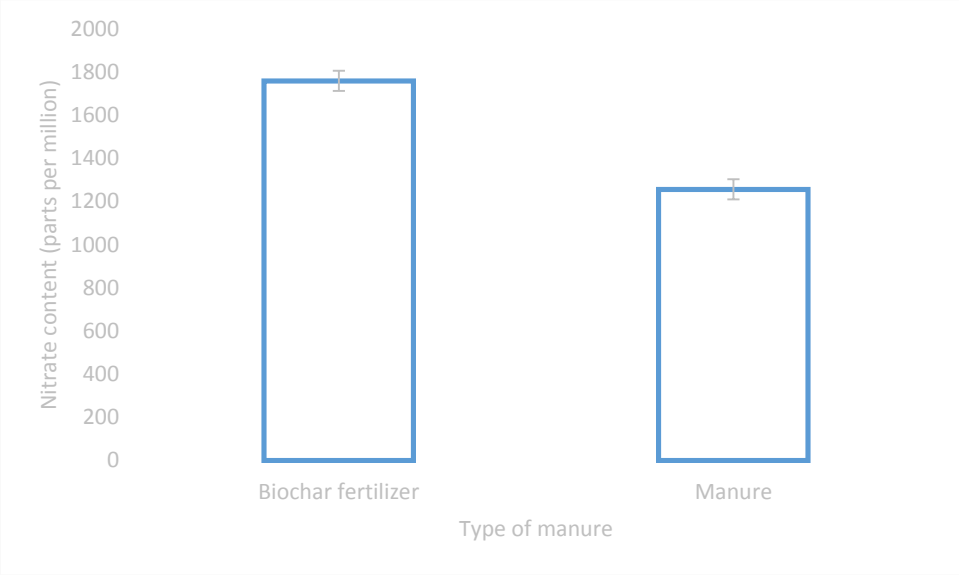


Figure 14: Effects of biochar fertilize addition and manure on nitrate retention

The results from this study indicated that plots that had biochar natural fertilizer retained significantly ($P<0.05$) higher amounts of nitrates against leaching (Figure 12). The higher amounts of nitrates found in biochar fertilizer applied plots is a testimony to higher cation exchange capacity. This property was also confirmed by other authors in literature. For poorly resourced farmers which have challenges in affording fertilizers biochar fertilizer is a solution to their poor soils. The majority of the small scale farmers are located in sandy soils and leaching is their major challenge hence biochar organic fertilizer can bring a relief to them.

Effects of biochar fertilizer on chlorophyll content of leaves

Chlorophyll content represent the ability of a plant to capture light energy and convert it to molecules of carbohydrates. It is also a function of the availability of nitrogen in soils. The results indicated that chlorophyll content was significantly ($P<0.05$) higher in biochar natural fertilizer applied plots compared to manure applied plots (Figure 13). The amount of chlorophyll is usually co-related to yield obtainable from the plots. These results agree with earlier results on nitrogen content. It means the higher the

amount of nitrogen the higher the amount of chlorophyll. Biochar has proved superior to manure with respect to chlorophyll content.

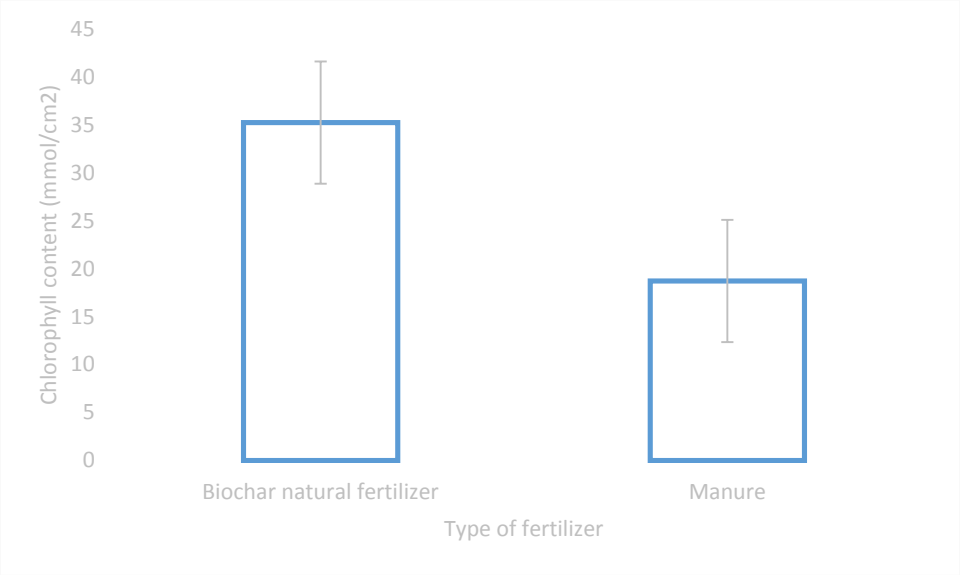


Figure 15: Effects of biochar natural fertilizer on chlorophyll content.

Sunflower plant height, head diameter and yield

Biochar had a bigger plant height compared to manure applied plots (Figure 15)

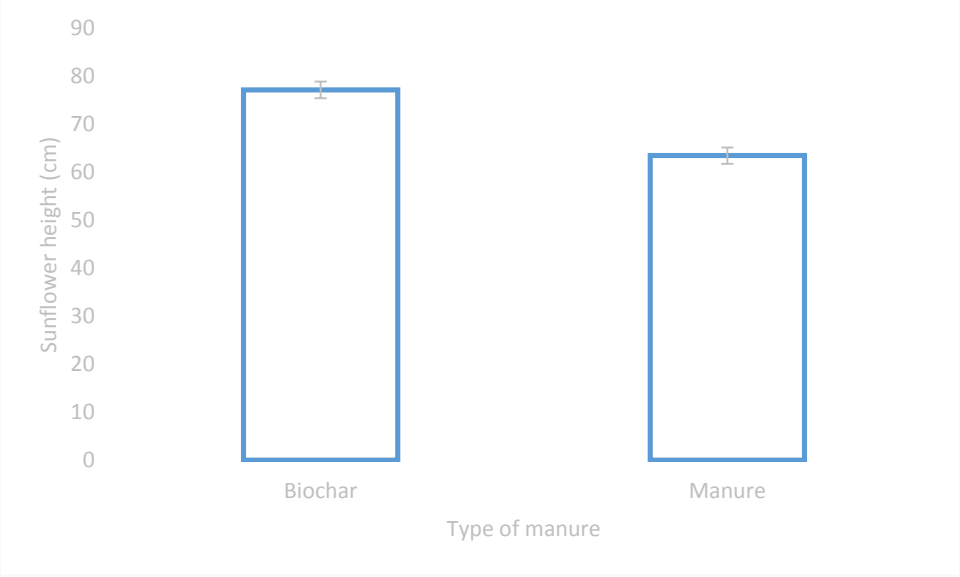


Figure 16: Effect of fertilizer type on sunflower height

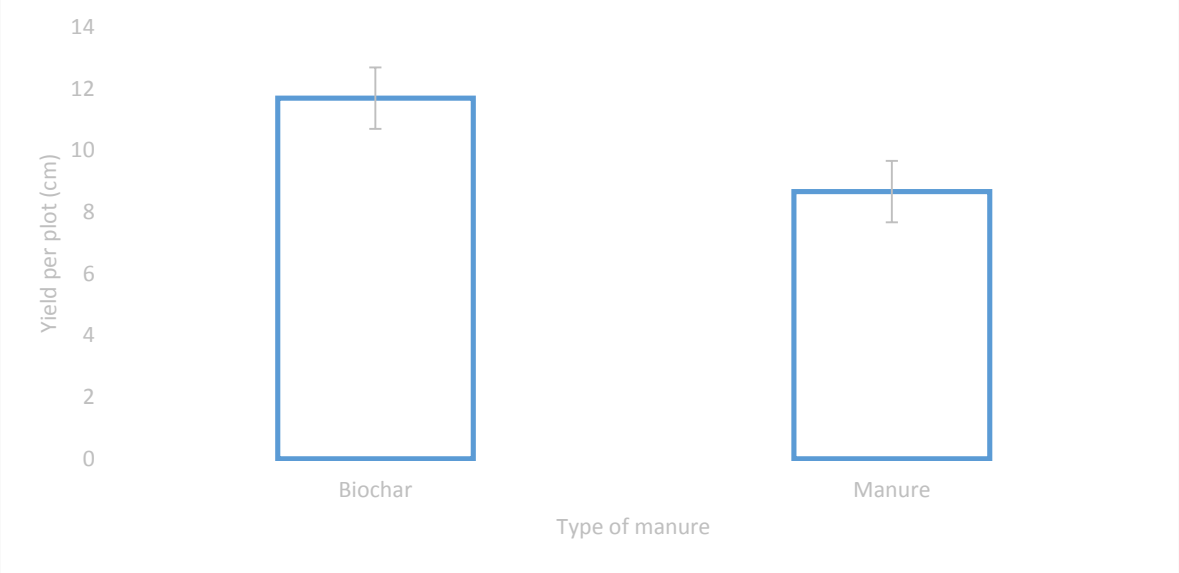


Figure 17: Effect of fertilizer type on yield

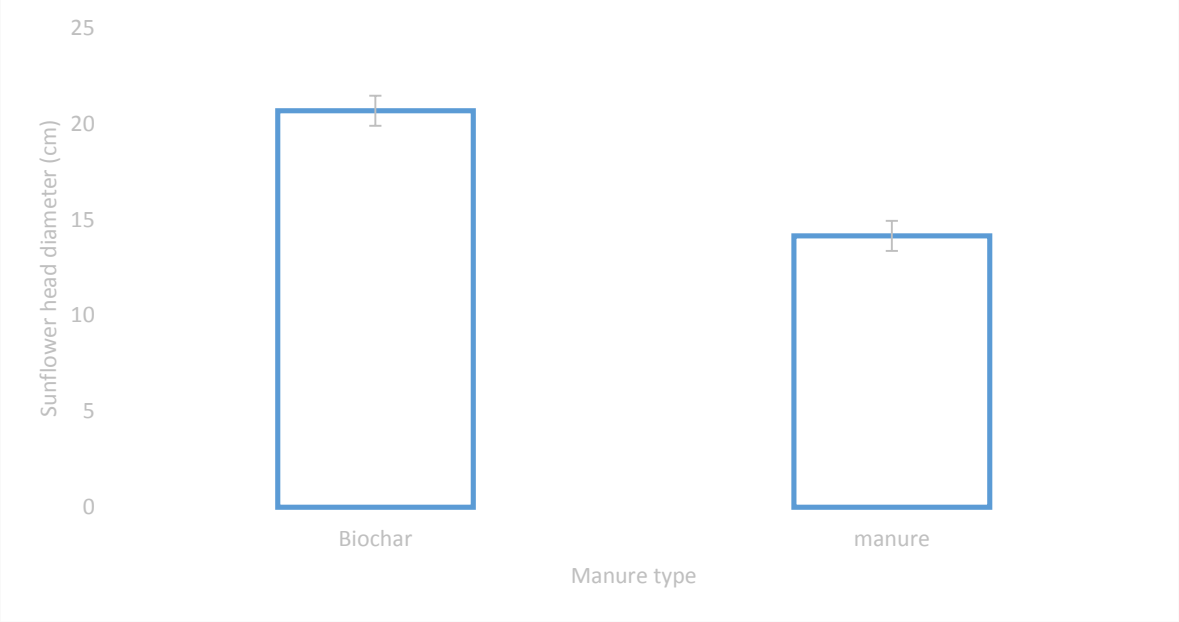


Figure 18: Effect of fertilizer type on sunflower head

All the crops showed better field and crop quality on biochar fertilizer applied plots compared to farmer practice which is manure only. The size of the cob and yield from the plots were significantly higher where biochar natural fertilizer was used (Picture 5.1).

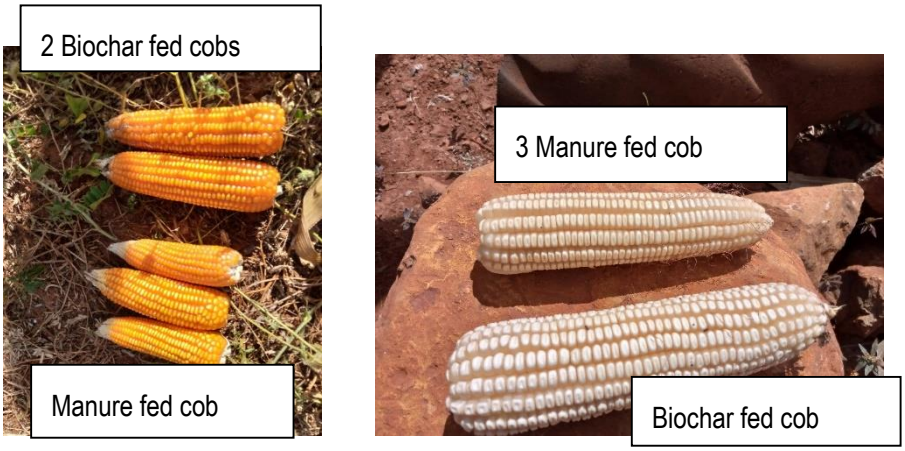


Figure 19: Comparison of Maize on Bichar and Non Biochar manure

Tephrosia for tick control

Each farmer per district as given 100 seeds for the establishment of of *Tephrosia vogeli*. Each farmer had received training on growth and caring of *Tephrosia* plants. The farmers however, had challenges with the germination of seeds.

