FAMILY POULTRY STUDIES IN KWAZULU-NATAL

Part 1. ON-FARM SURVEY OF FAMILY POULTRY IN MAKHUZENI SUB-WARD

Part 2. DRIED BREAD WASTE AS A REPLACEMENT FOR MAIZE IN THE DIET OF CAGED LAYING HENS

SANELE ORANCE DLAMINI

Submitted in partial fulfilment of the requirements of the degree of
Master of Science in Agriculture

Discipline of Animal Science and Poultry Science
School of Agricultural Sciences and Agribusiness
Faculty of Science and Agriculture
University of Natal
Pietermaritzburg
2002

I hereby certify that this research is the result of my own investigation. Where use was made of the work of others it has been duly acknowledged in the text

Sanele Orance Dlamini

TABLE OF CONTENTS

ABSTRACT

This work was in two parts, the first part was an on-farm survey of family poultry production and the second study was on-station research which investigated the replacement of maize by bread waste in layer diets. The on-farm survey was an analysis of family poultry production practices and the socio-economic factors that have an impact on subsistence poultry production under household conditions. This study was designed to make a contribution to the understanding of family poultry production and to assist in improving production levels. This was one way towards assisting the long-term sustainability of subsistence animal production, which contributes to household food security endeavours in South Africa.

The on-station trial was conducted in order to determine the biological response and economic advantages of laying birds being fed high levels of bread waste. This study was exploratory in nature and was aimed at providing a viable alternative energy feed ingredient that could contribute to maize replacement in layer diets. Therefore, the study was not intended to compare maize against bread, but rather sought to make a contribution by exploring an alternative energy feed ingredient suitable for use in layer diets under small-scale poultry production scenarios, depending on the extent of damaged or stale bread availability.

The study on family poultry was qualitative and involved three main methodologies, participatory rural appraisal (PRA), case study and agro-technical measurements. The results revealed that these fowls were kept primarily for usage during cultural ceremonies. Other secondary roles involved subsistence consumption as meat, eggs and sometimes, these chickens are sold as a source of immediate income. The flock size was considerably influenced by the principal household husbandry practices undertaken. The major husbandry practices included indoor laying, hen tethering (holding) and early chick separation and such family poultry practices were associated with larger flocks.

The extent of family poultry husbandry practices indicated that approximately 62% of the households practiced forced in-door hen laying, 50% of the households engaged the hen tethering practices, while only 25% practiced early chick separation. These husbandry practices in the various households make a contribution to family poultry production in terms of flock size. The majority of households fed primarily yellow maize grain and kitchen waste to chickens as a supplement to the range of feed resources obtained through scavenging.

The peak breeding and production season for family poultry occurs during the autumn to winter season. Many factors influence the peak production period and they include predation (hawks, dogs and cats), feed availability and weather conditions. Hawk predation tends to be low at this time of the year because the hawk hibernates while undergoing molting. Furthermore, the period coincides with low grass cover, which minimizes the incidence of predation by wild animals, as they become more conspicuous. The incidence of chicken diseases at this time tends to be minimal because of persistent cold weather conditions which do not promote development of most infectious chicken diseases, like Newcastle disease, sores and many of the respiratory diseases. Moreover, feed availability during this period of the season tends to be high and the feed is in the form of post-harvest maize grain waste. Approximately 38% of households treated the most problematic Newcastle disease with traditional herbs as opposed to 13% and 25% who used conventional medication and vaccination practices respectively.

In the on-station trial, diets were formulated in such a way that maize was replaced by bread in layer diets at the levels of 0, 20,40, 60, 80 and 100% respectively. The production variables which were measured included egg weight, egg production and feed intake. Egg output, rate of lay and feed conversion efficiency were subsequently derived from the above variables, and used to ascertain the biological response and the economic implications for maize replacement in terms of the cost of the layer diet.

This study revealed that layer diets with increasing levels of bread content lead to a

linear decline in biological response of cage laying hens. The economic analysis consistently indicated that better marginal returns (Rand) could be obtained at 0 and 20% maize replacement by bread in the diet. However, the use of high levels of bread, greater than 20% leads to unfavourable economic returns due to a decline in most biological variables. In situations where maize is not easily available or excessively expensive, bread waste could serve as an alternative energy source in layer diets.

Key words: small-scale poultry production system, household food security, family poultry, poultry husbandry practices, small-scale egg production units, alternative non-cereal feed resources, maize replacement, bread waste

ACKNOWLEDGMENTS

The author wishes to express his most sincere gratitude and appreciation for the assistance given by the following:

Mr S.C. Slippers, Senior lecturer, Discipline of Animal and Poultry Science, University of Natal, Pietermaritzburg, for his effort in securing my funding for a Masters via the Agrarian Research Development Programme (ARDP) and in supervising of the work.

Dr U. Bob, Lecturer in the Geography Department with the University of Durban-Westville, for co-supervising the first part of this work.

Dr R.G. MacGregor, of Heifer Project South Africa, for co-supervising the second part of this work.

Dr P. Njuho, Senior lecturer in Biometry, School of Mathematics, Statistics and Information Technology, University of Natal, Pietermaritzburg, for assistance with the statistical analysis of the second part of this work.

Dr M.A. Dube, Senior Lecturer in the Department of Extension and Agric-Education at the University of Swaziland (Agriculture Faculty) for his contribution to this work.

Dr P. Iji, Post-doctoral Fellow with the University of Natal for his assistance in some parts of this work.

Mr T. Ngwa, for sharing his insight on the use of some of the participatory rural appraisal techniques.

Mr L.P. Du Toit, Technician with the Discipline of Grassland Science, School of Applied Environmental Sciences, University of Natal, Pietermaritzburg, for his assistance in drying of the bread.

Ms K.P. Baartjees (fiancée), **Mr Mthobisi Dlamini** (son) **and Mrs Z. Nsibande**, for their understanding, patience, sacrifice, support and encouragement throughout this period.

Mr A. Nixon, Audio Visual Centre, University of Natal, Pietermaritzburg, for the assistance offered in scanning the graphics of this work.

Mr D. J. Dlamini, for his assistance in formatting and editing of this work.

Mr S.M. Dlamini, Mr P.N. Khumalo and Ms G. Khumalo, for their continued support and care.

All fellow post-graduate students of 1999 and 2000, from the Discipline of Animal and Poultry Science, University of Natal, Pietermaritzburg.

All the technical staff and support staff of the Discipline of Animal and Poultry Science, University of Natal, Pietermaritzburg, for assistance with the laboratory analysis of feed at the faculty, and experimental management at Ukulinga Research Farm.

The work leading to this dissertation was supported financially through the Agrarian Research Development Programme (ARDP), funded by The Netherlands.

PREFACE

Poultry production in South Africa has moved steadily into the 21st century and the commercial production systems simulate that of the developed world and therefore has big development potential. This favourable situation can be attributed mainly to technological progress in terms of breeding, nutrition, disease control and management. In South Africa, the poultry industry varies from a large-scale commercial sector, across a medium- to small-scale commercial sector, to subsistence-based poultry sector, the latter almost invariably on a very small-scale.

The large-scale commercial poultry production sector consists largely of five principal poultry companies (with strong multinational links) and these companies are found mainly in and around urban areas. The companies are Rainbow Farms, Country Bird, Early Bird, National Chicks and Country Fair (Fourie, 2000). The production efficiencies of this poultry system depend exclusively on high inputs, for example capital investment, exotic hybrids, commercial feeds and technical innovations. This sector of commercial poultry is responsible for 75 to 80% of the country's total poultry production and marketing of white meat and eggs (Fourie, 2000).

The small- to medium-scale commercial poultry production enterprises are primarily under sole ownership. These enterprises are driven by entrepreneurs who buy day-old chicks from commercial hatcheries which are then reared into broiler chickens or alternatively they buy pullets (commercial layers) at point of lay for egg production purposes. These poultry systems contribute 20 to 25% of the total white meat and eggs produced in South Africa. The contribution of this poultry production sector to white meat consumption is in the form of commercial sales of slaughtered and live chickens, and consumption of own produce which occurs in the rural, peri-urban and urban settlements (Fourie, 2000). Egg production on a medium scale is purely commercial, while small-scale egg production can be either purely commercial or, as is the case with household-scale egg production units (approximately 10 to 12 hens in a battery cage), have elements of subsistence and commercial enterprise within the same system. Here, some of the eggs produced are used for home consumption, and the rest of the eggs have to be sold to buy the feed that keeps the system functioning.

The contribution of the subsistence sector to poultry production in South Africa is not known, but is widely assumed to be low. This sub-sector makes use of indigenous fowls interbred to a certain extent with pure breeds. The term "family poultry" will be used in this dissertation to refer to these fowls, kept under extensive conditions (that is, a free-ranging or scavenging production system at household level). These birds are predominantly found in the rural and peri-urban areas, but also occur to some extent in urban areas. Family poultry rearing is the traditional system of poultry production in the rural areas of South Africa. While family poultry are important in the production of meat and eggs for household consumption, these birds also have socio-cultural significance, for example, sacrifice in cultural ceremonies such as ancestral rituals and traditional healing practices.

The commercial poultry production system is largely an urban phenomenon and benefits the urban consumers (Payne and Wilson, 1999; Fourie, 2000; Guèye, 2001). This sector is well served by research, and relies heavily on technologies thus developed. As a result, commercial poultry production is highly efficient and succeeds in meeting the demands of the ever increasing (urban) population. In contrast, the subsistence poultry production sector has received hardly any attention from the agricultural research fraternity in South Africa. With this background in mind, the present study was undertaken to address issues of small-scale poultry production at the rural household level.

The research conducted for this masters study was financially supported by the Agrarian Research Development Programme (ARDP), funded by The Netherlands. The ARDP aimed at presenting and inculcating a new paradigm in agricultural and rural development research amongst young researchers at South African universities. The programme intended addressing the general failure of the agricultural knowledge system in South Africa to responding to the agricultural and rural development challenges with regard to African agriculture. The prevalent discipline-oriented research paradigm fails to contextualise this sector of South African agriculture and also fails to recognize the importance of the human element at the receiving end of the research and development efforts. To address these shortcomings of disciplinary research, the new agrarian research paradigm proposes a multi-disciplinary, and participatory, people-centered approach, which unfolds mostly on the farmer's field, yet may link backwards and forwards with research stations and laboratories. In the process, indigenous bodies of knowledge and the day-to-day realities of rural dwellers are tapped into as the base for development and dissemination of innovations. The traditional role of the researcher as technology developer, and of the farmer as adopter of technology, is replaced by a process of mutual learning and adaptive technology development. Farming Systems Research (FSR) (De Boer and Singh, 1995) embodies most of what is required by the proposed new research paradigm. Hence, FSR was adopted as the overarching methodological approach to this study.

This dissertation is made up of two distinct, but related, parts. The first part reports the results of non-experimental research on family poultry keeping in a rural setting in KwaZulu-Natal Province, Republic of South Africa. This may be seen as the first stage (of four) in FSR, namely the diagnostic stage. In the second part, results of on-station research is reported, focusing on finding a solution to the problem of escalating feed cost that is threatening the sustainability of the household egg production system. This represents the second stage of FSR (the design or experimental stage). Further stages of FSR were not covered in this study.

Both segments of the small-scale poultry production sector covered by this study, namely the family poultry keeping system and the household egg production system, are important in household food security, by increasing self-reliance in the provision of affordable supplies of animal protein and micro-nutrients in rural areas. Malnutrition affects a large number of children in the rural areas of South Africa, estimated at between 30 and 45% of rural children under the age of five years (NFCS, 2001b). Stunted growth in children, as a result of sub-clinical protein deficiency, is often encountered (NFCS, 2001b). Hence, any animal production system that contributes to a self-sufficient supply of animal protein in rural areas is worthy of investigation. The long-term aim should be to maximize the contribution of such systems to household food security in rural areas, through a thorough understanding of the factors that either strengthen or constrain such poultry production systems. On the basis of such information, appropriate technological interventions can be designed, tested and implemented, in participation with the eventual beneficiaries.

PART 1

ON-FARM SURVEY OF FAMILY POULTRY IN MAKHUZENI SUB-WARD

1.0 INTRODUCTION

Agricultural production in South Africa is generally considered to meet food security needs at national level. However, according to Van Rooyen (1998), agricultural production in the Southern African Development Community (SADC) may not successfully address issues of food shortage at household level. This situation applies in South Africa as well, where it was shown that (in 1990) 83% of African households in rural areas lived below the poverty line (ABSA, 1993; May, 1998; May, 2000). Van Rooyen (1998) estimated that one out of four children under the age of 10 years is malnourished and stunted while May (2000) had similar findings, but specifically reported its prevalence in children under the age of six. According to the NFCS (2001a), one in ten of all South African children aged 1 to 9 years is underweight, while just more than one in five are stunted. Younger children (1 to 3 years), and children in rural areas were reported more severely affected (NFCS, 2001a). The most vulnerable group of people are those living in the provinces with a proportionally higher rural population segment. There is a close link between the malnutrition problems and the poverty state of the vulnerable provinces. However, poverty rate is a better indicator of the extent of provincial vulnerability and the provinces are Northern Province, North West, Eastern Cape and KwaZulu-Natal (KZN). However, May (2000) and the NFCS (2001a) findings generally reflect that malnutrition of children is a problem of all provinces in South Africa.

The province of KZN has the highest rural population (5.4 million) and the second highest urban population (3.2 million) of all nine of South Africa's provinces (Central Statistical Service, 1995). Hence, food insecurity at household and individual level to some extent is embodied within the rural population of KZN (May,1998). Therefore, contributions towards addressing lack of household food security should be considered to be a nutritional reward for women and children of this province. Small-scale poultry production is but one of the many ways of doing so. FAO (1997) and Hanekom (1997) have pointed out the potentially important contribution of the small- to micro-scale poultry production sector to obtain household food security and poverty alleviation. The African livestock statistics for 1995 cited poultry as one of the most numerous of all farm animal species on the continent (Guèye,1998). This is an indication of the wide prevalence of poultry rearing on the African continent. Therefore, the food produced by poultry from a variety of production systems, cannot be ignored on a continent faced with poorly nourished people, attributed in part to an insufficient supply of animal protein (Billet, 2000).

Over the years the per capita consumption of poultry meat in South Africa has increased tremendously, from 2.5 kg per year in 1960, to 18 kg per year in 1997 (Billet, 2000). This increased poultry meat supply can be attributed largely to the growth of the commercial poultry sector, with the large-scale and medium- to small-scale commercial enterprises respectively contributing 75 to 80% and 20 to 25% of the white meat supply in South Africa (Fourie, 2000). Nevertheless, poor nutrition with its root causes in poverty (see May, 2000; NFCS, 2001b) remains problematic in rural households of South Africa as indicated earlier (ABSA, 1993; May ,1998; Van Rooyen, 1998; May, 2000; NFCS, 2001a). This contrast implies that the increased consumption of poultry meat was a phenomenon of the more affluent urban households, with a lesser impact on the diet of poor people in rural areas of South Africa. According to NFCS (2001b), the total protein intake of children aged 1 to 9 years in all of South Africa was above the Recommended Daily Allowance (RDA), urban children consumed significantly more total protein than rural ones, and rural children consumed relatively less of their dietary energy intake (5%) from animal protein, compared to the urban cohort (7%). Subsistence agriculture was found not to be a significant source of any of the six most consistently consumed foods (maize, sugar, tea, whole milk, brown bread and margarine) in South Africa (NFCS, 2001b). Meat (of any description) and eggs are conspicuously absent from the list of most consistently consumed foods.

Therefore, the growth of the commercial poultry industry in South Africa has at best had a very marginal impact on inadequacies in supply of animal protein to rural dwellers over a period of four decades since the 1960s. On the other hand, family poultry production has survived on the African continent as a traditional practice from ancient times, and therefore must be considered a viable and sustainable system of poultry keeping for households. However, it is clear that the meat and eggs supplied by family poultry is not adequate to overcome the low intake of animal protein amongst the rural children of South Africa. This implies the presence of one or more factors that constrain the productivity of family poultry.

Family poultry production systems have been widely studied in many Asian countries (Aini, 1990; Arenas, 1997; Barua and Yoshimura, 1997) and African countries (Tadelle, 1996; Guèye, 1998; Guèye, 1999; Branckaert and Guèye, 1999). However, little research in this regard has been done in South Africa (Nhleko *et al.,* 1996; Naidoo, 2000). Throughout Africa, family poultry is raised in extensive, semi-intensive and small-scale intensive husbandry systems (Guèye, 2000). However, the majority of family poultry units in South Africa practice under the system of small-scale backyard folds (Wethli, 1999), commonly referred to as scavenging production systems with reference to the birds having to scavenge for most of their feed.

Through scavenging, family poultry have the capacity to biologically convert poor quality feed (kitchen waste, leftover grains, worms, insects and herbage) and to deposit it as protein in the form of eggs and meat (Arenas, 1997; Naidoo, 2000). Generally, the family poultry production system is an attractive venture to peri-urban and rural people because it requires minimal use of land, labour and capital. Hence, family poultry can be raised by even the poorest social strata of rural people (Guèye, 2001). The low-input requirement in the family poultry production system makes it ideal for resource-poor households, because the size of the production unit can be adjusted to the financial means and area available. Thus, it is a suitable poultry production system to contribute towards household food security and poverty alleviation.

Globally, family poultry are under the care of women and young children. In many countries, women have taken the responsibility of feeding, management and marketing of these chickens. Moreover, family poultry production is an important component within the smallholder integrated farming practice. Family poultry integrates well with the use of local resources as seen with crop by-products being used as chicken feed while chicken droppings are utilized as organic fertilizer in sandy soils.

The major constraints to family poultry production are infectious diseases, especially Newcastle disease, while predation by birds of prey and carnivores is also prevalent in many African and Asian countries. Newcastle disease is the most widespread infectious disease in Africa and its symptoms are generally described by the family poultry keepers (Guèye, 1999). The disease results in severe rearing losses and affects many organs, particularly the central nervous system of the bird. These constraints of diseases and predation have a major impact on productivity of these chickens at household level. Nutrition, confinement, health status and husbandry are amongst the other factors influencing the productive performance of these chickens in different household localities (Barua and Yoshimura, 1997).

The relative lack of research on family poultry production in South Africa has been compounded by the agricultural research and development orientation of the past. Traditionally, agricultural research and development was reductionist or discipline-oriented in nature. Such a research paradigm successfully served in meeting the technology development needs of the commercial-scale poultry production system. However, this traditional approach did not consider the relative goals and needs of small-scale farmers in general, and hence that of family poultry keeping under subsistence production conditions.

Therefore, a different approach to agricultural research and development is being sought for this latter context. Such a new agricultural research paradigm should recognize the complex, heterogenous environment and constraints of poorer households under subsistence farming conditions. The complexity emanates from interaction of many ecological and socio-economic factors embodied under this household situation some of which may be in conflict with one another. Hence, effective research and development for this context require combining skills and insights from a wide range of disciplines, spanning from natural to social sciences (McCraken *et al.*, 1988). Additionally, the decision on which innovations or interventions are appropriate, in both the short and long term, requires careful analysis and dialogue between development specialists, policy makers and the farmers themselves.

Such a holistic, interactive approach is by nature multi-disciplinary and compatible with the Farming Systems Research and Extension (FSR/E) principles. This approach is more likely to succeed in meeting the complex needs of resource-poor smallholders than the conventional methods (McCraken *et al.*, 1988; Narayan, 1996). Such methodologies effectively help in building up the local capacity of rural people to solve their own problems and encompasses the process of sound decision making. Such a research approach was deemed appropriate to gain an insight into the social and cultural context of family poultry production within eight rural households in Makhuzeni sub-ward, KZN. Therefore, the aims of this non-experimental, on-farm research were to:

(i) gain practical experience in a more holistic, participatory and multi-disciplinary approach to agricultural research and development

(ii) apply this new approach in a descriptive study of family poultry production in eight households at Makhuzeni sub-ward, KZN, in order to gain an in-depth understanding thereof. By documenting these insights, baseline information becomes available for comparison with family poultry production elsewhere in Africa and the World. Such information also provides important insights for formulating policies towards sustainable development of family poultry production.

In order to gain an in-depth understanding of family poultry at household level, it was decided to limit the study to only eight households via a case study approach, rather than doing a broader, but less in-depth study. To ensure heterogeneity in the few households studied, a non-probability sampling technique (purposive sampling) rather than random sampling was used. Under the broad aim of studying family poultry production within a small-scale, subsistence farming context, a number of more specific objectives were set to focus the research. The first part of the dissertation presents a household level analysis of family poultry, a case study of eight households in the Makhuzeni sub-ward, and was designed to address the following specific objectives:

1. Assess the feeding practices that are used for family poultry
2. Investigate the types of scavenging feed resources available to family poultry
3. Investigate the types of supplementary feeds provided to family poultry

4. Ascertain the reasons for keeping family poultry (that is, functional uses)
5. Investigate the husbandry practices applied to family poultry, other than feeding
6. Quantify measurable production indicators of family poultry such as flock size and composition, body weight, egg numbers and egg weight
7. Investigate the constraints to family poultry production
8. Identify the integrated farming practices influencing family poultry production
9. Attempt to determine the influence of different husbandry practices on family poultry productivity

1.1 Significance of the study

The findings of the study could contribute to the development of appropriate technologies that can be valuable for rural development planners and policy makers. They would be able to understand the dynamics of family poultry production at household level through the farming system research approach. The data could assist agricultural extension officers in their attempt to understand and recognize traditional production practices as sustainable technology within household farming systems. The findings could demonstrate to agricultural scholars, the potential of traditional practices and their implications on the productivity of family poultry at household level. The information could also enhance the process of documentation of indigenous knowledge on family poultry in South Africa.

1.2 Statement of the problem

Small-scale family poultry production is a common practice for many peri-urban and rural people of South Africa. However, research on indigenous knowledge and associated traditional production practices with family poultry is limited in South Africa and yet in principle, this poultry production system contributes to the lives of many rural people. This poultry production system in the developing world has the potential to contribute to poverty alleviation in the form of subsistence household income generation and to animal protein intakes.

Poverty has widely been acknowledged as the most serious problem facing post-apartheid South Africa (Budlender,1999). In South Africa, one out of four children experience malnutrition and/ or stunted growth due to poverty, leading to poor access to protein intakes (Van Rooyen *et al.*;1996 Van Rooyen,1998; May, 2000). The main contributor to such malnutrition is poor animal protein and micro-nutrient intakes within the poverty stricken urban and rural households (May, 2000; NFCS, 2001a). Therefore, such background information serves to consolidate the overall need to study family poultry production, particularly the husbandry practices and the socio-economic factors impacting on the productivity of this sustainable poultry production system. The investigation of the production system and its associated practices are appropriate strategies that can make a contribution to this subsistence animal production system.

1.3 Methodology

This was an on-farm study involving use of both qualitative and quantitative approaches to ensure the intensive study of family poultry in each participating household. Three principal methods have been used and these were: the case study approach, participatory rural appraisal and agro-technical measurements.

1.4 Data analysis

This was a descriptive study and it involved investigations on people's perceptions. The unit of analysis was the household. The data analysis approach involved content analysis in the process of summarizing the qualitative data in specific themes. In many cases inferential statistics were used in the results presented and interpretation.

1.5 Chapter sequence

This study was divided into six chapters. Chapter One briefly discusses the importance of family poultry as a small-scale production system in South Africa being viewed as having some potential to contribute to poverty alleviation. This poultry sector could support endeavours towards improving poor animal and micro-nutrients intake experienced by many households. The chapter then proposes an intervention strategy, which relates to the participatory and emphasizes the need for bottom-up research endeavours as suggested by several authors. Chapter Two of the study comprises a literature review of the global food insecurity challenges in developing countries and describes this situation as it stands in the Southern African region, and the proposed regional approach to the problem. Elements of the family poultry production system are discussed. The chapter focuses on family poultry practices in African as well as Asian countries *vis-a-vis* the South African situation. Chapter Three describes the research protocol in terms of methodologies and procedures used in conducting the study. Chapter Four presents the results of the study. Chapter Five consists of the discussion of the findings and looks at the implications for family poultry production in eight participating households of the Makhuzeni sub-ward. Chapter Six presents the concluding remarks and recommendations of the first part of the study.

2.0 LITERATURE REVIEW

2.1 Introduction

It is anticipated that the human population of the world will increase from 5285 million in 1990 to 7032 million in the year 2010, and such growth will emanate mostly from the developing countries (Branckaert and Guèye, 1999). This is an enormous challenge to developing countries in their attempts to improve food access and availability in the forthcoming years. Interestingly, Msane (1995) and Sinyangwe (1999) observed that small-scale poultry production was one of the most vibrant and viable ventures in animal agriculture for many peri-urban and rural households. Small-scale family poultry production is widespread in many developing countries and hence it can serve as one of the many feasible animal alternatives for food production other than ruminants and pigs (Branckaert and Guèye, 1999). With sustaiaibility and food security in mind, South Africa may be required to efficiently utilize every available resource to produce food, and undoubtedly the small farmer at household level may play an enormous role in securing long-term household food sufficiency.

In the past, little attention was given to small-scale poultry production and particularly family poultry under subsistence farming, whereas the long-term prospect for growth requires commitment and dedication (Billet, 2000) and most importantly special poultry keeping skills. Therefore, an in-depth understanding of the family poultry production system can help in terms of income, protein production and interrelated socio-economic functions. Attempts to address the challenges of poor nutrition, poverty and gender inequalities in South Africa, require that the starting point be a shift in the research orientation in favour of the small-scale farming system. Subsistence family poultry production in many African countries is recognized and contributes substantially to the annual egg and meat production (Guèye,1998). Family poultry on average constitute 80% of the continent's poultry flock (Branckaert and Guèye,1999; Guèye, 2000). In Africa, family poultry represent an appropriate system to feed the fast growing human population because it makes use of locally available resources.

The focus in this literature review is towards developing an understanding of food insecurity, poverty and associated problems from household and individual perspectives, with particular reference to family poultry production. The review looks at the Southern African region and its regional initiatives in addressing food insecurity and poverty. This is followed by a review pertinent to the South African situation, which focuses on family poultry, in areas of husbandry practices such as feeding, production, management, production constraints and other socio-economic implications associated with their production. The literature attempts to provide the relevant background about this small-scale poultry sector under a scavenging system of production, and looks at family poultry across developing countries, *vis-a-vis* the South African situation.

2.2 Food insecurity in the southern African region

One of the major concerns of humankind today is that of adequate nutrition and this concern stems from those countries experiencing food insecurity and these are mostly the developing countries, including South Africa. Food insecurity seems to be a technical term to some people; yet, when it is defined in its most basic terms refers to lack of nutritious food needed to keep people alive and healthy (FAO,1999). The opposite to such a term is the situation of being food secure, which has been defined by many authors (Reutlinger, 1987; National Department of Agriculture, 1995; Haddard, 1997; FAO, 1999; May, 2000) along the lines of the ability of all households in a nation to acquire a calorie-adequate diet at all times. However, it can be deduced that food security consists of two primarily interrelated components, and these are food availability and food access. Additionally, food insecurity or lack of access to a nutritionally adequate diet at the household or community levels take various forms. There could be chronic food insecurity, which occurs when the food supplies become constantly exhausted and therefore, cannot satisfy the nutritional requirement for all (FAO, 1999). This is likely to occur mostly with the low-income groups of people such as the urban poor, rural poor, smallholder farmers and pastoralists (FAO, 1999). These groups of individuals often lack sufficient income and know how and cannot produce enough food for adequate nutrition. Transitory food insecurity on the other hand occurs when there is a temporary decline in access to adequate food mainly because of unstable food production, food prices or incomes (FAO, 1999). Transitory food insecurity cases have occurred in many regions but in the Southern African region it occurred in the early 1990's (FAO, 1999).

Globally, the world's current rate of progress in addressing food insecurity shows an average reduction of 8 million people per year (FAO,1999). Surprisingly, the current projections indicate that more than 600 million people in the world will still go to sleep hungry in most of the developing countries by the year 2015. This implies that, on average, food insecurity needs to be reduced by at least double the present rate a year for the developing countries. The present rate of food insecurity alleviation of 8 million people a year does not favour the goals set in the 1996 World Food Summit (FAO, 1999). This highlights the extent of food insecurity challenges which globally need contributions from various angles, including the work on family poultry.

In Africa, food insecurity and poverty are closely linked (Abalu, 1999). The situation of food insecurity and poverty has been attributed in many cases to chronic under-production and unemployment. In the 1970's, food insecurity approaches were mostly concerned with national and global food supplies while the development strategies for Africa were imposed from above and this resulted in failures in most initiatives to improve the life of the majority of Africans (Levin, 1994). This problem has led to the emergence of new strategies in the 1980's, with the emphasis on food access, at household and individual levels (FAO, 1999). The implications of this are that the information systems need not be concerned with food supplies, but with the wider issues such as long-term livelihood and coping strategies. Most African countries have begun to realize the need for supporting and developing food security initiatives both at the continental and regional level, focussing on food access and affordability aspects. South Africa is being rated as a middle-income country. This rating is often based on average values, such as average per capita income. However, the extent of poverty and extreme inequality amongst the people of South Africa renders the country similar to most of the developing countries (Budlender,1999).

