Evaluation of the feed resources and analysis of body condition scores of local pigs in a semi-arid smallholder farming area of Zimbabwe

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A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in Animal Science

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2006

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ABSTRACT

Evaluation of the feed resource base and analysis of body condition scores of indigenous pigs in a semi-arid smallholder farming area of Zimbabwe

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The objectives of this study were to characterise the types, seasonal distribution, and nutritive value of feed resources and growth performance of local pigs in Chinyuni ward, Chirumanzu district. Pig herd sizes were (mean ± sd) 3.3 ± 2.73, with 90% of pigs being scavengers. Consumption of pigs accounted for 98 %, sales (91%), manure production (98 %) and social functions (11%) of the production objectives. The major feed resources were brewers' dried grain (BDG) (36%), kitchen waste (34 %), watermelons (27 %), *Commelina benghalensis* (30 %) and *Richardia brasiliensis* (16 %). *Commelina benghalensis* had the highest CP concentration of 234.4 g/kg; *R. brasiliensis* had 134.7 g/kg of CP while BDG had a better amino acid profile. There were differences ($P < 0.05$) in the body condition scores of pigs and between months for each sex. Females had an average BCS (mean ± sd) of 2.5 ± 0.86, whilst that for males was 3.1 ± 0.80. The major constraints to pig production were inadequate feed (99 %), lack of technical assistance (69 %), and shortage of building materials (40 %). The results indicate that pig production plays an important role in giving rural people access to food; however, productivity of pigs in Chirumanzu was low.

DEDICATIONS

"Of all occupations by which gain is secured there is none better than agriculture, nothing more productive, nothing more worthy of a free man" Cicero

To my late mother, Mrs A. T. Chikwanha, my family and Mr. E. R. H. and Mrs. L. L. Madimu.

ACKNOWLEDGEMENTS

I express my gratitude to RUFORUM for funding this project. I thank my supervisors, Mr. T. E. Halimani, Professor M. Chimonyo and Dr. E. Bhebhe for the guidance and assistant in my project.

My sincere gratitude goes to the Chirumanzu community for cooperating and allowing the use of their district as a project site. Many thanks go to the staff of the Department of Animal Science for their technical assistance.

I also like to thank my family for being there. To Mr. and Mrs Madimu and family, I don't know where I will be if it wasn't for you. You were there from the day I stepped into a classroom and I am now leaving the doors of university; you are still there, MAY THE ALMIGHTY BLESS YOU ALWAYS. To my classmates (2004-06), guys what would a Masters' class be without you. Lastly, I would like to thank all those who are not mentioned here but have been there for me.

AND TO THE ALMIGHTY FOR GIVING ME THE CHANCE TO EXPLORE AVENUES THAT I HAVE ALWAYS DREAMT OF

THANK YOU!

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LIST OF ABBREVIATIONS

ADF = Acid detergent fibre

BCS = Body condition score

BDG = brewers' dried grain

CP = Crude protein

CSO = Central Statistical Office

DE = Digestible energy

DM = Dry matter

EE = Ether extract

FAO = Food and Agricultural organisation

g/ kg = Grams per kilogram

g/ kg MJ DE = Grams per mega joule of digestible energy

GE = Gross energy

GLM = General linear model

MJ/ kg = Mega joule per kilogram

NDF = Neutral detergent fibre

SAS = Statistical Analysis System

SD = Standard deviation

SEM = Standard error of mean

SPSS = Statistical Package for the Social Sciences

CHAPTER 1

1 INTRODUCTION

Eighty per cent of the world's poorest people earn their living directly or indirectly from agriculture (Food and Agricultural Organisation, 2005). Yet, rapid population growth and low agricultural productivity continue to increase the gap between food supply and demand in sub-Saharan Africa. In Zimbabwe, the majority of smallholder farmers are situated in the semi-arid regions, which constitute approximately 74% of land area (International Service for National Agricultural Research, 1997). In these areas, food insecurity and low levels of income are the major challenges that are faced by the majority of the people. One potential solution of improving the livelihoods of poor farmers is through improved small stock production. Traditional small-scale animal production does not require heavy labour and is usually assigned to women and children, who usually have fewer off-farm employment opportunities. In addition, due to high pressure on land, small stock production is becoming more important, especially in smallholder farms.

Smallholder farmers in many parts of the tropics prefer local breeds and genotypes because of their adaptation to the local prevailing conditions. The rational exploitation of local feeds and local breeds of livestock is sustainable as it increases outputs from resources that are usually wasted. Local breeds have received insufficient attention and have been prejudiced because of the preference of imported breeds. These breeds require high inputs and intensive management (Rodrìguez and Preston, 1997) and are, therefore, inappropriate for the smallholder farmer. There is little published information on the production, marketing and consumption of indigenous pigs under smallholder conditions in developing countries. As Preston and Sansoucy (1987) have suggested, one way to achieve a sustainable animal production system is to match livestock production with the available local resources. Feed needed by one sow of an imported breed (e.g. Large White and Landrace) is sufficient for two and a half indigenous sows (Mukota) and a combined litter of 20 piglets (Holness, 1991). Although this figure does not automatically mean that the Mukota is more efficient than the imported breeds; it emphasises the need to match resources available to the growth potential of the pigs, hence, there is need to promote the use of indigenous breeds where feed resources are scarce.

Feed shortage is, arguably, the major constraint to smallholder pig production in Zimbabwe. This could arise from insufficient knowledge about the nutritive value of the available feed resources and the inability or failure to conserve feeds for dry season feeding (Adesehinwa *et al.,* 2003). In the smallholder farms, availability of local feed resources used for pigs is unstable and unbalanced throughout the year (Hai and Pryor, 1996). The severity of under-nutrition is worsened by the frequent droughts, which are common in Southern Africa.

1.1 Justification

Productivity of the local pig is generally low (Holness, 2005). This is strongly affected by the environment, especially intermittent feed supplies. There is a dearth of information on feeding management and nutritive evaluation of feed resources in different seasons. Supplementation with energy and protein-rich feeds, such as soya bean meal and cottonseed meal has been shown to improve growth performance in the fast-growing imported pigs (Mushandu *et al*., 2005). Unfortunately, these conventional commercial supplements are beyond the economic reach of smallholder farmers and are rarely used in this sector. A wide variety of locally available feed resources are not fully exploited in pig production. These include common weeds, pumpkins, tree legumes and crop residues, such as maize cobs (Ndindana *et al.*, 2002). Determining the nutritive value of the available feed resources will enable development of intervention strategies to improve pig production in the smallholder sector. Increased pig production raises incomes and reduces cash-flow problems faced by most smallholder farmers. In addition, pigs can contribute to the alleviation of protein deficiency in the diets of people in developing countries. The pig is considered a very promising small stock for rural development because it requires little capital, equipment, space and labour, and provides an inexpensive, readily available and high quality meat as well as an a opportunity to turn kitchen waste and agricultural by-products into edible products.

1.2 Objectives

The overall objective of this study was to characterise pig production in an arid smallholder farming area of Zimbabwe. The specific objectives of this study were to:

1. Establish the types and seasonal distribution of local feed resources in Chinyuni ward – Chirumanzu District;

2. Determine the nutritive value of local feed resources over time
3. Determine changes in body condition scores of pigs over time.

1.3 Hypotheses

1. H_a: The different types of feed resources in Chinyuni ward follow a seasonal distribution;
2. H_a: Nutritive value of feed resources change with season;
3. H_a: Body condition scores of pigs in Chinyuni ward change with season.

CHAPTER 2

2 LITERATURE REVIEW

2.1 Introduction

In view of the predicted world shortages of cereal grains because of competing needs of the expanding human population, the availability and supply of grains and protein feedstuffs for livestock is likely to become more limited (Close, 1993). There is thus an urgent need for research to develop alternative feed resources, especially for monogastric animals. Large quantities of agricultural crops are involved in animal nutrition, the bulk of cereals and oil-rich pulses goes into animal nutrition as well as almost all grassland produce (permanent grass) and other home-grown fodder crops (Prevost, 1991). Animals play an important role in the conversion of primary, often non-edible products such as grasses and agricultural by-products, to edible animal products and contribute significantly to the supply of high-quality animal protein for human consumption.

The population of monogastric animals is growing very fast because of the quick turnover of capital and the available market. Amongst this group are pigs, which are found throughout the world, but their distribution is not uniform. On a world-wide basis, more meat is produced from pigs than from any other domestic species. It is estimated that over 65 % of the world's pig population is in the poorer developing regions, representing over 500 million pigs (Holness, 2005). Sixty-four million tons of pork is produced on an annual world production (Ramirez *et al.,* 2005). In Africa, pork production is around 565 000 tons per annum (McGlone and Pond, 2003). Cultural and religious differences between regions of the world are partially responsible for the differences in the distribution patterns.