However, in Manicaland Province: Makoni, Mutasa and Mutare districts the farmers established *Tephrosia* successfully and successfully used it to control ticks that transmit Theleriosis

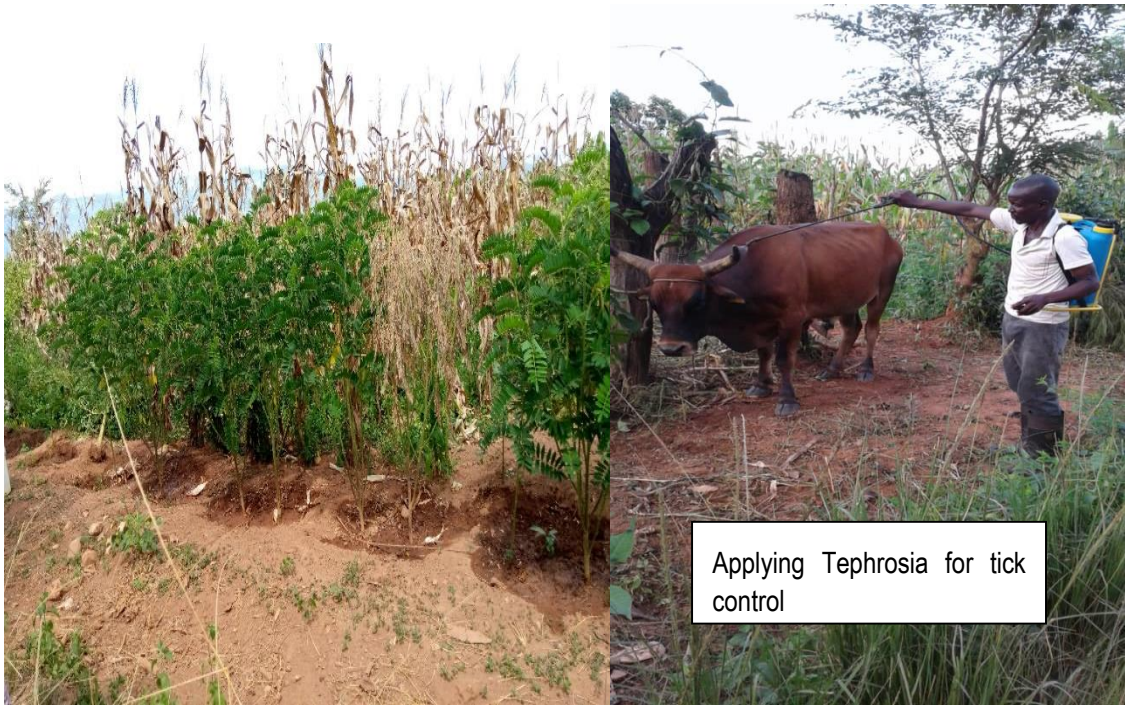


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Figure 20 : Tephrosia trees and its use in the control of Ticks

The results showed that Tephrosia application significantly reduced the tick numbers on cattle compared to conventional control through

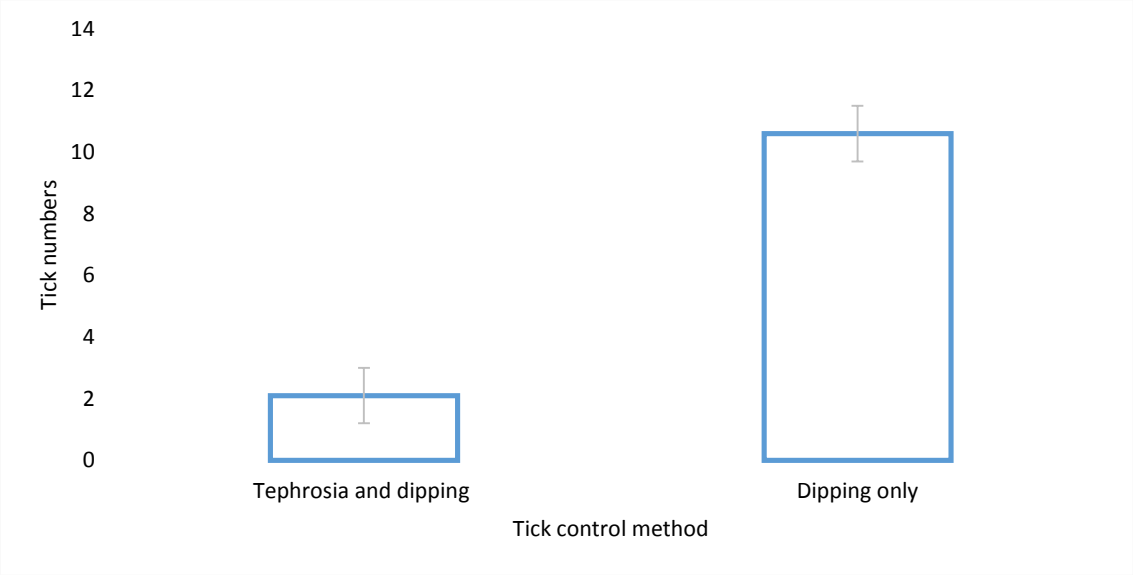

Figure 21: Number of ticks against control method

Effects of *Tephrosia vogelii* on tick control in cattle

Each of the ten farmers per district was given seeds for Tephrosia so that they could plant. Each of those farmers had received training on tree care for the Tephrosia plants. The seeds were planted on 30*30*30cm holes and were watered by the rains. After emergence the Tephrosia plants at 6 weeks had some of their leaves harvested and crushed and mixed with water for 4 hours. The paste was put in the knapsack sprayers and were applied on the cattle for tick control.

The cattle were allowed to dip normally with other cattle. Ticks were counted before and after application. The cattle which received *Tephrosia vogelii* were compared in terms of tick numbers with those which depended on dipping only.

The data were analysed using t-tests to determine the differences in tick numbers between those on which Tephrosia was applied and those that received normal dipping.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 LESSONS LEARNT

- Most farmers indicated that they prepared their own feed to feed their indigenous chickens
- Generally the farmers had no knowledge of *Moringa* based chicken feed and even those with *Moringa* trees planted at their homesteads had planted them for medicinal purposes rather than for chicken feed.
- The farmers in the ten districts gained knowledge on feed formulation and they indicated their willingness to test *Moringa* based chicken feed.
- The most common feed that they used to feed their chickens was sorghum, millets and crushed maize which was inadequate to meet the nutritional needs of the chickens.
- When used for demonstration trials, *Moringa* outperformed the farmers' feeds for all the three groups of indigenous chickens
- *Moringa* based feed gave above normal expected growth curve for broilers
- The most common source of organic fertiliser used by farmers is cattle manure which has a percentage of 90 %. None of the farmers used biochar in the surveyed districts hence this will become a new type of fertiliser. There was an immense potential for biochar based fertiliser given the expenses of fertiliser purchase.
- When biochar based natural fertilizer was used in demonstration plots it outperformed the manure that the farmers used in terms of growth, chlorophyll content, soil water holding capacity and nitrate retainance and yield.
- The main method used for the control of ticks in Zimbabwe is the use of acaricides

- The farmers in The Hauna area of Mutasa District were the ones who started the Tephrosia demo because they had the Tephrosia growing naturally in their environment.
- There was poor germination of the Tephrosia seed, raising the need for replenishing the seed given to farmers so that replanting could occur.
- Tephrosia grow well in warm and moist soil conditions
- Tephrosia tick control proved more superior compared to conventional tick control through irregular dipping.

4.2 Conclusions

From the set and implemented demonstration plots it can be concluded that

- *Moringa* based chicken feed is a potential agroecology practice that can increase the productivity of indigenous and broiler chickens
- Biochar based natural fertilizer is a natural fertilizer that increased the growth and yield of cereals and oil crops
- T*Tephrosia vogelii* showed its effectiveness in reducing the number of ticks compared to current dipping regimes.

4.3 Recommendations

From this assignment the following recommendations can be made

- *Moringa* based feeds should be promoted to other districts as it adds to the other agroecology practices, and has proved better and affordable when compared to other feeding regimes done by farmers
- Biochar based fertilizer gave better growth and yield and hence it should be promoted to other districts which did not participate in the demonstrations.
- Tephrosia should be successfully planted and maintained as it has potential to reduce tick infestations on cattle

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6. APPENDICES

APPENDIX 1:SCOPING QUESTIONNAIRE

Demographic profile of respondents

Date of interview .....

District .....

Ward .....

Sex: A. Male B. Female

What is your age: 18 – 30 31 - 45 45 - 55 45 -65 65 and above

Marital status: a) Single b) married c) divorced d) widowed e) Separated f) other, specify .....

How many people live in your household including yourself, are adults? (>18yrs).....

How many children < 5yrs years of age live in your household? .....

How many individuals living in your household, including you, are adults (>18yrs) and how many are children (i.e. persons

What is the highest level of education you have completed? a) none b) some primary c) primary education d) some secondary education e) secondary education f) tertiary g) other, specify .....

Main source of income: a) farming b) formal employment c) informal trade d) remittances

How many years have you lived in this community .....

What is your land size: a) Less than 1 ha b) 2ha c) Above 3ha

Farming experience...

Main crops grown

Crop	
Maize	
Groundnuts	
Cowpeas	
Millet	

Sorghum	
Others, specify	

Livestock ownership

Type	Yes	No	If yes, size
Goat			
Sheep			
Donkey			
Cattle			

SURVEY QUESTIONNAIRE ABOUT ON-FARM MORINGA BASED FEED

a) Name the groups of chickens you often keep

b) Broilers b) commercial layers c) indigenous chickens

c) Give the current chicken feed sources for

Chicken group/type	Main source of feed
Broilers	
Layers	
Indigenous	

d) What benefits do you derive from relying on the current feed sources…?

e) What challenges do you face in feeding of chickens…?

f) How much feed do the following classes of chickens take per period per chick:

Chicken group/type	Period	Amount of feed
Broilers	Brooding phase	
Broiler	Four weeks to slaughter	
Indigenous chicks	Day old to eight weeks	
Pullets	Nine to point of lay	
Layers/ breeder	Week 18 to 2 years	

g) Do you prepare your own feed

a) Yes b) No

h) Give the materials/inputs you use to prepare your feed

a) Maize b) sorghum c) Millets d) soya beans e) rapoko

i) State the source of your material .....

j) How do you prepare your chicken feed? .....

k) Does your feed promote fast growth rate and high carcass yield from day old to eight weeks and more eggs?

A) Very low b) low c) moderate d) high e) Very High

l) How concerned are you about the feeding costs?

a) very concerned b) moderately concerned 3)not concerned at all 4) don't know/not sure

m) What can be done in your opinion to reduce feeding costs in chicken production?

n) Have you heard about Moringa based chicken feed?

a)Yes b) No

a)If yes, from whom or from where did you hear about the Moringa based chicken feed?

i) Friends ii) Government iii) NGOs iv) private companies

b) What do you know about Moringa based chicken feed...?

c) If Moringa was available, would you be willing to use it?

i) Yes ii) No

o) Which type of feed best promote fast growth rate, increased feed digestibility, and high carcass yield from day old to eight weeks and more eggs

ETHNOVERT

1) In the past 6 months, has any of your cattle died as a result of tick borne diseases?

a) Yes b) No

2) How many cattle died .....

3) State the main cattle tick control method employed by your household

a) Acaricides--dipping/spraying - a) Yes b) No

b) Remove ticks from the host a) Yes b) No

c) Using local herbs a) Yes c) No

4) Which of the following do you practice at home as supplementary measures or which actions have you taken in your household to control cattle ticks?

Tick where appropriate

d) Acaricides--dipping/spraying - a) Yes b) No

e) Remove ticks from the host a) Yes b) No

f) Using local herbs a) Yes c) No

5) If you are using herbs, please answer the following questions

a) In the past 4 weeks, has anyone in the household used herbs…

b) List herbs used……

c) How often do you use them……

d) Explain the source, harvesting process/ extraction and application processes…

6) If no, if herbs against cattle ticks were available, would you be willing to use it?

p) Yes b) No

8) How often do you read/listen to/watch stories on 'cattle tick control?

a) Frequently b) occasionally c) infrequently d) never e) don't know/not sure

9) How often do you get information from the following sources on cattle tick control?

Circle where appropriate a) frequently b) occasionally c) infrequently d) never e) don't know/not sure

SN	Source	Rating
1	Government (Agritex)	
2	Community groups/friends	
3	Social media-Facebook/Instagram/twitter	
4	Workshops/lectures/	
5	Pamphlets/brochure/posters	
6	Television/radio/video/	
7	NGO	
8	Other, specify	

Attitude

d) How concerned are you about the impact of tick borne diseases on your herd?

b) very concerned b) moderately concerned 3)not concerned at all 4) don't know/not sure

e) Who in your opinion should be mainly responsible for controlling cattle ticks for your herd?

a) government b) cattle owners c) NGOs d) traditional leaders

f) Do you think any of the following will help reduce tick borne diseases as supplementary to main control measures?

a) Herbs b) Tick removal from the host c) Dipping/spraying

g) What can be done in your opinion to reduce effects of tick borne diseases on your herd?

a) increase in knowledge b) greater commitment/interest from authorities c) increase in external assistance d) greater support from community members e) other-specify:.....

h) Have you heard about Tephrosia as cattle tick control herb?

b) Yes b) No

i) If yes, from whom or from where did you hear about the Tephrosia?

j) Friends b) Government c) NGOs d) private companies

k) What do you know about Tephrosia? .....

l) If Tephrosia was available, would you be willing to use it?

q) Yes b) No

m) What are the different ways of receiving information about coronavirus that you would prefer?

a) Audio/radio b) video c) posters d) training manual

BIOCHAR ORGANIC FERTILIZER

1) Nature of soil fertility in rural areas:

a) Non fertile b) Fertile c) Very fertile

2) Use of soil fertility amendments in the rural sector

a) Yes b) No

3) Inorganic fertilizer usage:

a) Yes b) No

4) Perception on fertilizer usage:

a) use d) do not use

5) Fertiliser source

a) Government b) NGOs c) Self purchase

6) Use of organic sources of nutrient

a) Yes b) No

7) Which sources do you use

a) Cattle b) Sheep c) Composts d) Biochar e) Humus

8) Availability of organic sources

a) Not available b) Available

9) How do you make the Biochar

a) collect form fire places b) Make using pyrolysis c) No information

10) Which soil properties are improved by organic manure

a) Soil fertility b) water holding capacity c) Improves soil structure

11) Do you know the biochar making process

a) Yes b) No

12) Explain the biochar making process

.....