The SADC governments have shown some commitment to this problem of household and individual food insecurity by taking initiatives that will contribute to food access for all people at all times (Van Rooyen *et al.*, 1996; Abalu, 1999; Von Braun *et al.*, 1999;

Van Rooyen, 2000). These SADC countries have embarked on developing food security strategies that recognize the main sources underpinning food insecurity in the region. Globally, the main sources of food insecurity emanate from factors such as poverty, faltering development and weak external trade performances. In the past, this region's food insecurity was mostly considered as a problem of inadequate food supply but today it is more of a problem of inadequate purchasing ability, which is engulfing most developing countries (Budlender,1999; Van Rooyen, 2000).Therefore, the premise is about poverty which is the central cause of hunger and malnutrition and special efforts are needed to alleviate poverty in order to promote the increase to food access and entitlement (Kirsten *et al.,*1996).

The world as it stands today produces enough food to be able to cater for the people who inhabit it, but surprisingly there are still 790 million people in developing countries and 34 million people in developed countries faced with hunger and malnutrition (FAO,1999). This is indicative that the problem of food insecurity is less related to global food supply but is more linked to food access and affordability. The past food crisis in Africa in the early 1970's and in the mid-1980's are good indicators showing that food supply is not the central issue. This is because the previous emphasis was more on food supply or production and again it has shown that food availability at national level is not a guarantee of food security at the individual and household level (Frankenberger and McCasten, 1998).

The household food security approach that evolved in the late 1980's emphasized both the availability of food and stable access as the correct approach. This means that food availability at national and regional levels plus stable and sustainable access at local levels, are both considered critical for household and individual food entitlement (Frankenberger and McCasten, 1998). The emphasis is on food access and affordibility to all people. An improvement in the purchasing power entitles people and correlates positively with the enhancement of food security. Frankenberger and McCaston (1998) observed that most households derive such entitlements from own production, income, gathering of wild foods, community claims, assets, and migration. This means that several socio-economic variables may have an influence on a household's access to food.

There are approximately 140.2 million people living in the Southern African region. The overwhelming majority of these people of the region live in rural areas and are likely to be poor and food insecure. Most rural areas are relatively poor in terms of the natural resource base which explains the type of household conditions for the majority of the people. Therefore, there is no argument with respect to where to initiate serious food security measures in the context of the Southern African Region (Van Rooyen *et al.*, 1996; Abalu, 1999). Since food insecure people live in rural areas, the contributions to the solution of the region's food insecure problems need to focus more on measures enhancing the rural economy. Haddard (1997) and Von Braun *et al.* (1999) have conceded that the Southern African region has continued to be plagued by mass poverty, hunger and malnutrition, especially in the rural areas. Then, the challenge is to address the problems of poverty, malnutrition and hunger more as a regional approach. A number of approaches could be followed but it appears as though poverty exacerbates food insecurity and the associated nutritional problems. Poverty can be placed at the core of the conceptual framework, with population and environment being considered mainly for their link to it (FAO, 1999). The logic says that those people who are poor usually lack sufficient means to access food according to their dietary requirement and due to lack of expertise, are unable to produce it.

2.3 Food insecurity in South Africa

The South African food insecurity situation closely correlates with that of the Southern African countries (Van Rooyen *et al.*, 1996). In South Africa, food production is sufficient for the total population and so South Africa cannot be classified as part of the Low Income Food Deficit Countries (LIFDC).However, a large proportion of the total population of South Africa continue to experience acute problems of malnutrition, hunger and therefore South Africa displays the common features that predominate in the developing countries (Mekuria and Moletsane, 1996). Mekuria and Moletsane (1996) estimated that about 2.3 million South Africans, including children of under 12 years age and pregnant and lactating mothers were regarded as malnourished. Further, statistical information show that approximately 14.3 million South Africans are still vulnerable to food insecurity. Not only children, but women and the elderly, form the particularly vulnerable group to food insecurity in South Africa. The main contributing factors to the persistent stunted growth in children, are deficiencies in micro-nutrients, especially vitamin A, and iron (Kirsten *et al.*, 1998). Deficiencies of micro-nutrients, vitamins and essential minerals have been shown to have a negative impact on the people's health, social and economic standing (May, 2000 and NFCS, 2001a), both in South Africa and other countries. The NFCS (2001a) analysis in particular shows that under-nutrition in South Africa is more concentrated in the Eastern Cape, Northern Province and KwaZulu-Natal. Nationally, one in three children have a marginal vitamin A deficiency and its prevalence were reportedly higher in rural areas in children with poorly educated mothers. Furthermore, one in five children were found to be anaemic. The anaemia and poor iron status was prevalent in the urban areas in six to twenty-three months old children. Vitamin A deficiency, the most common cause of preventable childhood blindness, has a wide range of effects. Its main effects include reduction of the effectiveness of the immune system as well as retarded growth and development (NFCS, 2001a). Moderate vitamin A deficiencies lead to stunted growth and higher death rates. Iron deficiency, particularly during infancy and childhood, results in impaired learning and poor ability to resist disease (NFCS, 2001a). Anaemia tends to contribute to high maternal mortality and more severely to low birth weight and infant mortality (NFCS, 2001a). Kirsten *et al.* (1998) and NFCS (2001a) have shown the importance of vitamin A, iron and iodine deficiencies in some research work conducted with children in South Africa. Generally, poor dietary intake and nutritional status are of great concern because they have an adverse effect on physical and mental development, particularly in children (FAO, 1997). One cannot overlook their effects on the individual child's achievement and quality of their life. These dietary nutritional effects at a national level are more pronounced and impact negatively on social and economic development. Attempts to alleviate these micro-nutrient problems through (household) food security require sustainable approaches suited to the conditions of the household and individual. Interestingly, the FAO (1997) proposed a food-based strategy as one of the sustainable and feasible means to reduce or prevent micro-nutrient malnutrition. The food-based strategies suggested included small-scale vegetable and fruit gardens, while small animals such as poultry and fish were also viewed as having the potential to prevent micro-nutrient deficiencies. This is because these foods are excellent sources of essential micro-nutrients, including bio-available iron and vitamin A. Van

Rooyen (2000) proposed a regional approach as a strategy that will enable agriculture to contribute positively to alleviating the problems of poverty and unemployment (and hence, food insecurity).

Food insecurity in South Africa is closely associated to poverty and vulnerability (May,1998; Abalu, 1999; May, 2000; Van Rooyen, 2000). South Africa has undergone a new political dispensation, many distortions and dynamics introduced in the past have continued to contribute to poverty, and poverty continues to be the main contributor to lack of food access (May, 1998).

2.4 The poverty status and distribution in South Africa

Generally, poverty results in low food availability, low food access, overcrowding, unsanitary living conditions and improper child care, which are frequent causes of malnutrition associated problems (FAO, 1992a). The consequences of malnutrition are far-reaching and they include human suffering, social and economic complications in many cases. In many instances women tend to be more easily affected by food shortages than men because of their differing physiological requirements. In some cases, depending on the circumstances, women require a higher intake of vitamins and minerals proportionally to total dietary energy intakes than men (FAO,1997; Callens and Phiri, 1998; FAO 2000). For example, women who are pregnant or lactating tend to have a higher food requirements in terms of energy and nutrients.

This implies that there is the need to consider the importance of the specific nutritional requirement for all household members in terms of gender. Furthermore, many infant and young children deaths are as a result of poor nutritional status of their mothers. Surprisingly, women and children tend to be fed after the menfolk, and the girls after the boys (FAO,1992a). Another major compounding factor in this situation of imbalanced family nutritional satisfaction is that, in extended families, the majority of women tend to have many children and opt to deprive themselves of food rather than the young children (FAO, 1992b). This reveals that gender is an integral part to the success of most interventions meant to have a positive impact on the nutritional security of the vulnerable group, particularly women and children. Further, traditional gender roles and divisions are critical in terms of access to and control over resources, benefits and responsibilities for care.

In South Africa, in all provinces, the incidence of poverty is significantly higher in rural areas than in urban dwellings. Women in rural areas constitute 55% and 59% of the total adult population and the poor (May *et al.*,1996; Sotshongaye and Moller, 2000). This is probably because women are over-represented among the elderly who suffer from high poverty rates. In addition, women make up more than 60% of the population in the former Homelands, and they end up being over-represented in the poorest parts of the country. In South Africa as a whole, 29% of all rural households are female-headed households. Therefore, the incidence and experiences of poverty in South Africa have shown that women are likely to be far more affected than men.

The state of poverty in many rural areas has been reported as concentrated within the Africans with approximately 71% compared with 29% for those Africans living in urban areas (May, 2000). Across the races groups, indication are that about 61% of the African population of South Africa are poor and a mere 1% of the whites are poor (May *et al.*, 1996; May, 1998; May, 2000).

In the early 1990's, the poverty distribution across the nine provinces showed that the Northern Province, KwaZulu-Natal and Eastern Cape were the worst poverty stricken areas (ABSA, 1993; Mekuria and Moletsane, 1996). In May's (2000) study, the Northern and Free State Province's were reported to be the worst in terms of poverty. Furthermore, May (2000) indicated that the depth of the poverty was highest within the Free State and Eastern Cape provinces. Additionally, the percent population that is non-urban was highest in Northern Province, North West, Eastern Cape, Mpumalanga and KwaZulu-Natal, being 89, 65, 63, 60 and 57% respectively (May, 2000). In summary, all provinces in South Africa experience the problem of poverty even though its magnitude differs slightly.

2.5 Animal farming and food security

Agriculture, including fisheries, forestry and animal husbandry, have long been seen as a major source of income and livelihood for many of the world's poor population (FAO, 1997). In animal agriculture, many of the extension agencies in Africa have globally promoted increased household involvement in rearing of small livestock such as pigs, goats, sheep, rabbits and chickens. The aim of such a move is towards increasing the amount of protein from animal sources in the household diet.

Animal foods are a valuable source of micro-nutrients and therefore, can make a contribution to the control and prevention of nutritional deficiencies (FAO, 1997). Animal products such as eggs, milk and liver are known to be good sources of vitamin A. However, in general animal foods are not frequently consumed by many rural families because they are considered an investment by rural people. Additionally, the productivity of these animals is relative to household farming conditions and this is another major limitation.

Globally, the general practice in many poor communities is to allow goats, sheep, pigs and chickens to roam around under a free range scavenging system. These animals scavenge around the village vicinities during the day and only return to their owner's compound at dusk. The maintenance cost of such animals is generally low and therefore any gains in terms of animal products such as eggs or progeny are considered as some profit or bonus. Generally, women often take the primary responsibility for these small animals, especially in raising of goats, sheep and chickens. In some cases, these women take part in the decisions on whether to sell or keep poultry for home consumption.

In South Africa, a survey conducted by Kirsten *et al.* (1998) on 198 households in three tribal wards of the former KwaZulu-Natal found that farming accounted for roughly one sixth of the total household income. The majority of those households (about 90%) was involved in some agricultural activity, mainly for subsistence production purposes. The major crops grown included maize, dry beans, pumpkins, white potatoes and cabbages. Such agricultural practices have been reported by May *et al.* (1996) as important, and this was demonstrated by agriculture being ranked the third most important livelihood tactic used in rural areas. May (1998) illustrated the importance of agriculture by pointing out that poor women value subsistence agriculture even though they acknowledged the fact that it was a high risk activity. Therefore, the positive contribution of agricultural activities to household nutrition cannot be disputed (Kirsten *et al.*,1998). For example, livestock in rural KwaZulu-Natal plays a crucial role in the household economy. Hatch (1996), when describing the social system of the Zulu people, revealed that cattle in particular provide meat and amasi (sour milk taken as a meal with dried porridge), the mainstay of the Zulu diet. The hides are used as traditional shields and even for clothing while the wealth of a man is always reckoned in cattle. Although livestock ownership is centred on cattle, small stock are an important source of income. Small stock such as family poultry has not been intensively studied in South Africa and yet it forms part of the household farming systems in rural areas.

2.6 Rural poultry keeping systems

Rural poultry production is a sub-sector within the small-scale poultry production sector in South Africa. Leong and Jalaludin (1983), Aini (1990), Tadelle (1996), Guèye (1998) and Khieu (1999) have indicated that family poultry are generally reared under free range and therefore survive as scavengers. Family poultry production is practised as a subsistence form of farming and hence is found in many peri-urban and rural households in South Africa (Wethli, 1999). This poultry keeping system is globally characterized by small flocks, low input-output relations and high disease incidence in flocks (Aini, 1990). Such chickens are released in the morning and let loose to look for food and only housed at night on trees or in some form of night shelter. As in other African countries, family poultry production systems in South Africa rely on scavenging feed. Such poultry production systems are prevalent in remote areas where there is no great need for production efficiency and food is relatively scarce (Honeyborne, 2000). Predation and theft is generally characteristic in the rest of the developing world engaged in family poultry. Chickens are basically raised in a household setting in order to satisfy household needs, and to some extent, the needs of the local community (Billett, 2000). Generally, these chickens are a valuable resource for a household and are a readily available, cheap source of animal protein in the form of meat and eggs (Makarechian *et al.*, 1983; Aini, 1990; Tadelle, 1996; Aganga *et al.*, 2000; Billett, 2000; Honeyborne, 2000).The protein and micro-nutrients from scavenging birds (meat and eggs) is a valuable nutritional addition to generally poorly balanced diets of subsistence farmers in rural Africa (Verwoerd, 1998) and therefore, they cannot be ignored where malnutrition and poverty prevail.

2.7 Feeding management and feed resources

In small-scale family poultry production systems, scavenging is the main feeding strategy. Family poultry are thus allowed to roam freely during the day in search of food. They scavenge for a wide range of food resources such as caterpillars, earthworms, young shoots, natural vegetation, insects, grass, weeds, worms, termites, crop residues, and vegetable products, as outlined by Tadelle (1996), Barua and Yoshimura (1997), Arenas (1997), Gittens (1998) and Guèye (1998). In South Africa, and particularly in the north-eastern KwaZulu-Natal, Naidoo (2000) reported that their scavenging diet also included ticks, ants, fruits like *Opuntia vulgaris*, fruit skins from paw-paw and banana, as well as flying insects like moths and butterflies. These products supply the energy, protein, vitamins and minerals for scavenging family poultry. As a supplement to scavenging, small-scale farmers provide variable quantities of some maize grain, brewer's waste (*Sorghum caffrum*), vegetable waste and kitchen scraps. The number of times a small-scale farmer provides supplementary feed to scavenging chickens vary, and depend entirely on the household financial position in terms of food acquisition and availability. Universally, family poultry receive maize grain or other cereal grain supplementation once a day, either in the morning or afternoon (Khieu, 1999; Naidoo, 2000). Others, like Aini (1990) and Barua and Yoshimura (1997) observed a twice daily feeding practice, in the morning and afternoon, as a husbandry strategy to ensure that scavenging birds return to the homestead at the end of each day.

2.8 Production potential of family poultry

Literature on family poultry productivity generally describes a situation marked by high mortality, seasonal production and low yield in eggs and meat. However, family poultry have also been credited for their efficiency in waste disposal, and converting poor quality feed resources (for example, kitchen waste and harvest waste) into valuable animal protein and nutrients, in the form of eggs and meat. Interestingly, the production conditions for family poultry are extremely unpredictable and include harsh weather, fluctuating temperatures as well as unhealthy (poor sanitory) conditions. These conditions contribute immensely to poor biological performance of family poultry (Arenas, 1997).

Bird losses with family poultry change with different rearing stages. Chick mortality during the rainy season, as indicated by Aini (1990), accounted for about 60 to 70% losses. Chick mortality was estimated at about 30%, while the adult stage account for about 7% losses (Rangnekar and Rangnekar, 1999). Guèye (1998) reported a mortality pattern of about 50% up to the eight weeks of age, and 66% by the 12th week. Khieu (1999) observed an overall accumulative mortality of about 70 to 80% with family poultry in Cambodia. Mtambo (1999) reported an overall eight week mortality of 59.7%. In general, these mortality patterns strongly correlate to the incidence and out break of the most serious epizootic poultry disease of the world, Newcastle disease. Newcastle disease is quite a common disease amongst domesticated birds, particularly family poultry, turkeys and wild birds. Newcastle disease is also known as chicken pneumo-encephalitis or avian pseudopest. There are several factors contributing to the prevalence of Newcastle disease, including high poultry populations within differing bird age groups, close distance between farms, poor sanitation, exchange of personnel, vehicles and equipment. All these factors considerably increase the probability of the disease attack and spread.

The productivity of family poultry is seasonal. Their productivity links to the changes taking place in the scavenging feed resource base (Tadelle, 1996). The scavenging base of family poultry is not constant and depends very much on both the season and prevailing rainfall conditions. The part of the scavenging feed resource base coming from supplementation in the form of cereal grain and waste products, including those from the environment itself, varies depending on the household life activities, such as land preparation, sowing, and harvesting. Many of these household activities are seasonally based and they impact on the family poultry productivity such as the harvesting which coincides with the harvest grain waste.

2.9 Reasons for keeping family poultry

Family poultry are reared under subsistence farming for various reasons, like providing protein (meat and eggs) and for many other socio-economic functions, such as for ritual, religion, gifts, barter and medicinal purposes (Makarechian *et al.*, 1983; Saleque and Mustafa, 1996, Tadelle, 1996; Guèye, 1998; Naidoo, 2000).

2.10 The biological performance of family poultry

Family poultry grow very slowly and therefore are small in size. In Chad, Mopate and Lony (1999) found that the average live weight of hens of about 19 months old was 1.2 kg with a standard deviation of ± 0.3 kg. In Botswana, Aganga *et al.* (2000), reported the body weight of a mature cockerel to be about 2.2 kg on average, with a range in body weight from 1.0 to 3.9 kg. A mature hen was found to weigh about 2.0 kg, with a weight range from 1.0 to 3.0 kg. However, such data are limited in South Africa. Production data from across the African continent (as summarised by Guèye, 1998) are presented in Table 2.1. These production variables are important measures of family poultry productivity and they present a global picture on a few countries of the African continent in terms of family poultry production statistics.

Eggs per clutch refers to the total number of eggs a hen can lay in a physiologically determined sequence. The minimum number of eggs per clutch reported was eight and occurred in Senegal (Table 2.1). The maximum number of eggs laid per clutch has been reported as twenty and this was found in Morocco (Table 2.1). The number of eggs per clutch varies between countries and this could be due to several reasons underpinning households, including nutrition, health status, management and other socio-economic factors, like poverty and income for purchasing inputs (Guèye, 1998).

The number of clutches that can occur in year is an important indicator of production potential of hens in terms of the total number of eggs likely to undergo brooding by the hen. The number of clutches per year are equivalent to the number of times the hen undertakes broodiness over the same period. From the average number of eggs per hen in a single clutch, and the average number of clutches per year determines the total egg laying potential of a hen (Guèye, 1998). This measure is important in assessing the potential egg protein produced by a family poultry hen. This shows only the biological potential of the hen and is not an indication of eggs meant for human consumption. In most of the countries representing Africa in Table 2.1, the least number of eggs per hen per year was reported in Ghana, with only 20 eggs, while the largest number was observed in Benin, with 100 eggs per hen per year ((Guèye, 1998).

Family poultry can lay eggs in a sequence (called a clutch) after every brood. The number of possible egg clutches that can be obtained in a year is important in terms of evaluating family poultry productivity. The number of possible clutches per year have been reported by many scholars and for the rest of Africa it is summarized in Table 2.1. Wide variation exists in the number of clutches, but Branckaert (1995), Tadelle (1996) and Tadelle and Ogle (1997) reported a reasonably consistent range of two to three clutches per hen per year.

The size of a hen's egg depends on two principal factors: the breed and the age of the hen (Smith, 1990; Etches, 1996). The different breeds in family poultry have different body weights, and thus lay different sized eggs. Furthermore, egg size is also influenced by age; as the hen gets older, bigger eggs are laid. In Cameroon and Burkina Faso, an average 30 g egg was reported and is expected from family poultry (see Table 2.1). Such an average egg weight became the minimum egg weight across those countries representing Africa. The maximum average egg weight of 50 g was reported only in Marocco.

Some data on the egg weight of family poultry in Africa are summarized in Table 2.1. The egg weight of a variety of indigenous chickens breeds show a wide range of values, from 34.5 with standard deviation of ±0.7 g as reported by Sonaiya (2000).

Aganga *et al.* (2000) found that the egg weight ranged from 38 to 60 g, while Tadelle (1996) reported that the average egg weight was 38 g. Branckaert (1995) reported an average range in egg weight of about 45 to 50 g. In the north-eastern KwaZulu-Natal in South Africa, family poultry were found to be able to produce eggs weighing 48.9 with a standard deviation of ±4.4 g (Nhleko and Slippers, 1996). Generally, the egg weights reported for South Africa fall within the average egg weight range for Africa of 30 to 50 g per egg (Guèye, 1998).

An egg laid by a mature hen needs to be fertilized in order to hatch but not all fertilized eggs do hatch. The number of eggs that hatch against the total number of eggs that underwent brooding by a hen (expressed as a proportion) indicates hatchability. Hatchability under natural brooding is influenced by many factors, especially hen characteristics and many environmental variables, including temperature and humidity (Smith, 1990). The hatchability in these countries representing Africa was reported as a range from 60 to 90%. The lowest hatch was reported in Burkina Faso while the highest occurred in Sudan and Burkina Faso. However, this production variable was not measured in the present work.

The mature weight of birds is one production measurement of interest and it represents the size (body weight) of a mature hen and cockerel. Mature body weight is an important biological parameter if the interest is on developing an insight into the extent of meat protein generated by family poultry. The mature body weight of hens and cockerels shown in the different countries indicate some variation. Such variation could be attributed to differences in breeds, age and rearing conditions. The minimum mature body weight of 0.7 kg of hens was reported in Benin, while the maximum 2.1 kg recorded was reported in Tanzania (Guèye, 1998). The mature body weight in cockerels was found to be 1.2 kg and was reported in Benin whereas the maximum body weight recorded was 2.9 kg as reported in Tanzania.

Table 2.1 Production parameters of family poultry in Africa (after Guèye, 1998).

Country	Eggs/ clutch	Clutches/ year	Eggs/hen/ year	Egg weight (g)	Hatchability (%)	Mature weight (kg)	
						Cock	Hen
Benin	-	-	50 -100	40	-	1.2 - 1.8	0.7 - 1.2
Burkina Faso	12 - 18	2.7 - 3.0	-	30 - 40	60 - 90	-	-
Cameroon	-	-	50 - 80	30	82	2.5	1.3 - 1.8
Ghana	-	2.5	20	-	72	-	-
Mali	8.8	2.1	35	34.4	69.1	1.6	1.02
Morocco	12 - 20	-	60 - 80	35 - 50	70	1.2	1.2
Nigeria	10	2 -3	-	-	80	-	-
Senegal	8 -15	4 - 5	40 - 50	40	80	1.8	1.2
Sudan	10.9	4.5	50	40.6	90	2.1	1.3
Tanzania	12 - 13	3	36	37.9 - 49.5	-	1.2 - 2.9	1.0 - 2.1

- Not reported

Generally, family poultry producers across Africa keep a small number of birds in their flocks; between 5 and 20 per household (Guèye, 1998). Previously, Tadelle (1996) reported an average flock size of 5 to 10 per household in Africa. In Botswana, Moreki *et al.* (1997) and Mushi *et al.* (2000) each reported an average flock size per household of about 18 and 21.5 respectively each with a corresponding standard deviation of ±11.6 reported by the former, and with a flock range of 7 to 47 reported by the latter. Rangnekar and Rangnekar (1999) in India reported that the family poultry flock size fluctuates and depends on whether one belongs to the under-privileged group of people or the Muslim rural families and it ranged between 6 to 10 and 6 to 12 respectively. In the north-eastern KwaZulu-Natal, South Africa, a survey of 96 households showed a mean flock size of 22.2 with a standard deviation of ±13.8 family chickens, while other poultry species such as ducks, geese, pigeons and turkeys were also reared in smaller numbers (Nhleko *et al.,* 1996).

The potential egg production of family poultry has been generally declared to be low when compared to exotic breeds. Globally, the literature indicates that the laying capacity of family poultry varies and initially it was reported as 50 to 100 eggs per year per hen (Huchzermeyer, 1973), while Tadelle (1996) and Branckaert (1995) subsequently reported an average of about 40 to 60 small sized eggs per year. Sonaiya (2000) observed an egg production of 99.6 with a standard deviation of ± 7.7

per hen per year. Overall, in Africa, the annual egg production per bird was found to range between 20 to 100 eggs (Guèye, 1998). Such a level of egg production is typical of family poultry keeping, compared to the 250 eggs per year that can be laid by an exotic breed. These low egg production figures are justifiable under the low-input system of family poultry rearing.

The point to value here is that the birds convert feed resources that would otherwise have no value as human food, into high quality proteins and micro-nutrients (eggs and meat). Though family poultry genetically produce a low number of eggs and grow slowly, at least they are able to yield some meat and a few eggs for the disadvantaged and resource-poor people in rural settings, from little or no external input (and hence, virtually no cost). A survey in the Nkandla area in North-eastern KwaZulu-Natal revealed that 40% of the households owned goats, 92% owned chickens, 16% owned pigs and 68% owned sheep (Hatch, 1996). Such results indicate that family poultry are the most numerous domestic animals kept in households.

2.11 Socio-economic aspects and gender issues in family poultry production

Family poultry are not only an important source of eggs and meat, but they are also valued for many social, religious, cultural and economic functions for rural people. In South Africa, these issues have not been adequately studied and yet have some influence on family poultry rearing. The importance of family poultry in rituals has been reported by Tadelle (1996) and Guèye (1999). Verwoerd (1998) reported that in traditional medication, the blood from these chickens is highly valued in many aspects, including cleansing bad luck with fresh blood from slaughtered family chickens depending on the prescription by the traditional healer. In North-eastern KwaZulu-Natal, Naidoo (2000) also reported the use of family poultry in cleansing ceremonies by traditional healers, with strong emphasis on plumage colour of the birds so used. Family poultry are used in many ceremonies, such as during birthdays, marriage and death. The birds can be given as gifts to important invited guests or visitors. The chickens are also an important source of petty cash for a rural home (Kumtakar, 1999). During times of desperation, family poultry have been sold to acquire cash for payment of children's school fees and making small grocery purchases (Guèye, 1999; Naidoo, 2000). However, Guèye (2001) noted that, across the African continent, organized marketing of family poultry can be a strategy that would enhance the production of family poultry as means to encourage the chickens' productivity.

In a household, males and females have different roles to play in terms of responsibilities. Such roles change from one location to the other, depending on factors such as, groups, culture or religion of the people. Therefore, in the household context, the term gender basically means who does what within the household production system. Women and their children in developing countries across Africa are responsible for family poultry husbandry practices, particularly in their feeding and management (Saleque and Mustafa, 1996; Tadelle, 1996; Alders *et al.*, 1997; Arenas, 1997; Rangnekar and Rangnekar, 1999; Guèye; 1998; Kumtakar, 1999). This is mainly due to the fact that family poultry production do not require much time to manage.

In Burkino Faso, Zougrana and Slenders (1992) reported slightly contrasting findings, in that the responsibility for these chickens is bestowed on men, as each morning, on behalf of all family members, they give grains to these chickens. Such gender issues may be important to recognize the social and cultural organization of a rural household, as concerted measures are being made to assist small-scale farmers and the majority of unemployed rural people. In North-eastern KwaZulu-Natal, it was found that family poultry production was the responsibility of women in 74% of the 96 households surveyed (Nhleko *et al.,* 1996). The average age of the poultry keepers in the latter study was 45.7, with a standard deviation of ±11.8 years for women, and 49.8 with a standard deviation of ±14.0 years for men. This indicated that family poultry rearing in the surveyed area is mostly under the care of mature and older (female) members of the household.

2.12 Family poultry husbandry practices

Family poultry management is generally described as principally free-range oriented. The main household activities in their management involve providing these chickens with supplementary food in the form of cereal grain in the morning and then letting them out to scavenge for the rest of the day. It is typical that the hens would be left to lay their eggs in bushes and surrounding areas. As a result, it is difficult to monitor their egg production performance. Such kind of family poultry management practices have generally not changed in rural Africa. Besides the provision of feed, the other management activities mainly include the provision of sheds, feed troughs and water utensils (Barua and Yoshimura, 1997). However, according to Rangnekar and Rangnekar (1999), water facilities are not provided for family poultry (in India), and this is considered as a factor contributing to chick mortality.

According to Aini (1990) and Barua and Yoshimura (1997), these chickens naturally incubate their eggs and are sometimes provided with a laying facility, either wooden boxes or nests made from locally available material, such as bamboo baskets and grass straw. These nests are located on the sheds or surrounding household structures. One of the fields of interest of the present study was to identify the husbandry practices used by small-scale farmers with respect to reproduction (egg laying, incubation of eggs, hatching), rearing of chicks, juveniles and pullets up to adult chicken stage, and general household flock management. Very little is known about these husbandry practices in the South African context.

In North-eastern KwaZulu-Natal, South Africa, Naidoo (2000) reported management practices such as leaving the chicks with their mother (hen) as a common practice. The reasons given for such a practice was that it assisted chicks in developing instincts to danger and different ways of protection. The farmers were aware that practices of this nature left the chicks to be vulnerable, as easy prey to predators, and exposed them to harsh weather conditions.