2.2 The indigenous pigs of Southern Africa

In many parts of Africa, pigs have not been fully characterised into specific breeds, and are variously classified as 'indigenous' or 'local' (Holness, 1991). In Southern Africa, pig breeds are widely spread in the smallholder areas of Zimbabwe, Tanzania, South Africa, Malawi and Zambia (Kanengoni *et al.,* 2004). In Zimbabwe, indigenous pigs are generally known as Mukota and are predominantly black and much smaller than the commercial or imported breeds, such as the Large White and Landrace. The indigenous pig can be classified as monogastric omnivore or pseudo ruminant with a limited capacity to utilise dietary fibre through hindgut fermentation (Nuwanyakpa *et al.,* 1997; Holness *et al.,* 2005). Local livestock breeds play an important, even crucial role for sustainable rural livelihoods and utilization of marginal ecological areas. Besides providing a wide range of products, they yield important non-monetary benefits, by providing dung that is vital to sustain intensive crop cultivation, by being a component of indigenous rituals and social exchange systems, and by representing a mobile bank that can be cashed in times of need. They thus form an essential component of sustainable rural livelihoods (Köhler-Rollefson, 2003)

The indigenous pigs have an enhanced capacity to utilise fibrous diets, hence increase the efficiency of utilisation of agricultural by-products (Ndindana *et al.,* 2002; Kanengoni *et al*., 2004), which are usually burnt or thrown away. Indigenous pigs are also able to reproduce at low planes of nutrition (Holness, 1991; Kanengoni *et al.,* 2002). They not only require low-inputs, in terms of feed, but they also thrive in local environments. The indigenous breeds have a tendency to lay down fat, which enhances survival chances in areas with permanent or seasonal nutritional stress. They are more mobile and better equipped to scavenge and root. The Mukota is considerably less susceptible to heat and more resistant to most local diseases and parasites (Holness, 2005). Studies by Zanga *et al.* (2003) have shown the Mukota pig to be resistant to some parasites, such as *Ascaris suum*. These characteristics contribute to hardiness and survivability when crossed with an exotic breed (Holness, 2005).

2.2.1 Importance of pigs in smallholder sector

Throughout the developing world, pigs have been kept in small population sizes such as would facilitate by-product utilisation and encourage simple husbandry practices. They represent a source of cheap protein to meet protein requirements for a healthy life. Due to lack of resources in the smallholder sector, most farmers have been unable to move from the simple scavenger system to commercial pig production. These pigs play an important role in the livelihoods of smallholder farmers in sub-Saharan Africa (Ly, 2000) providing sustenance as meat, income from sales and a safety net of capital assets to face risks and misfortunes in harsh environments, and to a lesser extent as manure for crop production. In some communities, pigs are kept for cultural purposes (Holmann *et al*., 2005; Lemke *et al*., 2005), such as payment of gifts and supply of meat during ceremonies.

2.3 Small-scale pig production systems

Small-scale pig production systems are prevalent in most tropical countries, where farmers keep only a few breeding sows. The major comparative advantage of this system lies in its production efficiency, as there are few if any purchased inputs. The gross income received from the sale of live animals and meat is virtually the net income. However, the increasing cost of conventional commercial feeds has slowed down the intensification of animal production in most tropical countries, and the traditional small-scale production system continues to have economic and nutritional validity. The efficiency of traditional small-scale animal production lies in the fact that it utilizes excess family labour and surplus on-farm feed to produce important household income and high quality protein (Bishop, 1995).

Traditional animal production fulfils multiple roles, all of which help to enhance the household's survival potential and its quality of life. Most pigs are kept under scavenge-based conditions where their small size and the ability to survive on minimal inputs make their management an easy activity for any household to pursue (Rushton and Ngongi, 1998).

2.3.1 Scavenge-based pig production systems

Scavenge-based pig production is the most common system of rearing pigs in large parts of the tropics. It is usually the simplest and cheapest. This form of production is characterised by low inputs, with pigs being allowed to wander freely and scavenge for all or most of their food. Occasionally, pigs receive poor quality supplementary feed such as banana and maize stalks, kitchen waste and coarse maize meal (Scherf, 1990). Supplementation is usually practiced during the dry season when feed is usually scarce.

However, supplementary feeding is not widespread and is often subject to seasonal availability of surplus grain. The supplements are generally of low nutritional quality (Holness, 1991) with an imbalance of nutrients, specifically protein (Rodriguez and Preston, 1997). The size and the composition of pig herd vary widely. The free-range system is apparently resilient although economic studies by Keluke and Kyvsgaard (2003) have shown that these traditional production systems are wasteful and unprofitable due to poor feed conversion, high mortality rates, low reproductive rates and poor final products.

2.3.2 Semi-intensive pig production systems

Pigs in the semi-intensive pig production systems are confined hence represent a commitment on the part of the farmer to supply feed and water to his pigs (Holness, 1991). The farmer makes an effort to provide some form of supplementation through locally available feed resources. Most of the pigs are kept in properly built pens during most of the year. The provision of feed is a high priority, since the pigs are not allowed sufficient area and time to scavenge. In addition, mortality and loss rates are relatively low compared with the other systems. The risk of predation, theft and loss caused by poor nutrition are much lower (Rushton and Ngongi, 1998).

Semi-intensive production units have good access to markets and most of their produce is sold. However, they do rely on external inputs such as feed, vaccines and occasionally labour (Rushton and Ngongi, 1998). In some cases, the external inputs extend to the purchase of imported breeds of pigs from commercial breeders. This results in farmers shunning the use of indigenous pigs due to their slow growth rate (Ncube *et al.,* 2003). Increases in herd size will almost certainly imply higher investment costs in areas such a supplementary feed, health care and housing.

2.3.3 Intensive pig production systems

In intensive pig production systems, the producer has moved away from subsistence to small-scale commercial production. The units may comprise up to 50 heads, and the producer will grow and purchase feed specifically for his enterprise. Due to the increased capital cost, the farmer attempts to manage his pigs to optimise output, including some veterinary protection against parasites and diseases. Marketing may be informal, through local butchers, or into the large-scale commercial sector, but in any event will be planned to bring a regular income for the enterprise (Holness, 1991).

2.4 Feeding of the indigenous pig under smallholder conditions

The indigenous pig can ingest and utilise large quantities of high-energy fibrous type foods such as freshly cut, palatable forages such as grasses, legumes, weeds and herbs. The common kitchen rearing of indigenous pigs improves the efficiency of family labour. This is because as the family meals are prepared, a variety of farm waste such as spoiled farm produce, plant trimmings, husks from maize and groundnuts and also kitchen swill are directly fed and readily devoured by the animals. Therefore, under most smallholder farm conditions, the ration of indigenous pigs consists of farm-produced kitchen refuse, agricultural by-products and leguminous feeds (D'Mello, 1995). However, the major nutritional limitations of these feed resources are that they are relatively high in fibre, especially leaves and foliage from trees and shrubs and agricultural-by products such as maize cobs (Ndindana *et al*., 2002). On the other hand leguminous fodder not only contains high fibre but also have high concentrations of potentially toxic or anti-nutritional factors (Mueller-Harvey and McAllan, 1992; Makkar, 1993). This puts a constraint on their digestibility, due to the anatomy of the pig's digestive system (Rodrìguez and Preston, 1997).

2.4.1 Feed resources for indigenous pigs

Since domestication, pigs have depended wholly or in part on their human caretakers to provide the nutrients required to sustain life (Ellis *et al.,* 1997). Non-conventional feed materials, such as agricultural by-products can contribute to the nutritional needs of pigs. The inclusion of such materials in pig diets reduces feed costs and increases efficiency of utilisation of resources in the smallholder systems (Kanengoni *et al*., 2004). Feed resources and amount used depend on the harvesting seasons (Tra, 2003) since feeds for pigs come mainly from farm-produce such as maize, brewing by-products, weeds, kitchen wastes and vegetables.

Fibrous crop residues are an important feed resource in mixed farming in the tropics, yet many of these are characterised by low metabolisable energy (ME) and digestible protein content (Steinbach, 1997), which barely cover the animal's maintenance requirements. However, the nutrient requirements of indigenous pigs reared in the tropics have yet to be adequately established.

2.5 Energy sources

In the smallholder sector, maize, sorghum, millet, pumpkins, watermelons, sweet potatoes and wild fruits comprise the main energy sources. Due to the competition between humans and pigs for cereal grains, it is more economical for farmers in the smallholder sector to use the non-conventional energy sources that are locally available. However, this must not compromise the energy requirements that must be supplied by the diet to make efficient use of dietary protein (Miller, 2004).

2.6 Protein sources

Although cereals play an important role in agriculture, they have low levels of poor quality (unbalanced) protein. For protein provision, all cereals are deficient in lysine with secondary deficiencies in threonine and tryptophan. Soya beans remain the most important and preferred source of high quality protein for animal feed. Soya bean meal has a high crude protein content of 44 to 50 per cent and a balanced amino acid composition, which is complementary to maize meal for feed formulation (FAO, 2005). Other sources of protein include various oilseed meal crops, leguminous plants, crop residues, and by-products, such as brewers' dried grain and some insects. Some of these products vary considerably in the value and significance in animal feed protein supply.

2.6.1 Protein requirements

The quality of protein is determined by its content of amino acid, and their digestibility and availability. Quality can be considered as the degree to which the absorbed amino acid mixture accords with the balance required by the animal (Wang and Fuller, 1989). Utilisation of dietary protein in pigs is usually affected by the composition of the diet, that is, amino acid content, protein to energy ratio, and the efficiency with which protein is incorporated into the body tissue (Bikker *et al.,* 1995). Thus, quality is therefore usually a function, not of any individual feedstuff, but of a combination of feedstuffs in the diet as a whole (Whittemore, 1998). It is important to consider the quality of protein rather than the quantity when formulating feeds for monogastric animals because dietary proteins are broken down to their component amino acids in the gastro-intestinal tract before absorption into the bloodstream. Table 2.1, shows the ideal essential amino acids requirements for pigs.