TRAINING MATERIALS

APPENDIX 2: BIOCHAR NATURAL FERTILISER MAKING FACT SHEET

Making biochar natural fertiliser

1.1 Introduction

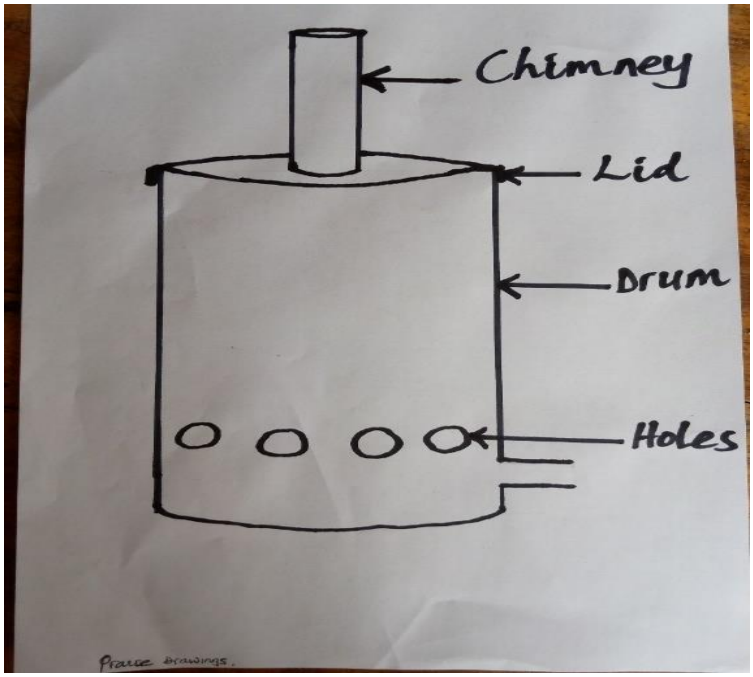
Biochar natural fertilizer is a carbon rich charcoal formed from the pyrolysis thermal decomposition of organic biomass or agricultural residues which is used as a soil amendment when mixed with compost manure.

1.2 Attributes of biochar

- Biochar improves water holding capacity of the soil thus helps in water retention for a longer period as a result of the highly porous structure.
- Reconditioning of the soil
- Biochar increases cation exchange capacity of the soil which in turn reduces the loss of nutrients through leaching.
- Increases nutrient use efficiency
- Provides a niche for micro organisms
- Improved water holding capacity and infiltration rates results from increased porosity and pore size distribution.
- Reduction in soil bulk density as a result of biochar low density
- Potential for improved aggregate stability and soil structure
- Increased cation exchange capacity resulting from negative charges on biochar's high surface area
- Liming effect (increased soil pH which can make nutrients more available in acidic soils
- Reduced nutrient loss through leaching and associated improved fertiliser efficiency linked to increased CEC and water retention.

1.3 How is it made?

- Made from scrape metals
- An old drum and a pipe for making a chimney



How to make biochar

Fill the drum with biomass from living organisms such as plants

The biomass should be dry

Light up the biochar through the lower opening

When the fire is glowing close the lower opening so that air only enters through the holes

When the biomass is charred, leave it to cool and offload

Hot compost

Composting is controlled decomposition, the natural breakdown process of organic residues.

Composting transforms raw organic waste materials into biologically stable, humic substances that make excellent soil amendments.

The Composting Process

- Composting occurs through the activity of microorganisms naturally found in soils.

The active phase of composting

- As temperatures in the compost pile increase, *thermophiles* (microorganisms that function at temperatures above) take over.
- This is called the *active phase* of composting.
- In the active "thermophilic" phase, temperatures are high enough to kill pathogens and weed seeds and to break down phytotoxic compounds (organic compounds toxic to plants).

Hot compost

Produces a microbe-rich, full-spectrum nutrient source

- Creates compost quickly.
- Hot compost piles can be finished in as little as 8 weeks.
- The high temperatures generated kill weed seeds.
- Composts larger amounts of material than in a passive compost system.

How to make a compost

1. Start your compost pile on bare earth
2. Lay twigs or straw first, a few inches deep
3. Add compost materials in layers, alternating moist and dry
4. Add manure, green manure (clover, buckwheat, wheatgrass, grass clippings) or any nitrogen source
5. Keep compost moist

Making biochar-based natural fertiliser

1. Take one volume of biochar and mix with the same volume of manure
2. The manure can either come from the compost or cattle manure
3. If using cattle manure, it should be cured
4. Curing is heaping the manure for a period up to five months before mixing with biochar

Biochar based fertiliser application

- After mixing apply at rate that is equivalent to two cups per planting hole
- The fertiliser is compatible with Pfumvudza

APPENDIX 3: TEPHROSIA FACT SHEET

FARMERS' FACT SHEET

Growing of *Tephrosia vogelii*

Introduction

The aim of this fact sheet is to provide farmers with a step-by-step guide and instructions on how to grow and use of *Tephrosia vogelii* in cattle tick control in an understandable, easy to follow and participatory manner.

General description:

- Tephrosia is a leguminous herb/shrub which can grow to a height of 2-3 m in five to seven months. Flowers are purple, red, or white in colour and are 2.5 cm wide.

Scientific name: *Tephrosia vogelii*

English common names: Fish bean, Fish-poison bean, Fish-poison-tree, Vogel's Tephrosia

Zimbabwean common names: Chitupatupa

Land preparation:

- Dig basins measuring about 15 cm wide and 30–35 cm long (about the size of a man's foot) and 15 cm deep (about as deep as your hand) with spacing of 150cm between rows and 40cm within rows from the centre of one basin to the centre of the next basin.

Soil requirements

- Tephrosia grows best on well-drained, loamy soil with a pH 5-6.5 and is tolerant of poor, acidic soils.

Manure requirements

- Put 1–2 drink cans of manure in each basin and partially fill the basins with soil.

- Leave the surface about 5 cm lower than the original ground level so water will tend to collect in the basin.

Sowing and germination

- Soak seeds in cold water for 24 hours before sowing to enhance germination.
- Sow 2-3 seeds per hole at the beginning or middle of the rainy season to make sure they get sufficient rains for establishment.
- Cover seeds 9 to 12 mm in heavy soils and 12 to 20 mm in light soils
- Germination will start 8-10 days after sowing.

Harvesting and processing for cattle tick control

- Green leaves; harvest is done usually after 2 or 3 months
- Harvest the leaflets of Tephrosia plants (they have the highest (about 80 to 90%) amount of total retinoid (active ingredients)
- Pound the fresh leaves in a mortar to extract the active ingredients (the crushing of leaves does not need to be done perfectly)
- Soak 50 g of pastes in 100 ml water for 12hours
- Filter the juice through a cloth
- Filtered juice is called paste

Application of *Tephrosia vogelii* paste on cattle

- Use paste directly in a sprayer or use a cloth
- Wash/spray animals with paste/extract of the plant
- This treatment is effective up to seven days.
- After seven days the spray must be repeated.

Pests and diseases

- Tephrosia suffers from root-knot nematodes that attack tomato, tobacco, egg-plant, paprika and green peppers.
- It should not be planted at a site where any of these or related plants have been grown recently, or where it is planned to grow them in the next season

- Stems of Tephrosia are prone to attacks by the fungus

NB: If all of the spray is not used immediately, it will still be approximately 70% effective 24 hours later if kept out of direct sunlight. However, after 24 hours, the mixture quickly loses strength and efficacy.

Seed Harvest and storage:

- Harvest pods by shaking the branches or pulling the pods with a hook
- Dry pods in the sun for an additional 2 to 3 days if necessary
- Lightly thresh pods in a sack bag using a stick to release the seeds
- Separate the seeds from the pod trashes by sieving and winnowing
- You can store your seed over a period of 2-3 years without no loss in its viability
- Seeds are dried to moisture content between 6 and 10% prior to storage.

Advantages of *Tephrosia vogelii*

- The advantage of Tephrosia is that, unlike most synthetic pesticides, it leaves no residue on crops because rotenone breaks down within 3 - 5 days after application.
- The affordability of Tephrosia makes it very attractive to subsistence and small scale farmers who raise livestock.
- T*Tephrosia vogelii* seeds are typically sold for around $0.20 per kg, which is very inexpensive compared to most other crop seeds offered on the market.
- Since it is highly adaptable, this plant grow in most areas. Tephrosia reproduces through seeds. Without pesticide and chemical treatment, the seedling survival rate is 60%.

WARNING: Please note that Tephrosia is dangerous to fish, humans, domestic animals and wildlife. When using Tephrosia, try to keep the extract away from your skin or use gloves if available. Wash hands with soap as soon as you have finished applying it on crops or animals. Do not use Tephrosia to poison fish, or dispose of it in water courses.

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APPENDIX 4: MORINGA GROWING FACT SHEET

FARMERS' FACT SHEET

LET'S TALK ABOUT GROWING *MORINGA OLEIFERA*

Why *Moringa?*

- *Moringa* provides essential nutrients and proteins all year round.
- *Moringa* is easy to grow and process for use as feed
- *Moringa* dried powder can be stored for later use

STEP 1: LAND PREPARATION

- ❖ Select well drained soil
- ❖ Mark planting stations 50*60cm for leaf production (Fig 1)
- ❖ Dig 15cm basins
- ❖ Apply 300g biochar natural fertilizer per basin
- ❖ Cover manure with soil and place at least two seeds per hole

Preparing land for sowing *Moringa* seeds

STEP 2: PLANTING & CROP MANAGEMENT

Direct sowing of seed

- Sow seed, and transplant young seedlings after 4weeks post emergence

Sowing: sow 2 or 3 seeds per planting station at 2 cm deep

Spacing: For leaf production; sow at 50 cm in row and 1m between rows

For both seed and leaf production sow at 3m in row and 5 m between rows

- *Moringa* Plants develops more easily and grows stronger with direct sowing.
- Protect seedlings from animals, children and fire.

Growing *Moringa* from Stem cuttings

- Stem cuttings grow faster but develop a shallow root system that makes plants more susceptible to moisture stress and wind damage.
- Select stem cuttings from branches of a tree that is at least one year old; and avoid using young green stem tissue.
- Cuttings should be 45–150 cm long.
- Cuttings can be hardened in the shade for three days before planting in the nursery or in the field.

- Add 300g of manure/compost to planting hole to encourage root development.
- Plant one-third of the length in the soil (i.e., if the cutting is 90 cm long, plant it 30 cm deep)
- Water regularly to keep the soil moist and NOT dump
- Continue watering first two months under dry conditions
- *Moringa* survives dry conditions once established

STEP 3: HARVESTING *MORINGA* LEAVES

- Trim the apical growing shoot, 90 to 100 days after planting (10 cm from the top), when the tree is 0,6 to 1 m high (Fig 1)
- Trimmed *Moringa* produces more branches and increase leaf biomass that gives a better harvest.
- If left to grow without cutting the main trunk, the fast-growing tree will grow straight and tall, producing leaves and pods only.
- Use a sharp cutting knife or pruning saw to make smooth cuts or pluck compound leaves.
- New shoots emerge from just below, where the cut is made (Fig 2).
- Subsequent cuttings can be done every 80days for chicken leaf meals
- The cut *Moringa* plant will produce a shrub with leaves easy to collect (Fig.2).

Moringa shrub

- If plants are grown at closer spacing, and higher density (20cm x 20cm), cut plants about 30 cm above ground.

STEP 4: DRYING LEAVES

- Dry *Moringa* leaves under shade to prevent the loss of nutrients
- Protect drying leaves from dust and pests to prevent contamination
- Regularly shake the leaves to avoid moulds when placed on a wire mesh
- The drying process should be completed as quickly as possible to prevent the growth of moulds;
- One can use open air drying by hanging *Moringa* leaf bunches from roof with string.
- Mould *Moringa* leaves should be thrown out or used for compost.

Fresh leaves.....dry leaves.....leaf powder

Fig 3 Drying leaves

STEP 5: PACKAGING and STORAGE

- *Moringa* Leaf OR ground Powder should be stored in ***air-tight plastic containers protected from heat, humidity and light***.
- Moist *Moringa* leaves /powder encourages the growth of molds or mildews which could poison chickens
- Exposure to heat or light will destroy the nutrient content of. *Moringa* Leaf Powder
- *Moringa* can be stored for ***up to 6 months*** under clean dry conditions

- Dried powder must be stored in air-tight containers, protected from light and humidity, and kept below 24°C.

LET'S PROMOTE GREEN AGRICULTURE THROUGH GROWING MORINGA

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APPENDIX 5: MORINGA POSTER

INNOVATIVE CHICKEN FEEDING TECHNOLOGIES

THROUGH

UTILISATION OF *MORINGA OLEIFERA* LEAF MEAL

***Young Moringa oleifera* plantation**

***Moringa Oleifera* Leaf Nutrient Content**

CP 28.5**%**

ASH 10.78 **%**

CF 9.76 %

Gross energy (MJ/kg) 19.35

Leaves per 100g contain 440mg Ca, 70mg P, 7mg Fe, 110mgCu, 5.1mg I, 11.300 IUpro-vitamin A, 120mg vitamin B, 0.8 mg nicotinic acid, 220mg ascorbic acid and 7.4mg tocopherol per 100g. Per every 100g, pod is reported to contain 30mg Ca, 110mg P, 5.3mg Fe, 184 IU pro-vitamin 0.2 mg niacin, 120mg ascorbic acid, 310mg Cu, and 1.8mg I (Makkar and Becker, 1997)

WHY *MORINGA OLEIFERA* LEAF MEAL?

Feeding Chickens on *Moringa Oleifera*

- maintains healthy chickens & reduced mortality

***Moringa* offers Good Ecological Benefits**

- wind breaks

- tender and golden brown meat
- produce tasty meat

- supply of nitrogen through nitrogen rich biomass
- improvement of the quality of water and air,

Socio-Economic Benefits

- contributes to improved diets and health,
- firewood
- HIV/AIDS alleviation
- Food security and income generation.