Past approaches have generally shown that improving nutrition, housing and health care are some of the effective strategies to increase family poultry productivity (Tadelle, 1996). Therefore, there seems to be a need towards developing an understanding, through research, of other husbandry interventions practiced by households that influence family poultry productivity. Moreki *et al.* (1997) suggested management practices, such as early chick separation, as strategies to combat chick losses and ultimately improve family poultry productivity. These are feasible household management strategies which are not generally known, at least in South Africa.

2.13 The health, predation and other constraints to family poultry production

The major constraint of family poultry production is the existence of many poultry diseases. This is due to the poor hygienic conditions for family poultry kept under free range. There is high infestation with infectious diseases and external parasites (Aini, 1990). In many developing countries, Newcastle disease has been singled out as the most serious infectious and economically disastrous family poultry disease (Aini, 1990; Tadelle, 1996; Barua and Yoshimura, 1997; Moreki *et al.*, 1997; Guèye, 1998; Kumtakar, 1999; Mushi *et al.*, 2000; Sonaiya, 2000). Under household conditions, family poultry are never vaccinated with any standard Western type of vaccines.

The general practice by many family poultry farmers in rural settings of Africa is to address disease control once the symptoms appear in their chickens (Guèye, 1998), and in many cases they opt to use antibiotics meant for human use (Guèye, 1998). This implies that these farmers treat symptoms of the disease, rather than causes of the disease. In spite of global concern about diseases and particularly Newcastle disease, many household dwellers still continue to use and rely on traditional remedies as preventative measures to control the disease. For example, Naidoo (2000) reported that for external parasites such as lice, mites or fleas, wood ash or brown shoe polish was a common remedy used in the North-eastern KwaZulu-Natal, South Africa.

Traditional remedies against Newcastle disease in The Gambia involve family poultry farmers making a liquid blend from droppings of any wild bird with goats milk which is then given to chickens to drink (Guèye, 1998). In South Africa, particularly in North-eastern KwaZulu-Natal, Naidoo (2000) reported the use of black vinegar added to birds' drinking water once every week, as a remedy for Newcastle disease. Aloe, vinegar and brown sugar, as a boiled concoction put into drinking water, is another alternative in the fight against Newcastle disease by family poultry farmers (Naidoo, 2000). In some cases for Newcastle disease, Naidoo (2000) reported some individual use of Tamboti (umThombothi; *Spirostachys africana*) wood and *Trihilia dregeana* administered through drinking water after being crushed. In Botswana, the feeding of green mulberry leaves prior to a warning about the presence of Newcastle disease is practised, and Guèye (1998) reported that the latter practice induces diarrhoea in birds, and a reaction of such nature by birds is seen as a good indication of having acquired immunity against the viral Newcastle disease.

These various traditional medicinal practices performed on family poultry often involve natural plant products, called herbs. Many are used in treating poultry diseases affecting the respiratory, locomotor and nervous systems (Guèye, 1999; Mushi *et al.*, 2000). Chavunduka (1976) reported practices involving the use of fruits such as *Capsicum annum* and *Capsicum frutescens* by family poultry farmers in Zimbabwe. The use of aloe plant leaf extract is a general therapy in many African countries such as The Gambia, Zimbabwe and Tanzania and this clearly indicates the potential of traditional medication application with family poultry (Kitalyi, 1998). These findings correlate with those obtained in the North-eastern part of KwaZulu-Natal, South Africa by Naidoo (2000) on the use of aloe (*Aloe maculata*). This herb is chopped, submerged into drinking water and served to treat general respiratory diseases noticed with the characteristic sneak symptoms (sneezing) in chickens. The use of leaves of *Tetradenia riparia*, crushed and mixed with aloe, is common in that region, while even *Aloe greeni*, prepared by chopping and submerging in water, is considered another effective remedy for respiratory ailments. Therefore, there is extensive use of traditional remedies across the African continent and it is a general practice of disease treatment and prevention under subsistence farming conditions (Guèye, 1998).

Predation has been mentioned by several authors as another serious threat to family poultry production. Predation by snakes and hawks has been reported to cause considerable losses (Guèye, 1998). Naidoo (2000) reported that households in KwaZulu-Natal identified wild cats, mongooses, hawks and snakes as the main predators of family poultry. Some preventative measures have been suggested against snakes. These involve growing plants such as *Euphorbia* species and lemon grass, or even placing sliced garlic *(Alluvium sativum)* near chicken shelters. To prevent predation by hawks requires the use of spiny fruits of *Cucumis pustulates*, placed in the bird's drinking water points, which reportedly provides sufficient physical protection (Guèye, 1998). Other practices involve selection for natural aggressiveness among the flocks. This technique has been successful in reducing chick losses, but may not be good enough with young hens lacking mothering experience. Naidoo (2000) reported the use of trees, hedges and plastic jackets on chicks (as a scarecrow) as adequate to ward off hawks.

In summary, the major production constraints in family poultry have been found to relate to predation, diseases, high mortality and limited feed resources. In India, Rangnekar and Rangnekar (1999) found in a ranking exercise that the most serious problem was mortality at chick stage rather than at adult stage. Predation by birds of prey and theft by humans was ranked second. Saleque and Mustafa (1996) generally reported the major constraints to family poultry production as being high mortality, low productivity, nutritionally unbalanced feed in rural areas, lack of organized marketing mechanisms and poor government services on livestock matters. The high incidence of close in-breeding, high incidence of diseases, predation, mortality, use of traditional remedies (medicinal plants) in disease control, poor feeding practices, daily management and housing have been identified as issues of concern with family poultry (Aini, 1990; Tadelle, 1996; Barua and Yoshimura, 1997; Moreki *et al.*, 1997; Guèye, 1998; Kumtakar, 1999). Therefore, these constraints and other interrelated socio-economic issues require investigation through research, as they retard the productivity of family poultry. This review of relevant literature substantiates the choice of certain aspects of family poultry production as focal points in the present study, as indicated in the introductory chapter.

3.0 METHODOLOGY AND PROCEDURES

3.1 Introduction

This study intends to make a contribution to the understanding of the family poultry production system within the context of a household. The focus was on the socio-cultural issues, husbandry practices, roles and constraints associated with the production of family poultry. There was a need to look at family poultry and its dynamics in a holistic manner. The social, cultural and economic aspects were important to ensure a better understanding of the production of family poultry. Hence, the methodological approach was carefully chosen to ensure its appropriateness.

Appropriate research methodologies were those that recognized and accommodated the complex nature under which family poultry production is practised within the context of rural livelihoods. Eckman (1999) pointed out, in investigating issues of the rural poor, that it is important to recognize that these poor people cannot be studied in isolation, because one is dealing with the complexities of people's lives. Therefore, a participatory approach was found to be one of the feasible alternatives that could contribute to study some of the human complexities. For a comprehensive and holistic investigation on the dynamics of family poultry, both qualitative and quantitative methodologies were found suitable. A single methodological approach has limitations, where the interest is about a social unit such as a household or community, because it renders insufficient information (Leedy, 1997).

The qualitative research methodologies used involved the case study and Participatory Rural Appraisal (PRA) approaches. In this work, the PRA embodied methods such as participant observation and some methods involving direct participation. The direct participation methodologies were: semi-structured interviewing, seasonal diagramming, household sketching, transects, and ranking and scoring. These qualitative methodologies were considered to be appropriate approaches to the central problem of studying family poultry and its dynamics. Leedy (1997) concedes that such methodologies are particularly effective where the concerns involve human beings, interpersonal relationships, personal values, meaning, beliefs, thoughts and feelings.

These qualitative methods attempt to assist in attaining rich, real, deep and valid data from a rational stand-point about family poultry (Thompson, 1997).

The quantitative methodology used involved the collection of some agro-technical data taken once during the household interviews. These measurements yielded important baseline biological data on family poultry in the eight participating households. The biological variables measured involved the collection of numerical information on eggs, bird numbers and bird weight. This chapter begins with a brief background about the historical and geographical information of the study area. Then the procedures follow, with a description of the methodology, how it was used and also how the data were analysed and presented using each method.

3.2 The study area

The historical information about Makhuzeni sub-ward indicates that for many decades the area operated under the control system associated with the Bantu Authorities Act of 1951. For many decades the sub-ward was an area designated to African people. The Bantu Authorities Act of 1951 designates the chief as the chair of the tribal authority. The chief selects, from among men in his chieftaincy, the headmen who will assist in ensuring the smooth operation of the tribal authority's administration of the community. The magisterial district for the tribal authority of Makhuzeni sub-ward is Hlanganani, situated in the Southern KwaZulu-Natal Midlands. This is a deep rural area, situated on the southern spur of the Drakensberg, by road about 60 minutes south-west of Pietermaritzburg, in KZN, South Africa.

A brief look at the demographical and geographical features of the study area seems appropriate at this stage, in order to relate these features with the issues raised during the introduction and literature review such as poverty, women and the malnutrition of children. Information about the human population demographics was extracted from 1996 census statistics for the area (Census Statistics, 1996). The total human population of Makhuzeni sub-ward is 25 374, of which 14 402 (56.7%) are female and 10 972 (43.3%) are male. Children younger than 10 years form the largest population segment (9 525: 37.5%). Most of the people in the area live in traditional dwellings (4

179 from a total of 4 713, that is 88.7%). Only 600 people (2.4%) were formally employed, whilst 2 679 (10.6%) were unemployed and looking for employment in 1996. Within the economically active age category, 9 276 (36.5%) were not working, nor were they looking for employment. In 12 871 cases (50.7%) the employment status was not specified. The individual income in Makhuzeni varies from no income (14 146 cases) to more than R30 000 (one case). These data and other available statistics on the type of dwellings, water sources, sanitation and fuel use in this sub-ward, all point to an impoverished, deep rural community likely to be experiencing problems associated with poverty and malnutrition at the household level.

Information on the physical geography, climate and agro-ecology of the study area (Makhuzeni sub-ward) of Centocow ward (Hlanganani district) have been extracted from the work published by Camp (1999), for the bio-resource unit Yc15 of KwaZulu-Natal. The Makhuzeni sub-ward is located at 29° 55' South latitude and 29° 43' East longitude in the Southern Midlands of KwaZulu-Natal, South Africa. The total area is estimated to be about 23 466 hectares. The annual mean minimum and maximum temperature in the area is 9 °C and 21.6 °C respectively. The annual mean rainfall of the area is about 900 to 1100 mm, with the vegetation pattern being a combination of grassland to forest. The topography of the area is rolling or broken hills, with an altitude range of 900 to 1400 m. The terrain ranges from moderate to steep slopes, with slope percent categories of 5 -10% and above 12% respectively.

The extent of cultivation is classified as moderate, that is about 10-50% of the land area. The area consists of high potential crop ecotopes, which means that the soils are well drained and are 500 mm deep with clay content of no less than 15% and a slope not exceeding 12%. The indicator species, which are the plant species used in the identification of the area, are *Hyparrhenia hirta*, *Rubis cuneifolia* and *Solanum mauritianum*. The cropping pattern of the area includes growing of cabbage in colder areas during September to January with mean annual temperatures of 13-16 °C. Carrot growing, especially hybrid carrot, is possible during October to January. The open-pollinated carrot type can be grown as a transplant during the same period as the hybrid carrot. Dry beans, lucerne, maize and soyabean are potential crops of the area. Potatoes are planted as a dryland crop during October to February, with minimum annual temperatures of about 13-16 °C. However, it can also be planted as an irrigated crop at the same time.

3.3 Procedure

3.3.1 Sampling

The process of selecting a small group (eight households) from among the many households was an important exercise in the study. Purposive sampling, a non-probability sampling technique, as described by Brink (1987) and Shah (1990), assisted in obtaining the final eight households to be studied. This sampling technique is based on the judgement of the researcher, while the involvement of key informants ensured the adherence to criteria set for purposive sampling. As a general criterion, all participating households had to own family poultry. Further selection criteria included identification of the following:

A household with a flock numbering at least thirty family poultry chickens. The key informants were asked to suggest at least three households perceived to be constantly and successfully keeping a lot of these chickens. These households were visited for confirmation and the household with the highest number was chosen, with the involvement of the relevant family members. The interest in such a household was to explore the factors behind successful family poultry production.

A household perceived as old around the sub-ward. Such a household was perceived to have experience about the sub-ward and this was another way of extending the information gathering network beyond keeping family poultry. This household was potentially important in contributing to the relative historical, cultural, and traditional trends on family poultry.

A female-headed household. This was to ensure some of the gender dimensions are addressed in terms of family poultry. Female-headed households are prevalent in rural homesteads of South Africa and therefore a contribution was needed from such households.

A household with a high socio-economic status. The socio-economic status was perceived as being important by the key informants. A contribution from such a household was important in the information gathering process. This was to help ascertain the different approaches and values attached to family poultry.

A household prominently practising integrated farming. This household was important for detailed information on how family poultry is viewed from the integrated farming perspective. The support of each household farming practice and how they complement each other was another contribution expected from such a household.

A household involved in traditional healing practice. Generally, one of the major roles of family poultry keeping is in their use in performing traditional rituals. Due to the complexity of households under the community setting, it was important to consider a contribution from such a household involved in traditional healing practice. This was meant to ascertain the viewpoint of the household on family poultry production as influenced by healing practices. It is possible that such a homestead rears these chickens from a different perspective and even for a different purpose.

A household situated far from the main village activities. This characteristic was important as it forms part of the integrated information gathering on family poultry. This household was viewed as operating under a different micro-social and environmental conditions as influenced by its seclusion from main village activities. The aim was to look at family poultry kept under somewhat isolated and difficult conditions in terms of acquiring farming inputs and services.

A household perceived to be experiencing poverty. This criterion was found to be suitable because it is one of the dominant household characteristics found in many rural and urban households of South Africa (May *et al.*,1996). In this study, the identification of such a household was based on qualitative terms and was determined by the key informants. The aim was to get more insight on family poultry from those who are experiencing poverty.

3.3.2 Field notes

Field notes were kept by the researcher in order to record events and observations every night. It was important to ensure that the notes were written in full immediately at the end of the day. Burgess (1994) proposed some basic principles on field data recording. Firstly, that a regular time and place be set aside for writing of field notes. Secondly, that field notes should contain date, time, location and details of the main informants. Thirdly, that field notes be written in duplicate or triplicate, so that an account of a single event or material from a particular interview (and observation session or PRA exercise) can be used in different phases of data analysis. The last principle requires careful consideration of what has to be recorded and what is to be omitted from the field notes.

3.3.3 Case study

Guijt (1998) described a case study as a method involving a focused, in-depth discussion with a selected sample of people or households about any topic that is selected for research investigation. Burgess (1994) considered a case study to be a unit case, which may be a person, a small group, a community, an event or an episode. Therefore, a case study was viewed as some focused study which can be undertaken either with an individual, household, group or community in relation to one or more events. In this study, the case study method was used along with the participatory mode and within the PRA principles. Such a method tends to provide insights about how people deal with change and why change occurs in specific ways by following a sequence of personal events over time by trying to identify key characteristics. Furthermore, the method was used in order to be able to provide important background information on human dynamics within the context of family poultry production.
The case study approach was deemed appropriate, as it allowed detailed examination of family poultry production systems in their natural setting within an existing organizational unit, the household (Bogdan and Biklen, 1992; Guijt, 1998). Du Preez

(2000) conceded that the case study method is particularly useful when the instrument for questioning consists of 'how' and 'why' questions with open-ended responses. Since the interest in the present study was more on developing an understanding of the complex social, cultural, and economic contexts of keeping chickens within rural household conditions, the case study approach was suitable. Moreover, such a research approach, according to Du Preez (2000), has the unique ability to deal with a full variety of evidence derived at via interviews and observations.

However, one of the major limitations of the case study method lies in its low external validity; that is, it is not possible to generalise the findings of such a study to a broader context, such as a population or universe (Bogdan and Biklen, 1992; Leedy, 1997). A survey of an appropriate number of households from a given population, for example the region, magisterial district, ward or sub-ward, would have ensured a high level of external validity. In this case, a conscious decision was taken at the outset to use a more in-depth participatory approach of studying family poultry production, which meant that the survey method was not the best choice. The number of households to be studied had to be decided upon on the basis of compromise between the time available for fieldwork (three months), the need for in-depth study and the need to integrate participatory techniques of data collection. It was therefore decided to limit the number of households for the case study to eight. The initial plan was that the researcher would live with each household for a period of 10 days. This proved to be difficult in practice and the researcher spent only six days interacting with each household during the day only, while lodging with the chief at night. The main reason was that participating households were cautious to allow an "outsider" to stay with them at night, because they were protective of their privacy and wanted to establish the true *bona fides* of the researcher from a more comfortable distance.

For data processing, all reports include some qualitative information of a descriptive nature. Narayan (1996) suggested some qualitative data analysis approaches and outlined the most common ones as being the narrative, content analysis and quoting of anecdotes. Content analysis is a term used to describe the analysis of reported information: looking for trends, themes or events. Therefore, the content analysis approach was used in summarising the descriptive information or even in transforming the qualitative information into quantitative form. The process of content analysis was conducted by developing coding categories for quantitative tabulations. Initially, the data would be searched for regularities and patterns, as well as main topics or themes covered (Narayan, 1996). The exercise involved writing down of words and phrases that represent topics and patterns. The observations made during individual household visits and interviews aided in providing more descriptive information. A hand tabulation was used to draw up frequencies, percentages and means or averages. Observations were made on the environment, infrastructure, natural resources within homesteads, and the relative standing of family poultry and other livestock in the farming activities of households.

3.3.4 Participatory rural appraisal

Participatory forms of research emerged in the 1970's as a response to the failure of conventional research techniques to adequately address the issues in the Third World or developing contexts (Thompson,1997). Participatory research is based on the belief that development should be people-centred and grows like a tree which starts producing roots at its base (bottom), leading to new branches found at the top-most part (Thompson, 1997; Chambers, 1998). So people are central to any kind of development initiatives and the communities directly contribute to the decision-making processes. Participatory Rural Appraisal (PRA) evolved from the methodology called rapid rural appraisal (RRA). The emergence of the RRA was a result of three main reasons (Thompson, 1997). Firstly, the growing dissatisfaction with questionnaires and their results. Secondly, the need for faster, more cost-effective methods of obtaining information, and lastly, the anti-poverty biases resulting from researchers who spend little time in areas under investigation. The PRA methodologies provide the needed awareness that rural people are knowledgeable about issues affecting their everyday life. Their use has enhanced the recognition of the existence of indigenous technical knowledge, when considering development oriented issues (Thompson, 1997; Chambers, 1998).

In the 1980s, the RRA had undergone some modification, which led to the PRA, a more intensive participatory oriented approach. However, it is important to realize that both

RRA and PRA share similar basic principles and methods, but the main distinguishing factor lies on the roles, behaviour and attitudes (Thompson, 1997). The RRA does enable outsiders to make use of indigenous knowledge but the mode remains more extractive. This is because those who are experts play a dominant role in setting of the agenda and planning, and in obtaining and analysing the information. However, the PRA is more participatory and communities play an active role in these tasks, thus bringing about the change in emphasis relative to PRA. The early 1990s were marked by a very fast spread of PRA, and this fast pace was noticeable with the non-governmental and government organizations in India (Pretty *et al.,* 1991). The term PRA refers to an approach and method for learning about rural life and conditions from, with and by rural people (Midnet PRA Interest Group, 1994; Thompson, 1997; Chambers, 1998). Therefore, PRA is a practical field-level methodology in which actual experience is gained through working with rural people within the community. One of the major advantages of PRA is that it permits the researcher to act as a facilitator and catalyst but not as an expert. Participatory rural appraisal is not a rigid method but rather a systematic, semi-structured activity conducted in the field, most effectively by a multi- disciplinary team (Thompson, 1997). This implies that PRA can be an easily adapted to a variety of local and specific needs. Participatory rural appraisal is said to be quite effective if the intention is to quickly acquire new information and new hypotheses for rural development (Joachim and Heather, 1991; Narayan, 1996; Thompson, 1997; Chambers, 1998.

Participatory rural appraisal can be subdivided into two methodological fields : those methods indirectly or directly supportive of PRA and those methods involving intensive direct participation of villagers or people (Shah, 1990; Guijt, 1998). This study has, on the basis of background information on PRA, opted to use direct participant observation as one of the techniques supportive of PRA. The other PRA techniques used involved those associated with direct participation of people, which included semi-structured interviews and some of the diagramming techniques. The diagramming techniques found to be appropriate in this study on family poultry dynamics from a household perspective were: transects, household sketching, social resource mapping, seasonal calendar, Venn diagram, ranking and scoring, and a strength, weaknesses, opportunities and threat (SWOT) analysis. The diagramming techniques were of special importance in ensuring consensus and in initiating a base for resolving conflicts and differences of opinion. There is no argument about the effectiveness of diagrams in enriching discussion through visuals means, as indicated by Narayan (1996). The other advantage relating to the use of these diagrams, is their contribution to enhancing discussion of similarities and differences on family poultry issues, both with the literate and illiterate groups of people. Furthermore, the use of visuals tends to release tensions and people get involved while revealing their concerns (Shah, 1990; Narayan 1996). Therefore, the PRA methodology was appropriate for the present work as it provided a degree of openness which cannot be achieved if field research is to be conducted with a hierarchical approach (Shah, 1990; Narayan,1996)

Although the participatory approaches suited the nature of the study, their use does not guarantee that the outcome will be positive and sustainable (Eckman,1999). This implies that though the methodology may be suitable, the outcomes may lack assurance and can be either for or against the expectations.

The major problems with the use of PRA are that they are premised on the possibility of consensus, assume that the benefits of participation are self-evident, and that the negative effect of an outsider coming to implement or initiate the will of the people cannot be overcome (Thompson, 1997). Furthermore, PRA lacks theoretical background about the nature and dynamics influencing people's participation. The lack of background about the community is a major weakness of the PRA methodology (Thompson, 1997; Guijt, 1998). Participation is quite unlikely to be equally accessible to all members of the community and this could be influenced by many factors such as time, distance, gender and political alliances. In addition, within a community there are complex issues relating to power and the tendency is that those who are powerless will keep their suggestions to themselves, and their views might be considered to be of less value by other members in higher social strata (Thompson, 1997). This often results in dominant views being interpreted as universally accepted by the community (Thompson, 1997). There is a misconception that outside development facilitators can and must act as neutral observers in the process of data gathering and interpretation, and yet there is significant influence that outsiders, such as facilitators, have on PRA programmes.

If PRA is a once-off development exercise without a follow-up process, there is a danger that expectations can be raised amongst the community which are not fulfilled (Thompson, 1997). This could be working against the principle of empowerment, so people are encouraged to develop critical awareness of their action and a follow-up instituted by the community alone may be demoralizing and frustrating. The PRA methods have some rural bias, since only the techniques and materials suiting the rural situation are emphasized. Visual representation methods with PRA may create problems in terms of representation and interpretation for some communities (Shah,1990; Thompson, 1997). Much of what is labelled PRA often remains extractive in practice, as data analysis and planning occurs away from the field. Though PRA methods have been described as easily adapted to suit specific local needs, by the same token they can be modified to confirm the agendas, positions and/or programmes of the researcher, policy-maker or development institution. This undermines the value of the method for critical policy analysis (Thompson, 1997; Guijt, 1998).

Despite all these problems experienced with the PRA methodology within the qualitative research approaches, PRA is a powerful way of promoting participation, while adhering to the principles of a bottom-up approach in issues designed to contribute to development (Narayan, 1996; Thompson,1997; Chambers, 1998; May *et al.*,1996).

3.3.4.1 Semi-structured interviews

Semi-structured interviewing is a major PRA method involving direct participation by villagers. Semi-structured interviews are partly structured and mostly unstructured, depending on the individual or group response. The use of semi-structured interviews, together with other Participatory Rural Appraisal techniques helped in filling gaps and refreshing memories. Semi-structured interviews are very easy to execute, even by relatively inexperienced people, in a short time while allowing for a quality interview (Narayan, 1996). Besides the interviews with the heads of household, the snowballing technique (Shah, 1990) was used to identify other household members deemed to have outstanding technical knowledge about family poultry production. Data collection was an integrated approach, involving the use of various methods and techniques in an attempt to ensure an in-depth exploration of the research questions. Semi-structured interviews were conducted with household heads individually, or with any other household member knowledgeable about family poultry production. This was an important requirement to avoiding talking to only adult male family members, because women and young children participate in many farm work activities, as suggested by McCracken *et al.* (1988). For objective interviewing, a set of observational guide questions was developed and followed as an interview schedule. These questions were open-ended and the interview would start with a few pre-set questions and further questioning depended on the answers received, until the matter was explored to some depth. This allowed probing into areas which the villagers perceived as important, thus enhancing the interview discussions.

The interviews were sometimes conducted in formal places, but in many cases it was informal, so as not to disturb the daily work activities of the respondents. Some were conducted under trees, along the way and at work sites (crop fields). During interviews, the respondents were encouraged to offer their perspective in a free-flowing manner, without serious consideration of interference by the researcher, in the process of questioning. Interviewees were told to feel free in exercising their right to terminate the interview if they were committed to a particular task. This stimulated earnest opinions, details and free participation. The areas of questioning were intended to develop an intensive understanding of family poultry production within the household context. Questions relating to feeding practices relating to family poultry were asked. The management practices undertaken with family poultry from morning until dusk when chickens return from scavenging were also the focus of the questions. Constraints to family poultry productivity and suggestions to improve the situation were sought. Finding out the role of family poultry was one of the major questions. The social aspects involved questions relating to gender, employment, educational background and issues relating to household size. The number of chickens kept by households and any matters relating to their production were also part of the interview.

Relevant data about family poultry production (and associated background information about participating households) were of a descriptive nature, and the process used in data collection (and eventually, analysis) involved writing down of words and phrases that represent topics and patterns. At first the information was organized by hand tabulation, and some of the data deemed appropriate for computer analysis were analysed, as later presented in the form of frequencies, percentages, means or averages and standard deviations. For computer analysis an appropriate software programme was used (Minitab, 1998).

3.3.4.2 Transects

Transects are displayed as diagrams, usually showing a cross-sectional view or route of a community (Guijt, 1998). They are similar to maps and require direct participation of the village people. Transects consist of two elements: the transect walk and the diagram that records the walk. They require a systematical walk through the area of interest, with the informants. Such an exercise was ideal in the identification of issues relating to infrastructure, services, living areas and land-related features Thompson (1997) and Guijt (1998).

The informants used in this exercise were carefully chosen and the key informants (two inner council members and two community members) assisted in this process. This selected team represented immense local experiences, being constituted from community members living in the sub-ward. Prior to the official walk, the team of four members was briefed about the purpose of the walk. Thompson (1997) emphasized the need in such an exercise to observe what people point out as significant to them, as this assists in assessing the community's needs and priorities. The walk was systematic as it was meant to pass through and cover the entire sub-ward living areas, starting from the Western to the Eastern direction. The process observed the methodological sequence outlined by Guijt (1998). The plan in conducting the transect first was to use part of the information in verifying the selection criteria of the final eight participating households, as a triangulation process.

3.3.4.3 Participant observation

Direct participant observation was used in conjunction with other data collection methods. Direct observation by itself is generally not enough and therefore it needs to be supplemented by other PRA methods to make it participatory, and in the process to enrich the information generated (Shah, 1990). This observational method was used to gather information about physical conditions and behavioural practices. The researcher directly observed and partially participated in events considered part of the process of observation as described by Burgess (1994) and Narayan (1996), but some modification was made in as far as the residing arrangement was concerned. The researcher was permanently accommodated at the Inkosi's residence and made early morning visits to households, spending the whole day observing households. Bogdan and Bicklen (1992) stated that during an observation it is important for one to work towards winning the acceptance of the people, not as an end, but because it allows the researcher to pursue the study goals. This was a structured observation as described by Narayan (1996) and it was found suitable since the researcher had a predetermined, limited period of six days to spend with each family. The first two days was spent on familiarisation between the researcher and household members and *vice versa*. Establishing some rapport within the two days orientation was important for opening further avenues during the data collection process.

This orientation time was also a good opportunity to start on the structured observation in its natural occurrence using an observational sheet with the following:

Household composition
Number of rooms
Type of dwelling
Who releases chickens in the morning?
Who feeds them?
Where do the chickens live in the homestead?
Other livestock available
Type of scavenging feed resources
Who manages the chickens and livestock on a daily basis?
What happens during laying?
Where do they lay?
What happens to those with chicks?
Many other behaviour patterns and/or practices.

3.3.4.4 Household sketching

Household sketching is a direct participation method under the PRA. It is a mapping technique that helps in the location of the biophysical, economic and social features of a household. These were visual representations by people of how they see their individual households and may not be as precise as a formal map, and not to scale (Guijt, 1998). The exercise was conducted in conjunction with individual household interviews. Family members, the head of household and other household members were asked to contribute to drawing the household setting and other features perceived as important.