Table 2.1 The essential amino acids for pigs, and the amounts of essential amino acids in the 'ideal' protein for growing pigs

Essential amino acids	Amount of ideal requirements for growing pigs (g/kg protein)
Lysine	70.0
[1]Lysine:Energy ratio (g/MJ DE)	0.9
Methionine and cystine	35.0
Threonine	42.0
Tryptophan	10.0
Isoleucine	38.0
Leucine	70.0
Histidine	23.0
Phenylalanine and tyrosine	67.0
Valine	49.0
[2]Ratio of essential: non essential amino acids	45:55

Source: Holness (1991)

[1]Whittemore (1998)

[2] Wang and Fuller (1989)

2.6.2 Energy to protein ratio

Pigs need nutrients for maintenance and production. The requirements are met by nutrients in the feed. Maximal lean growth, regardless of the animals' genetic potential, can only be achieved when nutrients, specifically amino acid and energy, are supplied in the diet at the appropriate ratio (Lawrence *et al.,* 1994). The amount of amino acids consumed by the pig is determined by the feed intake and the digestible energy (DE) in the diet. Thus, the amount of protein per unit of DE is more important than the absolute concentration of protein (Bikker *et al*., 1995). These factors, in turn, directly influence voluntary intake in the growing pigs fed *ad libitum* (Chiba *et al.,* 1991). Therefore, the level of amino acids should be related to the digestible energy in the diet. Energy and amino acid imbalance results in improper growth, poorer feed efficiency and an inadequate rate and efficiency of protein and fat deposition. Nutrient requirements should best be stated in terms of specific pig type producing a specific end product circumstance. This is necessary considering that pigs of different breeds, weights and physiological status have different nutritional requirements (Whittemore, 1998).

2.7 Chemical composition of non-conventional feeds for pigs

Non-conventional feed ingredients are available in large quantities world wide. The most important problem in relation to the use of these materials is the variability in their chemical composition, nutritional value and presence of potentially toxic substances. This lack of consistency is mainly due to the way the original material is processed. The fibre or more precisely, the non-starchy polysaccharides make up the bulk of these ingredients and represents the major cause of variation. The challenge ahead is to characterise the chemical structures of these carbohydrates, identify their strategic use in various stages of monogastric production (Choct, 2001). Methods to improve digestibility and nutritional content of some non-conventional feeds have been developed (Hamilton *et al*., 1996). Considerable decreases in cost of feedstuffs can be obtained by using least-cost ration formulation techniques. In addition, a variety of plants forages deserve attention, since they are major feed resources for pigs in the smallholder sector (D'Mello, 1995). Some of the feed resources that have not been characterised include weeds, such as, *Richardia brasiliensis* and *Commelina benghalensis*.

2.7.1 Mexican clover (*Richardia brasiliensis*)

Richardia brasiliensis is a perennial or annual prostrate herb, often forming a mat, from the central taproot, with stems densely covered with spreading hairs. This is mainly found along grassy roadsides, in gardens and crop fields as a weed (Verdcourt, 1989).

2.7.2 Wandering jew (*Commelina benghalensis*)

Commelina benghalensis is a fleshy, herbaceous, creeping annual, which can become perennial depending on moisture conditions. It is found in wet and dry lands making it a troublesome weed in arable and plantation crops. It grows best in moist and highly fertile soils. Stems have high moisture content and once well rooted the plant can survive for long periods without moisture availability and can grow rapidly on the onset of rains. It reproduces through both seeds and vegetatively, spreading by runners which root at the nodes and by re-establishment of stem fragments. Additionally, underground stolons can give rise to cleistogamous flowers and seeds along with the production of normal aerial flowers (NAPPO, 2003).

2.8 Methods of preserving feed resources for pigs

Due to the scarcity of feed resources and also competition between humans and monogastric animals, such as pigs, there is need to preserve some of the available feed resources for later use during adverse periods. Methods that can be used for the preservation include ensilage and hay making (McDonald *et al.,* 2002).

2.8.1 Ensilage

Forages have been preserved using organic acids for many years and the process is referred to as ensilation. This process has been used to preserve carbohydrate rich materials, either alone or on fermentation with other materials. Preservation by ensiling is a method by which the shelf life of crops and agro-by products can be enhanced. Ensilage is a simple and low cost option for smallholder farmers, who have seasonal feed shortages. It can preserve feeds that are seasonally abundant for later feeding during periods of feed shortages. Also ensiling can render some previously unpalatable products useful to livestock by changing the chemical nature of the feeds (Chedly and Lee, 1998). Ensiling is the process of controlled fermentation of raw materials of high moisture content by activities of microorganisms in anaerobic conditions, which encourages the growth of lactic acid bacteria, or by use of chemical additives (McDonald *et al.,* 2002).

Ensilation of non-conventional feed resources or waste materials can offer a simple and inexpensive means by which smallholders can preserve feed for later use. This is more appropriate for these farmers who are located in arid environments that are prone to seasonal feed shortages.

2.8.2 ***Hay***

The aim of making hay is to reduce the moisture content of the green crop to a low level enough to inhibit the action of plant and microbial enzymes. The moisture content of a green crop depends on many factors, but may range from 650 to 850 g/kg, tending to fall as the plant matures. In order to store the green crop satisfactorily in a stack or bale, the moisture content must be reduced to 150 to 200 g/kg (McDonald *et al.,* 2002). Although, this might be an option for farmers to preserve feed; it is difficult, especially during the wet season, since most smallholder farmers do not have sheds to protect deterioration of hay.

2.9 Housing of pigs in the smallholder sector

There are various housing systems for pigs in the smallholder farming areas, with most offering minimal protection to the animal against the harsh environmental conditions prevalent in this sector. A proper housing unit must fulfil functions such as prevention of bullying, protection of suckling piglets, the handling and removal of excreta, the facilitation of mating, the allocation of quarters in which pigs may rest and grow (Whittemore, 1998). Yet, in the smallholder sector, most farmers are unable to meet these requirements and hence offer compromising housing structures. Due to the scarce feed resources, housing is only provided during the rainy season and the pigs are let out to scavenge during most of the dry season when they are no crops in the fields.

2.10 Conclusion of literature review

There is limited information on the pig production systems of local pigs in Zimbabwe. Opportunities for intensification in the smallholder sector are limited because of the inability of farmers to pay for external inputs. The dearth of information on the nutritional value of locally available feeds resources has hindered intervention for improved pig production. Their perceived merits have been generalised and their nutrient composition has not been evaluated, hence cannot be extrapolated from nutritive value of conventional feeds. Improving local indigenous pig productivity requires the understanding of the existing production system. The use of local feed resources in pig production, in particular weeds and agricultural by-products can produce synergistic effects and minimise use of external inputs. The information generated by this project will be utilised in developing feeding management strategies for improved smallholder pig production.

CHAPTER 3

3 A SURVEY OF SMALLHOLDER PIG PRODUCTION SYSTEMS AND CONTRIBUTION OF PIGS TO THE LIVELIHOODS OF CHINYUNI WARD OF CHIRUMANZU DISTRICT OF ZIMBABWE

3.1 Abstract

Data from 79 households were collected from Chinyuni Ward in Chirumanzu district, using a structured questionnaire in October 2005 to establish the role of pigs, feed resources in different seasons, health, housing management and constraints to pig production. Seventy-seven percent of the households were headed by males who were the major decision makers. The average household head age was 50.3 ± 12.71, with an average household size of 6.0 ± 2.68. There were 3.3 ± 2.73 pig per household were and 90 % of pigs were owned by females. Consumption accounted for 98 %, sales (91 %), manure production (98 %) and social and cultural gatherings (11 %). The major feed resources were brewers' dried grain (36 %), kitchen waste (34 %), watermelons (27 %), *Commelina benghalensis* (30 %) and *Richardia brasiliensis* (16 %). The major constraints to pig production included inadequate feed supplies (99 %), lack of external assistance (69 %), and shortage of building materials (40 %). Ninety-percent of pigs were scavengers and were penned during the wet season only. Since there were no defined management practices as exemplified by the poor housing and nutritional programmes; characterisation of these systems in the smallholder sector will enable development of intervention strategies to improve pig production.

3.2 Introduction

Domestic animals are valuable assets for resource-poor rural farmers (Anderson, 2003), especially in the smallholder sector of Zimbabwe where over 70 percent of the people are regarded as poor (Central Statistical Office, 2004). Pigs are a source of household income and food security in many rural-based economies of developing countries (Ly, 2000). In the typical management system of local indigenous breeds, pigs are fed on green plants or allowed to roam freely, scavenging for a wide range of natural and cultivated plants such as vegetable wastes, grasses, weeds and water plants (Rodriguez *et al.,* 1997). However, chemical composition and the potential of these feed resources for feeding pigs have not been characterised. Utilisation of such feed resources increases the efficiency of crop/livestock farming systems and smallholder pig production.

3.3 Objectives

The objective of this study was to identify feed resources, feeding and housing management systems and constraints to indigenous pig production in Chirumanzu smallholder farming area.