PERFORMANCE OF BROILERS FED *MORINGA OLEIFERA LEAF MEAL* SUPPLEMENT

Moringa fed Broilers (12% inclusion)

Conventionally Fed Broilers

COST BENEFIT ANALYSIS

Reduced costs compared to purchased commercial feed

	Conventional Feed	*Moringa* at 5%	*Moringa* at 10%
Total Cost	$3.19	$3.12	$3.04
Total Revenue	$6.00	$6.00	$5
Returns/$ invested	$0.88	$0.92	$0.65

How to prepare the Feed

GENEAL MIXING GUIDE PER 100kg bag

Maize - for energy 60kg

Soya/Sunflower - for protein 30 kg

Moringa - supplement protein 10 kg

- rotate mixer for three minutes to give a uniform mixture

N/B Final mixing ratios will be guided by the quality of raw materials in terms of nutrient content

Composition (kg/100kg) For Chicken diets

Raw Materials	Chick Starter 18-19% CP	Growers – Pullets 16% CP	Breeders 15 – 16% CP	Layers 15% CP	Broiler Starter 20 – 22% CP	Broiler Finisher 16 – 17% CP

Maize	74.3	78.3	80.3	81	68	78
Soya	17.7	11.7	9.7	9	24	14
Moringa	6	8	8	8	6	6
Additives	2	2	2	2	2	2
Total	100	100	100	100	100	100

Using the Poster

This manual was specifically prepared for the farmers in Gokwe South, Gokwe North, Zhombe, Shurugwi, Bindura, Mount Darwin, Guruve, Makoni, Mutare and Mutasa Districts under the LFSP Program. It can however, be used by anyone in related environments.

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APPENDIX 6: MORINGA FEEDING FACT SHEET

FARMERS' FACT SHEET

LET'S TALK ABOUT PREPARING & *FEEDING MORINGA OLEIFERA* BASED CHICKEN FEED

Why turn to *Moringa* based feed?

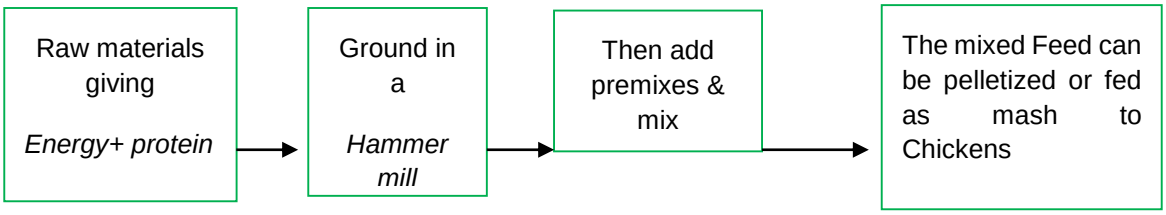
Chicken feed is constantly escalating thereby reducing the viability of the poultry industry. Therefore, this fact sheet guide farmers on how to prepare own feed stuffs using *Moringa Oleifera* leaf. *Moringa* is a useful plant that can be used for food, medicine or livestock feed. Feeding *Moringa Oleifera* leaf meals at appropriate inclusion levels of up 12% gives normal chicken growth performance.

Read to find out some of the benefits derived from feeding chickens on *Moringa* based feed

WHAT RAW MATERIALS ARE USED FOR MAKING MORINGA BASED FEED?

Maize (for energy) Soya or Sunflower + *Moringa* leaf (for Protein) Premixes (Vitamins & Minerals)

STEPS IN Feed production



Chick starter mash

Grower Pullet mash

GENERAL FEED MIXING GUIDE PER 100kg FEED - where premixes are not available;

Add Maize - for energy supply **@** **60kg**

Add Soya/Sunflower - for protein supply @ **30 kg**

***Add Moringa* -** portion for protein, minerals & Vitamins **@** **10 kg**

TOTAL **100kg**

N/B Final mixing ratios will be guided by the quality of raw materials in terms of verified nutrient content

- Rotate feed mixer for three minutes to give a uniform mixture
- Use the table provided in your **Fact Sheet** to prepare feed rations for different classes of your chickens

Composition (kg/100kg) For Indigenous Chicken diets

Raw Materials	Chick Starter 18-19% CP	Growers – Pullets 16% CP	Breeders 15 – 16% CP
Maize	74.3	78.3	80.3
Soya	17.7	11.7	9.7
Moringa	6	8	8
Additives	2	2	2
Total	100	100	100

PACKAGING - Use clean plastic to avoid contamination

A: *Moringa* Broiler Starter B: *Moringa* Broiler Finisher

FEEDING QUANTITIES

A) Broilers -0-4weeks = 1.5 kg/chick (Broiler starter mash)

5weeks to 8 =3.5kg/bird (Broiler finisher mash)

B) For Indginous chickens - 0-8weeks **- Give-** 2kg/chick (Chick starter mash)

9 - 18 weeks **-Give-** 7kg/bird (Growers pullet mash)

19weeks - to end of lay (1yr) **- Give-** 35kg/bird (breeders mash)

C) Commercial layers - 0-8weeks = 2kg/chick (Chick starter mash)

9 - 18 weeks = 7kg/bird (Growers mash)

19 - end of lay(1yr) = 45kg/bird (Layers mash)

WHAT ARE THE BENEFITS OF FEEDING MORINGA BASED CHICKEN FEED?

- Reduced chicken mortality and morbidity
- No synthetic antibiotics are added to the feed
- No growth hormones additives are given
- Produces Chicken of appealing golden colour
- There is reduced feed cost as *Moringa* grows well under harsh environments, unlike Soya.

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PROMOTING GREEN AGRICULTURE

APPENDIX 7: TRAINING MANUAL ON BIOCHAR NATURAL FERTILIZER

LESSON 1: INTRODUCTIONS

1.1 Introduction and objectives

Biochar is a solid product that remains after biomass is heated to 300- 7000C under oxygen deprived conditions, a process called pyrolysis. Biochar is a form of charcoal that present enormous opportunities in enhancing crop growth, remediating contaminated soil and preventing climate change causing carbon emissions. Biochar is also known by the names agrichar or the simple term, black carbon. Biochar is not a fertilizer per se but a soil conditioner with potential to improving soil functions by reducing nutrient loss through increased bioavailability of nutrients and increased nutrient leaching. Biochar natural fertilizer is a carbon rich charcoal formed from the pyrolysis thermal decomposition of organic biomass or agricultural residues which is used as a soil amendment when mixed with compost or cattle manure.

1.2 Forming biochar

Biomass (Solid) → Biochar + Liquid or oil (tars, water + volatile gases CO_2; CO; H_2)

1.3 What does it do to the soil?

Soil conditioner

- Biochar improves water holding capacity by up to 200%of the soil thus helps in water retention for a longer period as a result of the highly porous structure.
- Reconditioning of the soil
- Biochar increases cation exchange capacity of the soil which in turn reduces the loss of nutrients through leaching.
- Increases nutrient use efficiency
- Provides a niche for micro-organisms which assist in the decomposition of organic matter

- Improved water holding capacity and infiltration rates results from increased porosity and pore size distribution.
- Reduction in soil bulk density as a result of biochar low density and improves soil aeration
- Potential for improved aggregate stability and soil structure

- Increased cation exchange capacity resulting from negative charges on biochar's high surface area which enables high nutrient holding capacity
- Liming effect (increased soil pH which can make nutrients more available in acidic soils
- Reduced nutrient loss through leaching and associated improved fertiliser efficiency linked to increased CEC and water retention.

1.4 Objectives

- To be able to make a pyrolysis machine using scrap metal
- To equip the farmers and extension with skills to produce biochar from plant materials
- To train farmers in hot compost making using locally available materials
- To train farmers so that they gain skills in manure curing
- To train farmers so that they get skills in the making of biochar based natural fertilisers

2.0 LESSON 2: Making a pyrolysis machine

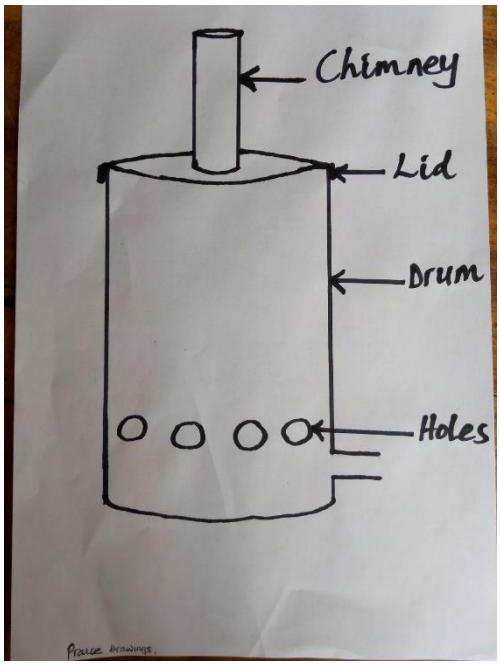
2.1 Materials needed for making a pyrolysis machine

1. An old disused drum
2. A metallic pipe
3. Pieces of metals for making handles

2.2 Manpower

The process requires a welding machine and scrap metals and the welder.

2.3 Structure of the pyrolysis machine



- The pyrolysis is made up of a drum with a lid that has a chimney at the top.
- The bottom of the drum has small holes to allow reduced quantities to penetrate the machine
- The opening at the bottom of the drum has a hole which is used to light the materials so that burning can start

2.3 The making of the pyrolysis machine

Step1: Remove the covering on one end and convert it into a lead

Step 2: Cut the pipe and weld it onto the lid of the drum

Step 3: Open a hole on the drum near to the base which will be used to light up the plant materials

Step 4: open small holes on the nearer to the base of the drum for oxygen entrance

LESSON 3: MAKING BIOCHAR

3.1 Materials needed in making biochar

- Twigs and tree branches
- Bedding grasses
- Hard and soft woods

- Invasive plant materials
- Manure

3.2 Biochar making

Biomass dried: wet materials will first need to dry before charring so will cause lots of smoking.

- Biomass fed into pyrolysis machine.
- Pyrolysis machine heats biomass without oxygen while removing vapours (gas and oil)
- Biomass converted into biochar.
- Biochar removed from pyrolysis machine.
- Biochar is stored.

LESSON 4: Hot compost making

4.0 Hot compost

4.1 Composting

Composting is controlled decomposition, the natural breakdown process of organic residues. Composting transforms raw organic waste materials into biologically stable, humid substances that make excellent soil amendments. Compost is easier to handle than manure and other raw organic materials, stores well and is odour-free. Most importantly, the final product is a valuable soil resource. Compost can replace materials like peat and topsoil as seed starters, container mixes, soil amendments, mulches and natural fertilizers in commercial greenhouse production, farms, landscaping, turf and land remediation

4.1 The Composting Process

- Composting occurs through the activity of microorganisms naturally found in soils.
- Under natural conditions, earthworms, nematodes and soil insects such as mites, sow bugs, springtails, ants, and beetles do most of the initial mechanical breakdown of organic materials into smaller particles.

4.2 The active phase of composting

- As temperatures in the compost pile increase, *thermophiles* (microorganisms that function at temperatures above) take over.
- The temperature in the compost pile typically increases rapidly to 130- 150 oF within 24-72 hours of pile formation, which is maintained for several weeks.
- This is called the *active phase* of composting.

- In the active "thermophilic" phase, temperatures are high enough to kill pathogens and weed seeds and to break down phytotoxic compounds (organic compounds toxic to plants).

4.3 Hot compost

- Produces a microbe-rich, full-spectrum nutrient source
- Creates compost quickly.
- Hot compost piles can be finished in as little as 8 weeks.
- The high temperatures generated kill weed seeds.
- Composts larger amounts of material than in a passive compost system.

4.4 Feed stocks

- Composts can be made from most organic by-products.
- Common feed stocks are poultry, hog and cattle manures, food processing wastes, sewage sludge, leaves, brush and grass clippings, sawdust, and other by-products of wood processing.
- The hot compost is constantly turned and watered
- The minimum size of a thermal compost is 1.5m x1.5m x 1.5m
- Small composts may not achieve the desired temperatures
- The size should be small enough so that one person can gather the materials needed
- A 2 x 2x 2 can also be made to obtain more compost

4.5 Ingredients

4.5.1 Green material

- Green materials are important because of the food they contain
- Green materials can be grass, leaves and weeds
- The green material make up 40 % of the total material

4.6 Dry material

- The dry part of the compost provides the woody component
- Examples are twigs, maize cobs, wood shavings

4.7 Nitrogenous source

- The nitrogen content component part of the compost is an important part of the compost

- Manure is usually used a source of nitrogen
- Animal manure is important in the compost as it contains urine
- Legumes are also an important part of the compost
- The nitrogen materials should be mixed with other materials
- Other sources of nitrogen are ammonium nitrate and urea
- Amounts of nitrogen source required
    - Manure: 6 – 10 wheelbarrows
    - Legumes should constitute 20 % of the material
    - Ammonium nitrate or urea amount should be 16 – 20 kg

4.8 Water

- Water activates life in the compost
- Microorganisms are responsible for the breakdown of the living materials to manure
- More than 1000 litres of water will be required over an 8 week period

4.9 Oxygen

- Thermal composting is an aerobic process so the presence of oxygen is necessary
- Conditions should allow for oxygen penetration
- The compost is usually lifted to allow penetration of air

Lesson 5: Manure curing

5.1 Introduction

- Manure is an important source of organic matter and major nutrients such as nitrogen, potassium and phosphorus together with micronutrients.
- However, in most cases the manure will need to be cured to improve mineralisation and weed spread

5.2 Manure curing

5.2.1 Heaping

- In this instance manure is heaped outside the cattle pen for a period of 3 – 5 months for curing to occur

- Inside the heap high temperatures in excess of 80°C will be generated and that may help in killing weed seeds
- Methane will also be generated ad it will help in killing pathogens and weed seeds
- Research has also found that the heaping process assists in improving mineralisation of manure

5.2.2 Soil pit method

- In this method a pit can be dug with dimensions that can hold the quantity of manure desired
- The manure will be put in the pit and covered for a period ranging from 2 – 5 months
- The high temperatures generated in the heap and methane will assist in killing weed seeds and improve mineralisation

6.0 Lesson 6: Making and application of biochar natural fertiliser

6.1 Introduction

Biochar is not a fertiliser per se but a soil conditioner with potential to improve soil functions by reducing nutrient losses, increasing bioavailability of nutrients and decreasing nutrient loss.