The exercise involved the use of stones, sticks and any other objects as models in the process of illustrating important physical features and issues. Constant probing was used to get more information about issues relating to the structures and this created interaction between the researcher and the family members. The information gathered was to show the relative position of major items, and the general biophysical setting of the individual homestead. The position of livestock and family poultry was the focus within the household farming practices. This diagramming exercise was important in showing the resource utilisation, socio-economic information and relationship between one or more of the factors within the household environment (Joachim and Heather, 1991; Narayan, 1996).

The analysis and presentation involved a drawing and a narrative description, thus comparing the eight household sketches in terms of resource utilization, socio-economic factors and the important relationship between one or more of the important features. For example, the effective and efficient use of an abundant natural resource like stones or rocks, which were seen to be used by many households in levelling the sloping grounds around the homesteads. Also, the ability to fence around the homestead surroundings and the nature of fencing material used by individual homestead represents the diversity in natural resource utilization. The individual household sketches are later presented as illustrations in Chapter 4 (see 4.3.1).

3.3.4.5 Social resource mapping

This method is a direct participation tool within the PRA methodology. This is a mapping method consisting of socio-economic information about the individual households as well as the entire location (Thompson, 1997; Guijt, 1998). The method was used to show information relating to the environment, both natural and human-made and included land use activities, physical features, water points, rivers and roads.

The exercise was conducted with eight heads of household. The group was divided into two groups of four members each and the two groups were derived randomly through a numbering system. This involved assigning all eight heads of households numbers from one to eight and the grouping was determined by whether a member had an even number or an odd number. Each group had a volunteer facilitator who had the task of getting fellow members to draw up a map of the Makhuzeni sub-ward, independently of each other. The mapping had to start with the demarcation of the turn-off from the main road leading to Bulwer and Underberg. This began with the road leading to the sub-ward. The map was to contain prominent features like natural resources, infrastructure, dwellings, landscape, land use practices and any other physical features regarded as important (Guijt and Pretty, 1993). These two groups were allowed to draw up a draft map on the ground and this was later transferred onto a manilla paper for plenary presentation.

Both groups were closely monitored by the researcher and participation was encouraged by posing critical questions such as "what about this? ", and "where is it located?", and "who has access to it?". The use of social mapping was appropriate as it provided information about the surroundings of the sub-ward and a final consolidated draft was drawn using information from both groups. This exercise was conducted in order to provide the required in-depth information about the resources, dwellings, fields and any information relating to family poultry in a much broader perspective. The mapping is presented in Chapter 4 (see 4.3.3).

3.3.4.6 Seasonal calendar

In the context of the PRA methodology, a seasonal calendar is classified as a method directly involved with participation of the villagers. This calendar shows the main activities, problems, and opportunities throughout the year in a diagrammatic form (Shah, 1990; Thompson, 1997; Guijt, 1998). The seasonal calendar can be based on weekly, monthly or seasonal classification. Chambers (1998) pointed out that with seasonal calendars people are able to illustrate tasks, problems and opportunities throughout the annual cycle in a diagram form. With that in mind, and the primary focus being on family poultry under different household farming conditions, it was found appropriate in assisting the data collection process. Seasonal calendars were viewed as techniques with the potential to show times of difficulty and vulnerability, or any other significant variance, which has an impact on people's lives.

The peak, slack and intermittent farming practices were to be identified, for family poultry production. The same group members who drew up the social map were used in this exercise. The initial two groups was combined at this point. The volunteer group facilitator helped in leading the discussion on this task. The unit of analysis for this exercise was the group comprising of head of households or household representatives.

A full monthly calendar for the year had been drawn in advance, in an attempt to save time, as the exercise can be time consuming (Guijt, 1998). The researcher introduced the task by asking for the different farming and non-farming activities that households are constantly engaged in as livelihood strategies. These activities were listed on a manilla paper for all to see and each explained in vernacular (isiZulu). Then, the facilitator started the discussion by asking participants to specify the times when each activity occurred and solicited reasons in terms of its importance. The facilitator started from January and went through until the last month (December). Each task was justified by some time frame (days or weeks) to clearly show the beginning and end of an activity. Strategic probing for clarification as a way of cross-checking and ensuring interaction encouraged other members in verifying information. The information reflected by the seasonal calendar was discussed and later presented graphically as a mapping. The seasonal calender is presented in Chapter 4 (see 4.3.4).

3.3.4.7 Venn diagram

Venn diagrams are also known as institutional or chapati diagrams. The technique shows the key institutions and individuals in the community and their relationship. This is still one of the PRA methodologies classified as a method requiring direct participation of the villagers (Shah, 1990). In general, these visuals seek to represent the role of individuals, institutions and their degree of importance in decision-making. In the study, this technique was used to ascertain the perceptions of a focus group on the contextual relationships between family poultry in Makhuzeni and individuals and institutions or organizations with a direct or indirect influence on family poultry.

The focus group consisted of six heads of household and three members from a community poultry development group. As a caution, it was important to be clear about what was being monitored, as this process can be confusing if the discussion deals with all relationships that are essential for all aspects of the farm enterprise (Midnet PRA Interest Group, 1994; Guijt, 1998). Therefore, the researcher, in leading such discussions began by generally identifying individuals and organisations or institutions that are external to the community and yet are important for family poultry production.

A list was thus made on manilla paper. This was soon followed by introducing a picture of chickens around a homestead, to focus attention on family poultry production as the central issue. With family poultry at the centre of the diagram, the relationships of individuals, organisation or institutions listed earlier, were integrated. Their relative importance was indicated by making use of different sized circles (the bigger the circle, the more important) placed at varying distances from the centre (the closer to the centre, the more important). Communication linkages between actors were developed by joining two or more of the circles as a subset of the other. The Venn diagram is presented in Chapter 4 (see 4.3.5).

3.3.4.8 Ranking and scoring

The methodology of ranking and scoring involves direct participation of villagers and entails people identifying lists of criteria for specific objects or issues. These items are then used to rank priorities and needs. The pair-wise ranking (Shah, 1990) was found the ranking technique suitable for this work. This technique provides the opportunity for rural people to physically rank and re-rank some items or preferences or uses and explain their reasons for a given ranking (Shah, 1990; Guijt, 1998).The exercise was conducted with a focus group, consisting of a member from each of the eight participating households, and three members from the community poultry development committee.

From the preliminary data collected during the individual household interviews, a list of factors was extracted and grouped into themes. For example, a list of family poultry diseases affecting family poultry was formulated. The diseases were placed in a grid or matrix table on manilla paper written in vernacular (isiZulu) and participants were asked to weigh up these diseases (as paired factors). The process carried on until all pairings were completed. For each pairing, the group had to reach a consensus on the relative rank through group discussion. Probing to ensure full participation was needed and the researcher was very articulate in the questioning. The group ranking is preferred, as it provokes more discussion than individual ranking (Guijt, 1998).

For every pair-wise ranking exercise, a scoring would be derived by counting the number of times a factor appeared on the pair-wise sheet and a priority ranking worked out, presented in numerical order. This exercise was used to establish people's perception by prioritising factors from the following important fields with specific reference to Makhuzeni sub-ward:

Functional uses of family poultry
Feed resources available for family poultry
Husbandry practices for improving productivity of family poultry
Constraints to family poultry production
Important family poultry diseases

For the analysis, the item's individual scoring and ranking was drawn in one section of the matrix table or grid. Clarification and reasoning remarks were made before the presentation of the mapping exercise.

3.3.4.9 SWOT analysis

The exercise was intended to explore people's perceptions of the strengths, weaknesses, opportunities and threats associated with family poultry production in Makhuzeni sub-ward. The focus group for this exercise consisted of members from the eight participant households, namely three male heads of household, two female heads of household and three male members of household. Strengths, weaknesses, opportunities and threats columns were drawn up on manilla paper. The volunteer facilitator had to lead the group discussion in this exercise.

The exercise was started with a real chicken placed in front of the group and a question was asked in vernacular (isiZulu) pertaining to the strengths villagers thought they have with respect to family poultry rearing in Makhuzeni sub-ward. The process was repeated with reference to weaknesses, opportunities and finally the threats, as perceived by the group. Probing was important and was constantly used to encourage group interaction. The researcher constantly emphasised the need for everyone to participate and let the ideas be discussed and validated by the group. The members were encouraged to feel free to share ideas, rather than thinking of some of their ideas as being less important. This helped in ensuring full participation. A table indicating the strengths, weaknesses, opportunities and threats is presented in Chapter 4.3.12.

3.5 Agro-technical data

Some quantitative biological data were collected on family poultry in Makhuzeni sub-ward during February to April 2000. During the six days spent in each household to observe and to conduct individual interviews, counting and weighing of birds was instituted. All agro-technical data were collected once during the household observation and interview process. Recordings were made on the number of eggs, egg weight, and the number and weight of birds in different age and gender categories (chicks, juveniles, pullets, adult cockerels and hens).

These categories were qualitatively described depending on the knowledge of the informant (person in charge of the family poultry husbandry practices in the home). The qualitative description was based on an estimated age of bird and narrative information from the informant. This was necessary in order to ensure some degree of accuracy and at making it compatible with local conditions (mutual acceptance). An adult cockerel was regarded as a sexually mature, active male chicken. An adult hen was identified as a mature, sexually active or non-active female chicken that has brooded eggs once or more. A pullet was described as a maturing, female chicken that was ready and capable to lay an egg at any time for the first time in her life and she engages in mating with a mature cockerel, but has never brooded eggs. A chick was considered as any immature female or male bird, that had no complete body feathering. A juvenile was any immature female or male bird with complete body feathering. These were the bird category guides followed when collecting data on family poultry, such as flock structure and average or mean weight. The number of birds recorded during interviewing was confirmed by a physical count. Counting and weighing of birds were done at a time pre-arranged with the household member responsible for the chickens. This was normally in the evening when the birds returned to the homestead to roost after the day's scavenging, or early in the morning before the birds were released or started scavenging.

In some cases, particularly for juvenile chickens that proved difficult to capture, only a sample of birds could be weighed. Body weights were measured with an electronic scale (to the nearest 2 g). Eggs were counted and individually weighed if found available during the six day visiting phase. This was conducted during the day with an electronic scale (to the nearest 0.1 g).

The biological data (quantitative measurements and enumeration data) collected during the six days spent with each household were analysed with descriptive statistical tools to obtain frequency, range, averages, means and standard deviations. For this purpose an appropriate statistical software programme was used Minitab (1998).

3.6 Chapter summary

The chapter described a multi-disciplinary methodological approach (involving the case study, Participatory Rural Appraisal and agro-technical measurements) in investigating diverse issues that help provide an in-depth understanding of family poultry production under household conditions. These methods were individually explained in terms of their appropriateness for this kind of study. The positive attributes in terms of appropriateness of each method were explored, while corresponding limitations about these methods were presented. The chapter also highlighted the non-probability sampling techniques which were found suitable for the study. Finally, a description of the procedures undertaken with each method was given.

4.0 RESULTS

4.1 Introduction

Eight households were studied in-depth and their selection criteria were outlined in Chapter 3. The results are presented as themes using content analysis with the main objective of reporting trends in a summarized format, as suggested by Narayan (1996). The tables and graphs presented are accompanied by a brief description of the results. The presentation of the work includes case study information obtained from the individual households, participatory rural appraisal data and agro-technical information on various aspects relating to family poultry production. The case study method was used to provide general background information about the eight households, based on household size and gender, employment status and occupation and educational level. Furthermore, within the participating households, gender, employment status and occupation, educational level and livelihood activities form part of the important background information. These themes provide the necessary socio-economic information about the people living in eight rural households of Makhuzeni sub-ward. General themes about the sub-ward were developed via PRA methodologies; *vide* transect walk, household sketch, social resource mapping, seasonal calender, SWOT analysis and the scoring and ranking exercise. The last part in the results presentation involves the quantitative data on agro-technical variables, obtained through measurement and enumeration methods.

4.2 Socio-economic and cultural aspects of participating households

A household composition survey was conducted as a quantitative component of the social fabric of the households engaged in family poultry production. The purpose of collecting these data was to study the intrinsic and diverse factors existing within households that may relate to and influence family poultry production practices in rural households. The following factors were studied and provide valuable data about the households and their social existence.

4.2.1 Household size categorized by gender

Table 4.1 illustrates the size of participating households, categorized by the gender of the household members. It is clear that there were more female than male households members in the sample.

Table 4.1 Household size categorized by gender

Household	Household size	Gender Distribution	
		Female	Male
A	1	0	1
B	4	1	3
C	3	2	1
D	3	3	0
E	5	1	4
F	6	3	3
G	3	1	2
H	9	3	4
Mean	4.25	2.25	1.75
Standard Deviation	2.44	1.49	1.16

4.2.2 Employment status and occupation

In attempt to define employment status, the Central Statistical Service of South Africa in the 1996 census categorised status according to whether a person is employed, unemployed or not economically active. There are two categories in the explanation: employed and unemployed, which make up the category of economically active people. Employed describes those people who are economically active. The unemployed category includes those who are not working but are within the economically active group. The economically active category of people in South Africa, according to Ardington and Lund (1996), is between 20 to 59 years of age. The economically inactive encompasses those who are not presently part of the labour force. Work was defined as including working for pay, profit or family gain.

Work status considered whether a person is an employee, an employer, self-employed and working alone or in a family business. For the purpose of the present study employment status takes into account whether a person is employed, self-employed or unemployed and provision is made to show reasons when unemployed. Further probing of respondents was necessary when response was unemployed or not working. Table 4.2 illustrates the employment status within the participating households. The distribution of employment in these households shows a marked difference between the few employed and many unemployed household members. There was about 89% unemployed household members who were within the economically active group and potentially liable for employment, and only 11% were formally employed in a nearby grocery shop.

Table 4.2 Employment status by gender within the participating households

Employment status	Female		Male		Total	
	n	%	n	%	n	%
Economically active group:						
Employed	1	13	1	10	2	11
Unemployed	7	87	9	90	16	89
Sub-total	8	100	10	100	18	100
Economically inactive group:						
Pensioners	2	40	4	37	7	44
Scholars	3	60	3	27	6	38
Pre-school	0	0	4	37	4	25
Sub-total	5	100	11	100	16	100
Total	13		21		34	

4.2.3 Activities of Rural People

Previous livelihood studies, according to Du Preez (2000), focused narrowly on activities that generated income, and yet livelihood activities were about more than just income generation. The discussion on rural people's activities attempts to develop a broad view of what rural household members are engaged in, irrespective of the activity contributing to their income or not. The information collected on the various agricultural activities of participating households is summarized in Table 4.3. Agricultural activities found to be predominant in most of these rural households included: subsistence crop production related activities (such as land preparation, planting, weeding, community gardening, family gardening, and harvesting), chicken, goat and cattle husbandry.

Table 4.3 also demonstrates the household members who participated actively in a specified agricultural activity. However, some household members in a few households were not involved in many of these livelihood activities, mainly because of unavailability of finance to purchase inputs. Therefore, the extent of engagement in the various agricultural activities is influenced by purchasing ability, indicating that the latter factor is contributing to socio-economic diversity in rural households.

Land preparation, planting and weeding were the major activities conducted in producing field crops. Vegetable production was another activity (which contributed to household food production), which was conducted either in a community garden or in the family gardens or in both. Field crop and vegetable production tends to be seasonal activities, which is critical in subsistence food production systems of the participating households. The primary aim of these activities is enhancing production for home consumption as opposed to marketing or income generation. In the male headed households, men seem to play a major role in land preparation, while the rest of the agricultural activities such as planting, weeding, community gardening and harvesting are performed by women and children. The livestock activities featured both gender groups. Chicken rearing tends to depend on whom heads the household. Men were more numerous as heads of households than females in the participating households. This could have been influenced partly by the restricted sample size and non-random sampling method used in this study.

Table 4.3 Activities of rural people as perceived and observed in households

Household (H/H)	Land preparation	Planting	Weeding	Involvement in community garden	Involvement in family garden	Harvesting	Chickens	Goats	Cattle
A	The male head of H/H on the family garden	The male head of H/H on the family garden	The male head of H/H on the family garden	No one	Male head of H/H	Male head of H/H on family garden only	Male head of H/H	Not reared	Not reared
B	All H/H members	Wife of the head of H/H	Wife of the head of H/H	Wife of head of H/H	Wife of the head of H/H	Wife of the head of H/H	Male head of H/H	Not reared	Male head of H/H
C	All H/H members	All H/H members	Wife of the head of H/H	Not applicable - has an old spouse	All H/H members	All H/H members	Wife of the head of H/H	All members of H/H	Not reared
D	Female head of H/H and eldest daughter	Female head of H/H and eldest daughter	Female head of H/H and eldest daughter	Too old	Female head of H/H and daughter	Female head of H/H	Female head of H/H	Not reared	Not reared
E	All members of female-headed H/H	Wife of the head of H/H	Wife of the head of H/H	Wife of the head of H/H	All H/H members	All H/H members	Male head of H/H	Sons and male head of H/H	Male head of H/H
F	All members of female-headed H/H	All members of female-headed H/H	All members of female-headed H/H	Eldest daughter of female-headed H/H	Eldest daughter of female-headed H/H	All members of female-headed H/H older than 10 years	Eldest daughter of the female-headed H/H	One son of the female-headed H/H	Not reared
G	No one involved	No one involved	No one involved	No one	Nothing planted	There was no cropping	Wife of the head of H/H	Not reared	Not reared
H	Male head of H/H	Male head of H/H	All members of H/H and workers	Wife of the head of H/H	Wife of the head of H/H	All members of H/H and workers	Wife of the head of H/H	Herdsman of the H/H	Not reared

4.2.4 Employment and occupational standing of heads of household

The results in Table 4.4. demonstrate that the majority (75%) of the heads of households engaged in family poultry production in the eight participating households were not working, as opposed to 25% who were self-employed or engaged in community work. This was not surprising, because many of them (88%) were pensioners. Three quarters of the participating households were male headed households.

Table 4.4 Employment status and occupation of heads of participating households by gender

Household	Gender	Employment status	Occupation
A	Male	Not working	Pensioner
B	Male	Not working	Pensioner
C	Male	Not working	Pensioner
D	Female	Not working	Pensioner
E	Male	Not working	Pensioner
F	Female	Not working	Pensioner
G	Male	Not working	Pensioner
H	Male	Self -employment	Bricklayer
Total = 8	6 (75%) Male 2 (25%) Female	7 (88%) Not working 2 (12%) Working	7 (88%) Pensioner 1 (12%) Bricklayer

4.2.5 Educational level of heads of participating households categorized by gender

Table 4.5 illustrates the educational level of the heads of households categorized by gender. The term educational level refers to the highest level attained and the educational categories adopted in the study were slightly modified from those used by Du Preez (2000). The gender distribution and the educational background of the head of households show that more male heads of household had some primary and secondary education. Neither of the two female heads of households in the study had received any formal schooling, whereas only one out of six men had never been to school. This situation probably reflects the generally marginalized position of rural women in terms of education opportunities.

Table 4.5 Head of household educational level categorized by gender

Educational level	Female		Male		Total	
	n	%	n	%	n	%
Never to school	2	25	1	13	3	38
At least primary school	0	0	4	50	2	5
At least secondary school	0	0	1	13	1	1
Total	2	25	6	75	8	100

4.2.6 Livestock statistics of the eight participating households

The different types of livestock reared by the participating households are illustrated in Table 4.6. Numerically the dominant type of livestock was family poultry, contributing approximately 60% of the total livestock population. Family poultry (chickens) was the only livestock species owned by all households, and this probably implies that everyone (even those households perceived by their community as poor) can afford to keep family poultry. In terms of monetary investment, family poultry comes third after cattle and goats. The approximate monetary value contribution from family poultry was about 5.2% of the total. The rearing of donkeys show their importance as means of transport in the area.

Table 4.6 Type of livestock kept by the eight participating households

Type of livestock	Frequency of keeping H/H with	H/H without	Total Numbers	Range in Numbers	Approximate monetary value (Rand)
Cattle	5	3	57	0 - 31	114 000
Family poultry	8	0	234	4 - 94	8 190
Donkeys	3	5	10	0 - 5	3 500
Horses	1	7	1	0 - 1	3 000
Goats	3	5	53	0 - 21	23 850
Sheep	1	7	10	0 - 10	4 500

Cattle = R2000/unit; Family poultry = R35/unit; *Donkey = R350/unit, *Horse = R3000/unit; Goat and Sheep = R450/unit.

*Van Aswegen (2002 -personal communication).

4.2.7 Perceived production potential of family poultry

The production potential of family poultry was explored on the basis of production indicators such as number of eggs per hen, number of clutches per year and identification of the peak production period in terms of chick output. These production variables were discussed with the heads of participating households. There were some differences in terms of perceived production potential of family poultry. The number of eggs laid by a hen at a single clutch varied as reflected by the heads of households. The variation in the potential number of eggs that can be laid by a hen is illustrated in Table 4.7. Household heads reported clutch sizes varying from nine to 22 eggs per hen, while the number of clutches per year reportedly varied from three to six. Such variation may be attributed to differences between individuals in terms of factual memory, observation skills or household farming conditions.

Table 4.7 Production potential of family poultry

Household	Clutch size (eggs/hen)	Number of clutches per year	Peak production season (based on chick output)
A	13 - 18	4 - 5	Summer
B*	11 - 15	4 - 5	Summer
C**	18 - 22	6	Autumn-Winter
D	10 - 15	Not sure	Autumn-Winter
E	9-15	3	Autumn-Winter
F	10-17	3	Not quite sure but regulated by feeding
G	10-15	3	Autumn-Winter
H	10-18	3	Autumn-Winter

* Household B, allows hens to brood a maximum of 13 eggs even if more eggs are laid.
** Household C, allows hens to brood a maximum of 18 eggs, even if more eggs have been laid.

Knowledge about the peak production time of family poultry is important in terms of any proposed interventions and contributes to the understanding of these chickens at household level. The peak production period was identified as summer by two heads of household. However, five heads of household indicated that autumn-winter was the appropriate time for intensive family poultry production. The latter was probably the appropriate period, because it is congruent with evidence from the seasonal calender, and other production determinants (e.g. availability of grain harvest waste, low incidence of diseases and favourable weather conditions).

4.2.8 Impact of poultry husbandry practices on flock size

Households were grouped according to two contrasting husbandry practices (outdoor vs indoor laying practice; hen tethering vs no hen tethering; early chick separation vs no early chick separation). The total number of birds of those households using a particular husbandry practice was expressed as a percentage of the total of birds in all eight households, to get a flock size index associated with that practice (Figure 4.1). For example, outdoor and indoor laying practice was used by respectively three and five households, and the corresponding number of birds was 38 and 196 (from a grand total of 234 birds).

Hence, the flock size index associated with outdoor laying practice was 16.2%, as opposed to the 83.8% for the indoor laying practice. The average flock size for households using the outdoor laying practice was 12.7, with a standard deviation of ±7.8 (ranging from a minimum of four, to a maximum of 19). In households using indoor laying, the average flock size was 39.2±31.6 (minimum of 18, maximum of 94). When contrasting hen tethering with no hen tethering, the respective flock size indices were 65% (three households) and 35% (five households). The average flock sizes were 50.3±38.9 and 16.6±7.9 for households using tethering or no tethering respectively. The corresponding minimum and maximum flock sizes were 19 and 94 (tethering used) and four and 25 (tethering not used).

Two households (25%) practiced early chick separation, and the flock size index was 56.4%. In the six households (75%) not using early chick separation, the flock size index was 43.6%. The average flock sizes were 66.0±39.6 (early chick separation) and 17.0±7.2 (no early chick separation). The corresponding minimum and maximum flock sizes were 38 and 94 (early chick separation) and four and 25 (no early chick separation). These practices reveal the extent of variation in flock size found within households as determined by these family poultry production strategies. These production strategies have never been reported before and are illustrated in Figure 4.2 with indoor laying practice in a kitchen and Figure 4.3 with households performing a hen tethering practice.

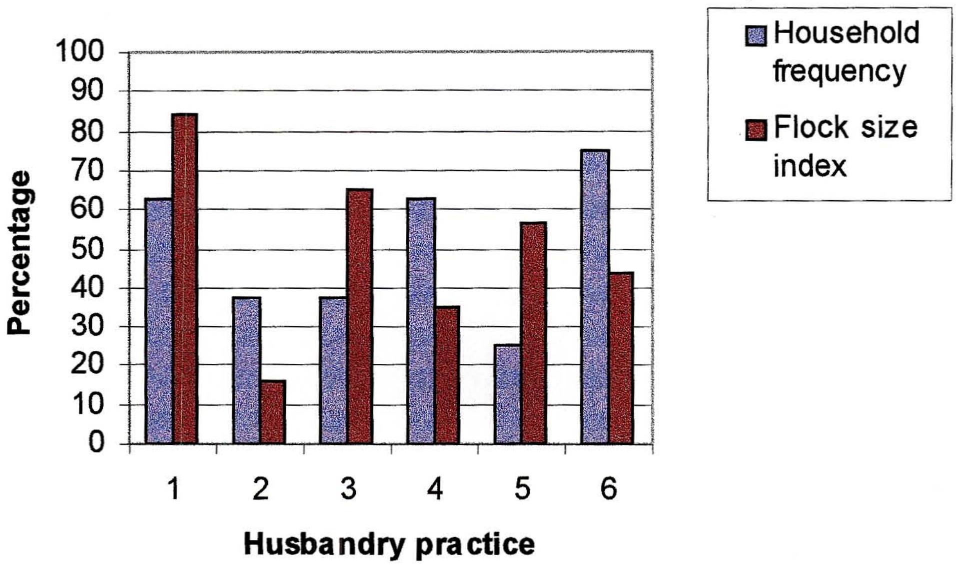

Figure 4.1 The comparative effects of husbandry practices on family poultry flock size (1 = Indoor laying, 2 = Outdoor laying, 3 = Tethering, 4 = No tethering, 5 = Early chick separation, and 6 = No early chick separation)

Figure 4.2 Indoor hen laying practice in a kitchen using removable nest material

Figure 4.3 Indoor hen tethering practice and forced indoor laying using a cardboard box

4.2.9 Socio-economic dynamics in family poultry production

The educational level of head of households (at least secondary school) tends to have a positive effect on flock size, while gender (female-headed households) probably did not show a discernable effect on flock size. The various socio-economic factors, husbandry practices, and their influence on flock size are illustrated in Table 4.8.

Table 4.8 Summary of links between socio-economic and agro-technical factors in the eight participating households

Household (H/H)	Selection criteria	Gender of head of H/H	Education level head of H/H	Poultry husbandry practices						Flock size
				Indoor laying	Outdoor laying	Hen tethering	No hen tethering	Early chick separation	No early chick separation	
A	H/H situated far from village activities	Male	At least primary school	No	Yes; in the veld	No	Yes	No	Yes	4
B	H/H with at least 30 family poultry	Male	At least primary school	Yes; in the kitchen	No	Yes; in the kitchen	No	Yes	No	38
C	H/H involved in traditional healing	Female	Never been to school	No	Yes	No	Yes	No	Yes	18
D	H/H perceived to be old	Male	At least primary school	Yes; in a shed	No	Yes; in the kitchen	No	No	Yes	21
E	H/H headed by a female	Female	Never been to school	No	Yes; in the family garden	Yes; in the kitchen	No	No	Yes	25
F	H/H practicing integrated farming	Male	Never been to school	No	Yes; in the family garden	No	Yes	No	Yes	19
G	H/H perceived to be poor	Male	At least primary school	No	Yes; in the veld	No	Yes	No	Yes	15
H	H/H perceived to have high socio-economic status	65Male	At least secondary school	Yes; in the kitchen	No	Yes; in the kitchen	No	Yes	No	94

4.3 Participatory rural appraisal

4.3.1 Household sketch

The eight household sketches were important in an attempt to obtain detailed, integrated information as reflected by the individual sketches. The homestead setting in terms of appearance, organization and natural resource utilization varied between households. The diversity could be associated with several factors, such as age of the homestead; number of economically active members within the household, especially those who are employed within or externally from the village and contributed some remittance to the household; and most importantly, the extent of poverty which in most cases will determine the purchasing ability of the homestead. The layout of some homesteads and their resource organisation was poor, in that the homestead surroundings were without perimeter fencing and this was found in three households. Only one homestead was located under an extremely bushy and neglected environment. This could perhaps be explained by the state of poverty in that household, which may also have a considerable influence on other socio-economic factors such as the perception on family poultry rearing and the ability to integrate the use of natural resource inputs.

The location of the pit toilets differed from household to household. Some had the pit toilets close to the homestead and particularly on the upper lands. This was a potential health hazard for the humans living in these homesteads. There was a high potential of sewage seepage from pit toilets polluting water resources, and even family gardens, thus posing risks to human health. Generally, in all the household sketches, traditional dwellings are clustered together without leaving much open space between the dwellings. Space was found to be the principal limitation as a result of the sloping topography and seemed to impact on the entire homestead's setting. The majority of the dwellings were round houses (rondavels) and their walls were made of mud or mud blocks. The roofing of these traditional dwellings consisted of thatched grass, which is an abundant natural resource available from low lying lands adjacent to the cropping land. This demonstrates integrated use of available natural resources, involving soil and water in making mud blocks for the walls, while the thatch grass was found suitable for roofing purposes. Natural resources like stones and rocks have become not only a useful resource in land terracing but also in construction of cattle kraals in some of the participating households.