3.4 Materials and Methods

3.4.1 Description of study site

The study was conducted in Chinyuni Ward of Chirumanzu district, which lies in the southern part of Zimbabwe, about 290 km south of Harare. The area is located 19º34' 60 S and 30º45' E, at an altitude of 1300 to 1440 m above sea level. The district lies in natural region III, an arid agro-ecological zone where farming operations are extensive. The district receives 650 to 800 mm annual rainfall. Mean maximum temperature ranges from 25ºC to 39ºC in cold and hot seasons, respectively. The area experiences seasonal droughts and severe dry spells during the growing season, which makes this region generally unsuitable for cash cropping. The farming system is based on livestock production but can be intensified to some extent by growing drought-resistant fodder crops.

3.5 Secondary data collection

Secondary data on pig herd size, management systems, distribution and ownership were collected from the Department of Livestock Production and Development (LPD), Department of Veterinary Services (DVS), Agriculture Research and Extension (AREX) services and Central Statistics Offices (CSO).

3.6 Sampling of households

Households for the interviews were selected randomly from Chinyuni ward in Chirumanzu district. A total of 79 households were selected from 10 villages. Selection of farmers from each village was not uniform due to the variability of the number of households in the different village. Only farmers with at least one pig were selected for the survey.

3.6.1 *Administration of structured questionnaires*

Structured questionnaires were administered to investigate the demographic, socio-economic, education and extension support characteristics of the households. Aspects such as, feed resources, livestock production system, housing management and constraints to pig production were captured. In addition, integration of the pig enterprise to other livestock and to the cropping enterprises was investigated [See Appendix 3].

3.7 Statistical analyses

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) (1999) to ascertain demographic information, frequency of livestock numbers, specifically, cross-tabulations with chi-square statistics to elucidate the relationship between sex of household head, marital status of household head, family size and household number to livestock numbers. Frequency of feed resources used in different season was analysed using SPSS (1999).

3.8 Results

3.8.1 *Household demography*

Males headed 77.2 % of the households, whilst females headed only 22.8 %. There were 77 % married couples, 20 % widowed individuals and 3 % divorcees. All the respondents were resident on-farm with farming (crop and livestock production) as a major source of livelihood. The average household head age was 50.3 ± 12.71 (mean ± sd), with an average household number of 6.0 ± 2.68. Arable land per household averaged 2.5 ± 0.79 hectares. Only 23 % of these farmers had access to irrigation, whilst 77 % had no irrigation. There was no association between pig herd sizes and sex, age, marital status of household size and pig numbers ($P > 0.05$). There was, however, an association between village and pig numbers ($P = 0.015$; Table 3.1).

3.8.2 *Livestock ownership*

The common livestock species found in the area were cattle, goats, pigs and poultry. The mean (± sd) of pig herds per household was 3.3 ± 2.73, ranging from 1 to 11 pigs. Females were the major owners of pigs with a contribution of 90 %, with only 10 % co-ownership. Besides pig production, households also kept other livestock and grew field and garden crops. Table 3.2 shows the frequencies of some of the livestock kept by farmers in Chinyuni ward.

3.8.3 ***Role of pigs in the household livelihoods***

All the respondents considered pigs as an integral part of their livelihoods. Ninety-eight percent of the households kept pigs for home consumption, sales (91 %) and manure (98 %) production. The preceding reasons were cited as the major reasons for rearing pigs. Eleven percent slaughtered pigs for social and cultural gatherings. There was a perception that dominated among some household members, who regarded pigs as a nuisance and pose a threat to the health to human.

3.8.4 ***Feeding and housing management***

Seventy-five percent of the respondents practiced supplementary feeding during the dry season. Various strategies such as culling (76%), gifts-out (47%) and scavenging were practiced by farmers in order to avert the inadequate feed supplies. Feeding of pigs was conducted mostly by women; men were involved in the construction of pig houses. Feeds for pigs were locally sourced either from individual farms or bought from farmers that had irrigated fields. None of the farmers purchased commercial feeds. During the dry season, most farmers depended on agricultural by-products for feeding pigs. The seasonal feed distribution is shown in Figure 3.1. During the wet season, *Commelina benghalensis* (30 %), *Richardia brasiliensis* (16%), and maize suckers (16 %) were the main feed resources that were fed to pigs. The least used were sweet potato vines, maize cobs and vegetables, each with a contribution of 1 %. During the post harvest season, watermelons (27 %), brewers' dried grain (18 %) and kitchen waste (16%) contributed the bulk of the diet. The least contributor during this period was hominy chops. During the dry season brewers' dried grain (36 %) and kitchen waste (34 %) were the major feed resources fed to pigs as supplementary feed.

During the dry season 100 % of pigs were free-ranging and only penned during the wet season. Few farmers made an effort to provide roofing for their pigs when pigs were penned and most of the pens were muddy due to the rains. However, for those farmers that provided roofs for their pigs, the following materials were used grass (63 %), asbestos (10 %), corrugated iron (4 %) and 23 % other cover such as plastic sheets.

Table 3.1 Chi-square tests of association between selected parameters

Type of association	χ^2 value	P -Value
Sex of household head and pig numbers	8.5	*P = 0.485*
Marital status and pig numbers	12.3	*P = 0.831*
Age of household head and pig numbers	0.5	*P = 0.778*
Village and pig numbers	20.5	*P = 0.015*
Total number of family members and pig numbers	98.2	*P = 0.503*

Table 3.2 Mean livestock numbers per household in Chinyuni Ward, Chirumanzu District

Livestock species	N	Mean	SD	Minimum	Maximum
Pigs	79	3.3	2.73	1	11
Cattle	79	5.8	5.44	0	24
Goats	79	2.5	3.24	0	16
Sheep	79	0.1	0.95	0	8
Donkeys	79	0.4	1.06	0	5
Chickens	79	6.7	5.56	0	20
Turkeys	79	0.4	1.56	0	9
Guinea fowl	79	0.1	0.61	0	3

The majority (85 %) of the farmers did not provide any bedding or constructed floor. Bedding from grass comprised 11 % and 4 % had concrete flooring. Pig pens were constructed using bricks, stones or wooden poles, with 8, 8 and 84 per cent, respectively.

*3.8.5 **Constraints to smallholder pig production***

All the respondents cited inadequate feed supplies as the major constraint to pig production. This was greatest during the late dry season when most of the agricultural by-products and weeds are virtually depleted. Forty-six percent of the farmers cited financial resources as a setback to increase in output, whilst 71 % cited lack of external assistance from agricultural and research extension (AREX) officers and local veterinary officers in pig production. Shortage of building materials (42 %) and vaccines and drugs (9 %) were other factors that contributed to low pig productivity. Only, 14 % and 22 % cited internal and external parasites, respectively, as causes of death to pigs. Thirty-three percent had no idea of diseases that killed their animals.

3.9 Discussion

Most households were headed by males. This is an observation that agrees well with the studies by Chimonyo *et al*. (1999), Mashatise *et al*. (2005) and Muchadeyi *et al*. (2005). This reflects the patriarchal nature of smallholder farming sector in Zimbabwe. This patriarchal society also considers males as owners of most valuable resources including livestock. Women are usually the owners of poultry species. On the contrary, women in Chirumanzu owned more pigs than their male counterparts, except for a few households were there were co-owners. These findings were in contrast to the research findings by Mashatise *et al*. (2005) who reported that most of the pigs in a similar communal area were owned by males. However, the number of cattle and goats were higher compared to pigs. This could have been due to the fact that these animals are able to utilise high fibre diets than pigs and are also used for draft purposes. Although pigs have a caecum, which is part of the large intestines and houses a population of microbes which break- down fibre, their ability to digest fibre is limited (Holness, 2005). Males owned mostly large stocks and small ruminants; they were also the main decision makers at household level. Farmers cited the pig as an easy animal to rear as it is able to survive on left-overs. However, some farmers complained that pigs were competing with humans for the available feed resources, especially during periods of feed scarcity. This agrees with reports by D'Mello (1995) and

Holness *et al*. (2005). Most farmers ventured into pig production because of the increasing cases of stock theft, especially goats.

The large variety of livestock kept by farmers is typical of most smallholder farming areas in Zimbabwe. This diversity in livestock species kept might be a strategy to spread risk (Chikura, 1999; Holness *et al.,* 2005). This is a common practice for farmers who reside in the arid and harsh environments of the country. Household size did not influence the number of pigs kept by farmers. The reason for small pig populations per household was as a result of inadequate feed supplies. This was done so as to balance the available feed resources to pig numbers. The small numbers per household did not mean that farmers did not derive benefits *per se* from pigs but was a survival strategy. This confirms the findings by Mashatise *et al*. (2005), that early culling in the smallholder sector is not related to reproductive performance but related to resource availability.

Availability of feed resources was the major factor limiting pig productivity. The fact that maize constitutes 70 % (Holness, 2005) of the stock feed for pigs and due to the shortages of maize for human consumption; farmers prefer to feed non-conventional feeds to their animals. Most farmers are unable to purchase conventional feeds to counteract the feed shortages. This was a noticeable feature especially at the end of the dry season. Most farmers were providing limited feed as supplementation, to try and avert the feed shortages. However, most of the feed resources were not even adequate to supply the maintenance needs of the pigs and most pigs were emaciated (see Fig. 3.7). The shortage of food is an inevitable situation considering that pigs and humans share the same energy and protein sources (D'Mello, 1995).