- Biochar on its own does not contain enough nutrients for crop growth
- Supplementing biochar with other organic fertilisers renders biochar materials more suitable for stimulating growth
- This is generally called charging the biochar

6.2 Charging biochar

- There are many ratios that can be used in biochar charging and these include 1:1 by volume
- This varies with the amount of nutrients contained in the manure
- Biochar assists in other properties whilst the manure supplies nutrients in the manure.

6.3 Application of biochar natural fertiliser

- The charged biochar organic fertiliser will be applied per planting station or broadcasted in the field
- The biochar based natural fertiliser can be used in Pfumvudza plots currently under promotion from the Ministry of Agriculture in Zimbabwe.

APPENDIX 8: TRAINING MANUAL FOR *MORINGA* CHICKEN FEED

***MORINGA* OLEIFERA GROWING GUIDE**

MORINGA PRODUCTION *using Natural Fertilizers - Biochar blend*

TRAINING GUIDE FOR SUPERVISORS, FIELD STAFFAND LEAD FARMERS

Using the Manual

This manual was specifically prepared for the farmers in Gokwe South, Gokwe North, Zhombe, Shurugwi, Bindura, Mount Darwin, Guruve, Makoni, Mutare and Mutasa Districts under the LFSP Program. It can however, be used by anyone in related environments.

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1.0 INTRODUCTION

Moringa oleifera (Lam), introduced to Africa from India, is an important multipurpose tree sparsely cultivated in Zimbabwe. It has become naturalized in many locations in Zimbabwe (Maroyi, 2006). *Moringa* is one of the most useful trees, as almost every part of the tree can be used for food, or have some other beneficial property as medicine or livestock food. The provenances commonly grown by Zimbabwean farmers are Binga, Mutoko and Malawi. Provenance means place where *Moringa* plant is found or taken from. In Zimbabwe, *Moringa* is being used as one of the trees grown in combination with crops by smallholder farmers. It is a suitable tree for agroforestry in the home because of its numerous benefits.

Moringa oleifera (Lam) is commonly called drumstick or horse radish tree and is locally known as Zakaland or Mpulanga among the Tonga speaking people of Zimbabwe. In Zimbabwe, Binga can be considered as the area where the tree was first cultivated and is said to occur in the wild (Maroyi, 2006). From Binga it is said to have spread into other areas such as Mashonaland East, West and Central, Midlands and Masvingo provinces.

Small holder farmers use the tree as an inter-crop in multi-storey systems, and hedge or decorative plant. *Moringa oleifera* has a wide range of adaptation from arid to humid climates with a prospect to be grown in a wide range of ecological zones. The tree adapts to a rainfall range of 300-1400 mm per year with soil

pH of 6-7, (Mayer and Stelz, 1993). It does not require fertile soils, but performs well on marginal and poor soils (Jahn *et al.*, 1986). Once *Moringa* is established it will not show any sign of moisture stress.

1.1 Social-Economic Importance

The tree provides materials for:

- ✧ utensils and construction,
- ✧ contributes to improved diets and health,
- ✧ HIV/AIDS alleviation,
- ✧ Food security
- ✧ income generation
- ✧ Social-cultural uses in religious and cultural functions

1.2 The Ecological benefits

- ✧ improvement of the quality of water and air
- ✧ supply of nitrogen through nitrogen rich biomass
- ✧ formation of soils
- ✧ recreational and aesthetic uses such as tourism
- ✧ Carbon sequestration

2.0 MORINGA OLEIFERA CULTIVATION

2.1 Land Preparation

- ❖ Select well drained soil
- ❖ Mark planting stations 50*60cm for leaf production
- ❖ Did 15cm basins
- ❖ Apply 300g biochar natural fertilizer per basin
- ❖ Cover manure with soil and place at least two seeds per hole

Fig 1: Land prepared and mulched

2.2 Planting material

Moringa can be planted vegetatively or from seed.

VEGETATIVE

- Cuttings of **0.5m to 1.5m** long with stem diameter of 4 to 5 cm can be planted in summer or spring (under rain-fed conditions)
- Two year old cuttings 30cm long and 0.75 to 2.0cm diameter root faster than cuttings from one year old plants according to research.
    - Direct sowing of seed
    - Sowing seed and transplanting of young seedlings after 4weeks post emergence

Sowing: 2 or 3 seeds per planting station at 2 cm depth

Spacing: For leaf production =50 cm to 1 m

For both seed and leaf pod production =3 to 5 m.

- *Moringa* develops more easily and grows stronger with direct sowing.
- Protect seedlings from animals, children and fire
- Seed - *Moringa* trees grown from seed produce longer rooting system than one from vegetative propagation
- Longer rooting system is suitable for the semi-arid tropical conditions

2.3 Growing conditions

- ✓ *Moringa oleifera* grows well under hot, humid and wet conditions with rainfall in excess of 3000 mm/anum.
- ✓ *Moringa* grows in a variety of soil conditions ranging from sandy or loamy to heavy clays.
- ✓ In Zimbabwe *Moringa* thrives well in areas of marginal rainfall and poor soils similar to those found in Binga and Mutoko areas.
- ✓ The tree tolerates mild frosts and establishes well in alkaline soils of up to pH9.

2.4 Fertilization/manuring

- In Zimbabwe, rural farmers have produced *Moringa* fertilising it with cattle manure and composts
- The fertiliser that gave high plant performance is constituted as 21-7-20 NPK enriched, with minerals and trace elements.

- The general application rate per hectare is32 and 48 kg per week.
- Reduced application rates of 16 kg per week are said to have produced plants of good condition.
- In addition to NPK - urea can be applied at a rate of 8kg per hectare every two weeks.

2.5 Pest and Disease Control

Moringa is generally resistant to pests and diseases. During the rainy season, leaf eating caterpillars can eat a sizeable part of a *Moringa* plants. Where mild attacks are observed, remove infected plant parts, but under severe attacks one may resort to using insecticides.

3.0 *MORINGA* ESTABLISHMENT

For the production of green matter, the optimal plant density under sandy fertile soils is 10 x 10cm or one million plants per hectare. The planting density and harvesting frequency depends on the production objectives. The greater the plant population, up to an optimal of one million plants per hectare, the greater the biomass production (Table 1). When the aim of production is green fodder with maximum protein content and less fibre content, then harvesting should be done, frequently, every 60 days. When the objective is to produce maximum lignocelluloses fibre, then harvesting is done after 6-8 months of growth. The longer the time to harvesting the greater the trunk diameter and the bigger the branches and leaves. Pod bearing starts 6-8 months after planting. Regular pod production starts after the second year and can go for up to 40 years.

Fig 2: Established *Moringa* plant

Moringa tree is most suitable in those areas where the costs associated with production of commercial crops are high.

Table 1. Biomass production of *Moringa* at first cutting at different plant densities.

Planting density (plants/ha)	Fresh matter (metric tons/ha)	Dry matter (metric tons/ha)
95000	19.6	3.33
350000	29.7	5.03
900000	52.6	8.94
1000000	78.0	13.26

Source: Foidl, *et al.,* (2001).

4.0 HARVESTING

Leaves are harvested when plant is 1.5– 2.0 m (±90days). Harvest leaves by snapping leaf stems from branches. Harvesting young shoot tips will promote development of side branches (Fig 3)Fig 3: *Moringa* coppicing after first cutting. Use small hand scythe to cut plants to a height of at least 30cm above ground. If trees are left to grow much taller than 1.2m, the lower part becomes hard making it difficult to cut. Six harvests can be made per year with **8kg** of fresh leaves, with stems removed, producing one kg of dried leaves. *Moringa* harvested for biomass remains productive up to three years and beyond three years productivity declines as high inputs of fertiliser application do not match with output. During harvesting, workers must wash their hands with soapy water to avoid contaminating harvested material

with germs. For forage production under intensive farming systems, in trials held in Nicaragua, up to **120 tons dry matter/ ha/yr** in eight cuttings after planting 1 million seeds/ha was achieved.

4.1 What affects Moringa leaf yield?

- Plant density - too high population result in mutual shedding

- harvesting management, i.e., age at first harvest, height and frequency of cutting and season of harvest.

4.1.1 Plant spacing

Moringa leaf yield increases with increasing planting spacing.

The biomass production varies from 8 – 18 tons DM/ha for *Moringa* (Sanchez, 2006). In northern and western parts of Africa, Nicaragua, Senegal and Gambia, *Moringa oleifera*, under intensive production system can be planted at a population of 1 000 000 plants per hectare, and produce approximately a leaf biomass yield of 13.26 metric tons per hectare per harvest on dry matter basis (Sanchez (2006)). *Moringa* has capacity of producing up to 20 tones DM of utilizable biomass in a growing cycle of 50 days at 20×20 cm planting spacing. At 10 cm × 10 cm spacing, leaf yields were 7–8 kg/m^2 at the first cutting in well irrigated, drained and manured beds, with up to seven cuttings a year. Spacing of least 2 m × 3 m is recommended for perennial polycultures, depending on pruning frequency of the trees, the shade tolerance and other requirements of the companion crops, as well as space required for equipment access (Radovich, 2009). Spacing of 5 m × 5 m may be considered appropriate for seed production. Any plant spacing used should be done after paying consideration to the confounding effects of such factors as soil type, altitude, season, rainfall and intended plant use.

4.1.2 *Management factors*

Management factors that affect fodder yield per unit area and long-term productivity include age at first harvest, harvesting frequency and height and season of harvest. In order to get a bushy coppice of foliage of shrubs after the first cutting, a complete development of the root system is required. If first cutting is done before ninety days or very late (senescence state) then that can significantly reduce the coppicing. It is advisable to leave forage plants uncut until they reach an initial height of at least 1.0 to 1.5 m (±90 days). This establishment period can be greater than one year in some cases (Palada and Chang, 2003).

4.1.3 Frequency of cutting

Cutting/plucking frequency refers to the number of times that the *Moringa* tree is cut or grazed. Cutting interval has a dominant influence on total DM yield than cutting height. In some areas the highest total biomass yield is obtained under longer harvest intervals, although with a lower leaf-stem ratio. In some areas it was found that the maximum edible yield of the shrubs occurred at short cutting intervals.

4.1.4 Cutting height

No major difference, concerning the relation between cutting height and number of shoots per stem were recorded in *Moringa* fields.

4.1.5 Defoliation

Defoliation is divided into cutting and grazing and can be described in terms of frequency and intensity.

Frequency = how often the trees are cut or grazed, Intensity = the amount of leaf and stem remaining after defoliation. Severe defoliation intensity require longer intervals between defoliatns to allow the trees to recover. Grazing is often less severe than cutting in intensity, as animals remove mainly leaf while cutting removes whole branches. Cutting interval has a more dominant influence on total yield than cutting height. Cut *Moringa* leaves are used to supplement low quality, naturally occurring grasses and crop residues fed to ruminant animals.

4.1.6 Cutting interval

Cutting frequency affects shoot number and size of leaves.

Dry matter production is substantially greater for long defoliation intervals of approximately 75days than more frequent defoliation (Gadzirayi 2014).

Fifty day and 75 day harvesting cycles also produce better biomass yield.

Moringa shoots intended for use as fodder can also be harvested at seventy five (75) day intervals.

4.1.7 Cutting height

Higher cutting heights produce higher yields. Isarasence *et al*., (1984) reported enhanced growth in fodder trees cut at 120 cm compared with those cut at either 30 cm. Fast and early regrowth is also supported more by movement of carbohydrate reserves from stem rather than just from current photosynthesis. A low cutting height of 5 cm is detrimental to both yield. In *Moring Oleifera* the appropriate cutting height, done manually, is at 20 cm up to 1.5 m height and this depends on the production system. Where inter-cropping is practiced *Moringa Oleifera* plants should be harvested at a height when they are high enough so that they are not shaded by the companion crops. There is no definitive evidence as yet as to how to choose the cutting height when the plant is grown under diverse agro ecological regions with diverse management agronomic practices in Zimbabwe. Generally cutting height has shown to have only marginal effect on the growth of most fodder tree species, but can have effects on sprouting ability and survivability of the plants for subsequent harvests.

4.1.8 Age at first harvest/tree size

Other factors which influence coppicing after defoliation are tree size and timing of defoliation. The older the tree at first cutting, the higher the rates of regrowth and biomass yield, since older trees would have thicker stems, more carbohydrate reserves and a deeper more extensive root system. As general practice leave forage trees uncut until they reach a height of at least 1-1.5 m. In *Moringa. Oleifera*, optimal growth

and biomass yield at first harvest has been given in terms of the plant height that is when tree reach height of 1-1.5 m.

Leaves from wider spacing *Moringa* fields can be harvested after plants grow 1.5–2.0 m, which usually takes at least 60 – 90 days in well - drained fertile soils (Gadzirayi 2014). Cutting forage trees at different seasons of the year (dry vs. wet season) and at different stages of development (flowering vs. vegetative) will also influence subsequent regrowth. On the other hand, trees are usually deep-rooted and therefore have access to moisture in the deeper soil layers. They may also be expected to have a large amount of reserves in stems and root system, which may not easily be exhausted.

5.0 NUTRIENT COMPOSITION OF *MORINGA OLEIFERA*

Table 2. Chemical composition of *Moringa Oleifera* parts (0% dry matter)

Nutrient	Leaves	Kernels	Fat free kernel meal
Crude protein	26.4	36.7	61.4
Lipid	ND	41.7	ND
Ash	8.87	3.8	5.65
Neutral detergent fibre	1.51	4.8	8.2
Gross energy (MJ/kg)	19.35	26.7	19.4

Source: Makkar and Becker, (1997)

In addition to the nutrient content shown in Table 2, *Moringa* leaves and pods contain high levels of vitamins and minerals.

Leaves per 100g contain 440mg Ca, 70mg P, 7mg Fe, 110mgCu, 5.1mg I, 11.300 IUpro-vitamin A, 120mg vitamin B, 0.8 mg nicotinic acid, 220mg ascorbic acid and 7.4mg tocopherol per 100g. Per every 100g, pod is reported to contain 30mg Ca, 110mg P, 5.3mg Fe, 184 IU pro-vitamin 0.2 mg niacin, 120mg ascorbic acid, 310mg Cu, and 1.8mg I (Makkar and Becker, 1997).The true protein of leaves (23% in DM) is potentially available in the animal's intestines. The seed kernel contains about 40% by weight of oil. The seed oil contains 9.3% palmitic, 7.4% stearic, 8.6% behenic, and 65.7% oleic acids among the fatty acids (Makkar and Becker, 1997). These nutrient levels are attractive for resource - poor and nutrient deficient rural small holder farmers, hence the reason for adapting *Moringa* to rural communities.