Each of the eight households studied had at least three rondavels and at most four. In most of the households at least one main house was present and this was constructed differently. Though the main house was not round, it was also mud-walled and the main distinguishing feature was the corrugated iron roofing. This main house consisted of more than one room. In all homesteads, open space (both in the front and more so in backyard) was a major limitation. In most of the dwellings the backyard spacing was so restricted that movement around was difficult or impossible. The sloping terrain was the major contributing factor to this limited space in homestead layout.

Most of the households have some form of perimeter fencing demarcating the homestead area except in three households. The perimeter fencing material was mostly made of diamond mesh fence wiring and none made from tree branch cuttings because the area is devoid of trees. The homestead surroundings are without any natural shrubs or trees. This may be one of the major limitations with family poultry production in the area. Lack of trees deprive the chickens of a natural place to (safely) roost at night. The people of the area might have been forced to consider keeping their chickens indoors, which might have led to the emergence of indoor family poultry practices.

Most of the households have planted kikuyu grass strips in front of their homesteads. These grass strips were found to be useful in reducing muddy conditions during the rainy season, while for animals like family poultry they acted as a scavenging area, particularly during the dry winter months. This benefit extends to other household animals such a donkeys and horses who often grazed on the grass. Except for one household, the households had a family garden that were used to produce vegetables for family consumption. In these gardens, vegetables such as cabbages, beans, and swiss-chard (commonly but incorrectly known as spinach) were the basic vegetables. A few households had fruit crops in their family gardens such as bananas and peaches and such fruits contribute to the household human dietary nutrition. Maize (as green mealies) and sorghum were also grown for home consumption. The household sketches are presented in Figure 4.4 through Figure 4.11.

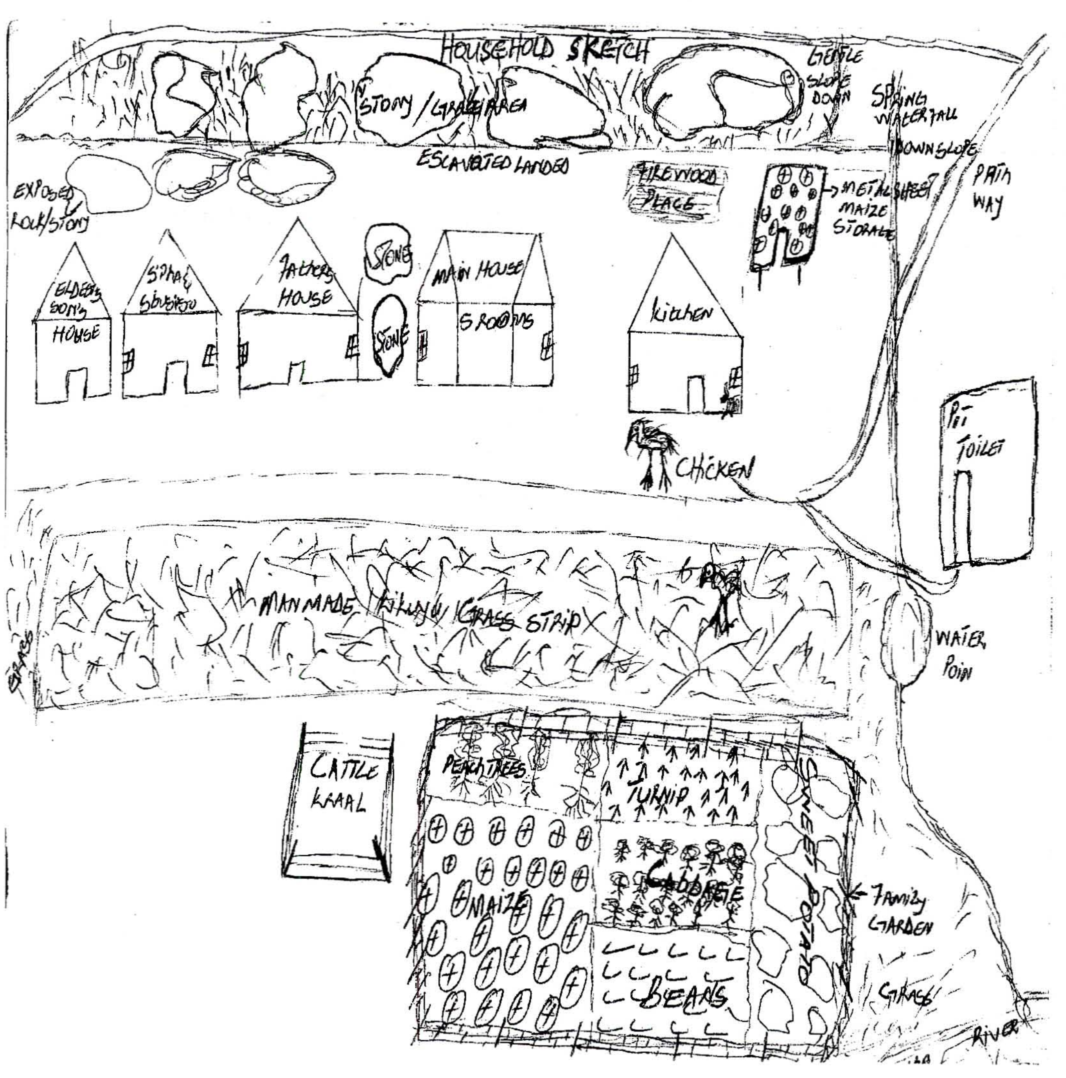

Figure 4.4 Household sketch B (A household with more than thirty family poultry)

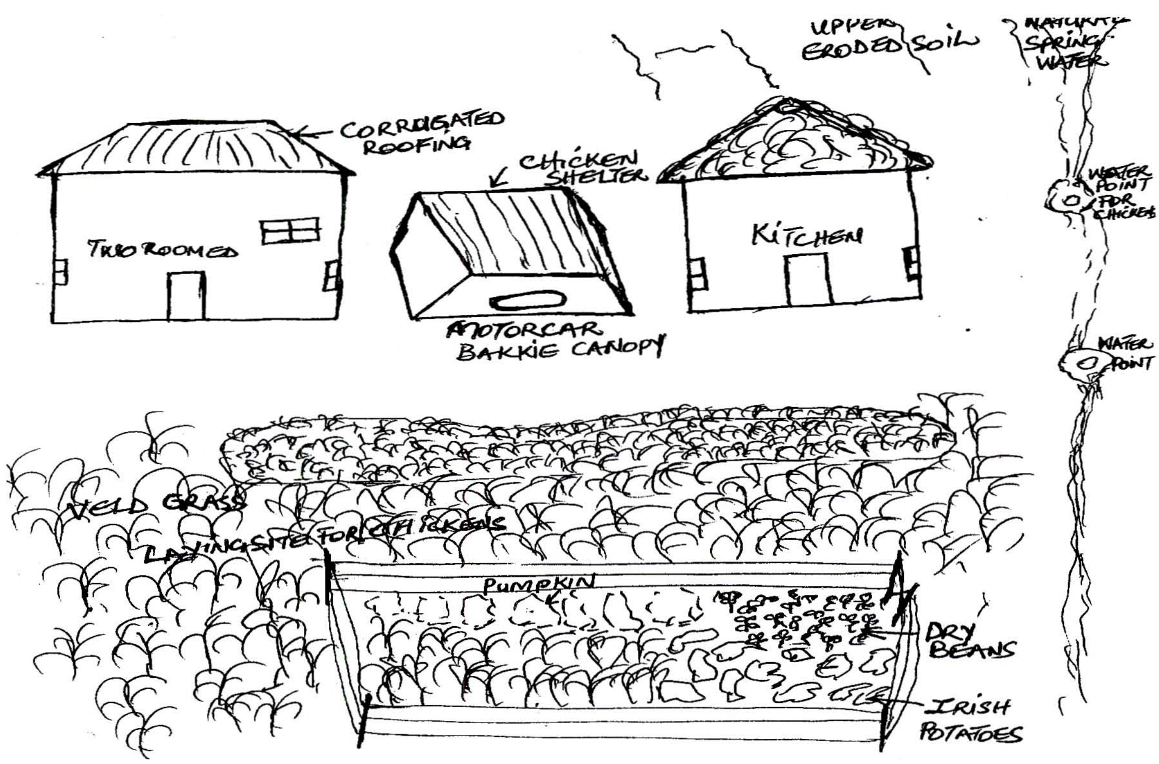

Figure 4.5 Household sketch A (A household situated far from main village activities).

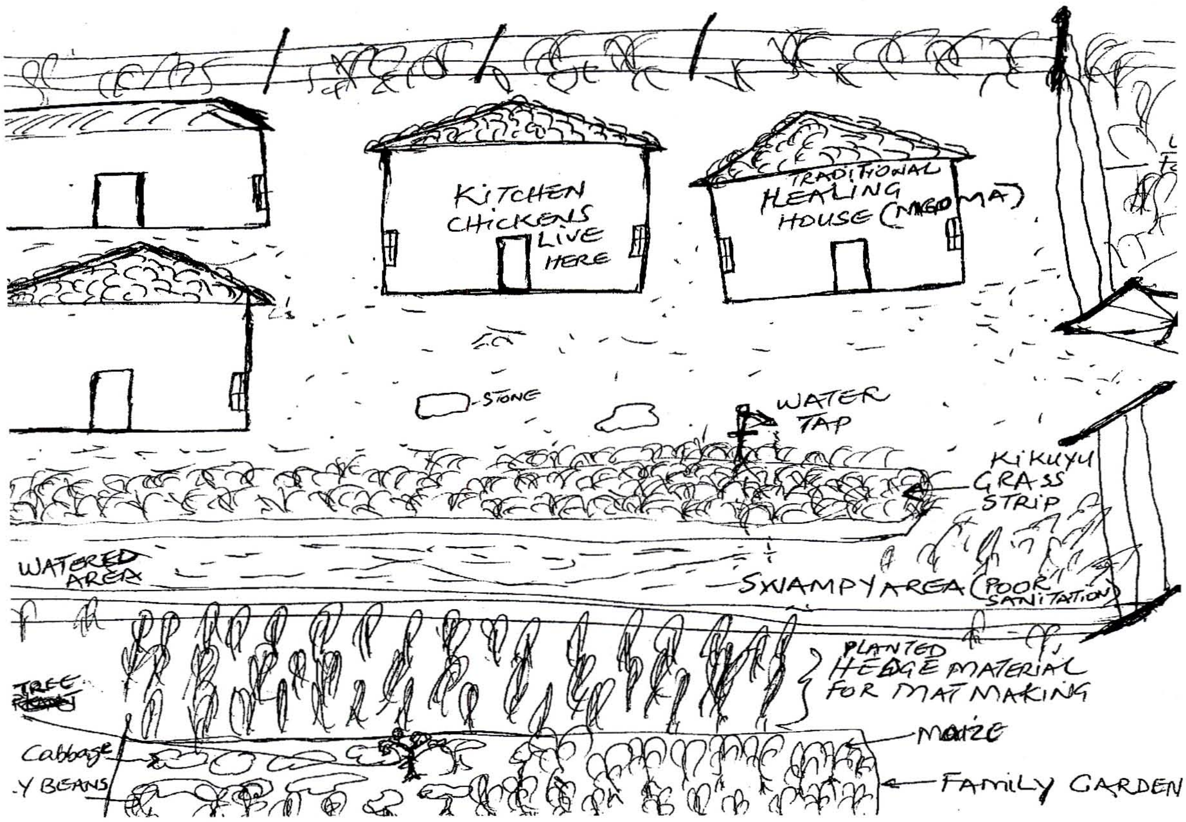

Figure 4.6 Household sketch C (A household involved with traditional healing)

Figure 4.7 Household sketch D (Household perceived to be old in the village)

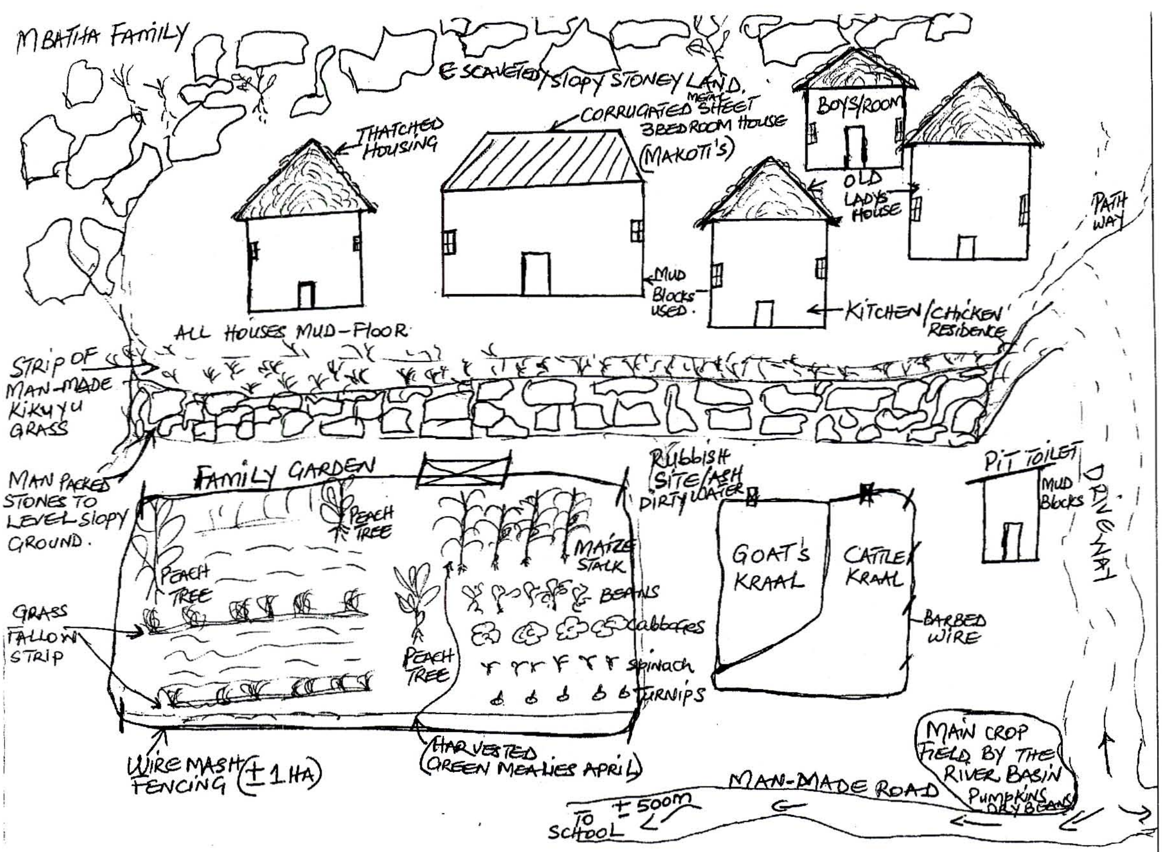

Figure 4.8 Household sketch E (A female-headed household)

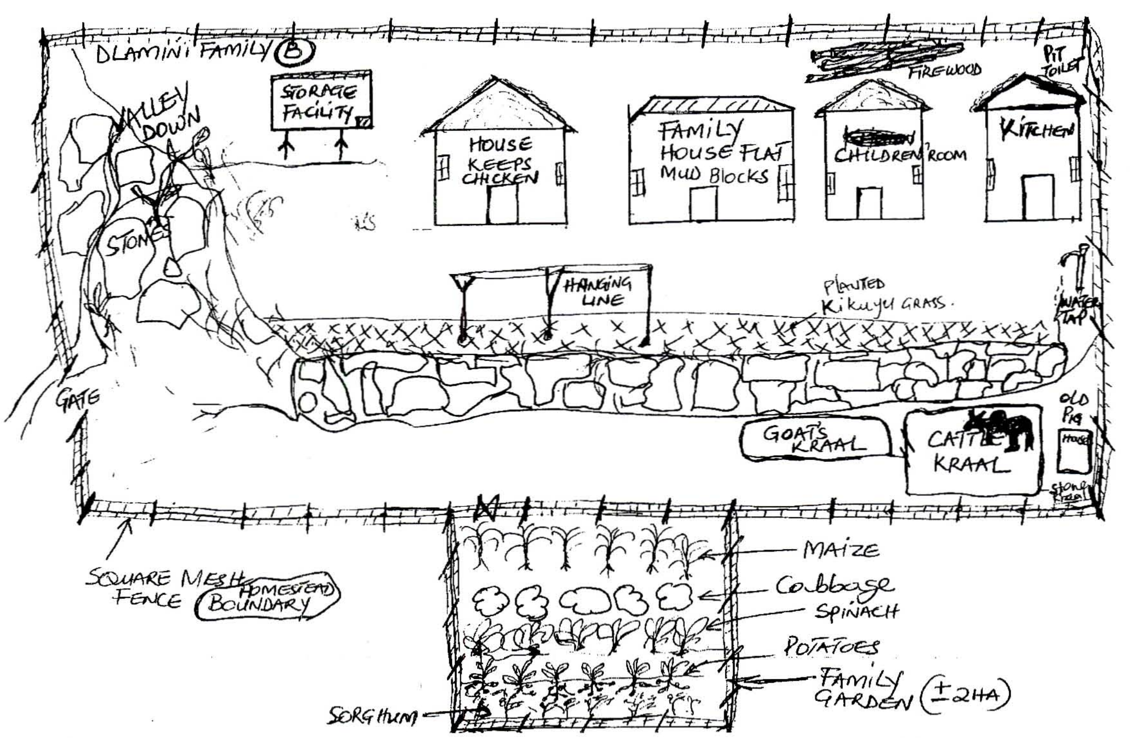

Figure 4.9 Household sketch F (A household practicing integrated farming).

Figure 4.10 Household sketch G (A household perceived as experiencing poverty)

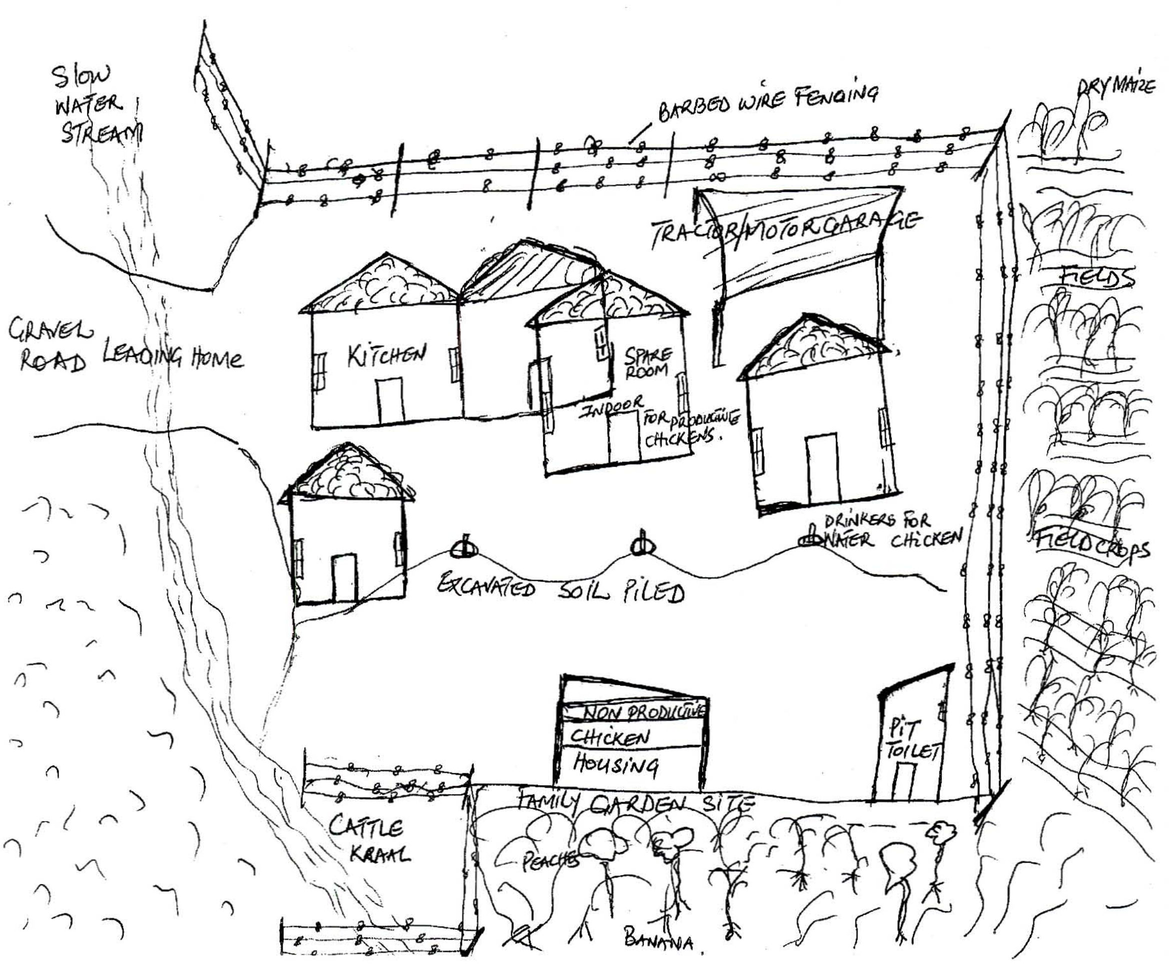

Figure 4.11 Household sketch H (A household with high socio-economic status).

4.3.2 Transect

The transect walk of the sub-ward is illustrated in Figure 4.12. The transect walk was undertaken from the western side of the area towards the eastern side. The walk has shown that households are situated mostly on the upper lands. This was mainly attributed to the nature of the land-scape. The west to east view of the landscape demonstrates an undulating terrain which starts at two highest points, one on the extreme west and the other on the eastern side. The two upland points show where most of the people of the sub-ward reside and no public access roads lead to the homesteads, most of which are separated from the centrally located, main public road by approximately two kilometres. The absence of public road access to the homesteads was of some concern to the respondents, as most public transport stops by the main road, unless specifically requested to do otherwise. Even then, most transport owners raise complaints about the state of privately constructed access roads. The upper lands are quite eroded and very steep, and runoff rainwater constantly erode the privately constructed roads. The hilly and mountainous terrain have natural water springs which make a contribution to the water catchment of the area. The water flowing from the springs empties into the two river tributaries (Njanjana and Jokweni). Every year the two tributaries are a menace to the lives of the people, as these tributaries easily flood, thus restricting transport and people's movement.

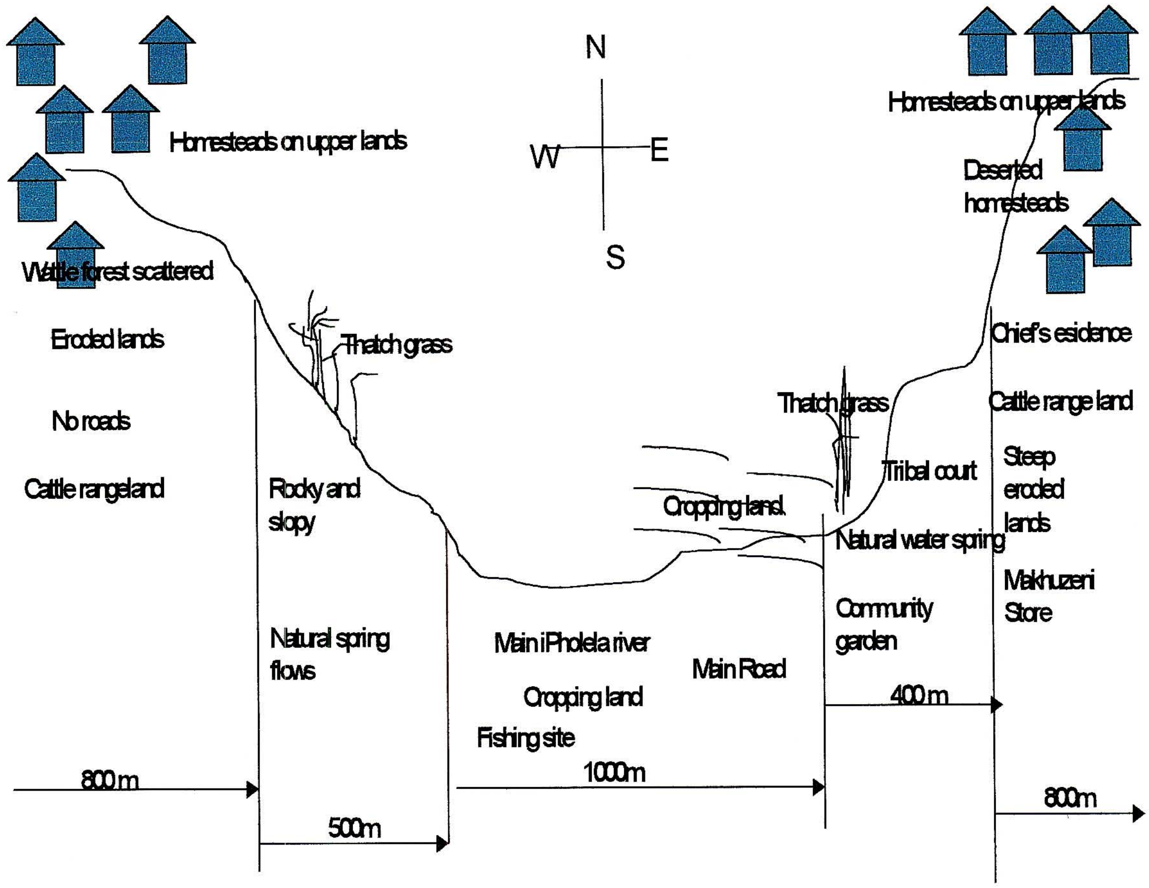

Figure 4.12 The transect walk of Makhuzeni sub-ward

The main river (called iPholela) passes through the area and is found located at the central point (low-lying land) between the west and east elevated lands. As one moves down from the higher lands, some long thatch grasses emerge. The thatch grass is cut as roofing material, and this is one of the livelihood activities of the people from the Makhuzeni sub-ward, including the participating households. The thatch grass site leads to the low lying arable land situated close to the banks of the iPholela river. The main crops grown on the agricultural land were field crops such as maize, beans and sorghum. The iPholela river does not only provide water to the community for household use, but it contributes to protein intake, in the form of fish. Some community members use the river for fishing purposes, which serves as another important livelihood activity. Beyond the iPholela river, the centrally located main road is found. Further to the east, the community garden is found and immediately after the tribal court and cattle dip can be seen. Most of the grazing animals, such as cattle and goats were found away from the cropping and residential area. These animals are kraaled at night and each morning are sent to the upper lands, where the rangelands for grazing are located.

4.3.3 Social resources of Makhuzeni sub-ward

The social map of Makhuzeni sub-ward is illustrated in Figure 4.13. The map shows that the sub-ward has one main gravel road passing through the community area to Centocow mission hospital. At the entrance point of this main road, there is a commercial pine forest which sometimes act as a source of fuel (firewood) to nearby homesteads. The road is winding due to the topography of the area. The road is not accessible all year round. During the rainy season public transport becomes a problem in the area and household dwellers have to ride on their horses and donkeys. Many households in the sub-ward are found located on the upper lands. The area has two primary schools and no secondary school within a 10 kilometre radius. The two primary schools are separated by a distance of approximately one kilometre. There is a Zionist church building, close by the only grocery shop of the area (called Malinda grocery).

The main road travels downward towards most village dwellings. On the low-lying lands, there is a stretch of arable land near the banks of the iPholela river. This part of the land represents the main cropping area of the sub-ward. The cropping area is concentrated around the iPholela river banks and its two two tributaries (Jokweni and Njanjana). The abundance of water sources in the form of natural springs and the main river provides the possibility for various forms of irrigated cropping. The uplands adjacent to the cropping land are occupied by thick thatch grass. The thatch grass patch spreads further to steeper lands of the area. The thatch grass is an important source of household income during winter. Community members are hired to cut the grass by outside thatch buyers. Thatch grass cutting has provided seasonal income to many households of the sub-ward.

4.3.4 Seasonal calendar

The seasonal calendar of Makhuzeni sub-ward is presented in Table 4.9. The seasonal calendar reflects that in the sub-ward rainfall starts in October until February-March. However, the presence of rainfall seems to reduce the productivity of family poultry in these eight rural households. From the crop farming perspective, the start of rainfall is appreciated as it signifies the planting time for food production in many households. This seasonal change to summer brings out new vegetative growth for plants, particularly grasses and shrubs. These grasses and shrubs act as cover for the predators to attack their prey, especially the stray dogs and cats. Family poultry were found not to thrive during the rains, and the major reason offered by the household members was that it restricts their scavenging base,

Table 4.9 Seasonal calender for the Makhuzeni sub-ward

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Rainfall & Temperature												
Crop Farming	Weeding of maize fields by women & children		Eating green mealies		Planting vegetables		Field crop harvesting & waste grain benefits family poultry				Land Preparation & planting maize, potatoes, sorghum	
Livestock Farming	Livestock in rangelands				Goat kidding		Cattle calving					
Village Activities			Mud house repairs	Mat making	Making mud blocks	Thatch season (selling thatch grass)						
Family Poultry Production	High predator incidents			Peak production (laying and breeding)						Slack production		
Family Poultry Diseases	Lice and sores			Fewer diseases and predators (e.g. hawk still under moulting)								

and secondly the wet weather conditions promote fungal and bacterial disease growth. This period was also marked with high vulnerability of family poultry to predation, as the predators like hawks normally come out of their hiding sites, attracted by the warm conditions. Furthermore, the warm conditions tend to favour the incidence of external parasites, such as lice, and the development of head sores in young chickens.