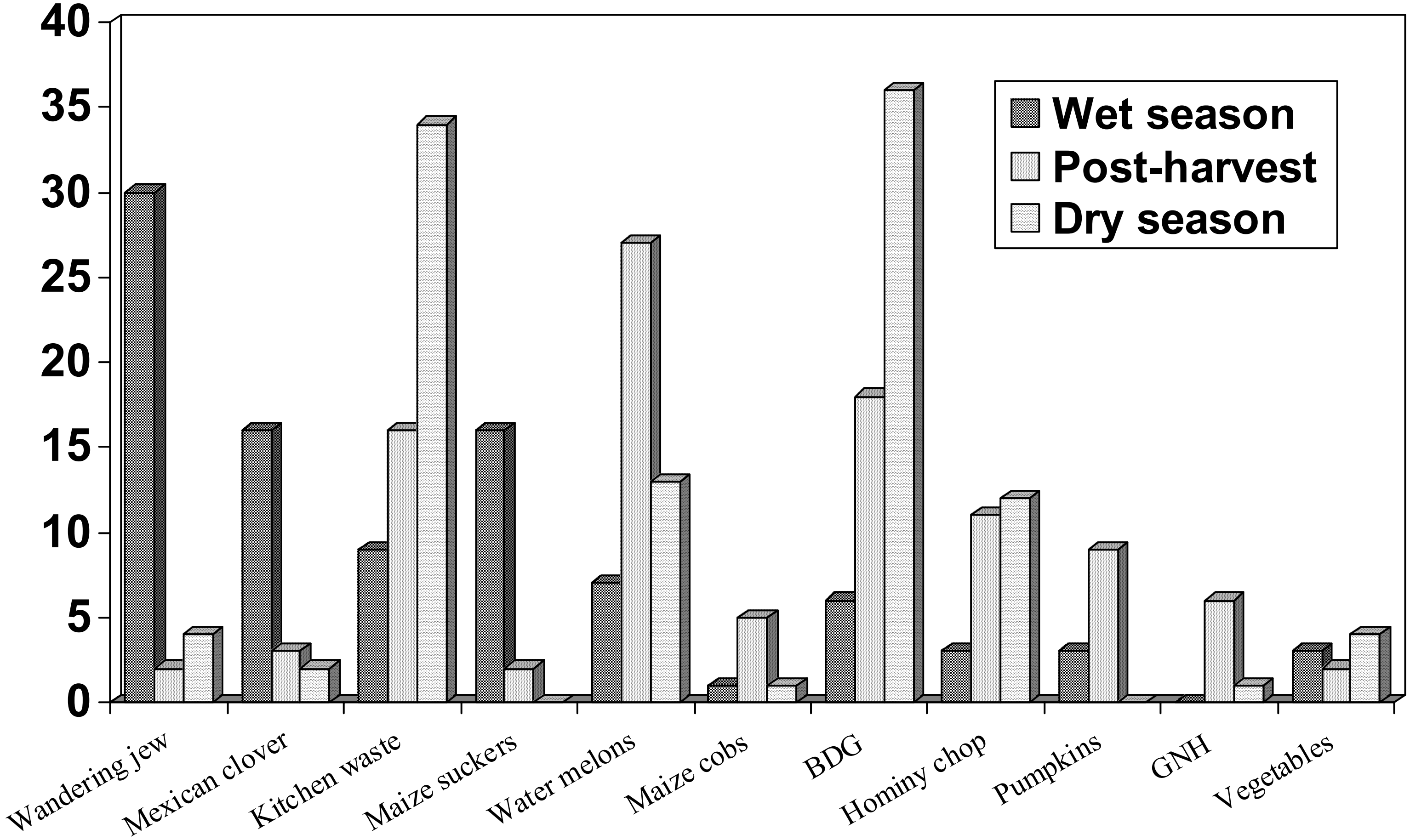

Figure 3.1: Seasonal distribution of pig feed resources in Chinyuni ward, Chirumanzu district

There were high proportions of farmers using brewers' dried grain as a feed resource for pigs during the post-harvest and dry season. The use of agro by-products such as brewers' dried grain in non-ruminant feeding appears to be the available option left for farmers in the tropics to address the issue of competition between human beings and pigs for cereals and for other conventional ingredients. The integration of animal production and agro by-products will ensure that animals play a complementary role, rather than a competitive role with man in meeting the requirements. The increase in the use of hominy chops during the post-harvest season reflects the integration of the cropping and livestock enterprises. Farmers are able to spare some hominy chops from the harvest for their pigs. This agrees with several literature reports (Makkar, 1993; D'Mello, 1995; Ly *et al.,* 1998; Cheverria *et al.,* 2002; Halimani *et al.,* 2005)

From discussions with the respondents, it was noted that farmers did not seek assistance from the agricultural extension officers because they would be instructed to pen their pigs because of the high risk of transmission of zoonotic diseases between humans and pigs. This can be evidenced in Figure 3.7 where some pigs are foraging at a borehole and people are collecting water. The high percentage of households reported that their pigs did not suffer from any diseases, except for some pigs which were suspected to have cysticercosis. This agrees with studies by Holness (1991) and Zanga *et al*. (2003) who stated that Mukota pigs are relatively resistant to diseases.

Most housing structures were constructed from local materials. Few farmers were unable to provide adequate housing structures because they did not have proper building materials. The majority of the housing structures were constructed from wooden poles with no roofs. This was due to a shortage of financial resources to purchase building materials. However, most of these structures violated the welfare of pigs; most pigs were kept in muddy places and this could be the reason for the poor growth rates that are characterised by Mukota pigs (Ncube *et al*., 2003). This explains their ability to survive under harsh environmental conditions, which are experienced in the smallholder farming sector. Proper housing would actually prevent fighting and tail biting, preventing overcrowding, which is one of the major causes of depressed performance of pigs (Holness *et al*., 2005) However, most of the farmers expressed lack of resources as the major factor that influenced the type of housing structures. This observation was noted by Ramlah (1996), who cited availability of resources as a major determinant affecting livestock production in the smallholder sector.

Provision of housing to pigs during the dry season is a common feature in the smallholder sector, especially during the dry season when there are no crops in the fields. It was noted that pigs that were free ranging performed better than those that were penned. This may be due to two reasons; lack of hygiene and inadequate feed. Farmers who penned their animals may have failed to provide adequate feed for the penned animals while foraging pigs had a higher chance of meeting their daily requirements. Whittemore (1998) reported that pigs given free access to various feed sources are able to meet their feed requirements. Most smallholder pigs are exposed to unhygienic conditions (Mashatise *et al*., 2005). Due to the muddy condition of the pens, there is a likelihood of infection of the animal through parasites and pathogens. This was noted during the end of the trial; with high piglet mortalities as a result of poor hygienic conditions in the pens. This was contradictory to reports that we received from the farmers, who had earlier on denied high mortalities in the herds. This was another contributory factor that led to the neglect of pigs in addition to the lack of resources.

The high usage of pig manure is an indicator that most farmers had inadequate organic matter that they use in their fields. Most rural communities have a negative perception on the use of manure (Mashatise *et al*., 2005). However, in Chinyuni Ward, the majority of farmers used pig manure as a nutrient supply in their fields, mostly for horticultural crops.

3.10 Conclusion

Pig production is a major livelihood for farmers in Chinyuni ward of Chirumanzu district. However, the production systems are still in their infancy with little of external inputs. The area is characterised by inadequate feed for pigs; hence they are left to scavenge to survive for the greater part of the year. Since there are no defined management practices as exemplified by the poor housing structures and nutritional programmes; characterisation of the traditional system will enable development of intervention strategies to improve pig production in smallholder areas.

CHAPTER 4

4 CHEMICAL COMPOSITION OF PIG FEED RESOURCES IN CHIRUMANZU SMALLHOLDER FARMING AREA

4.1 Abstract

A study was conducted to determine the influence of month on the nutritive value of weeds (*Commelina benghalensis* and *Richardia brasiliensis*) fed to pigs and to determine the nutrient composition of the weeds, brewers' dried grain and groundnut hulls. *Commelina benghalensis* had the highest CP concentration of 234.4 g/kg in March. The CP of *R. brasiliensis* was lower when compared to *C. benghalensis* with a high of 134.7 g/kg. There was a difference (P = 0.0165) in the ash content for *R. brasiliensis* and *C. benghalensis*. *Richardia brasiliensis* had higher ash content than *C. benghalensis*. Neutral detergent fibre and ADF were also affected by month (P = 0.0068) and (P = 0.0001), respectively for both weeds. Brewers' dried grain had a better amino acid profile and a high gross energy of 19.3 MJ/kg than the other treatments. Based on the chemical composition of the feed samples; brewers' dried grain and *C. benghalensis* have a high potential as alternative feed resources for pigs.

4.2 Introduction

Smallholder farmers in the tropics and subtropics rely on locally available feed resources to feed their animals. Yet, feed supply in these areas is seasonal. This results in a seasonal pattern of wet season live weight gain and dry season live weight loss.