6.0 PROCESSING *MORINGA*

Moringa tree - harvested leaves ----drying leaves ----dry leaves ----Moringa powder

Fig 4: Moringa processing line

The harvested leaves must be washed and rinsed in clean water to remove any sand or dust. Leaves are manually stripped from branches and transported to the drying shade. The leaves are spread on screened trays that permit air circulation under a shaded area. During the dry season, two days are sufficient whereas in the wet season, up to six days may be needed for complete drying. When leaves are dry, they are crushed using a hammer mill with a finer screen. The leaf powder is then sealed in plastic bags or any other appropriate container. The stripped stems can be mixed with hay and fed to ruminants as a fattening diet.

Further reading

Gadzirayi (2014) The Nutritive Evaluation and Utilisation of *Moringa oleifera* Lam in Indigenous and Broiler Chicken Production: A Review. Greener Journal of Agricultural Sciences 4 (1): 015-021

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Makkar and Becker (1997) Nutrients and anti-quality factors in different morphological parts of the *Moringa oleifera* tree. Journal of Agriculture Science 128:311–322.

Maroyi (2006) The Utilisation of *Moringa oleifera* in Zimbabwe: A Sustainable Livelihood Approach. Journal of Sustainable Development in Africa 8: 172 – 185.

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Palada and Chang (2003) Suggested Cultural practices for Moringa. International Cooperator Guide 3:540-545. http://www.avrdc.org.11/10/12.

APPENDIX 9: TRAINING MANUAL FOR *TEPHROSIA VOGELII*

ABOUT THE MANUAL

The aim of this manual is to provide trainers; extension officers and lead farmers with a step-by-step guide and instructions on how to grow and use of *Tephrosia vogelii* in cattle tick control in an understandable, easy to follow and participatory manner. The manual is designed to guide trainers

through the training process, supporting them to better understand, design, organize, conduct and follow up on growing *Tephrosia vogelii* and use as cattle tick insecticides. This manual builds on several existing reports and manuals on growing and use of *Tephrosia vogelii*, combining them, and adjusting to the needs of the project. This manual is specifically prepared for the farmers in Gokwe South, Gokwe North, Zhombe, Shurugwi, Bindura, Mount Darwin, Guruve, Makoni, Mutare and Mutasa Districts under the LFSP Program. It can however, be used by anyone in related environments.

TRAIN-THE-TRAINER MANUAL

Growing *Tephrosia vogelii* for sustainable cattle tick control

Prepared by

AGRICULTURAL SUSTAINABILITY AND RESILIENT BUILDING CONSULTANTS

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APPENDIX 10:: TEPHROSIA PLANT PROFILE

Introduction

Environmental challenges resulting from the use of persistent insecticides are resulting in the increase use of rotenoid materials to take the place of insecticides. Increase concern over pollution, greater use could be made of natural ingredients such as rotenone, which presents little residue problem. *Tephrosia vogelii* is a potential source of rotenone and related rotenoids for in secticidal and piscicidal uses. Most of the rotenoids in T. vogelii are concentrated in the leaves.

General description

Scientific name: *Tephrosia vogelii*

English common names: *Fish bean, Vogel's Tephrosia*

Zimbabwean common names: *Chitupatupa*

TTephrosia vogelii *is* a leguminous shrub found in many areas of tropical Africa. It is capable of reaching a height of 2 to 3m in 5 to 7 months and is short-lived perennial (Fig-1). The composite leaves contain 7 to 12 pairs of leaflets. The leaflets contain 90 percent of the active ingredients which are rotenone and deguelin. Flowers are purple, red, or white in colour and are 2.5 cm wide. Pods usually contain 8 to 16 seeds. Tephrosia grows best in full sun. Under favorable conditions, *Tephrosia vogelii* grows quickly and is tolerant of repeated pruning. It is also tolerant of strong winds, drought and grazing. However, prolonged drought may slow re-sprouting. Burning has little effect on *Tephrosia vogelii* due to its deep root system. If the plants are weakly branched, they should be pruned (topped) to promote branching. Only the leaves need to be taken off the shrub when harvesting. If removed carefully, the shrub will continue to produce leaves for extract. *Tephrosia vogelii* takes about 2 to 3 months to first green leaf harvest and two to three years from planting to first seed harvest.

Soil requirements

- It can grow in light (sandy), medium (loamy) and heavy (clay) soils, prefers well-drained soil and can grow in nutritionally poor soil.
- Suitable pH: acid, neutral and basic (alkaline) soils and can grow in very acid soils (Tephrosia grows best on well-drained, loamy soil with a pH 5-6.5 and is tolerant of poor, acidic soils).
- It can fix Nitrogen, it can grow in semi-shade (light woodland) or no shade.
- It prefers moist soil and can tolerate drought.
- It is important that the site is not waterlogged, as Tephrosia does not do well on such sites.

Land preparation

- Construct basins measuring about 15 cm wide and 30–35 cm long (about the size of a man's foot) and 15 cm deep (about as deep as your hand) with spacing of 150cm between rows and 40cm within rows from the centre of one basin to the centre of the next basin.

Manure requirements

- Tephrosia grows best on well-drained, loamy soil with a pH 5-6.5 and is tolerant of poor, acidic soils.
- Put 1–2 drink cans of manure in each basin. This amounts to 3– 4 tons of manure per hectare.
- After applying manure partially fill the basins with soil.
- Leave the surface about 5 cm lower than the original ground level so water will tend to collect in the basin.

Sowing and germination

- Tephrosia should be sown at the beginning or middle of the rainy season as it produces the most foliage during periods of adequate moisture.
- Soak seeds in cold water for 24 hours or in warm water for 5 hours at 45°C before sowing to enhance germination.
- Tephrosia can be planted in rows or broadcast.
- For green-leaf harvest, the recommended spacing is 40cm x 40cm, with 2-3 seeds per hole; when planted as hedge also, the spacing should be 1.5m between the rows.
- For large plantations, when sown in rows, the recommended sowing rate is 5 kg/ha and when broadcast 8-13 kg/ha.
- Cover seeds 9 to 12 mm. in heavy soils and 12 to 20 mm in light soils
- Germination will start 8-10 days after sowing.

- Harvest fresh leaves from the Tephrosia plants *(leaflets contain about 80 to 90 percent of the total rotenoids, roots and stems have low content of rotenoid*).
- If removed carefully, the shrub will continue to produce leaves for future use.
- Harvest leaves by free hand.
- Yield is approximately 4 to 5 tonnes per hectare
- To extract the active ingredients, pound the fresh leaflets in a mortar.
- The crushing of leaves does not need to be done perfectly.
- The grounded leaflets are called paste.
- Soak approximately 50 g of pastes for every 100 ml water.
- After soaking the leaves in water for 12hours or boiling them for 30 minutes, filter the juice through a cloth

- Wash cattle using a cloth/spray animals with paste/extract of the plant. It is important that the sprays have direct contact with ticks.
- This treatment is effective up to seven days. After that time the spray must be repeated. If all of the spray is not used immediately, it will still be approximately 70% effective 24 hours later if kept out of direct sunlight. However, after 24 hours, the mixture quickly loses strength and efficacy.

Seed harvesting

Fig 2: Pods

Source:

- Seeds are dark brown to black
- Seed weight is approximately 50 g. per 1,000 seeds.
- The moderate-sized seeds (about 50 g. per 1,000 seeds) of T. vogelii remain viable for long periods under cool, dry conditions but deteriorate rapidly under warm, humid conditions.
- Peak seed production is between July and September. However, trees produce smaller quantities of seed throughout the rest of the year.
- Collect seed from as many trees as you can. If you only have a few trees available for collection, exchange a portion with your neighbours who have other trees. By doing this, a wide genetic diversity (biological variety) is kept in the planted material. This will help to ensure good tree performance and provide a safeguard against pests and diseases.

Collecting seeds

- Pick the brown pods with the ripe seeds directly from the shrub.
- Dry collected pods in the sun for 2 to 3 days until all of them are open.
- Thresh the pods lightly to release the seeds
- Separate the seeds from the pod fragments by sieving and winnowing.

Storing seeds

- If seeds are to be stored, it is best to dry them for at least 3 to 4 days under shade.
- They do not need to be dried if they are sown within two months of harvest.
- Dried seeds can be stored for more than 1 year, if kept in sealed containers in a cool dry area.
- The moderate-sized seeds (about 50 g. per 1,000 seeds) of T. vogelii remain viable for long periods under cool, dry conditions but deteriorate rapidly under warm, humid conditions.

Advantages of *Tephrosia vogelii*

- The chemical in the leaves is called rotenone, is classified by the World Health Organisation as a moderately hazardous or Class II pesticide. Tephrosia, unlike most synthetic pesticides, it leaves no residue because rotenone breaks down within 3 - 5 days after application.
- T*Tephrosia vogelii* takes three months to mature. It is also good as a shade or boundary crop and can be planted between rows of other plants or around the circumference.
- It can adapt many different climates and weather types.
- T*Tephrosia vogelii* seeds are typically sold for around $0.20 per kg, which is very inexpensive compared to most other crop seeds offered on the market.
- It can adapt to many different climates and weather types.
- Since it is highly adaptable, without pesticide and chemical treatment, the seedling survival rate is 60%.
- It is tolerant to pruning, drought, strong wind, and grazing.
- However, drought often stops it from re-sprouting, so the more water it has, the more successful it will be for future use.

WARNING: Please note that Tephrosia is dangerous to fish, humans, domestic animals and wildlife. When using Tephrosia, try to keep the extract away from your skin or use gloves if available. Wash hands with soap as soon as you have finished applying it on animals. Do not use Tephrosia to poison fish, or dispose of it in water courses.

APPENDIX 11. SUMMARY OF THE TRAINING SESSIONS

Province	District	Implementing partner	Date of training	Stakeholders	Number trained	Male to female ratio	Facilities available at the household
Midlands	Gokwe south	WHH	26/10/2020	Agritex Local government Farmers WHH/Extra	44	19:25	Livestock, field and indigenous chickens
	Gokwe North	WHH	27/10/2020	Agritex Local government Lead farmers WHH/Extra	15	10:5	Livestock, field and indigenous chickens
	Kwekwe	WHH	29/10/2020	Agritex Local government Farmers WHH/Extra	16	6:10	Livestock, field and indigenous chickens
	Shurugwi	WHH	2/11/2020	Agritex Local government Farmers WHH/Extra			Livestock, field and indigenous chickens
Mashonaland central	Bindura	Enterprise	3/11/2020	Agritex Local government Farmers Enterprise			Livestock, field and indigenous chickens
	Mt Darwin	Enterprise	3/11/2020	Agritex Local government Farmers Enterprise			Livestock, field and indigenous chickens
	Guruve	Enterprise	5/11/2020	Agritex Local government Farmers Enterprise			Livestock, field and indigenous chickens

Manicaland	Makoni	Practical action Inspire	9/11/2020	Agritex Local government Farmers Practical Action/Inspire			Livestock, field and indigenous chickens
	Mutasa	Practical Action inspire	11/11/2020	Agritex Local government Farmers Practical Action/Inspire			Livestock, field and indigenous chickens
	Mutare	Practical action Inspire	13/11/2020	Agritex Local government Farmers Practical Action/Inspire			Livestock, field and indigenous chickens

APPENDIX 12: ITINERARY FOR DEMO SET UP

The itinerary shows the dates for the exercise from its start to its end.

Dates	**Activity**	**Output**	**Resource persons**
26/11/20	Travelling to Bindura	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
27/11/2020	Demonstration set-up in Bindura District *10	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
28/11/2020	Travelling to Mount Darwin		CT Gadzirayi

			R. Mandumbu E. Zivenge
29/11/2020	Demonstration set up in Mount Darwin *10	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
30/11/2020	Travelling to Guruve		CT Gadzirayi R. Mandumbu E. Zivenge
1/12/2020	Demonstration set up in Guruve *10	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
2/12/2010	Travelling to Gokwe		CT Gadzirayi R. Mandumbu E. Zivenge
3/12/2020	Demo set up in Gokwe South *10	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
4/12/2020	Demonstration set up Gokwe North * 5	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
5/12/2020	Demonstration set up in Gokwe North*5	Demonstration set up	CT Gadzirayi R. Mandumbu

			E. Zivenge
6/12/2020	Travelling to Kwekwe		CT Gadzirayi R. Mandumbu E. Zivenge
7/12/2020	Demonstration set-up in Kwekwe *5	Demonstration set up*5	CT Gadzirayi R. Mandumbu E. Zivenge
8/12/2020	Demonstration set up in Kwekwe *5	Demonstration set up in Kwekwe	CT Gadzirayi R. Mandumbu E. Zivenge
9/12/2020	Travelling to Shurugwi		CT Gadzirayi R. Mandumbu E. Zivenge
10/12/2020	Demonstration set up in Shurugwi *5	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
11/12/2020	Demonstration set up in Shurugwi*5	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
12/12/2020	Travelling to Makoni		CT Gadzirayi R. Mandumbu E. Zivenge

13/12/2020	Demonstration set-up in Makoni *5	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
14/12/2020	Demonstration set up in Makoni*5	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
15/12/2020	Travelling to Mutasa		CT Gadzirayi R. Mandumbu E. Zivenge
16/12/2020	Demonstration setup in Mutasa *5	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
17/12/2020	Demonstration setup in Mutasa *5	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
18/12/2020	Travelling to Mutare District		CT Gadzirayi R. Mandumbu E. Zivenge
19/12/2020	Demonstration set up in Mutare *5	Demonstration set up	CT Gadzirayi R. Mandumbu E. Zivenge
20/12/2020	Demonstration set in Mutare*5	Demonstration set up	CT Gadzirayi

			R. Mandumbu E. Zivenge
21/12/2020	Travelling to Harare		CT Gadzirayi R. Mandumbu E. Zivenge

APPENDIX 13: DISTRICTS VISTITED

Bindura District

The team visited Bindura district on the 26th to the 27th of November, 2020. The level of preparedness is shown on Table bellow:

Farmer name & contacts	**Ward**	***Moringa* feed demo**	**Biochar demo set-up**	**EEthnoveterinary demo**
Fred Moyo (27/11/20)	11	Sites for *Moringa* planting were identified. Construction of chicken run was still to be constructed.	Biochar made using locally manufactured pyrolysis. Biochar fertilizer already made and applied to plots. Glyphosate to be applied for weed control. Planting was the pending activity.	Animals were identified and cattle handling facilities constructed. Site for *Tephrosia* planting was identified.
Mr Tigere (27/11/20	12		Planting plots were prepared. Biochar still to be made.	
Mr Shonhiwa	12	The chicken run was available but needed partitioning into sections that handle all the chicken classes.		Cattle to be used in the demonstration were identified. Cattle handling facilities constructed. The site for *Tephrosia* planting prepared.
Mr Muchabaiwa (27/10/20 and 28/10/20)	14	The chicken run needed partitioning. Chicks, growers and layers were already available.. Date set for partitioning is 30/11/20	Field set up done and planting stations made. Biochar still to be made.	