The temperatures increase concurrently with the start of rainfall and begin to drop around March-April. April to August was identified as the appropriate time for prolific breeding and production in family poultry. This is the period coinciding with the harvesting of field crops. The period provides more maize grain supplement in the form of harvest grain waste. This is the start of winter where there is no rainfall and temperatures are low. Such weather conditions cause low disease incidences and low predation rates by raptors. The crop farming pattern of the sub-ward was identified to start in October and extend to August. Among the first activities undertaken are land preparation and ploughing of fields (using draft animals) and these tasks were performed primarily by men. Planting of crops like maize, potatoes and sorghum as field crops follow soon after ploughing. This activity was found to involve mostly women and children. Weeding of fields follows, also performed by women and children.

Green maize harvesting and eating occurred in March. Planting of vegetables for the family garden was conducted between April and May. Field crop harvesting of dry maize and its storage was a task for women and children and was conducted from June until August. Other activities were found to be income generating practices. These involve mud house maintenance and repairs (Kubhonda) carried out in preparation for the Easter vacation period and again towards Christmas time. Mat making (Incema), mud block making and thatch grass cutting were among the common seasonal income generating activities. These activities are performed from the beginning of April up until August. Women and children were reported as being collectively responsible for these activities.

4.3.5 Individual and institutional relations relating to family poultry production

The Venn diagram of the Makhuzeni sub-ward is presented in Figure 4.14. Some of the individuals and institutions mentioned may not be directly linked to family poultry production, but enhanced the livelihoods of participating households in the sub-ward.

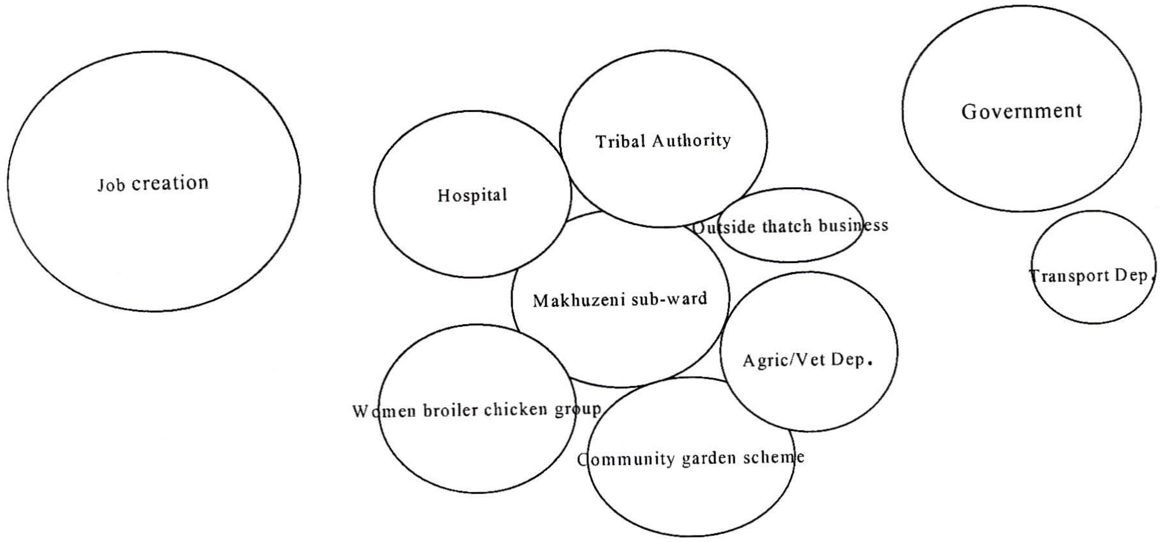

Figure 4.14 The Venn diagram of Makhuzeni sub-ward

The exercise was conducted with eight heads of households and twelve community members who had come for a community project meeting, but willingly joined the group of family poultry producers. The following individuals and institutions were identified as vital for the Makhuzeni sub-ward:

Tribal authority
Women sewing group
Women broiler group
Women community garden group
Government
Centocow mission hospital
Agriculture/ Veterinary department
Outside business community
Road and transport department

The tribal authority and administration of the sub-ward consisted of the chief, headman and other sub-committees such as inner council members. The tribal traditional authority administration is an institutional organization that is valued mainly for the leading role that its members play in the sub-ward and they are government representatives. The people reflected that the tribal authority participated in important issues such as settling community matters, particularly resolving conflicts and grievances. The households acknowledged members of the tribal authority for their contribution to the identification and initiation of prospective community projects, such the construction of new classes in one of the primary schools and the emerging broiler poultry group. The other institution identified as important was the women sewing group. The group was valued for the contribution it extends to the members in terms of acquiring and improving the sewing skills of women around the sub-ward. The group members empower each other in terms of life skills for development. The womens community garden scheme was also seen as one of the institutions held in high esteem. This gardening scheme was valued for its contribution to household food availability and for contributing to household nutrient intakes and household income. The community garden scheme was involved in the growing of vegetables such as cabbages, carrots, onions, beetroot, yams, swiss-chard and tomatoes. The produce from community gardens was mainly for home consumption and partially for sale. The selling took place between garden members and beyond.

The women's community garden operates with the assistance of an extension officer, living a kilometre away from the garden site. In this sub-ward a highly-valued business community group was the thach grass buyers from outside the sub-ward. This group contributed seasonally (July to August) to household income, when locals from the sub-ward were hired to cut and bundle the thatch grass.

The Centocow mission hospital was another important institution of the community. The hospital was valued for the contribution to the quality of life of the people in terms of providing health care facilities and services. The agriculture and veterinary department is recognized for its contribution to the agricultural production skills of the people in the area. Expertise and services that are rendered by the extension department include advice on crop input, crop varieties and animal vaccination services.

The major concerns were also ascertained and the first was relating to government. Government was seen as being distant from the community. This was found as an issue relating to governance in the consultation and decision-making process. This was attributed strongly to the lack of direct communication links between the government and the people. The Department of Transport was an illustration as proof of the poor communication links between those in charge and the community members. The department was criticized for its failure to keep the only public road of the sub-ward accessible at all times. The response to reporting of road problems normally take a long time. The frequent flooding of the low-water bridges across the two tributaries (Jokweni and Njanjana) of the iPholela river during the rainy season, was a serious menace to normal commuting by the sub-ward.people. School children in particular constantly return home on rainy days and this affects their academic progress. The other transport concern raised by those villagers involved in family poultry production pertains to unreliable public transport in the sub-ward. Sometimes the minibus taxis are unavailable or unable to take those people carrying large luggage items, such as bags of maize. This problem has partially contributed to some communities preferring to continue keeping animals like donkeys and horses as useful alternative transport means, suitable in such rural conditions.

The other major concern which was said to be an indicator of government's failure was the unavailability of jobs. The poor state of employment opportunities for young people was squarely blamed on government. The people believe that government must provide jobs as a way of showing the delivery process. The respondents observed that the rate of crime seem to be increasing in the sub-ward and this was attributed partly to unemployment problems which tend to affect the young generation.

4.3.6 Perceived and observed feed resources in family poultry production

The process in identifying the range of feed resources perceived suitable and eaten by family poultry was one of the important objectives of the study. Productivity of family poultry is important and relates to the feed resources made available to these chickens. The wider the feed resource base, the better the chances of enhanced family poultry production. Table 4.10 illustrates the various potential feed resources of family poultry as perceived by heads of household. The feed resources were classified into two main categories. There are those feed resources given to family poultry as determined by the household conditions, and those feed resources emanating from natural scavenging, their extent depending on the weather conditions.

The feed resources given to family poultry as identified by heads of household were predominantly yellow maize, white maize and scrap food. The scavenging feed resource base consisted mainly of vegetative materials and many insect types. The vegetative materials included weeds, grasses, pollen grain, flowers, grass seeds, vegetables such as wild amaranthus, swiss-chard and cabbages. The insects included were grasshoppers, maggots or worms, and termites. The scavenging resources seem to contribute mainly to the dietary protein requirement of family poultry, while the feed resources given as supplements are the apparent energy sources.

Table 4.10 Feed resources for family poultry as identified by heads of household

Household	Feed resources given to family poultry	Natural Scavenge material for family poultry
A	1.Yellow maize, 2.Sorghum brew by-product	1. Insects 2.Maggots / worms 3.Grasses 4. Weeds 5.Green / vegetable material 6. Pollen grain
B	1.Yellow maize 2.White maize	1.Insects (grasshopper) 2.Grasses 3.Vegetables
C	1.Yellow maize 2. Samp 3. Meal rice 4. Kitchen scraps	1.Insects 2.Stone/ grit 3.Green leaf material 4.Flowers 5.Weeds (amaranthus) 6.Grass seeds
D	1. Yellow maize 2. Kitchen scraps 3. Commercial mixed fowl feed	1.Insects (grasshopper) 2.Grass
E	1.Yellow Maize	1. Grass 2.Flowers 3.Sand 4.Insects (grasshopper)
F	1.Kitchen scraps 2.Yellow maize	1.Vegetable (swiss-chard) 2.Grass 3.Green leaf material (amaranthus) 4. Insects (grasshopper)
G	1.Yellow maize 2.White maize 3.Kitchen scraps	1.Stones (grit) 2.Insects (grasshopper) 3.Sunflower
H	1.Yellow maize 2.Commercial growing mash	1.Vegetables (cabbage, swiss-chard, turnip) 2.Insects (grasshopper)

4.3.7 Priority ranking of feed resources

In terms of priority ranking, Tables 4.11 and 4.12 demonstrate that in feed resource scoring for family poultry production, yellow maize received top priority, with a score of seven points. This was because when yellow maize is in abundance, in the form of harvest grain waste in crop fields, the production of family poultry improves discernibly. Such a period was found to coincide with the harvesting in autumn-winter. Where yellow maize is unavailable, white maize received a scoring of six points. Mixed fowl feed, a commercial feed resource given to family poultry, received a score of five points. Insects or invertebrates received a four point score and was moderately ranked as a feed resource enhancing family poultry productivity. The commercial feed resource called growing or rearing mash received a scoring of three points. Though mixed fowl feed and growing mash were commercially manufactured feeds, the eight households considered them as marginally valuable when compared to either white or yellow maize. Kitchen scraps received two points in the scoring exercise, while grass material received a scoring of one point, and vegetable material zero point.

Table 4.11 Pair-wise ranking exercise on family poultry feed resources

Feed resources	YM	MFF	IS	GM	RGM	WM	VM	KS
YM*	-	YM	YM	YM	YM	YM	YM	YM
MFF*	-	-	MFF	MFF	MFF	WM	MFF	MFF
IS*	-	-	-	IS	IS	WM	IS	IS
GM*	-	-	-	-	RGM	WM	GM	FW
RGM*	-	-	-	-	-	WM	RGM	RGM
WM*	-	-	-	-	-	-	WM	WM
VM*	-	-	-	-	-	-	-	FW
KS*	-	-	-	-	-	-	-	-

YM* Yellow maize, MFF* Mixed fowl feed (a commercial feed), IS* Insects, GM* Grass material, RGM* Rearing or growing mash (a commercial feed), WM* White maize, VW* Vegetable waste, KS* Kitchen scraps.

Table 4.12 Scoring of family poultry feed resources

Feed resource	Scoring	Ranking
Yellow Maize	7	1
White Maize	6	2
Mixed fowl feed	5	3
Insects	4	4
Rearing/growing mash	3	5
Kitchen scraps	2	6
Grass material	1	7
Vegetable waste	0	8

4.3.8 Perceptions about family poultry health and disease control

The most problematic chicken diseases affecting family poultry identified by the heads of household included Newcastle disease, respiratory diseases, lice and sores. The heads of household used two principal approaches in attempts at treating and controlling family poultry diseases. These were the traditional and conventional approaches. In this study, the traditional approach refers to the remedies involving natural plant products or herbs, which have not been synthetically processed in a laboratory, while the conventional remedies include synthetic human medication and vaccines.

The comparative extent of the use of traditional and/or conventional control method on prevalent family poultry diseases are presented in Figure 4.15. There was a wide range use of traditional methods in treating and controlling of many family poultry diseases; 87% of respondents rely on the use traditional remedies such as soaked tobacco leaves, *Aloe florex*, and ground tobacco in treating even Newcastle disease while 13% of them make use of conventional means (La Sota vaccine).This could be a partial answer to the general bird losses experienced whenever there is a Newcastle disease out-break amongst family poultry in rural households. The treatment of respiratory diseases is generally based on traditional remedies: 75% participants use *Aloe florex,* while 25% of the respondents use Terramycin and Potassium permanganate (conventional medication). For lice or mites, 100% of the respondents heavily rely on the use of wood ash, a traditional medication. For sores, all the participants use many products that are designed for use by humans in various ways such as vaseline, shoe polish, paraffin and old motor engine oil.

4.3.9 Rating of Family Poultry Diseases

There was a need to ascertain from the heads of household their understanding and perceptions of the problematic diseases in family poultry production under household production conditions. The households generally perceived Newcastle disease, with a score of three points, as the most problematic disease which was of high priority.

The wide range of respiratory diseases, including coryza disease, received the second priority with a score of two points. Sores had a rating of one point, while the last in priority order was lice, with a score of zero point, as represented in Tables 4.13 and 4.14.

Table 4.13 Pair-wise ranking exercise on family poultry disease

Family Poultry Diseases	NC	RD	S	LM
NC*	-	NC	NC	NC
RD*	-	-	RD	RD
S*	-	-	-	S
LM*	-	-	-	-

*Newcastle disease (NC), *Respiratory diseases (RD), *Sores (S), *Lice/Mites (LM).

Table 4.14 Scoring of important family poultry diseases as perceived by respondents

Diseases	Scoring	Ranking
Newcastle	3	1
Respiratory diseases	2	2
Sores	1	3
Lice/mites	0	4

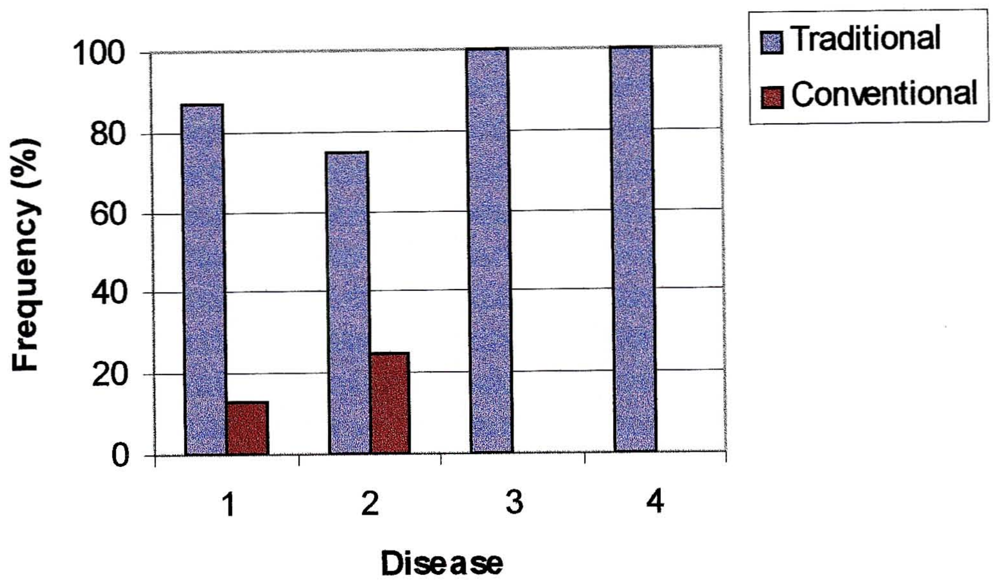

Figure 4.15 Comparative use of traditional versus conventional remedies for disease treatment/control in family poultry (1 = Newcastle disease, 2 = Respiratory disease, 3 = Lice, and 4 = Sores)

4.3.10 Perceptions about the production role of family poultry

Tables 4.15 and 4.16 illustrate that the eight family poultry producing households perceived the cultural or customary role performed with family poultry as valuable and awarded five points to indicate top priority in ranking. This implies that family poultry are most valued for cultural activities such as cleansing and sacrifices to ancestors. The second most valued reasons for those eight households in keeping family poultry was found to be for meat, with a score of four points. The other minor reasons given for keeping family poultry were outlined as gifts to visitors, subsistence income and transitory purposes (inherited traditional chicken keeping practice) which received scores of three, one, and zero point respectively.

Table 4.15 Pair-wise exercise on the production role of family poultry

Roles of family poultry	**CC**	**M**	**G**	**E**	**SI**	**TP**
CC*	-	CC	CC	CC	CC	CC
M*	-	-	M	M	M	M
G*	-	-	-	G	G	G
E*	-	-	-	-	E	E
SI*	-	-	-	-	-	SI
TP*	-	-	-	-	-	-

*Cultural/customary (CC), *Meat (M), *Gift to visitor (G), *Egg (E), *Subsistence income (SI), *Transitory practice (TP).

Table 4.16 The scoring of the production roles of family poultry

Production roles of family poultry	Scoring	Ranking
Cultural/customary	5	1
Meat	4	2
Gift to visitor	3	3
Egg	3	4
Subsistence income	1	5
Transitory practice	0	6

4.3.11 Perceived constraints in family poultry production

The constraints impacting severely on family poultry production as perceived by heads of households, were ascertained in this study. The principal constraint was identified as hawk predation with a score of 7 points and was ranked first as illustrated in Tables 4.17 and 4.18. The predation associated with animals such as wild cats and stray dogs had marginal effect compared to hawk predation and was scored 6 points and ranked second. Theft by humans, diseases, feed quality problems were not as serious a concern and were each scored 5 points and thus ranked third. The rest of the factors holding back household family poultry production such as finance (3 points), laying ability (2 points), feed quality (1 point) and growth ability (1 point) were respectively ranked sixth, seventh, eighth and ninth.

Table 4.17 The pair-wise exercise on family poultry constraints

Constraints of family poultry	**DS**	**FL**	**FQ**	**LA**	**GA**	**H**	**T**	**WC**	**M**
DS*	-	DS	DS	DS	DS	H	T	WC	DS
FL*	-	-	FL	FL	FL	H	T	WC	FL
FQ*	-	-	-	LA	GA	H	T	WC	M
LA*	-	-	-	-	LA	H	T	WC	M
GA*	-	-	-	-	-	H	T	WC	M
E*	-	-	-	-	-	-	H	WC	H
T*	-	-	-	-	-	-	-	WC	T
WC*	-	-	-	-	-	-	-	-	WC
M*	-	-	-	-	-	-	-	-	-

*Diseases (DS), *Feed quality (FL), *Feed quantity (FQ), *Laying ability (LA), *Growth ability (GA), *Hawk (H), *Theft (T), *Wild cat (WC), *Money (M).

Table 4.18 Scoring of perceived constraints to family poultry production by heads of households

Constraint	Scoring	Ranking
Hawk	7	1
Wild cat/dogs	6	2
Diseases	5	3
Feed quality	5	3
Theft	5	3
Money	3	6
Laying ability	2	7
Growth ability	1	8
Feed quantity	0	9

4.3.12 SWOT Analysis

The strength, weaknesses, opportunities and threats to family poultry production were identified and are illustrated in Table 4.19.

Table 4.19 SWOT Analysis

STRENGTHS	WEAKNESSES
- Family poultry provide easy and ready source of meat/food for family compared to other household animals. -Family poultry has a major contribution to many cultural activities and traditional sacrifices conducted by household members. -Family poultry solve household's immediate problems in terms of generating some small income during emergencies. - The space required for raising family poultry is small and therefore ideal for the household conditions.	-Family poultry are not properly managed in households because they are secondary in most household activities. -Family poultry feeding practices rely on poor quality feed. - Lack of finance to upgrade this production practice. -Most of the items to properly protect these chickens are improvised infrastructure.
OPPORTUNITIES	**THREATS**
-Development of marketing channel of family poultry as some business venture.	-Diseases are holding back the growth of family poultry, particularly Newcastle disease. -Predation a constant threat to production, especially the hawk.

4.4 Agro-technical aspects pertaining to family poultry production

This section relates findings of measured and enumerated aspects of family poultry production in the eight participating households.

4.4.1 The size and composition of family poultry flocks

Table 4.20 illustrates that the mean ratio of adult cockerels to adult hens was approximately 1:2 per flock. The mean flock number of female juvenile chickens was slightly higher than that of pullets, adult hens and adult cockerels. However, the mean number of male juveniles was slightly lower than that of female juveniles by at least 3 chickens.

Table 4.20 The mean size and composition of family poultry flocks

Category	Male			Female		
	Number	Standard deviation (±)	Range	Number	Standard deviation (±)	Range
Chicks	7	8	0 - 24	-	-	-
Juveniles	4.1	4.6	0 - 14	7.2	9.4	0 - 29
Pullets	-	-	-	2	2.0	0 - 7
Adult	2	2	0 - 7	5.6	4.9	3 - 15

4.4.2 Family poultry body weight and egg size in participating households

The mean body weight, body weight range and egg size in family poultry of the participating households were measured and mean values are as illustrated in Table 4.21. The mean body weight of adult cockerels was heavier than all other bird categories, particularly adult hens and pullets. The mean body weight of adult cockerels was at least 900 g above that of adult hens and 1500 g heavier than the body weight of pullets. The male and female juveniles were at least 370 g heavier than the mean body weight of chicks.

Table 4.21 The mean body weight and egg weight, and their range and standard deviation, for family poultry (chickens) in eight participating households in Makhuzeni sub-ward

Category	Mean body or egg weight (g)	Body or egg weight range (g)	Standard deviation (g)
Adult Cockerel	2590	1210 - 3124	± 730
Adult Hen	1650	1510 - 2362	± 230
Pullets	1065	1018 - 1662	± 62
Juveniles (Male and Female)	533	652 - 712	± 334
Chicks	163	160 - 394	± 181
Eggs	50.6	47 - 58	± 8

5.0 DISCUSSION

5.1 Introduction

The following discussion was developed in line with the objectives and results of the study and begins with a deliberation on socio-economic factors and their effect on family poultry production. The information discussed involves data based on observations and on perceptions of the respondents. These socio-economic factors form an important link to the in-depth study of family poultry particularly exploring the diverse household conditions under which family poultry are kept. The chapter also focuses on husbandry practices, production potential, production functions, health management, and constraints to family poultry as these are the important themes in the study. The family poultry husbandry practices are difficult to relate to (local) research work, since there are only a few reports available. The latter part of the discussion focuses on the agro-technical data and reference is made to other studies as reported in many Asian and African countries.

5.2 Socio-economic aspects of family poultry in Makhuzeni sub-ward

In general, the majority of household members under study were unemployed and therefore economically inactive. Even though the study involved only a few households, this is consistent with the high levels of unemployment facing South Africans in rural areas, as highlighted in the Census Statistics (1996), May (1998), Budlender (1999) and May (2000). This is mainly due to the unavailability of jobs for the economically active age group within the community surroundings, with jobs in urban areas contributing to labour migration. Unemployment is an important factor contributing to poverty of the people and poverty determines the entitlement and food access for household members. The poverty state which seemed to vary from household to household is one of the many socio-economic factors that contributed to the diversity between households.

The ability of individual households to acquire inputs (for example, feed, medication, vaccines) for family poultry production depends on the production role associated with family poultry, which differs from household to household. The gender of household to animal protein intake mostly as meat rather than eggs. Eggs are hardly eaten as they are used for hatching purposes. Some of the family poultry and specifically the male juveniles bird category are used as replacement stock. The male juveniles are also the easiest to sell when some cash is needed. Most of the income from family poultry is used for buying small grocery items like soap, sugar and sometimes for school fees. Ranking of the main role of family poultry requires people to draw a comparison between the cultural benefits against the financial and subsistence consumption benefits, which seems difficult. However, these findings were quite consistent with those reported by Makarechian *et al.* (1983), Saleque and Mustafa (1996), Tadelle (1996), Guèye (1998) and Naidoo (2000). Therefore, the role of family poultry production ranges from cultural, subsistence consumption (as animal and egg protein) and cash inflow for households. The other roles relate to family poultry practice as a farming practice that integrates well with the farming activities of rural households, e.g. beneficial use of waste products from the grain harvest.

5.4 Production performance of family poultry

The performance of traditional family poultry in the participating households at Makhuzeni sub-ward varies from one household to the next. This could be attributed to existing variation in the input-output relationship at each household and the socio-economic status of the household. Flock productivity was found to increase directly with the improvement in the level of management, feeding and socio-economic factors (educational level). The variability found in production performance between households was consistent with that reported by Tadelle (1996). The most prolific period for breeding and production of family poultry was found to be between autumn and winter. This is the period with low predation risk and low disease incidence because of unfavourable weather conditions for proliferation of pathogens. Therefore, cold weather impedes many bacterial and fungal diseases, and coincides with the period of harvest waste (grain) abundance. This indicates the correlation between household farming activities and the production performance of the chickens. These findings were consistent with those reported by Tadelle (1996), Moreki *et al.* (1997) and Guèye (2000).

5.5 Feeding and management practices used in family poultry production

The feed resource base for rural poultry production depends almost entirely on scavenging, with chickens allowed to roam freely during the day. The range of feed resources identified by heads of household was consistent with those reported by Aini (1990), Alders *et al.* (1997), Barua and Yoshimura (1997) and Naidoo (2000). The energy component of feed resources eaten by family poultry comes from the household environment, usually in the form of grain harvest waste. Since the crop farming activities vary seasonally and from household to household, availability of grain harvest waste, which is an important determinant of poultry productivity, is also variable.

The protein portion of the diet for family poultry is supplied by vegetation, insects and other invertebrates. These feed resources undergo individual biological life cycles and their abundance is seasonally based. From the results, it is evident why production performance of family poultry is seasonal and to a great extent dependent on availability of grain supplements and weather conditions favouring production of biomass. In autumn-winter, the absence of rainfall and low temperatures might be expected to limit production of biomass. If so, the protein supply would be limiting during autumn-winter season, while the energy from harvest grain waste is adequate. The study could not identify any form of protein feed supplementation used by households. This means that the protein feed resource base of family poultry entirely depended on scavenging.

During the spring-summer season, due to the presence of high rainfall, vegetative growth is enhanced. The rate of insect and invertebrate breeding and multiplication is high, thus contributing positively towards sustaining the protein supply for family poultry, while the grain supplement (energy) becomes limiting. Therefore, weather (via its effect on feed supply) has a seasonal effect on the chick output of brooding hens. The chick output per brooding hen was slightly higher in winter compared to summer. The number of eggs spoiled by harsh weather conditions (high rainfall and high temperatures) apparently contributed to this difference.

The number of clutches per hen per year was found to be between two to three, which was similar in range to those reported by Branckaert (1995), Tadelle (1996), Moreki *et al.* (1997) and Guèye (1998).

Yellow maize was found to be the main source of grain supplement given to family poultry. The reason yellow maize was used as the main energy source was based on the belief that it has special nutritional fat that improves family poultry productivity. Feed processing involved grinding of maize into small pieces for easy access by chicks and was a common practice in many households.

Theft and predation were ranked highly as major constraints impeding growth in family poultry production. These findings were similar to findings by other authors, including Rangnekar and Rangnekar (1999) and Naidoo (2000). Hen training for indoor laying and indoor hen tethering were found to be effective practices for protecting eggs and chicks respectively, and correlated positively with the improvement in flock size. In a few households hens are gradually put under some form of training (to lay indoors) and monitoring immediately after they start to lay The indoor laying practice was meant to protect eggs against predators, particularly wild cats, snakes and dogs. Indoor laying is particularly suitable during the autumn-winter time, where vegetation is low on the scavenging site, thus exposing eggs to predators and the direct effect of the sun. The number of eggs considered adequate for a hen for brooding depended on the mothering abilities and hatching experience of the hen in question. This was easily monitored and that was how some of the eggs considered in excess of the hen's brooding capacity, ended up being used for home consumption in some households.

Hen tethering has gradually become the favoured practice in reducing chick losses at chick stage. Hens with chicks were tethered indoors. Tethering begins late in the afternoon, and the hens in question would be released late in the morning on the next day (when predation risk from raptors is considered to be minimal). From experience the heads of household are able to detect and identify the peak and slack time of predation risk from hawks and other raptors. The hens with chicks are separately managed, taking into consideration periods of low predation risk.

Early chick separation from the mother hen, once previously reported by Moreki *et al.* (1997), was used in some households within the eight households studied. This practice improved family poultry productivity in terms of flock size. Besides the potential of such a practice, there is also an indirect improvement in the number of clutches per year, by allowing the hen more time with the cockerel, which can induce early breeding. The differences in flock size between participating households in Makhuzeni were attributed to the contribution from such husbandry practices (indoor laying, early chick separation and hen tethering). These family poultry husbandry practices in feeding, production and management have been modified by the heads of household to ensure reduced theft, predation risk, thereby improving production.