Pigs in the smallholder farming areas are characterised as scavengers, feeding on agricultural by-products, kitchen waste and some weeds (Holness, 1991). Due to the seasonality of rainfall in this area, there are seasonal fluctuations in terms of nutrient supply. The potential of feed resources for pigs in the tropics is superior to that of the temperate zone (Ly, 1993). However, there has been much less effective research in the tropics on locally available, non-conventional feed resources and their nutritional value as animal feedstuffs. Often valuable information resulting from studies in temperate countries requires proper interpretation before it can be applied in the tropics.

The energy and protein sources have a high potential in the smallholder sector but there is a need to work out the different methods to facilitate the management and to improve the knowledge about how to combine these resources in order to improve the nutritive value of the whole diet. The use of non-conventional feed resources is particularly important since cereal grains are needed for human consumption and are not readily available for feeding pigs, especially in developing countries. There is a need to characterise the chemical composition of the feed resources that are fed to pigs.

4.3 Objectives

The main objectives of this study were to assess the nutritive value of the different feed resources that are fed to pigs in Chirumanzu smallholder farming areas.

The specific objectives were:

1. To evaluate the effect of month on the chemical composition of *Richardia brasiliensis* and *Commelina benghalensis*;
2. To determine the chemical composition of *Richardia brasiliensis* and *Commelina benghalensis*, brewers' dried grain and groundnut hulls.

4.4 Hypotheses

1. H_a: Month has no effect on the chemical composition of *Richardia brasiliensis* and *Commelina benghalensis.*

4.5 Materials and methods

4.4.1 ***Sample collection***

Samples of *Commelina benghalensis* and *Richardia brasiliensis* were collected from Chirumanzu smallholder farming area on a monthly basis from the month of October 2005 to March 2006. Collection of samples consisted of the whole plant; five plants were selected from four fields. After each monthly collection, the samples were air dried for fourteen days at the University of Zimbabwe pending analysis. Samples of brewers' dried grain and groundnut hulls were collected at the beginning of the study.

4.6 Chemical analysis

Samples were milled through a 2-mm screen for chemical analyses. Samples were analysed for dry matter, crude protein, ash, ether extract (EE), as described by AOAC (1990). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) analyses were done according to the method described by Goering and Van Soest (1970). An amino acid profile of *Richardia brasiliensis, Commelina benghalensis*, and brewers' dried grain and groundnut hulls was conducted at the Agricultural Research Centre-Irene Analytical Centre, Pretoria, South Africa. The analysis of amino acid involved acid hydrolysis, pre-column derivatisation, separation by HPLC and detection using fluorescence detector as described by Einarsson *et al.* (1983). Tryptophan was analysed using enzymatic hydrolysis, separation by HPLC and detection using fluorescence detector as described by De Vries *et al*. (1980). Cystine was analysed using enzymatic hydrolysis, separation by HPLC and detection using fluorescence detector as described by Gehrke *et al*. (1985). The gross energy was done using the bomb calorimeter at the Institute of Mining Research (IMR), University of Zimbabwe as described by AOAC (1990).

4.7 Statistical analyses

The nutrient compositions of the treatments were subjected to analysis of variance (ANOVA) using the PROC GLM procedure of SAS (1996). The following linear model was used for the analysis:

$Y_{ijk} = \mu + M_i + W_j + M_i * W_j + E_{ijk}$

Where: Y_{ijk} = Response variable being chemical composition of the samples (DM, CP, Ash, ADF, NDF, EE);

μ = Overall mean common to all observations;

M_i = fixed effects of the i^{th} month (October, …, March);

W_j = fixed effects of the j^{th} weed (j= *Commelina benghalensis* and *Richardia brasiliensis*);

$M_i * W_j$ = interaction of month and weed;

E_{ijk} = random error distributed as N $(0, I\sigma^2_E)$.

4.8 ***Results and discussions***

4.8.1 ***Proximate analyses***

Table 4.1 shows the chemical composition of *R. brasiliensis* and *C. benghalensis*. It shows the energy content, dry matter (DM), crude protein (CP), ash, ether extract (EE), neutral detergent fibre (NDF) and acid detergent fibre (ADF). There was a difference (P = 0.0165) in the ash content of *R. brasiliensis* and *C. benghalensis*. *Richardia brasiliensis* had higher ash content than *C. benghalensis*. Neutral detergent fibre and ADF were also affected by month (P = 0.0068) and (P = 0.0001), respectively for both treatments. However, month had no effect on the CP, DM and EE content of the weeds. *Commelina benghalensis* had the highest CP, which ranged from 207.9 to 237.4 g/kg.

Brewers' dried grain had the highest GE 19.3 MJ/kg. *Richardia brasiliensis* had higher energy levels than *C. benghalensis*. The highest energy levels of *R. brasiliensis* were recorded in November at 16.1 MJ/kg and the lowest were in December at 10.6 MJ/kg. The highest energy levels for *C. benghalensis* were recorded in February at 14.9 MJ/kg and were least in the month of January at 12.0 MJ/kg. The increase in protein content implies that such forages can be conserved for dry season feeding pigs considering that most farmers is this sector are not able to purchase conventional commercial protein sources, such as soya bean meal. *Commelina benghalensis* has a great potential to be used as a protein source considering that it has a relatively higher CP than most leguminous leaf meals such as *Acacia karroo*, *Colophospermum mopane* and *Acacia nilotica*, which have been used as pig feeds (Halimani *et al*., 2005). There was however, a considerable increase in fibre content for both weeds; this can have serious implications on the intake and digestibility of such forages. This is due to the fact that the fibre content of forages has an influence on the intake and digestibility (Van Soest, 1987).

Table 4.1: The nutrient content **(g/kg)** of *Commelina benghalensis* (CB) and *Richardia brasiliensis* (RB)

Month	Weed	Gross energy[a] (MJ/kg)	DM	CP	ASH	EE	NDF	ADF
Oct	CB	13.1	823.7	208.6	22.6	18.4	408.0	196.1
Nov	CB	11.8	823.0	207.9	25.4	18.5	403.8	195.2
Dec	CB	14.4	820.5	218.6	23.9	18.2	482.8	182.7
Jan	CB	7.6	825.8	225.0	22.6	18.7	401.9	184.8
Feb	CB	14.9	823.3	227.3	23.8	19.3	402.0	185.4
Mar	CB	13.9	821.3	237.4	25.3	18.5	411.6	188.0
Oct	RB	14.0	873.4	100.8	75.9	16.0	492.0	389.1
Nov	RB	16.0	872.2	106.3	65.2	16.2	498.3	387.4
Dec	RB	10.6	868.4	109.9	63.7	15.9	471.6	391.9
Jan	RB	14.2	868.5	104.8	65.5	16.5	482.8	387.4
Feb	RB	14.8	872.3	111.9	62.8	16.4	470.0	388.9
Mar	RB	15.7	869.8	134.7	63.6	16.2	467.6	387.6
SEM		-	2.06	5.42	1.90	0.21	4.27	1.25
Significance		-	NS	NS	*	NS	**	***

NS - Not significant,* - *P* < 0.05, ** - *P* < 0.01, *- *P* < 0.0001**

4.8.2 Protein and amino acid profiles

The total protein and amino acid content of the feeds samples are shown in Table 4.2. Brewers' dried grain had the highest CP content of 219.5 g/kg, followed by *C. benghalensis*, *R. brasiliensis*, and groundnut hulls had the least, with mean values of 172.3, 94.9 and 86.7 g/kg, respectively. This is expected since brewers' dried grain is an end product of microbial fermentation and is most likely to have higher nutrient concentration as compared to the other treatments. The high CP agrees with reports by Yaakugh and Tegbe (1990), who obtain 21 % CP and 20 % crude fibre, despite the bulkiness of the ingredient. The resultant amino acid products are either end products of bacteria or other microorganisms produced during the fermentation process, or they can be originating from microbial matter attached to fibres in the brewers' grains. This is likely to modify the amino acid profile in the final product. This agrees well with research findings by Varvikko (1986) who demonstrated that residues of vegetable feed supplements in nylon bags can be markedly contaminated by microbes during rumen incubation. Fermentation during the brewing process mimics rumen fermentation, therefore, has a better amino acid profile.

Tryptophan quantities in R. *brasiliensis* and brewers' dried grain fall in the lower range of requirements for weight gain and feed efficiency. The required levels range from 0.13 to 0.19 % (NRC, 1998). However, *C. benghalensi*s has a surplus of tryptophan. The amino acid profile for *C. benghalensi*s and *R. brasiliensis* exhibited the usual profile of green plants (D'Mello, 1995), whereby the ratio of glutamic acid and aspartic acid are higher in both weeds in comparison to the other amino acids. The quantities of aspartic and glutamic acid were highest in *C. benghalensis*, *R. brasiliensis* and groundnut hulls. From all the treatments, brewers' dried grain had the highest concentration of most of the individual amino acids. The least amino was HO-proline in all treatments. Although, the treatments have a considerable CP levels, all the individual essential amino acids are below the ideal requirements for protein as stated by Holness (1991).