Mr Chifungo	17	Chicken house already built. The three chicken groups available. Subdivisions for the various types of chickens were still to be done. The farmer gave 5/11/2020 as the deadline to have done all the pending activities.	Field was identified. Planting holes still to be made. Biochar making still to be done. Date set for the pending activities was 30/11/2020	Cattle available together with cattle handling facilities. Sites for planting tephrosia was identified and planting stations marked
Ruzvidzo	17		The farmer will host the cowpeas demonstration plot. Land prepared. Biochar was not yet made.	

Mount Darwin District

Mount Darwin district was visited on the following dates: 28 – 29/11/2020. The state of their preparedness is shown on the table below.

Farmer	**Ward**	***Moringa* feed demo**	**Biochar demo progress**	**Ethnovet demo**
Takasora M	32		Plots and planting holes were already made. Biochar was being made during the visit. Level of preparedness was high	The cattle were identified and marked. Cattle handling facilities already made.
	32	The chicken house was already prepared with proper subdivisions for the three chicken groups. The farmers were waiting for the feed which was still to be delivered by the implementing partner.		
Chihanzu Tahwinha (0777195897)	**4**	The chicken was built and all the chicken groups available for commencement of the demo. Feed was still to be delivered by the implementing partner. The site for *Moringa* planting was identified and prepared.	Plots and planting holes were already made. Biochar still to be made. The implementing partner was yet to deliver seed. The final date for setting demonstrations was set at 9/12/20	Cattle for tick control demos were identified and marked. Cattle handling facilities were not ready and the farmer gave 10 December as the final date for making the handling facilities. Site for *Tephrosia* planting were identified.

Mr Mudzonga	5	The chicken houses were fully prepared with partitions already made. The implementing partner was still to deliver the feed. All the three groups of chickens required for the demo were available. The final date for the setting up the demo was 15th of December 2020.	Pyrolysis machine already made and biochar fully prepared. The biochar quantity was however inadequate and more needed to be made. The final date for setting up of the demo was set at 4 December 2020	Site for planting of Tephrosia was already identified and planting stations marked. Cattle for the demo were identified and marked. The cattle handling facilities were already present.

Guruve District

Guruve district was visited on the following dates: 29 – 30 November 2020. The results of the level of preparedness is shown on the table below**.**

Farmer name and contact	**Ward**	***Moringa* chicken feed progress**	**Biochar demo progress**	**Progress on ethnovet demo**
Mrs Honye	7	The site for *Moringa* planting was identified and prepared. The three chicken groups needed for the demonstration plot were identified and available. The chicken house was already constructed but needed partitioning	Plots prepared but the space could fit two plots so the famer was to make more plots. Biochar still not prepared. The farmer promised to plant by 8 December 2020. The seed was still to be delivered by the implementing partner.	The farmer had no livestock
Mr Karize	12	The farmer has adequate growers and layers but did not have chicks. He promised	Biochar was already made and manure was also available. Planting stations were made	Cattle were identified. The cattle handling facilities were already in

		to source the day old chicks. Chicken house was already there. The site for *Moringa* planting was identified and set up.	and field prepared. Seed was still to be delivered by the implanting partner.	place. The cattle for the demos were marked. The space for *Tephrosia* planting was identified and prepared.
Mr Muchiwa Godnas	8	The chicken house was already built. Partitions were still to be made and the three groups of chickens were all available. The area for planting of Moringa was already identified and prepared.	Biochar was already made and biochar natural fertilizer was already made. Seed had been supplied so the farmer was planting the demo the day we made the visit.	Cattle were identified and marked. Site for Tephrosia planting was also identified.
Mr Chiwore	6	The chicken houses were already there but had not been divided. The three groups of chickens were there at the farmer's premises but the demonstration had not yet begun.	Land was identified but not prepared. Biochar still to be made. Planting stations not yet made. The final date set for planting was 10/12/2020	Tephrosia was not yet planted. Although the site was identified marking of planting stations had not yet begun. The farmer gave a final date for the planting as 10/12/2020
Jurity White (0779171385)	20	All the three groups of chickens were available. The chicken houses were made but still needed to be subdivided. Moringa planting was still to be done.	Biochar had not been made but sova was available. Planting holes made by the farmer. Final date for setting up of the demo was 10/12/2020	The cattle were available and the handling pens were available. Tephrosia planting land had not been prepared.

Gokwe South District

Name of farmer	**Ward**	***Moringa* chicken feed demo**	**Progress of biochar demo**	**EEthnoveterinary demo progress**

Obert Mapani (0714640538)	9	The chicken feed was delivered but the demo had not started. The final date for the planting of Moringa and the start of the demo was 9/12/2020	The land had been prepared but biochar had not been prepared. The final day for the planting was 15 December 2020. Seed had been delivered.	The farmer had not prepared the site for Tephrosia planting. The cattle pens were already made and the cattle had been selected for the demonstration.
Chikozhero Charles	12	Moringa planting site was identified but still needed to be planted. The three groups of chickens were available but the pens needed divisions.	The land had been prepared. Biochar was made but awaited mixing and putting on the field.	The site for the planting of Tephrosia was identified but planting were still to be done. Cattle and the cattle handling pens were available.
Tete Tavengwa (0773704890)	13	The chicken houses were ready although they needed subdivision. All the chicken groups were present. The feed had been delivered and was awaiting mixing	The land had been prepared and biochar was still to be made. The final date for planting was set at 11 december 2020	The site for Tephrosia planting was identified but needed to be prepared.
Masukume W	16	All the three chicken groups were present at the site. The chicken houses were ready waiting to be subdivided so that the demonstration could start. Moringa was planted and had not yet germinated.	The biochar demonstrations were already planted and the ceops were emerging.	Tephrosia had already been planted and was awaiting germination. The cattle were identified and marked.
Masveure (0775434367)	16	Chicken run already constructed but needed subdivision. The various chicken groups were present. The demo setting date was set at 7/12/2020	Biochar had already been made and planting stations already done. Planting to be done by 7/12/2020	The site for planting Tephrosia had been identified. The cattle for the demo were identified and marked.

Njelele Margaret	15	All the chicken groups were present at the site. The chicken houses had been prepared although they needed further division to accommodate the various chicken groups. Feed had been delivered.	Plots for biochar had already been made. Biochar had been made and the final date for planting was set at 8/12/2020	The site for Tephrosia planting had been prepared although the tree seeds had not been planted. The cattle had been identified and marked.
Tsvangirai	19	The three groups of chickens were present at the site. The chicken houses were already made. Feed was delivered the same day of our visit and the final date for the setting of the demo was 8/12/2020	Biochar had been made and the planting stations already made. The final day for the planting was set at 8/12/2020	Tephrosia site had been identified and prepared but planting had not been done. Cattle for the demo were identified and marked
Simbarash Ndabambi	9	The three groups of chickens were available for use and the feed delivered. The chicken houses still needed some subdivisions for all the three sub demos to be carried out.	Biochar had been made. Planting stations were ready and the seed was delivered.	The site for planting Tephrosia had been identified. Planting tstiona have been made. The cattle handling pens were ready and the cattle for use in the demo had been identified and marked.
Ncube Lotshiwe	17	Chicken houses were available and feed was delivered the same day of our visit. The final day foe the set-up of our demo was 20/12/2020	Biochar had been made and all plots were ready for planting. Seed had been delivered and the final date for setting up of the demo was 12/12/2020	The site for Tephrosia had been prepared and the seed was delivered the same day of our visit. Cattle and all the handling facilities had been prepared. The final date for the setting up of the demo was 15/12/2020
Rumbidzai Tafirei	32	All chicken groups identified and the demos were to start in 20/12/2020	Biochar was ready and the planting station ready. The final	The site for Tephrosia planting was prepared. Plantig stations were made. Cattle for the

			date for the setting out of a demo was 15/12/2020	demo were identified and the final date for the demo was set at 22/12/2020

Gokwe North District

Farmer name	**Ward**	***Moringa* chicken feed demo**	**Biochar demo**	**Tephrosia demo progress**
Tendeukai Chigora (0784963168)	36	The three groups of chickens were available. The chicken feed were delivered to the farmers and awaited mixing. The chicken houses were built and subdivided.	Biochar had been made and planting stations for the planting maize and cowpeas were made.	Tephrosia had not been planted. The cattle for use in the demo were identified and tagged.
Mrs Gopoza (0783848037)	36	The chicken feed was delivered but was still to be mixed. The three chicken groups were identified and chicken houses still needed to be divided for the respective classes of chickens	The land had been prepared and planting stations marked. Biochar fertilizer was still to be made. Seed had been delivered.	Tephrosia seed had not been planted but the site was identified. The cattle for use in the experiment were identified and tagged. The cattle handling pens needed to be repaired.
Mr Mukuwani T (0782092001)	36	The chicken houses needed to be subdivided. The three groups of chickens were available. The site for Moringa Planting was identified and prepared.	Biochar has already been made using a homemade pyrolysis machine. The planting stations have already been made. Seed had been delivered and the farmer was ready for planting.	Tephrosia still needed to be planted. The site was identified and planting stations made. The final day of planting was set at
Ngwaru Makurumure(0776152405)	7	Moringa planting was still to be done. The three chicken groups were	The planting stations were ready but biochar was still to be made.	The site for Tephrosia planting was identified and planting stations

		available and the feed was delivered on the same day of the visit. Chicken houses were still to be subdivided.	The seed was delivered on the same day of our visit. The final day set for the demo was 12/12/2020	marked. Cattle for the demo were identified and tagged. The final day for demo implementation was 15/12/2020
Victor Machingura (0774414731)	36	The chicken groups were ready. The feed was delivered and the chicken houses were ready but needed subdivision.	Biochar had been prepared and land prepared for planting. The final date for demo setting was 15/12/2020	Tephrosia planning site had been identified. The cattle for the demo were ready.
Chindedza Enock (07130771306381	36	The chicken houses were ready and the three groups of chickens were available. The final day for the demo start was set at 18/12/2020	Biochar had not been made. All the plots were marked and seed was delivered. Final date for the setting up of the demo was 12/12/2020	Tephrosia planting site was identified and the cattle for the demo were ready.
Chabuda Vimbai 0784147798	14	The chickens for the demo were available. The feed was delivered the same day of the visit. The feed needed to be mixed. Chicken houses needed subdivision.	The biochar was still to be made. Planting stations were ready. the seed had been delivered and the final day for demo setting was 15/12/2020	Tephrosia site had been identified. Cattle for the demo were identified and tagged.
Hosiah Mangena	36	The three chicken groups needed for the demo were identified. The chicken houses were ready. The final date set for the demo was 26/12/2020	The biochar had not been made. Planting stations were ready. The final date for demo setting was 18/12/2020	Tephrosia planting site had been identified. Cattle for the demo were identified and tagged.

Kwekwe District

Name of famer and contact	**Ward**	***Moringa* chicken feed demo**	**Biochar demo progress**	**Progress on ethnoveterinary demo**

Monica Mapfumo	10	All chicken groups were available. The final date for the establishment of the demo was 10 December 2020	Biochar was successfully made and applied to the plot. All demonstration plots were already set up. Seeds were to germinate.	Tephrosia seed was already planted and awaiting germination .The cattle pens were ready and cattle handling facilities were already fitted.
Bridget Magutshwa 0779957172	12	All chicken classes were available. Moringa feed had been delivered. Chicken houses were ready but the demo had not kicked off. The final date for starting of the demonstration plots was 15/12/20	Land was prepared. Bichar was still being made. Planting had been delayed due to excessive rains.	Cattle were available and the site for planting of Tephrosia was already identified. The cattle handling facilities were already constructed.
Ntutuko (0715850167; 0785999673	12	The chicken houses were still to be subdivided. All chicken classes were available and the final date set for the setting of the demo was 15/12/2020	Plots were already made for planting demos. Biochar was not yet made. The final date for planting was set as 15th of December, 2020.	Site for Tephrosia planting identified. Cattle pens were constructed together with cattle handling facilities.
Oppar Dube 0777599788; 071732655	10	The chickens were available for the demo. The feed was delivered but the chicken houses were still to be constructed. Site for planting Moringa was identified and prepared. Final date for set up of demo was 15/12/2020	Plots were made correctly. Biochar was still to be made and the final date for setting of the demo plots was 15/12/2020	Site for planting Tephrosia was identified but had not been prepared. Cattle were available for the setting up of the demo.
Ntabeni Ncube Reflev	13		Biochar demo plot was prepared and planted. Not yet germinated. Plots were correctly prepared.	
Nyatsanza (0774580950)	5	Moringa site was identified and final date for planting was set at 1/01/2021. The feed had been delivered and awaited mixing as a group.	Biochar had already been made. Planting stations had been prepared. Final date for planting of demos was set as at 21/12/2020.	The site for planting the Tephrosia was identified and the final day for planting was set at 18/12/2020. The cattle for use in the demo were identified and marked.