5.6 Health management of family poultry

There were some differences between households on the use of conventional methods as opposed to traditional remedies for disease control and treatment. The educational level of those involved with family poultry appears to play an important role in family poultry disease management. Those heads of households with at least secondary school education were aware of a preventative vaccine against Newcastle disease. Those households where preventative medication against fatal diseases like Newcastle was not practiced, were headed by the lesser educated individuals. Conventional medication was widely used and involved human medication in treating and control of many exo-parasites, such as lice and mites.

Newcastle disease was the most worrying disease to poultry keepers. In these households, preventative and treatment practices are administered only after the start of a disease outbreak and this was consistent with findings by Guèye (1998). Households attributed such a practice to lack of finance and unavailability of commercial medication. However, some households strongly believe that Newcastle disease has never been a serious threat to their chickens. They confidently use traditionally accepted concoctions. Treated birds sneeze and during sneezing the disease attack is thought to be driven out. Alternatively, fresh tobacco leaf, submerged in drinking water, is used. Such medicine was claimed to be an effective medication for Newcastle disease.

The medicinal strength of tobacco has been demonstrated by the extent to which tobacco leaves control the internal worms in horses as substantiated by one respondent.

These findings show that the use of traditional remedies and dependence on them occurs in a wide range of households. The general use of these remedies on family poultry, as opposed to conventional methods, have been found in many African countries (Chavunduka, 1976; Moreki, *et al*., 1997; Guèye , 1999; Tadelle *et al*., 2000). In South Africa, similar findings have been reported by Naidoo (2000). Therefore, there is evidence that in family poultry practice, use of conventional remedies may be restricted by some factors, including the use of traditionally accepted medication. Guèye (2000) conceded that diseases in family poultry production will probably continue to be a problem to many poultry farmers because many poultry farmers in Africa tend to start treatment and control only once symptoms appear in flocks. In many households, there was a general lack of knowledge on the existence of proper medication and vaccines. This could be attributed to many factors, such as low educational background, lack of capital, unavailability of medicines, vaccines and unavailability of heat resistant vaccines for preventing Newcastle disease.

5.7 Constraints to family poultry production

Predation was cited as the major constraint to the growth in production of family poultry at household level in the eight households of Makhuzeni sub-ward in KwaZulu-Natal, South Africa. This was attributed mainly to chick losses to raptors, such as hawks. Predation was found to be a serious threat during the spring and summer season because of abundance of vegetative hiding sites as indicated by the respondents. In particular, hawks were less active in autumn and winter, due to the presence of unfavourable weather conditions and molting. The possible reasons why raptor predation received an overwhelming priority could be the ease with which its effect combines with other forms of predation, like wild cats and stray dogs. Other chicken losses can be due to different causes, such as poor nutrition and disease factors.

Predation is a major problem hindering family poultry production in many developing countries (Nhleko *et al.*,1996; Rangnekar and Rangnekar,1999; Naidoo, 2000; Tadelle *et al.*, 2000). Stock theft is another factor that has been found to influence family poultry productivity in many rural households. The extent and impact of bird theft is serious, as can be deduced from the behavior of households that opt to sacrifice either their kitchen or spare room in an attempt to curb theft. These findings were similar to those reported by others, like Alders *et al.* (1997).

Diseases were found to be among the constraints impeding growth of family poultry production, and in this context the findings of the present work fitted well with a previous study on the family poultry keeping system, by Barua and Yoshimura (1997). Diseases are a serious concern to family poultry production because of the over-reliance on traditionally accepted medication practices. This was partially evident from the claim by certain households on the extent of effectiveness of these remedies, even on viral disease like Newcastle. These findings on over-reliance on traditional remedies correlate with reporting by Moreki *et al.* (1997). Subsequently, such practices in family poultry production are becoming a hindrance to the use of other effective measures, like vaccines.

Feeding was another constraint and farmers conceded that they are not able to consistently supply sufficient grain supplement to family poultry. This explains one of the reasons for low productivity of family poultry, namely the seasonal nature of the scavenging feed resource base family poultry practice is dependent on. In the present study, few households practiced growing of yellow maize as a feed resource for family poultry.

5.8 Agro-technical data

Agro-technical data on family poultry have been measured and reported in some developing countries, such as Bangladesh, Indonesia, Chad, India, Nigeria, Ethiopia, Senegal, Zimbabwe, Kenya, Botswana, and to a limited extent in South Africa. The results of the present work showed variation in flock size between households. The mean flock size in the present study correlated positively with that reported by Nhleko *et al.* (1996), Moreki *et al.* (1997) and Mushi *et al.* (2000). However, the average flock size per household in the present study was slightly above the average flock size (5 to 10) for Africa as reported by Tadelle *et al.* (2000). Family poultry husbandry at the household level differs from household to household. The findings of the present study demonstrate that variation exist in terms of feeding, management, socio-cultural and socio-economic factors, which appear to be dictating the production performance of family poultry.

Feeding alone has a great influence, with the quantity and rate of grain feed supplementation having a huge impact, assuming that the scavenging feed resource base remains constant for all households. Some households provide grain supplementation once a day, while others feed twice a day, and these findings were consistent with reports by Aini (1990), Barua and Yoshimura (1997), Khieu (1999) and Naidoo (2000) respectively. The cockerel to hen ratio varied between households and may be reflecting the different breeding and management strategies existing within individual households. The cockerel to hen ratio also depends on the household's individual preference derived from experience and other socio-economic factors. The number of female to male juveniles chickens varied between households. Male juveniles turned out to be few compared to female juveniles. This appears to be due to the off-take of male juveniles being higher than that of juvenile females, either as gifts or for selling purposes, as breeding stock is rarely sold.

The present work has demonstrated production of relatively few eggs and variation between household flocks with respect to the number of eggs produced. The mean egg number per hen obtained was within the range reported for chickens in Africa producing two to three clutches of eggs per year (Tadelle *et al.*, 2000). The variation in egg numbers between household flocks indicates the extent to which household husbandry practices influence family poultry production. Households with better socio-economic circumstances, and practicing better feeding and management, had some extra eggs from their chickens.

There were differences in mean egg weight of family poultry between households. The present study indicated a mean egg weight of 50.6 ± 8 g which is within the range reported for indigenous chickens by Nhleko and Slippers (1996) in KZN and Aganga *et al.* (2000) in Botswana. However, the current study's mean egg weight was slightly above the mean egg weight reported by Branckaert (1995). The differences in egg weight may be due to differences in many factors, including ecology, crossbreeding and hen age. Observed household variation would appear to depend on the kind of intervention practices, such as feeding and management of family poultry found in that specific household.

The mean adult cockerel body weight of family poultry in the present study was found to be 2.59 ± 0.73 kg. This cockerel body weight was consistent with results by Aganga *et al.* (2000) in Botswana, on traditional Tswana adult cockerels. The cockerel body weight variation range in this study was 1.2 to 3.12 kg between households, apparently due to differences in age, and household husbandry practices. The mean adult hen body weight also varied between households in the present study. Interestingly, the mean adult hen body weight reported by Mopate and Lony (1999) was slightly below, while the mean adult weight of hen reported by Aganga *et al.* (2000) was slightly above those of the present study.

The differences could be related to breed (genotype) and also linked to uncontrolled cross-breeding of birds. Inter-household differences in the present study were found to be associated with differences in family poultry husbandry practices. The great production diversity can be attributed to several social, cultural and economic factors existing in the different households. Poultry husbandry differed from one household to another within the same village. Therefore, feeding and management practices of these chickens provide the base for their improvement, but there are other socio-economic factors that need to be considered, such as educational level, household composition and household social standing.

Households who could afford an increased amount of yellow maize grain supplementation, used in combination with other feed resources, such as kitchen scraps, enjoyed better production from their birds, as indicated by the agro-technical measurements taken. Households whose management practices involved indoor laying, indoor brooding, early chick separation, hen tethering and better poultry stockmanship, performed better than others. Households whose poultry farming practices were integrated with the other farming activities, such as mixed cropping, were better in the various agro-technical measurements such as flock size, egg numbers, bird weight and egg weight reported. The low production performance of family poultry may not be a reflection of the true biological potential of these birds. Improvement of the feeding, management, and health practices results in a corresponding improvement in production ability (bird weight, egg numbers, egg weight and reduced mortality through ill health). The differences in household conditions, including the physical environment, render family poultry production variable from household to household.

5.9 Chapter summary

The chapter discussed observed and perceived issues as they link to socio-economic factors, poultry husbandry practices, production functions, production potential, constraints and agro-technical information. The primary focus was exploring the influence of these factors on the production of family poultry in this study. The chapter has developed some understanding of family poultry as a small-scale production system in the South African context. Issues and concerns affecting the production approaches used by farmers in enhancing family poultry productivity under rural household conditions have been deliberated. These issues and concerns have not been extensively reported before in the South African context.

6.0 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, family poultry rearing is dependent on a scavenging system and therefore remains a sustainable household animal production system for many rural households. In the study, the heads of households were able to make their own understanding of the household conditions by using appropriate traditional knowledge (husbandry practices) in improving family poultry productivity. The family poultry production system has some important husbandry practices, which contribute to the viability of such poultry production systems within the household conditions. Indoor laying, hen tethering and early chick separation are management practices that are suitable for family poultry production, and which require minimal investment. Family poultry production systems contribute to subsistence needs of households, by providing animal protein (meat and eggs), and in some cases a small cash flow. Furthermore, certain cultural needs of rural people are satisfied, such as ritual slaughter of family poultry to meet ancestral obligations. Family poultry production is an economically viable and sustainable production system for resource-poor people because of the low input-output relationship.

This small-scale poultry production system is characterized by seasonal breeding and production, which correlates with many different bio-physical factors such as diseases, predation risk, availability of harvest waste as supplements to the scavenging feed resource base, weather conditions and other farming activities. The feed resource base for family poultry is inadequate to support high levels of production. The assistance required to improve family poultry productivity should consider the combination of available resources, socio-economic factors and the household husbandry practices undertaken.

Past studies in many Asian and African countries have focused on breed manipulation as one of the means to improve family poultry productivity and this has had some positive impact in improving the genetic constitution of the birds (Guèye, 1998). However, some of the husbandry practices such as hen tethering and indoor laying have not been reported before in family poultry. These husbandry practices have shown positive effect in reducing the risk of egg, chick, and juvenile bird losses against predation and harsh weather conditions.

Household and individual food security are equally important and must be addressed from a multidimensional point of view as suggested by the National Department of Agriculture, 1995.Therefore, there is need for governments and institutions to consider the findings of the study for policy makers and development planners. This study has made a contribution to the understanding of family poultry production under rural household conditions. Family poultry can be used as a strategy towards contributing to poverty reduction, which could improve food access ability to rural people. The following recommendations can be drawn:

- Where household food and nutritional problems are a serious concern, small-scale scavenging family poultry production systems deserve a greater consideration by government, research, development organizations and rural farmers because this poultry production system contributes to animal protein production for subsistence needs and partial income generation for rural households.

- An in depth understanding of the family poultry practices by policy makers and planners is an important component towards helping develop more feasible household food security strategies that could impact positively on family poultry productivity and a contribution made in the form of animal protein and micro-nutrient intakes.

- Small farmers, by nature of the scale of operation and limited resources, are reluctant to take risks and are less enthusiastic to try new practices. Therefore, technology interventions must be based on better utilization of traditional practices, indigenous materials and inputs which the small farmer has ready access to. Hence, extension workers should be aware of indigenous knowledge about family poultry production; to better equip them to provide effective technology that will be appropriate to the household farming conditions.

- Extension officers can assist towards poverty reduction through knowledge sharing and drawing up effective low-input strategies that can contribute to constant and consistent production of family poultry, for example hen-chick separation, hen tethering and indoor laying. Such strategies, if adopted by most farmers, could contribute to the improvement of family poultry productivity. Farmers could also share their traditional knowledge on family poultry with other farmers and extension staff.

- Greater attention needs to be focused on disease control and prevention. For rural animal health care, use of traditional medication should be highly favoured for rural households and if there are any means to improve the efficacy of these concoctions like dried and fresh tobacco leaves, these need to be encouraged. There seems to be a need for increased scientific research and extension work in the area of disease management and prevention for family poultry. This should include training and the provision of veterinary diagnostic services.

- A strong and functional institutional frame-work is needed. Small-scale farming needs to be encouraged. Integrated farm systems should be emphasised as a major component contributing to people's livelihoods. An efficient institutional system should also make provision for a marketing scheme for family poultry as a way to promote family poultry production.

- Strategic supplementation of both energy and protein in the diet of family poultry is necessary to enhance productivity under household conditions. This could be achieved through conservation of yellow maize for the energy part. For the protein needs of these birds, adoption of strategies promoting insect breeding, for instance the growing of termites.

- Institutions of higher learning, such as agricultural colleges and universities, needs to promote and support traditional knowledge systems as part of the formal training of students. This should apply to family poultry as well.

PART 2

DRIED BREAD WASTE AS A REPLACEMENT FOR MAIZE IN THE DIET OF CAGED LAYING HENS

1.0 INTRODUCTION

Since the early 1990's, a small-scale battery cage layer system for egg production was introduced into African households in rural areas of South Africa, namely in the Northern Province (Malepfane *et al.*, 1993; MacGregor and Abrams, 1996) and parts of KwaZulu-Natal (Nkosi and Jones, 1993). The system makes use of 12 laying hens kept in a battery cage system which is located at the home of individual families. The primary goal of this project was to contribute to improving family nutrition, through provision of high quality egg protein produced at low cost.

Consumption of eggs in rural households tends to be low because of a number of factors, including eggs not being available; the price of eggs being relatively high in rural areas; and the fact that eggs do not satisfy hunger like maize porridge (MacGregor, 1999 - personal communication). Furthermore, NFCS (2001b) reported that in South Africa subsistence agriculture is not a significant source of any of the six most consistently consumed foods, *vide* maize, sugar, tea, whole milk, brown bread and margarine. Therefore, meat of any description and eggs are conspicuously absent from the list of most consistently consumed foods. Eggs are one of the important sources of protein, zinc, vitamins A, D, E and the B vitamins and thus the consumption of eggs is likely to contribute to family nutrition in terms of protein and micro-nutrients. In South Africa reports indicate that nationally the main cause of stunted growth in young children is associated with inadequate intake of animal protein and micro-nutrients (NFCS, 2001a).

In South Africa, most malnutrition problems are found in young children (MacGregor and Abrams, 1996) living both in urban and rural areas and the extent of malnutrition is not based on the acute clinical symptoms such as kwashiorkor, but occurs as sub-clinical signs involving stunted growth, and the sub-standard ratios of height to age and body weight to age (NFCS, 2001a). Between 1980 to 1990 the extent of malnutrition in South Africa was in the order of 42%. Since then, malnutrition levels, as evidenced by stunted growth in young children, have not declined greatly, with levels of 23 to 27% being reported by May (1998).

The introduction of household egg layer units in rural areas proved to be a success, with approximately 6 000 operational (household) units installed in the Northern Province by the end of 1998 (MacGregor, 1999 - personal communication).The financial viability of the household egg production system relies heavily on low-cost infrastructure (cage) on the one hand, and affordable feed prices on the other. Escalation in the price of feed appears to be a major factor influencing the decision of whether households will continue or discontinue with the household egg production system (MacGregor and Abrams, 1996). The feeding cost of 12 hens, under the economic conditions prevailing in 1992, could be covered by the sale of four eggs per day at a price of 40 cents each. This meant that, under such economic conditions, the family would be left with six eggs for daily household consumption. In recent years, the feed cost has escalated to such an extent that it is now a threat to the sustainability of the household egg production unit. This is because the feed price has increased considerably to nearly double the 1992 prices in 2000. This situation, therefore, requires more (than four) eggs to be sold at a higher price than before in order to offset the feed cost of the 12 hens (MacGregor, 1999 - personal communication).

A solution to the high feed cost dilemma needs to be sought, in order to uphold the sustainability of the household egg production units for current users, while keeping the technology attractive to other prospective adopters (households), so that micro-nutrient and protein deficiencies amongst women and young children can be reduced. It has been found that families that possess laying units include eggs in the family diet regularly whilst families without an egg unit do not buy significant quantities of eggs for the reasons outlined earlier.

In South Africa the major contributing factor to the high cost of layer diets is the cost of the energy component rather than the protein part (Slippers, 2000 - personal communication). Poultry feeds in many chicken production enterprises rely heavily on cereal grain (maize) as the primary provider of this dietary energy.

This situation as it stands with the household egg production units points to a need to explore cheaper non-traditional alternative energy sources suitable for use in animal feeding in South Africa. Other countries such as Nigeria, India, Cambodia and Ghana have made use of non-traditional feed ingredients for many years (Job *et al.*, 1979;

Preston, 1992; Okai,1999). The main alternative non-cereal feeds include rejects from human consumption, such as cassava, sweet potato, African oil palm and sugar cane juice, and have long been used for livestock as an efficient way of recycling residues, by-products and wastes (Preston, 1992). There appears to be very little research work on the use of these feed resources in intensive on-farm feeding systems. Preston (1992) observed that the use of cane juice as a feed resource has some potential to develop low-cost, farm-based commercial feeding systems. Investigations on non-cereal alternatives to replace maize in chick diets have shown that sweet potato can replace maize by up to 60% without significant effects on the production traits such as body weight, food intake, food conversion and mortality (Job *et al.,* 1979). The main reason for such positive results was associated with the quality of protein found in sweet potato, which was low in concentration but of better quality comparative to that of maize.

An alternative cereal source for South Africa could be sorghum. However, because sorghum is a close substitute for maize the relative prices are similar. Therefore, sorghum is apparently not cheap enough to effect a significant change in the feed cost, when considered as an alternative to maize in animal diets.

Cereal by-products such as bran, maize bran, rice bran, dried bread waste, and brewers grain, are industrial by-products which are likely to be cheaper than maize. Therefore, a meaningful replacement for maize (in cost per unit weight) exists in many of the cereal by-products. A cheaper energy source in layer diets for those families involved in household egg production units would render this form of egg production system attractive, even to others.

Morrison (1957) reported that bakery waste, consisting of stale bread or damaged bread, can be obtained at a price that can make it economically viable as a source of animal feed. Zavon (2000) reported that bakery by-product can be a cost-effective substitute for maize. Harms *et al.* (1966) reported that there are sufficient quantities of bakery waste which could be used for inclusion in animal feeds. As people around the world continue to consume more meals away from home, the production of bakery by-products will continue to grow (Zavon, 2000). In South Africa, it appears that many major bakeries have a supply of damaged and stale bread which they discard in many ways; in some cases being fed to cattle, sheep and pigs. Furthermore, bakery by-products are often available in large quantities around urban areas, as reported by Leeson and Summers (1997).

The composition of bakery by-products tends to vary considerably due to variation in raw ingredients and inclusion of inert fillers. The energy content of bakery by-products often exceeds that of maize by 25%, because of the high fat and sugar content obtained from the raw materials (Leeson and Summers, 1997). In comparison with maize, bread has a higher crude protein content (25.5% versus 8.8%) and a slightly higher energy value (14.02 MJ ME/kg and 15.36 MJ ME/kg respectively). Bakery by-products vary considerably in fat content, fibre and ash depending on the fillers used (Leeson and Summers, 1997). If soyabean hulls are used as fillers, the bakery by-product meal will be high in fibre, whereas when limestone is used, ash and calcium levels tend to be elevated. Therefore, the energy content of bakery by-products often fluctuates depending on the fibre and/or ash content in the meal. Bakery by-products have a similar phosphorus content to that of maize, but a higher proportion of the phosphorus in bakery by-products is in a biologically available form (Leeson and Summers, 1997). This means that less phosphorus is excreted in the manure. The major limitation of bakery by-product meal is the high content of sodium which is attributed to high inclusion of salt (Leeson and Summers, 1997).

Research work on bread waste in layer diets by Damron *et al.* (1965) and Harms *et al.* (1966) with experimental diets containing low inclusion levels (three, six, and 12% of bread waste) in replacement of maize showed no significant effect on egg weight or egg production. Such research findings led to a pilot trial being initiated, in which damaged and dried bread replaced 50 and 100% of maize in a layer mash diet (MacGregor, 1999 - personal communication). Again, the preliminary results demonstrated no apparent drop in the biological performance of laying birds. Saleh *et al.* (1996) and Cheeke (1999) found that in broilers, replacement of maize by 25% dried bakery products led to no adverse effects on growth performance. Similar investigations in pigs by Okai (1999) revealed that there were no negative effects on biological performance, even when approximately 30% of the bakery waste (mostly biscuits) was used. The inclusion of these bakery waste products resulted in considerable reductions in the feed cost.

The cost of stale bread (approximately R 350 per tonne of dry matter) is numerically lower than the maize prices (approximately R 700 per tonne of dry matter) according to the 2000 price. The current maize price for 2002 is approximately R 1 700 per tonne. This experiment was planned to further investigate the biological and economic potential of dried bread as an alternative to maize in layer mash diets, with the primary aim of pursuing economic sustainability of the household egg production units in rural areas of the Northern Province, South Africa. In preliminary studies it was found that considerable quantities of damaged and stale bread products are available to rural communities from bread and biscuit factories in major cities and towns. This feed ingredient could contribute to the sustainability of small-scale poultry practices, including the household egg production units.

1.1 The hypotheses and objectives of the study

1.1.1 The hypotheses

The hypotheses of the study are that bread waste may be: a) a more economical energy source than maize in conventional layer mash diets: b) an energy source equivalent to maize in terms of biological performance of caged layer hens.

1.1.2 The specific objectives

This study was intended to:

1) determine the economic optimum replacement level of maize with bakery waste in conventional layer mash diets used for caged layer hens.

2) determine the biological optimum replacement level of maize with bakery waste in conventional layer mash diets, based on a biological response to variables such as, egg output, egg weight, total egg numbers, rate of lay, feed intake, feed conversion efficiency and body weight changes.

2.0 MATERIALS AND METHODS

2.1 Collection, drying and milling of bread waste

Damaged and stale bread (bread waste) was collected on a weekly basis from two local bakeries in Pietermaritzburg. On delivery, the bread was broken into smaller sized pieces to facilitate drying, as illustrated in Figure 2.1. The broken pieces were placed on a raised, perforated platform (metal frame with wire mesh covering) and were sun-dried. Oven-drying of the bread at 70-75°C for approximately 48 hours was quite an effective alternative to sun-drying and was employed as an emergency strategy during rainy spells, or when stocks of dried bread ran low. Adequate drying (over 90% dry matter) of the bread had to be ensured for successful stockpiling and milling, and oven-drying was particularly effective in preventing the growth of mould. After drying, the bread was separated into white and brown, stored and packed in separate feed bags, ready for milling. White and brown bread were milled separately and stored for ration mixing. Milling was done in a hammer mill fitted with a 6 mm screen and progressed until about one tonne of both white and brown bread accumulated, to sustain an eight week mixing cycle.

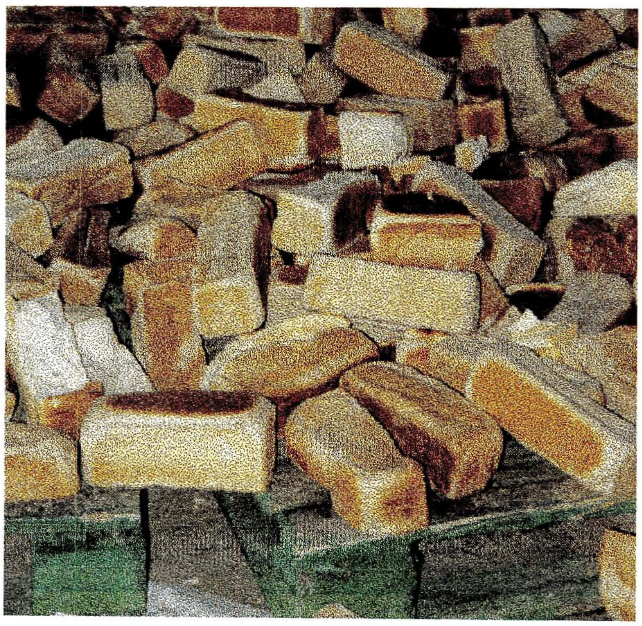

Figure 2.1 Dried bread ready to be broken into pieces

2.2 Experimental diets

The typical laying diet in South Africa consists of approximately 65% energy concentrates (yellow maize) and 35% protein and other concentrates. A computer feed formulation package, Winfeed (1995) was used to formulate two basal diets. The two basal diets were formulated to the National Research Council nutrient recommendations for laying hens (NRC, 1994). The first basal diet was a conventional layer diet consisting of yellow maize as the energy source, while the second basal diet was a conventional balanced layer diet in which maize was replaced by half white and brown bread as the energy source. The basal diet 1 (control diet) contained 65% of maize as the energy source, while basal diet 2 contained 65% of equal portions by weight of brown and white bread as the energy source.

The ingredients of the two basal diets and their rate of inclusion are presented in Table 2.1. The two basal diets were blended (mixed) to obtain six experimental diets containing 0, 130, 260, 390, 520 and 650 g bread/kg of diet respectively. The blending of the two basal diets into six experimental diets can also be explained in terms of maize being replaced by stale bread at rates of 0, 20, 40, 60, 80 and 100% of the dietary inclusion level of maize. The blending proportions of the two basal diets into six experimental diets are as presented in Table 2.2. The (calculated) essential amino acid and mineral composition of the six experimental diets are given in Table 2.3 and Table 2.4 respectively.

2.3 Experimental animals

A flock of 144 Amberlink point-of-lay hens was used as the experimental animals and was purchased from a reputable commercial breeder. Prior to the random selection of experimental birds, they were kept on the research farm for two weeks as a pre-treatment adaptation period. The house temperature was monitored and recorded daily, using a maximum-minimum thermometer, throughout the trial. Data collection started approximately three weeks after production of the first egg.

Table 2.1 Ingredient composition (g/kg of dry matter) of the two basal diets

Ingredient (g/kg)	Basal diet 1	Basal diet 2
Maize meal (yellow)	650	0
Dried white bread	0	325
Dried brown bread	0	325
Soyabean oil cake	193	53
L-Lysine HCl	1	5
DL-Methionine	1	2
Vit+min Premix (layer)*	3	2
Limestone	104	104
Mono Calcium Phosphate	11	10
Sunflower Husk (filler)	28	73
Sunflower oil	9	21
Fish meal	0	11
Plasterer's sand (filler)	0	70
Tryptophan	0	1

*The vitamin premix consisted of Vit A, 8×10^6IU; VitD_3, Vit B_1 0.5g; Vit B_2, 3g; Vit B_6, 2.0g; Folic Acid, 0.5g; Vit B_{12}, 20mg; VitE, 10g; Choline, 200g; Niacin, 20g; Panthothenic Acid, 5g; Vit , 5×10^6IU; Biotin, 50mg; and the mineral premix consisted of cobalt, 500mg; iodine, 1g; selenium, 200mg; manganese, 100g; copper, 10g; zinc, 100g; iron, 40g; antioxidant,125g; in 1.463kg of a base/carrier (feed lime) containing 34 -36% calcium.

Table 2.2 The blending proportions of two basal diets to form the six experimental diets

Diet	Content dried bread in diet (g/kg)	Replacement rate of maize with dried bread (%)	Blending proportion of basal diet 1 (%)	Blending proportion of basal diet 2 (%)
1	0	0	100	0
2	130	20	80	20
3	260	40	60	40
4	390	60	40	60
5	520	80	20	80
6	650	100	0	100

Table 2.3 The calculated available essential amino acid composition (% as fed) of the six experimental diets fed in the trial

	Dried bread inclusion levels (g/kg as fed)					
Amino acid	0	130	260	390	520	650
Arginine	0.85	0.79	0.73	0.67	0.61	0.55
Histidine	0.37	0.35	0.33	0.32	0.3	0.28
Isoleucine	0.58	0.56	0.55	0.53	0.52	0.5
Leucine	1.28	1.19	1.11	1.02	0.94	0.85
Lysine	0.68	0.68	0.68	0.68	0.68	0.68
Methionine	0.32	0.32	0.32	0.32	0.32	0.32
Methionine+Cystine	0.5	0.5	0.5	0.5	0.5	0.5
Phenyl+Tyrosine	1.06	0.99	0.93	0.86	0.8	0.73
Threonine	0.46	0.44	0.42	0.39	0.37	0.35
Tryptophan	0.19	0.18	0.18	0.17	0.18	0.16
Valine	0.67	0.64	0.6	0.57	0.53	0.5

Table 2.4 The calculated mineral composition (% as fed) of the six experimental diets fed in the trial

	Dried bread inclusion levels g/kg					
Mineral	0	130	260	390	520	650
Calcium	4	4	4	4	4	4
Available Phosphorus	0.36	0.36	0.36	0.36	0.36	0.36
Potassium	0.68	0.58	0.48	0.39	0.29	0.19
Sodium	0.18	0.42	0.67	0.91	1.16	1.4
Chloride	0.04	0.47	0.91	1.34	1.78	2.21
Ash	2.16	2.28	2.4	2.53	2.65	2.77

2.4 Experimental design and randomization

This was a single factor experiment, with bread inclusion level as the independent variable, at six graded levels of inclusion ranging from 0 to 650 g/kg of diet, with a 130 g/kg interval. A pen of four birds was the experimental unit and each experimental unit was replicated six times. Therefore, there were 36 pens and 144 birds in total. There were 18 pens on each side of the battery cage system. The hens were weighed individually on arrival, wing tagged and three weight groups established (light, medium and heavy). Stratified randomization was conducted, taking into account the three weight groups and cage structure (double-sided and three-tiered).