Table 4.2: The protein and amino acid content (g/kg) for *R. brasiliensis*, *C. benghalensis*, and brewers' dried grain (BDG) and groundnut hulls (GNH)

Analysis	*R. brasiliensis*	*C. benghalensis*	BDG	GNH
Protein	94.90	172.30	219.50	86.70
Lysine	6.70	9.00	11.20	6.80
Methionine + Cysteine	2.90	3.10	11.10	2.20
Threonine	3.00	4.60	7.40	2.90
Tryptophan	1.10	2.60	1.30	0.80
Isoleucine	3.90	5.60	10.30	3.70
Leucine	6.10	9.00	30.50	6.00
Histidine	4.20	5.10	12.30	4.10
Phenylalanine + Tyrosine	8.10	11.90	36.60	8.70
Valine	4.40	6.10	11.60	4.40
Arginine	4.20	7.60	10.10	5.60
Serine	3.20	5.30	9.70	3.50
Aspartic acid	8.90	21.40	12.80	9.60
Glutamic acid	7.80	12.70	36.70	8.00
Glycine	3.50	5.30	7.20	3.30
Alanine	4.00	6.20	15.60	3.20
Proline	3.1	5.00	16.50	5.10
HO-Proline	0.4	0.70	0.70	2.80
EAA: NEAA	1.04	0.92	0.84	0.93

4.9 Conclusions

Brewers' dried grain has a potential to be used as an alternative feed resource to commercial livestock in the smallholder sector considering its high nutrient composition and is abundant during the dry season. *Commelina benghalensis* is another option since it is usually available during the greater part of the year. Although it is has high protein content it is very difficult to preserve as hay due to its high moisture content, hence it can be preserved as silage. These feeds can be used in combination with groundnut hulls, which act as a stomach filler.

CHAPTER 5

5 SEASONAL VARIATION OF THE BODY CONDITION SCORES OF PIGS IN CHIRUMANZU

5.1 Abstract

The objective of this study was to evaluate the effect of month on body condition of pigs. There were differences ($P < 0.05$) in the body condition scores of pigs between months for each sex. There were differences ($P < 0.05$) in the body condition scores of pigs and between months for each sex. Females had an average BCS (mean ± sd) of 2.5 ± 0.86, whilst that for males was 3.1 ± 0.80. There was a decline of 44% in the number of females. Females had a lower BCS than the males over the study period. This figure reflects 56 % of animals at the end of the trial that were still surviving. However, there was a rapid decline in the number of males, with only 33 % remaining at the end of the trial. The greatest decline for males occurred in December; 50 % of the original numbers were left. The traditional pig production system, although resilient; is characterised by high mortality rates. The study showed that measurements of body condition scores, although subjective, is an important tool to monitor performance of pig herds, especially for resource-poor farmers who have limited financial resources.

5.2 Introduction

Body condition of sows in modern pig herds has become an issue of considerable importance because of the economic pressure to achieve optimal production targets (Maes *et al.,* 2004). In the smallholder production system, it is a convenient way of assessing the performance of pigs due to the limitations or unavailability of measuring scales. Maintaining an optimal body condition of sows improves animal welfare and is a prerequisite to achieve adequate production levels in pig herds. Phases of the reproductive cycle of pigs are related, any deviations of the normal body condition in one phase can have significant effects on performance in another phase and the effects of underfeeding in any one phase of the cycle may persist for several months or parities (Whittemore, 1998).

5.3 Objectives

The main objective of this study was to evaluate the changes in body condition scores of local pigs in Chinyuni ward, Chirumanzu on a monthly basis

5.4 Hypothesis

H_a: Body condition scores of pigs in Chinyuni ward change with season.

5.5 Materials and methods

5.5.1 ***Study site***

The study was carried out in Chirumanzu district, in Masvingo province, Zimbabwe. Detailed descriptions of the study site were given in Section 3.4.1.

5.6 Selection of pigs for the monitoring phase

Forty-five females and 12 mature pigs were selected for body condition scoring from 38 households. Inclusion of gilts and male pigs was done due to the small population of sows at the beginning of the monitoring phase. The body condition scoring was done by the researcher using an instrument in Appendix 1. The measurement for BCS was modified to that developed by Holness (1991) [Appendix 2].

5.7 Statistical analysis

Data collected were not linear and after transformation there was no change, hence it was analysed using a non-parametric statistic. The change in body condition scores of the pigs was subjected to a non-parametric Friedman procedure for repeated measures (SAS, 1996). The data were analysed using the following linear model:

Y_{ijk} $= \mu + M_i + S_k + E_{ijk}$

Y_{ijkl} = change in body condition score;

μ = overall mean common to all observations;

M_i = effect of the i^{th} month (October… March);

S_j = effect of the j^{th} sex of animal;

E_{ijk} = random error distributed as N $(0, I\sigma^2_E)$.

5.8 Results and discussion

The body condition scores (BCS) of the female pigs were lower than those of the males from October 2005 to April 2006. The number of females at the beginning of the trial was 45 and dropped to 25 at the end of the trial. This figure reflects 56 % of animals at the end of the trial that were still surviving. Only 33 % of the male pigs remained at the end of the trial from 12 to 4. There were few male pigs in comparison to females. The greatest decline for males occurred in December, with a decline of 50 % of the original number. The relatively smaller population of males than females is due to the fact that most households cull males and remain mostly with gilts. This is because the pigs are usually free-ranging and mating is random, hence many farmers depend on boars from other farmers. However, there was a steady decline in the number of female pigs over the study period. The rapid decline in the male population can be attributed to the festive season and most farmers tend to slaughter more of the males than females. The variation and decline of pig population is due to the inefficiency of the free-range system. This was explained by Keluke and Kyvsgaard (2003), who described the traditional systems of livestock production as resilient but economically wasteful and unprofitable due to poor feed conversion, high mortality rates, low reproductive rates and poor final products.

The BCS of the females averaged between 2.4 ± 1.14 to 3.1 ± 1.08, whilst those of the males averaged between 2.7 ± 0.65 to 4. There were differences ($P < 0.05$) in the body condition scores between the sexes. Also, there were differences ($P < 0.05$) in the BCS during the different months. The differences in BCS between the sexes are genetically related where males are relatively heavier and grow faster than females. This could be due to hormonal differences between the sexes. Besides hormonal effects this is due to seasonality of feed resources and suckling effects. The range for BCS for females was between 0 and 4, whilst that of males was between 2 and 4. Suckling by the piglets has a negative effect on the body condition of the sow. Due to inadequate feed resources; the sow is unable to meet the nutrient requirements for lactation and milk production. Therefore, the sow is likely to mobilise body fat reserves in order to meet the demand for milk production. Mobilisation of body fat reserves leads to the sow losing a lot of weight, hence the resultant low BCS. The minimum BCS of males is 2 because these are kept for slaughter and breeding only.

Although the use of body condition scoring might be subjective and not sufficient to obtain reliable picture of the back fat levels of sows in pig herds, it has been shown to correlate very well with the total amount of body fat (Maes *et al*., 2004), and in this respect, measurement of back fat levels constitutes an important tool to evaluate the total amount of body fat Maes *et al*. (2004) also showed that the number of stillborn piglets increased with decreasing back fat thickness at the end of gestation, implying that sows with very thin back fat levels at parturition should be avoided.

5.9 Conclusion

There were increases in the body condition score of pigs in Chinyuni ward. This highest increased was noticeable during the rainy season. Females had a lower BCS than males.

Table 5.1 Average monthly body condition scores of pigs

Month	N	Sex	Mean (±sd)	Min.	Max.
Oct	45	F	2.4 ± 1.14	0	4
Nov	43	F	2.5 ± 0.91	0	4
Dec	37	F	2.6 ± 0.76	2	4
Jan	32	F	2.8 ± 0.90	1	4
Feb	31	F	2.5 ± 0.85	0	4
Mar	29	F	2.6 ± 1.02	0	4
Apr	25	F	3.1 ± 1.08	1	5
Oct	12	M	2.8 ± 0.94	2	4
Nov	11	M	2.7 ± 0.65	2	4
Dec	6	M	3.5 ± 0.58	3	4
Jan	5	M	3.6 ± 0.55	3	5
Feb	4	M	3.5 ± 0.58	3	4
Mar	4	M	3.5 ± 0.58	3	4
Apr	4	M	4.0 ± 0.00	4	4

CHAPTER 6

6 GENERAL DISCUSSION AND RECOMMENDATIONS

6.1 General discussion

Livestock keeping, particularly pigs, has been shown to contribute significantly to household livelihoods and food security. Farmers in Chirumanzu mostly reared pigs as a source of cash, meat and manure production. It has been noted that supporting the smallholder agriculture may not increase food production for the export markets to the same extent as large commercial farming, but smallholder agriculture plays a role in giving rural people access to food, and its continuous neglect can have a severe negative social consequences (Bayer *et al*., 2003). This has been highlighted in this study where most farmers kept pigs for the household and trade will be at village level, where farmers sell their products to neighbours. This can however, be due to the unavailability of markets and other constraints that have led to low productivity. The survey has highlighted the level of livestock production, with major emphasis on pigs. The low productivity has been reported by several authors (D'Mello, 1995; Chimonyo *et al*., 1999; Mashatise *et al*., 2005 and Muchadeyi *et al*., 2005; Holness, 2005). These reasons include: inadequate feed supplies, no access to credit facilities, which have been constraints for resource-poor rural farmers wanting to improve productivity. Bayer *et al*., (2003) has blamed poor livestock performance on the ineffectiveness of the technical extension system as a contributory factor that also failed to improve animal production. This has resulted from shortages of qualified and trained field personnel, transport facilities and adequate extension packages.