Chenesai Maphosa (0779957172)	12	All the chicken groups were available. The chicken houses were ready for the demo. Chicken feed still needed to be mixed. The final date for the demo setting was set at 22/12/2020.	The biochar demo had been set and planted. The crop had germinated	The site for Tephrosia planting had been prepared. Animal for the demo were identified and tagged. Final day for the planting of the tephrosia was set as at 18/12/2020.
Angela Zhou	10	The chicken groups for the demo were available. The feed had been delivered but had not been mixed. Final date for the setting of the demo was 20/12/2020.	Biochar had been made and planting done. The crop had germinated.	Tephrosia seed had been planted and awaited germination. Cattle for the demo were available.
Revai Tembo	10	The chicken for the demo were available together with the necessary housing. The demo set up date was set as at 20/12/2020	Biochar had been made and planting done and crop awaited germination.	Tephrosia for the demo had been planted and yet to germinate. Cattle for the demo were ready.
Amos Mbiva	13	All the aspects needed for the setting up of the demo were ready. The final date was set at 22/12/2020	Biochar had been made and planting of the two crops was also done.	Tephrosia had been planted and awaited germination.

Shurugwi District

Farmer name and contact	**Ward**	***Moringa* feed demo progress**	**Progress of the biochar demo**	**Progress of the Tephrosia demo**
Mrs Mhlanga	10	The chicken demo was already running. The three groups of chicken were already feeding under the demo set-up.	All the crop demos already planted and germinated. The maize crop needed to be thinned. The sunflower were being	Tephrosia had been planted but had not germinated yet. Cattle for the demo were identified and marked.

			destroyed by chickens and the farmer was advised to do gap filling.	
Mrs Musipa	11	The three groups of chickens were present at the site. The feed had been delivered.	Plots were measured. Planting stations not yet made. Biochar not yet already made. Final day for planting was set at 12/12/2020	Tephrosia had not yet been planted. Cattle for use in the demo were identified and marked.
Manyiwa E (0777342760)	20	The chicks were already feeding although other chicken classes required to be set up.	Biochar had been made although the farmer had biomass to make biochar. Land had been prepared. The final day for the setting up of the demo was 17/12/2020	Tephrosia had not been planted although the site was prepared. The cattle for use in the demo were identified and marked
Lina Muzeza (0719153572)	20	The three groups of chicken were available but the demo had not been set.	The plots were made but no planting had been done yet. Biochar had not been made	Tephrosia had not been planted. The site had however been identified.
Chinembiri (0774458595)	9	Two groups of chickens were present and these are the layers and the growers. The chicks were not available. The feed had been delivered. Moringa was still to be planted although the site had been identified.	Land was prepared but the biochar had not been made. Biochar making was to be done in three days time. The final day for planting was 15/12/2020	Tephrosia had not been planted. The site had been identified. The final date set for planting tephrosia was 15/12/2020. Cattle had been identified and marked.
Chitengedza	9	The chicken run was present and all the chicken groups were also present. The	Biochar not yet preapared. The planting stations had been prepared. The final	Tephrosia had not been planted although the site was identified.

		feed had been delivered but the demo was still to start.	date for the setting of the demo was 17/12/2020	The biochar had been made and waited application into the field
Musindo Priscilla (0783484234)	8	The farmer had prepared the demo wrongly and it corrected. Final day for the setting of the demo was 20/12/2020	Maize and sunflower had been planted without biochar ad the farmer was instructed too correct the demo and apply biochar for easier comparison. Final day for planting was set at 15/12/2020	Tephrosia had not been planted. The site for planted had however been identified and needed. The livestock had been marked but the demo had not started.
Muhwandavaka Todd (0714078556)	7	All the chicken groups were available but the chicken run needed further division. Moringa was still to be planted although the site had been identified.	Plots for the demo had been made correctly made. Biochar was still to be made.	Tephrosia had not been planted but the site had been identified. The cattle pens had handling facilities and the cattle had been identified and marked.
Mapuma Soma	10	The Moringa feed demo had not been started. The farmer was helped on hoe to set the demo as he had not received training. The chicken groups were present for use in the demo.	The biochar was still to be made. The planting stations had been marked and the planting stations made. The final date for the setting up of the demo was 15/12/2020	Tephrosia had been planted but yet to germinate. The cattle for the demo had been identified and marked.

Makoni District

Farmer name	Ward	Moringa feed demo progress	Progress on Biochar demo	Progress on ethnoveterinary demo
Anna Mpotsa (0777723404)	20	All the three chicken groups needed for the demo were available. The chicken are available and needed subdivision. The date set for the demo is 23/12/2020	Biochar was being made at the time of the visit. The final date for planting that was set is 19/12/2020	Tephrosia already been planted. The cattle have been identified for the demonstration. The cattle handling pens are available. The nimals have been identified.
Mr Chandiringa (0775960337)	10	All the chicken groups were available. The chicken houses were ready and the feed had been delivered and awaited mixing.	All the crop demos were already set and was awaiting germination. It was verified that they had applied the correct rates of biochar and manure.	Tephrosia seed had been planted and awaited germination. The cattle pens were properly constructed. The cattle were identified and marked.
Mr Zumba (0773619927)	18	The chicken houses were ready and the feed had been delivered and awaited being mixed. All the chicken groups were ready. Moringa seed still to be planted.	The maize and cowpeas had been properly planted and awaited germination.	Tephrosia site had been identified but still needed to be planted. The cattle to be used in the demo had been identified and tagged.
Mrs Makina Josephine Muchakwanya (0712798604)	39	All the chicken groups were identified. The houses were divided and were ready for the start of the demo.	The biochar demos were already planted and awaited germination. All the stages had been done properly.	Tephrosia seed had been planted and awaited germination. The animals which were to take part in the demo were identified and tagged.

Gutu Hennington (0779939848)	25		All the crops were planted and the rates of biochar application were correctly done. The crops had germinated.	The site for Tephrosia had been identified and planted. The trees awaited germination. The animals for the demo were identified and tagged.
John Mugorosa	25	All the chicks were available and ready for the start of the demo. The chicken feed was delivered the same day we assessed the readiness of the farmer. The fnal date set for the start of the demo is 19/12/2020		
Ganyara (0785180892)	7	Moringa was planted on 16/12/2020. The chicken were ready for the demo. The chicken groups needed were all available at the demo site. The feed had been delivered and awaited mixing.	Biochar had been made and awaited application in the field. The planting stations already made. The final date for the implementation of the demo was 20/12/2020	Tephrosia had been planted on 9/12/2020. The animals for use in the demo had been prepared and tagged.
Mutumwa Matemai(0717925258)	35	Moringa seeds had been planted on the 8/12/2020. The chicken groups were available for the demos. The feed was still to be mixed.	Maize and cowpeas demos had been planted on 8/12/2020. The crop had germinated and awaited thinning.	Tephrosia had been planted on 8/12/2020. The animals for the demo had been identified and tagged.
Chavhunduka (0716262632)	2	Moringa planting site had been identified. The final date for planting of Moringa was 19/12/2020. All the three chicken groups were available and all the chicken houses were read for the rolling out of the demo.	Maize and cowpeas had been planted on the 8/12/2020. The demos were correctly done.	Tephrosia was to be planted on 18/12/2020. The animals were identified and tagged. The cattle handling pens were available.

Chinembiri (0774458595)	9	Moringa had been planted a week before our demo setup visit. The feed had been delivered but awaited mixing as they needed to do it as a group.	Biochar demo plots had been set up on 15/12/2020. The demo were done correctly and the farmers had prepared	Tephrosia planting had been done on the 14/12/2020. Animals for the demo had been identified and prepared and tagged.

Mutare District

Farmer name	Ward	Moringa Chicken feed demo	Biochar demo	Tephrosia demo
Emily Chishakwe (0774706783)	15	The feed had not been delivered. The chicken houses had been prepared. All the three chicken groups had been secured.	The biochar demo already set and had germinated. Weeding and thinning were two pending activities	Tephrosia had been planted but was still to germinate. The animals for use in the demo had been identified and tagged.
Remeredzai Musidzaramba (0771858316)	14		The biochar demo were already set and planted. The demo had germinated and awaited thinning. Crops planted were sorghum and sunflower.	
Collins Mukwaya (07770044166)	21	The chicken groups needed for the demo were all available at the farmer's household. The *Moringa* seeds had been planted. The chicken houses were all set and ready for the demo. The feed had been delivered and needed to be mixed as a group.	All the biochar plots already planted and germinated. They awaited weeding and thinning.	Tephrosia had been planted and the germination rate was very low. The farmer was given supplementary seed. The animals for the demo were identified and tagged.
Sheilla Yaya (0777773841)	20		All the biochar demos were set and had germinated. They awaited thinning and weeding.	Tephrosia had been planted. The catle for use in the demo had been identified and tagged. Poor germination of Tephrosia was a challenge and we added more seed to the farmers.

Jichidza Tsverukai (0773882447)	20	All the chicken groups were at the place. The chicken houses were all ready for the demo. The feed had been delivered and awaited mixing as a group		
Gwizo (0773374504)	8	The feed had been delivered and all the three groups of chickens were available on the trial. The final date set for the demo was 20/12/2020	Sorghum and cowpeas had been planted on the 13/12/2020 and germinated. The crop in the demos awaited weeding and thinning.	Tephrosia was still to be planted. The final date set for the planting of the demos on tephrosia was 20/12/2020. The cattle had been identified and tagged.
Mupobwa Tephros (0771280081)	28	The chickens groups that were needed for the demo were already with the farmer. The feed had been delivered and needed to be mixed as a group. The final date set for the demo is 20/12/20	The Biochar demos had been planted and germinated. The crops awaited thinning and weeding. The correct rates of manure and biochar natural fertilizer had been applied.	*Tephrosia* had been planted on the 5th of December 2020. The cattle for use in the demo had been identified and tagged.
Gawure (0775975478)	25	The three groups of the chickens needed for the demo were available. The feed had been delivered and awaited mixing. The demo was poised to commence on 20/12/2020.	The biochar demos had been planted on 11/12/2020. The crops had germinated and needed some weeding and thinning.	Tephrosia had been planted om 15/12/2020. The cattle for the demo were identified and tagged waiting the commencement of the demo.
Dzikiti (0775633427)	8	The chicken housed had been constructed but it needed further subdivision. The feed had been delivered and needed to be mixed by the whole group.	The demo plots for biochar had been planted and the crop had germinated. The crop needed to be thinned and weeded.	Tephrosia had not been planted and the date set for the planting of Tephrosia was 28/12/2020. The animals for the demo had been identified and tagged.
Mufudzi Makiwa (0776555407)	31		The biochar demos had been planted on the 11th of December 2020. The crops had germinated and they needed thinning.	Tephrosia had not been planted and the final date set for the planting of the demo was 18/12/2020. The cattle pens and handling facilities were available.

Mutasa District

Farmer name	Ward	*Moringa* chicken feed demo	Biochar demo	Tephrosia demo
Mupeti (0775865960)	14	The chickens were available for the demos. The demos were to start on 19/12/2020	The biochar demos had been set up and the crop had germinated and needed weeding and thinning. The farmers had applied the correct fertiliser quantities.	Tephrosia had not been planted. The final date set for planting the Tephrosia was 19/12/2020. The animals for use in the demo were identified
Christine Duri (0775244604)	15	All the three groups of chickens were available. The feed had been delivered but it needed to be mixed. The chicken house needed to be subdivided.	The biochar demos were already planted and had germinated. The crop needed weeding and thinning.	Tephrosia had not been planted and the final day fro plannting was 22/12/2020. The cattle for use in the demo had been identified.
Gutu PC (0785300596)	12	All the three groups of chickens needed for the rail were available for the demo. The demo was given 23/12/2020 as the final date for the implementation of the demo.	The biochar demo had been planted. The maize and sunflowers had already germinated and needed to be weeded and thinned.	Tephrosia had been planted but had not germinated. The cattle for use in the demo were identified and tagged.
Mrs Manhivi Shylet (0773630789)	11	The three groups of chickens were available. The feed had been delivered and needed mixing. Subdivisions needed to be done on the chicken houses.	The plots planted for the biochar were very small. The crops had germinated and needed weeding.	Tephrosia planting had not been done and the final date for that was 18/12/2020
Mrs Choice Murinda	24	The chicken houses were ready. The three groups of chickens required for the demo were all present. The demo was set to begin on the 20th of December 2020.	Biochar demos were all planted and weeded.	Tephrosia had been planted and poor germination had been realised. More seed was added to her to replanted the sections which had not germinated properly.
Mufiri (0782551456)	24	All chicken groups were available for the demo. *Moringa* feed had been delivered but still to be mixed. The chicken houses were ready for the demo whose final date for starting was 20/12/2020	All crops were planted on 1/12/2020. The crops had germinated.	Tephrosia seed had been planted on 15/12/2020. The cattle for the demos were available and the cattle handling facilities were available and ready for the start of the demo. Start date was set at 15/01/2020

Mwavurudza (0782088768)	31	The feed had been delivered. The three groups of chickens were available. The chickens were to start feeding on 18/12/2020	All the biochar demos had been planted on 2/12/2020. The crops had germinated and needed weeding and thinning.	Tephrosia had been planted and poor germination was realised. The animals for the demo were identified and tagged.
Mwandura 0787782994)	5	The feed had been delivered but needed mixing. The three groups of chickens were available at the farmer's premises.	Maize had been planted on 27/11/2020 whilst sunflower is still to be planted.	Tephrosia were planted. The demo will start on 27/02/2020. The animals for the demo were ready and tagged.
Dandama	31	Everything was ready for the chicken demo. Feed had been supplied and needed mixing. The final date set for the demo is 18/12/2020	The crops were planted on 12/12/2020. The crops had germinated and the rates used for applying manure and biochar were the same.	Tephrosia had been planted on 03/12/2020. The cattle for the demo were available.
Jamwanda (0783829667)	18	Everything was ready for the *Moringa* chicken feed demo. The feed had been delivered. The final date for the staring of the demo was set at 23/12/2020	Biochar was still to be produced. Planting was to be done on 21.12.2020	Tephrosia was planted on the 10/12/2020. Animals for use on the demo were identified and tagged.