The inconsistent feed supplies were notable in the performance of the pigs that were being monitored for body condition. Due to the scarcity of feed most pigs had low body condition scores ranging from 2.4 ± 1.14 to 3.1 ± 1.08 for females and for males averaged between 2.7 ± 0.65 to 4. This was evidenced in the body condition scores of pigs that were recorded during the dry season. The loss in body condition was more pronounced in the sows, especially those that had recently farrowed and were suckling. The effect of suckling had a negative impact on body condition of sows, since there will not be inadequate feed resources. The shortage of feed led most farmers to keep one or two breeding females during the dry season. This was done as a strategy to alleviate the effect of seasonal feed deficits that affected the animal performance. Some farmers preferred to cull some boars or gave-out their pigs to other households that had extra feed to spare. Farmers preferred to cull boars in order to balance population sizes to the limited feed resources. The major reason for culling boars was because mating was random and most sows had access to boars from other farmers during scavenging making it unnecessary for most farmers to keep boars. However, this practice may lead to poor production as there is a high risk of inbreeding, transmission of sexually transmitted diseases and the boar to sow ratio may be unfavourable. The traditional system of production practiced by most farmers in this area revealed that most of the pigs were scavengers and only penned during the wet season. This is the period when there are crops in the field, so most farmers would try and prevent their pigs from straying to nearby farms.

In spite of the feed shortages, farmers were still able to provide some supplementary feed to their pigs. These included brewers' dried grain, groundnut hulls and other agricultural by-products, weeds such as *Commelina benghalensis*, *Richardia brasiliensis*. The use of agro by-products such as brewers' dried grain (BDG) in non-ruminant feeding has been reported by Yaakugh and Tegbe (1990). Considering the high nutritive value of BDG, it is a more favourable option for farmers and will also serve to reduce the use of the same feed resources between human beings and pigs, especially cereals. Also the high energy content in BDG can be complemented by the high protein content of *Commelina benghalensis*. The supply of BDG is, however, intermittent since their availability depends on the number of people participating in brewing. *Commelina benghalensis* and *Richardia brasiliensis* were troublesome weeds that had found a better option as pig feed. The integration of animal production and agro by-products ensures that animals play a complementary role, rather than a competitive role with man in meeting their requirements. The use of diverse feed resources given free to will ensure that pigs are able to meet their feed requirements as stated by Whittemore (1998).

6.2 Conclusions and recommendations

The types, seasonal distribution and nutritional composition of the feed resources for pigs used in the smallholder sector have been characterised. There was a huge deficit of feed during the dry season that led to poor performance of the pigs. The pigs were highly emaciated, with low body condition during the late dry season. This study highlights that there was a significant effect of feed supply, which was affected by season, on the performance of pigs.

In this study brewers' dried grain, *Commelina benghalensis* and *Richardia brasiliensis* had high nutrient content and have a potential to be used pig production. Future studies need to be conducted to determine the least cost feed formulation using available feed resources and preservation of these during periods of abundance for use during times of feed deficit. Studies to correlate the back fat thickness (BFT) and body condition scores and linear measurements must be undertaken, so that equations can be developed for estimation of the growth performance of indigenous pigs.

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APPENDICES

Appendix 1 Survey instrument used to record body condition scores in Chirumanzu Communal Area

Body condition score of pigs **Month ____________**

Village	Household	Sex of pig	Body condition score

Appendix 2 The pig body condition scoring system

Score	Description	Assessment of fat cover ▪ Backbone ▪ Transverse spinal process ▪ Hips
0	Emaciated	Exposed, no cover on bones
1	Poor	Bones prominent, little cover
2	Moderate	Bones easily felt without palm pressure
3	Good	Bones only felt with firm palm pressure
4	Fat	Bones cannot be felt with firm palm pressure
5	Grossly fat	Further deposition of fat impossible

Appendix 3 Questionnaire used to capture data in Chirumhanzu Communal Area

Questionnaire

Village Name: _________ Questionnaire No. _______ Enumerator: ______________

Household demographics

1.	Age of household head.	
2.	Sex of household head	1 = male 2 = female
3.	Marital status of household head	Married ………………..1 Widowed ……………....2 Separated ……………....3 Divorced ……………….4 Single………………..….5
4.	Total number of household members	

Socio-economic situation of farmers

5.	Land size (acres)	Dry land/acres	Irrigated/acres	
6.	Do you have access to irrigation	Yes	No	
7.	Sources of income	**Source**	**Source of livelihood**	
		Pigs		
		Cattle		
		Goats		
		Sheep		
		Poultry		
		Donkeys		
		Field crops		
		Garden crops		
		Others (specify)		
8.	Other sources of income		Yes	No
		Formal salary		
		Remittances		
		Other (specify)		
9.	Livestock species owned by the household	Livestock species	Number	
		Cattle		
		Pigs		
		Goats		
		Poultry		
		Sheep		
		Donkey		
		Others (specify)		
10.	Ownership of pigs			

	Owner	Number	
	Father		
	Mother		
	Other (specify)		
11.	a. Do you keep records?	Yes	No
	b. If yes. Who keeps the records?		
	c. What type of records?		
12.	Participation of different gender groups in pig production?	Male	Female
	General management		
	Construction of housing		
13.	Reasons for keeping pigs		
	Sales		
	Own consumption		
	Cultural and social roles		
	Manure production		
	Others (specify)		
14.	Do you get assistance from extension workers in your pig production enterprise?	Yes	No
15.	Institutions that assist you?	Tick (if applicable)	
	AREX		
	LPD		
	NGOs		
	Other (specify)		

Feed management

16a.	Feed resources in different seasons	Type	
	Wet season		
	Post harvest		
	Dry season		
b.	Time of feed shortages (Season)		
c.	Strategies to overcome feed shortages		
d.	Do the pigs receive dietary supplementation?	Yes	No
e.	If yes. What type of supplements?	Bought-in (commercial) feeds	
		Own-farm feed resources	

Housing management

17a.	Is pig housing provided?	1 = Yes	2 = No
b.	If yes. What materials are used to construct the pigsties?		
c. Are the walls providing adequate:			
i. Ventilation			
ii Strength			
iii. Bio-security			
d. Is the roof providing adequate shade			
e. Type of floor		Concrete	
		Grass	
		Plain (ground)	
		Others (specify)	

Health management

18. Do you have any problems with		External parasites	Yes	No
		Internal parasites		
19a..	Do you intervene in the face of diseases?		Yes	No
b.	What time is of the year are diseases most prevalent?			
c.	What medicines are used?	Bought-in	Yes	No
		Ethno-veterinary medicines	Yes	No
f.	Do you get assistance from the local veterinarian on the identification of diseases?		Yes	No
20.	Constraints to pig production			

Appendix 4 ANOVA tables for the statistical analyses carried out

a) GLM for the effects of month on the DM content of weeds

		R-Square	C.V.	Root MSE	DM Mean
		0.992653	0.344657	2.91871	846.844
Source	DF	Type III SS	Mean square	F value	Pr > F
Month	5	47.7804	9.5561	1.12	0.3998
Weed	1	13730.0801	13730.08010	1611.72	0.0001
Month*Weed	5	33.9212	6.7842	0.80	0.5727

b) GLM for the effects of month on the CP content of weeds

		R-Square	C.V.	Root MSE	CP Mean
		0.990634	4.614164	7.66390	166.095
Source	DF	Type III SS	Mean square	F value	Pr > F
Month	5	2499.6678		8.51	0.0012
Weed	1	71786.0940	71786.0940	1222.20	0.0001
Month*Weed	5	261.3019	52.2604	0.89	0.5176

c) GLM for the effects of month on the Ash content of weeds

		R-Square	C.V.	Root MSE	Ash Mean
		0.992079	5.987275	2.69275	45.0313
Source	DF	Type III SS	Mean square	F value	Pr > F
Month	5	95.2319	19.0464	2.62	0.0797
Weed	1	10670.2751	10670.2751	1467.88	0.0001
Month*Weed	5	159.9377	31.9875	4.40	0.0165

d) GLM for the effects of month on the NDF content of weeds

		R-Square	C.V.	Root MSE	NDF Mean
		0.988275	1.368618	6.05109	442.131
Source	DF	Type III SS	Mean square	F value	Pr > F
Month	5	882.9485	176.5897	4.82	0.0120
Weed	1	35126.5062	35126.5062	959.33	0.0001
Month*Weed	5	1026.1525	205.2305	5060	0.0068

e) GLM for the effects of month on the ADF content of weeds

Source	DF	Type III SS	Mean square	F value	Pr > F
		R-Square	C.V.	Root MSE	ADF Mean
		0.999843	0.613502	1.77122	288.707
Month	5	135.604	27.121	8.64	0.0011
Weed	1	240026.001	240026.001	76508.71	0.0001
Month*Weed	5	213.692	42.738	13.62	0.0001

f) GLM for the effects of month on the EE content of weeds

Source	DF	Type III SS	Mean square	F value	Pr > F
		R-Square	C.V.	Root MSE	EE Mean
		0.971990	1.689957	0.29411	17.4033
Month	5	5	1.5573333	0.3114667	3.60
Weed	1	1	34.1770667	34.1770667	0.0001
Month*Weed	5	0.2857333	0.0571467	0.66	0.6601