2.5 Housing and lighting

A 3m x 4m, open-sided house fitted with battery cages was used. The unit was cleaned and disinfected before birds were moved into it. Natural cross ventilation was used. The birds were under a sixteen hour light programme for the duration of the nine months experimental period.

2.6 Batch mixing, feeding and egg collection

The six experimental diets were prepared on an eight week cycle. Feed was stored under cool room temperature at approximately 25°C and in dry conditions. This was done for convenience and to ensure constant fresh feed over the 36 week experimentation period. Birds received water through an in-line water system. They were fed restrictively, being allocated 110 g per bird a day, with *ad libitum* access to water. Feeding took place at the same time each morning. Feed allocated to each pen was accurately recorded and the remaining feed retained in the trough at the end of each day. The total feed remaining at the end of each week was measured and discarded. Eggs were collected once daily, in the morning, just after feeding. Daily egg numbers and egg weight were recorded while external egg quality status was monitored including cracked, broken and soft shelled eggs.

2.7 Measurements

2.7.1 Feeds and feed analysis

Before the start of the layer experiment, twelve different loaves of bread were purchased from a supermarket as samples for chemical analysis. These loaves consisted of both white and brown bread from two bakeries. All were evaluated for the following chemical components: calcium, phosphorus, moisture, ash, fat (ether extract), crude fibre and acid detergent fibre (ADF), according to the Association of Official Analytical Chemists (1998) methods. The neutral detergent fibre (NDF) was determined using the method described by Van Soest and Mason (1991). The apparent metabolisable energy (AME) was measured using the method described by Fisher and McNab (1988). Crude protein was measured according to the Association of Official Analytical Chemists (AOAC) (1998). Amino acids were determined chromatographically, via high sensitivity protein hydrolysate analysis, with a Beckman 6300 amino acid analyser (Moore and Stein, 1948; Beckman Instruments, 1983).

2.7.2 Daily feed intake (DFI) and feed conversion efficiency (FCE)

Daily feed intake (DFI) and feed conversion efficiency (FCE) are two items that need to be determined in animal production. DFI (expressed as g feed per hen per day) was calculated from the difference between feed offered and the residual feed, over successive seven day periods, for the duration of the experiment. This feed intake was also used in determining the feed cost (Rand) for the economic analysis in the study. The feed conversion efficiency (FCE; g egg per g feed) was calculated using the following equation: FCE = Egg output (g)/ Feed consumption (g).

2.7.3 Egg production

Daily egg numbers were recorded and later summarized as total egg numbers for a week. This was used to determine the rate of lay (eggs/100 birds d) and in computing egg output (g/bird d). The data were also used to calculate the weekly egg income (in Rand) for the economic analysis.

2.7.4 Rate of lay (eggs/100 birds d)

The rate of lay reflects the total number of eggs that were actually laid in a week and relates them to a 100 birds. It was calculated as the total egg numbers per treatment a week divided by the total number of hen-days with the product multiplied by 100 birds.

2.7.5 Egg weight (g/egg)

Egg weight was measured daily by weighing two eggs per pen (replicate). Once a week all individual eggs per pen were weighed for all replicates, to ensure accuracy in egg weight measurements. A digital electronic scale was used in recording egg weight up to the nearest 0.1 g. This measurement was used in the calculation of egg output (g/bird d) and for determining the feed conversion efficiency (g egg/g feed). The weekly average egg weight was also used in determining the egg grade distribution (small, medium, large, extra large and jumbo) which in turn determines egg pricing; the latter was needed for calculating egg income per week.

2.7.6 Egg output (g/bird d)

Egg output measures the egg weight of a single egg produced by a hen in a day. It was calculated as follows: weekly average egg weight (g), multiplied by the rate of lay (%) divided by 100.

2.7.7 Egg shell thickness (mm)

Measurement of shell thickness for all treatments was taken once a fortnight on a random selection of two eggs per replicate. Shell thickness was determined by measuring the thickness of the shell including the shell membranes with a micrometer. This method of measuring shell thickness is destructive, as it involves breaking the egg. The egg shells were allowed to dry first before taking the egg shell thickness measurement.

2.8 Economic analysis

In order to determine the estimates of the economic optimum replacement of maize by dried bread, marginal returns (Rand/period) were calculated. Marginal returns (Rand/period) were calculated by deducting the egg revenue (Rand) from the total feed cost in each experimental diet (Rand). The cost of the non-energy portion of the diet was R 2000 per tonne, whilst maize was priced at R 700 per tonne and bread at R 350 per tonne. Thus the cost of basal diet 1, which contained no bread, was calculated as follows: 0.35 x R 2000 + 0.65 x R 700 which equals to R 1 155/tonne. The other treatment diets were calculated in a similar manner, depending on the amount of maize and bread included. An example of the calculation of the cost of experimental diet 2 is as follows: (0.35 x R 2 000) + (0.65 x 0.20 x R 350 (dried bread)) + (0.65 x 0.80 x R 700 (maize)) = R 1 109.50/ tonne.

To calculate the weekly egg income, it was first necessary to relate the weekly average egg weight to the standard egg grades and then multiply by total egg production to obtain the total egg numbers per grade. The egg income per week was therefore determined from the multiplication of price per egg and total egg numbers for each egg grade. The price per egg for the different egg grades were obtained from a commercial egg producer (company) and were 31, 40, 42, 50 and 52 cents for small, medium, large, extra-large and jumbo respectively.

The weekly average egg incomes for the various treatment replicates were calculated from the proportional distribution of egg size, egg numbers produced during a particular week, and mean egg weight during that week. The egg income was expressed in Rand.

The economic analysis with bread price as a proportion of maize price was also calculated based on the relative diet cost, egg income and marginal returns (Rand/week) as outlined above. A template was developed in a spreadsheet in which the price ratio of bread to maize was altered while simultaneously affecting egg income and overall marginal returns (Rand per kg) per treatment. In order to determine the optimum bread inclusion percent as a proportion of the maize price, price ratios from 10, 20, 30, 40, 50, 60, 70, 80, 90, 100% relative to a current price of R 700 per tonne were used.

2.9 Statistical analysis

The data were managed with a standard spreadsheet and then exported for statistical analysis using SAS/STAT Software (1996). The general linear model (SAS/STAT, 1996) was used in analysis of the data. The production variables (rate of lay, egg weight, egg output, feed intake, egg shell thickness and feed conversion efficiency) were the dependent variables. These dependent variables were tested against the independent variable (dietary bread inclusion level), while pen (within treatment) was the error term for testing the overall treatment effect. This process resulted in generation of least square means (LS Means) for each egg production variable, while the relative standard errors were calculated based on the mean square values as later reflected in relevant tables and in Appendix 1. Time or period (a month) was introduced as a repeated measure. There were nine periods of one month duration, and the periods appear in the sub-plot.

In cases where the treatment by period interaction was significant, further investigation was carried out to pinpoint the source of such interaction. Graphical presentation was made for the treatment by period interaction only when it was significant.

Regression analysis was used to regress each measured variable against the level of bread inclusion. The regression indicated the overall biological response of the birds to increasing inclusion levels of bread in layer diets. Graphical presentations were made for each egg response variable against increasing levels of bread inclusion in layer diets.

The poultry producer may want to estimate and thus predict the extent of opportunity cost for a decline in biological production variables to each level of bread waste inclusion. Hence, a simulation model depicting biological response as a mathematical function, was included in the analysis of experimental data. The lactation curve function (Wood, 1967) was used for this purpose. The lactation curve function was chosen as it simulates the typical egg production curve in layers, and it illustrates the various production phases. The parameter estimates of the Wood model were derived by the least square method after log transformation of the data. The model was used to derive the exponential (non-linear) response over time, and the prediction estimates were obtained for rate of lay and egg output.

Wood's model : $Yn = an^{b} \exp^{(-cn)}$

where Yn = the egg production in period n.

a = scaling factor describing the initial egg production.

b = the rate of increase in egg production from the initial point (a) to peak production.

c = the rate of decrease in egg production after peak production.

e = 2.7183 (the base of natural logarithms).

The logarithmic transformation yields a linear equation, that is simply solved:

$$\log e\ Yn = \log e\ {}^*a + b^* \log e\ n^{-cn}$$

The log e, a, b and -c were derived by multiple regression of log e Y on log e^n and n. Time of peak production was derived as n = b/c.

The overall economic margins (marginal revenue, marginal feed cost and marginal return) were subjected to analysis of variance (general linear model) with bread inclusion level as independent variable (excluding the data of the zero bread inclusion level).

2.10 Modification of the experimental design

In the original experimental design there were six treatment levels. However, during the first batch mixing of the feed for the control treatment (0 g dried bread /kg diet), salt was not included, and the effects of this mistake were only discovered during the fourth week. This omission resulted in high bird mortality in the affected birds (0 g bread waste/kg diet), as a result of cannibalism.

An attempt was made to correct the deficiency by the end of the following week. However, at the end of the experiment, analysis of the results indicated that the early salt deficiency had a carry-over effect. This led to the discarding of data that were to be the control treatment (0 g dried bread/kg diet). Therefore, the results to be presented reflect only five levels (130, 260, 390, 520 and 650 g dried bread/kg diet). For the economic analysis of this study, extrapolated figures were determined and used for the control treatment (0 g dried bread/kg diet).

3.0 RESULTS

3.1 Chemical analysis

The amino acid composition and digestibility of white and brown bread are shown in Table 3.1. The low digestibility of lysine in both white and brown bread in comparison to other amino acids is the most interesting result.

Table 3.1 Available amino acid composition and digestibility (% as fed basis) of white and brown bread

Amino acid	Composition (%)		Digestibility (%)	
	White bread	Brown bread	White bread	Brown bread
Alanine	0.43	0.51	88.94	86.87
Arginine	0.55	0.63	89.88	88.28
Aspartic acid	0.67	0.77	83.70	82.10
Glutamic acid	5.27	5.18	97.06	95.98
Glycine	0.54	0.62	90.00	90.00
Histidine	0.32	0.34	92.40	87.92
Isoleucine	0.58	0.61	90.73	89.95
Leucine	1.02	1.05	92.51	91.39
Lysine	0.27	0.32	68.89	61.50
Methionine	0.20	0.18	92.31	92.57
Phenylalanine	0.73	0.75	93.28	92.23
Proline	1.66	1.66	97.08	96.47
Serine	0.58	0.61	95.18	94.26
Threonine	0.37	0.43	88.91	87.39
Tyrosine	0.25	0.28	90.74	89.43
Valine	0.55	0.60	90.22	89.29

The nutrient composition of bread is presented in Table 3.2. White bread has a higher protein content than brown bread, with both having similar energy values. The calcium tends to be low in both white and brown bread. The content of neutral detergent fibre (NDF) and acid detergent fibre (ADF) was slightly lower in the white bread than the brown.

Table 3.2 Nutrient composition of brown and white bread on as fed basis

Variable	Composition (%)	
	Brown bread	White bread
Crude Protein	13.99	17.23
Calcium	0.1	0.09
Phosphorus	0.26	0.19
Fat	0.88	0.89
Ash	3.32	3.55
Moisture (before drying)	25.14	33.76
Moisture (after drying)	10.10	9.78
*TMEn (MJ/kg)	14.3	14.93
Sodium	0.8	0.68
Added Salt	1.8	1.89
Crude fibre	1.7	0.98
Neutral Detergent Fibre (NDF)	15.76	12.54
Acid Detergent Fibre (ADF)	2.27	0.98

*TMEn Nitrogen corrected True Metabolizable Energy.

As illustrated in Table 3.3, bread has almost double the crude protein content of maize, whilst having a similar energy value. Maize tends to have a slightly higher crude fat content which makes it slightly superior in energy content when compared to bread *per se*. The ash content of bread is almost three-fold higher than that of maize, and ash content in feed ingredients tends to correlate negatively with nutrient digestibility. The NDF and ADF were respectively six folds and twelve folds lower in maize than bread, both these fibre fractions tend to have a considerable effect on the digestibility for nutrients in animal feed ingredients. In general, bread tends to have slightly higher values of amino acids than maize, with the exception of lysine as seen in Table 3.3.

The as fed basis chemical composition of the six experimental diets is presented in Table 3.4. In terms of dry matter, crude protein, crude fibre, fat and energy the six experimental diets were quite similar, with reasonably low estimates of variation.

Table 3.4 The as fed basis (%) chemical composition of experimental diets over five mix batches

Variable	Dried bread waste inclusion level (g/kg)							
	0	130	260	390	520	650	Mean	SE*
Dry matter (%)	91.88	91.90	91.90	92.00	92.00	92.00	91.95	0.02
SD **	0.78	0.89	1.06	0.91	0.92	1.38	-	-
Crude protein (%)	12.21	14.80	14.42	13.66	13.18	12.97	13.54	0.39
SD	1.18	0.79	0.56	0.44	0.28	0.16	-	-
Crude fibre (%)	4.82	4.24	4.94	4.53	4.43	4.80	4.59	0.13
SD	0.58	0.63	0.53	0.59	0.72	0.64	-	-
Fat (%)	3.80	4.33	3.84	3.47	3.44	3.27	3.70	0.16
SD	0.10	0.55	0.47	0.53	0.80	0.64	-	-
TMEn# (MJ/kg)	11.84	11.83	11.74	11.78	11.47	11.12	11.63	0.12
SD	0.42	0.34	0.45	0.37	0.28	0.38	-	-

*SE standard error. **SD standard deviation. #TMEn Nitrogen corrected True Metabolizable Energy.

Table 3.5 The mean response for the measured biological variables over the trial period

Variable	Dried bread waste inclusion level (g/kg)					
	130	260	390	520	650	SE*
Rate of lay (egg/100 birds d)	88.3	81.4	79.3	74.2	70.8	1.72
Egg weight (g/bird)	56.6	55.7	54.7	54.1	52.8	1.10
Egg output (g/bird d)	49.8	45.2	43.2	39.9	37.1	3.26
Feed intake (g/bird d)	107.3	105.1	106.1	106.4	107.3	2.19
Shell thickness (mm)	0.28	0.27	0.30	0.29	0.30	0.02
Feed conversion efficiency (FCE) (g egg/ g feed)	0.47	0.43	0.41	0.38	0.35	0.05

*SE standard error

3.2 Egg production variables

3.2.1 Rate of lay (eggs/100 birds d)

The mean rate of lay for the Amberlink laying hens, over the range of experimental diets of 130 g bread inclusion to 650 g bread inclusion per kg of diet are shown in Table 3.5. There was a significant difference ($P<0.01$) in rate of lay between the different treatments. There was an inverse relationship between rate of lay and bread inclusion. The rate of lay was highest at 88.3% in the diet containing 130g of bread inclusion, while a consistent linear decline was observed as bread inclusion percentages increased, with the lowest rate of lay being 70.7% in the diet containing 650g of bread/kg. (Figure 3.2). The linear trend was significant ($P<0.01$), while the quadratic and cubic trends were not significant.

The interaction effect between rate of lay and period as a repeated measure, (Figure 3.1) was highly significant ($P<0.01$).The higher bread inclusion levels of 390, 520, 650 g/kg dominated the interactions, but without any specific trend being apparent. The interactions occurred during the early stage of production (between the first and second periods; involving the treatment with 520 g bread/kg diet) and then again during the fourth to ninth period.

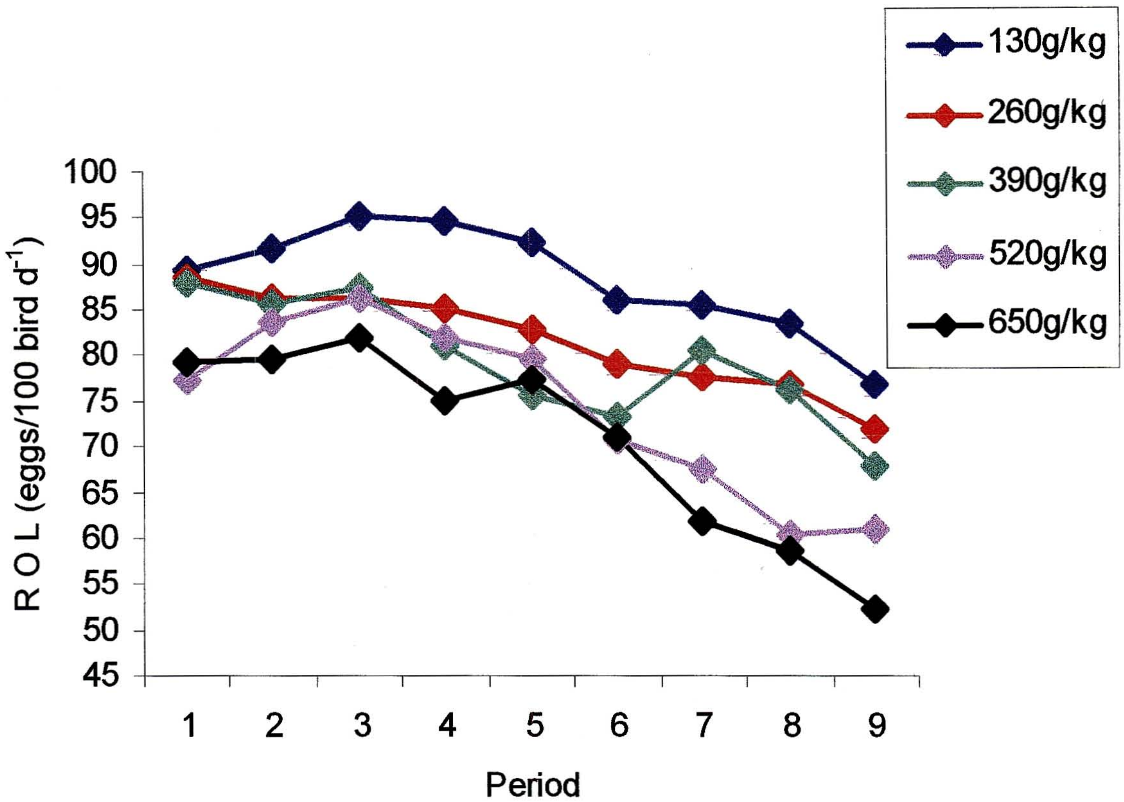

Figure 3.1 Rate of lay (eggs/100 birds d) response of Amberlink layers to ascending dried bread levels in the diet over the nine month trial period

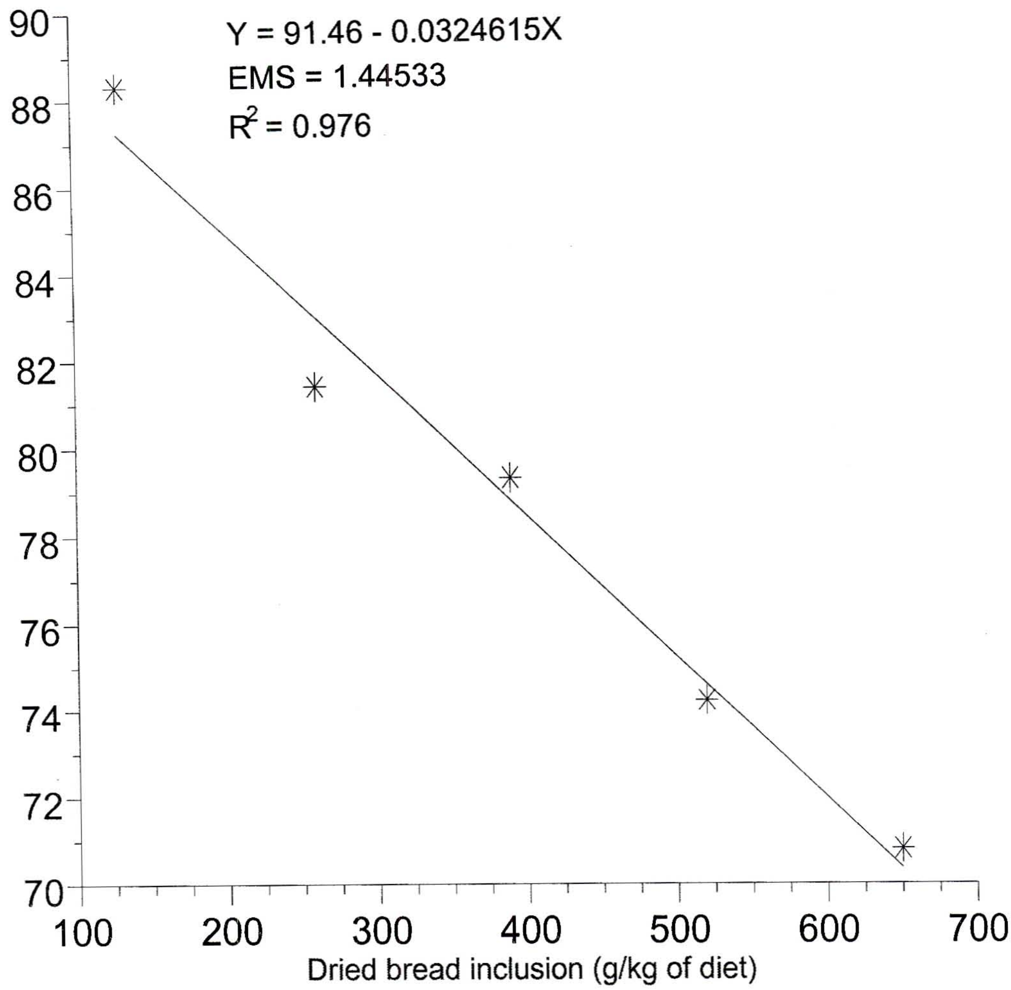

Figure 3.2 Rate of lay (eggs/100 birds d) response of Amberlink laying hens to ascending levels of dried bread waste

3.2.2 Egg weight (g)

The response in mean egg weight to the levels of bread inclusion is presented in Table 3.5. The difference in response between treatments was significant ($P<0.01$). The treatment by period interaction (Figure 3.3) was found to be highly significant ($P<0.01$). The egg weight treatment interaction was more pronounced in the first-two periods across all bread inclusion levels. The 390 g/kg bread inclusion level did not maintain a consistent trend and the egg weight (g) and from the seventh periods onwards was even below that of 520 g/kg bread inclusion level. The increase in egg weight associated with an increase in age of the hens, as indicated in Figure 3.3, is typical. The egg weight data indicate that the egg weight numerically declined as the bread level in the diets increased (Table 3.5). The regression of egg weight on bread inclusion level revealed a highly significant ($P<0.01$) inverse linear response (Figure 3.4). The quadratic and cubic response terms were not significant.

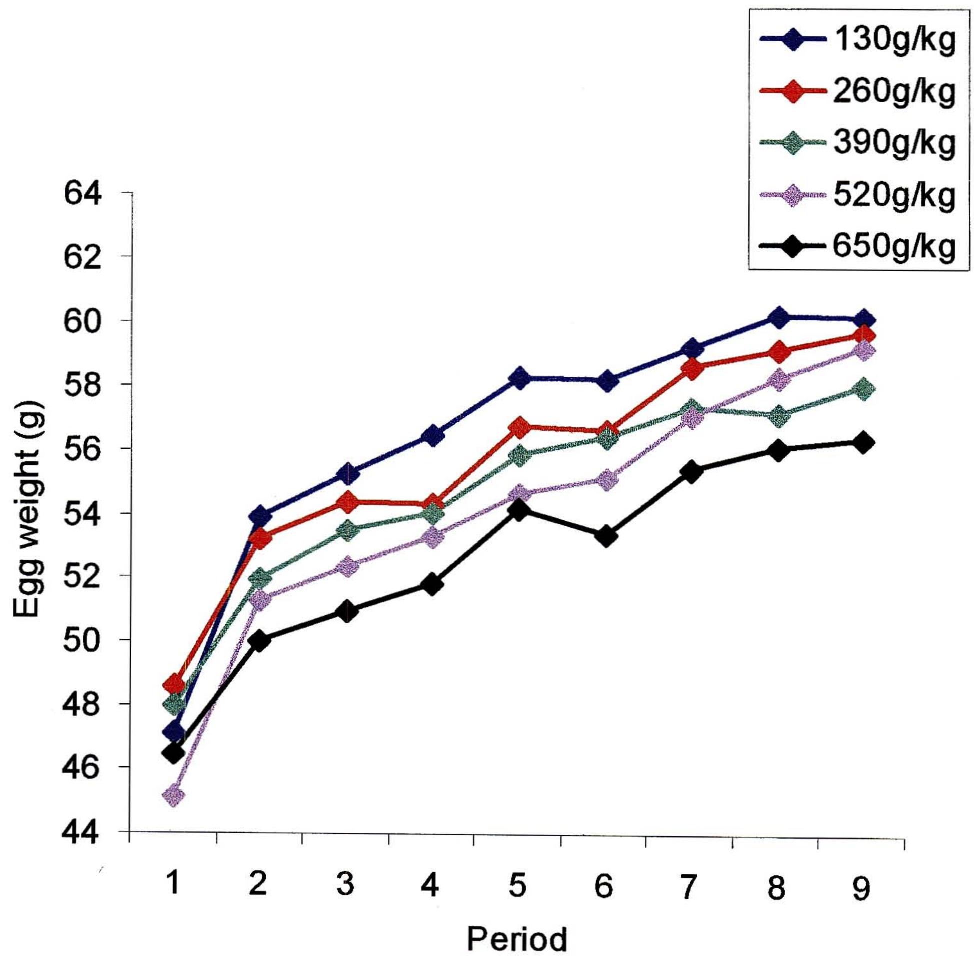

Figure 3.3 The egg weight (g) response of Amberlink laying hens fed graded levels of bread waste in diets over a nine month trial period

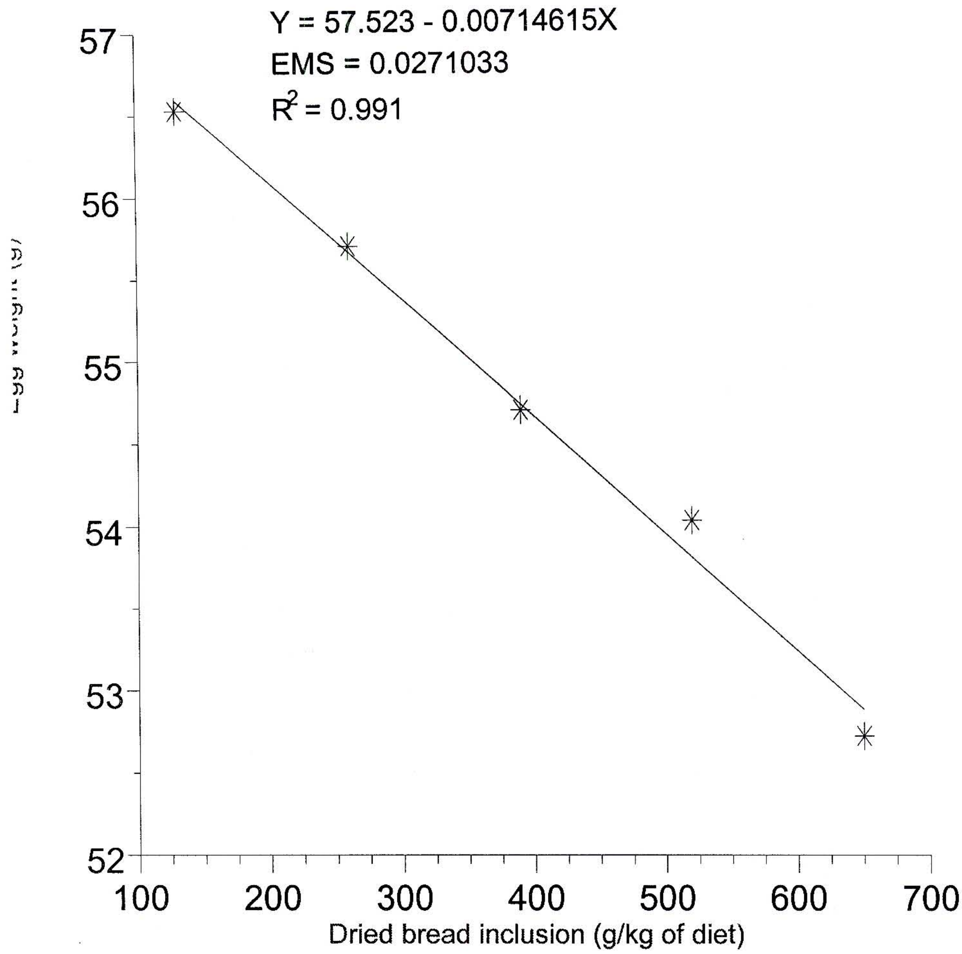

Figure 3.4 The egg weight (g) response of Amberlink laying hens to ascending levels of dried bread waste in the diet

3.2.3 Egg output (g/bird d)

The mean egg output of Amberlink laying hens are presented in Table 3.5. There were statistically significant differences between each treatment in egg output ($P<0.01$). The highest egg output was obtained on the diet with the lowest bread level inclusion (130 g/kg) and the lowest egg output corresponded to the diet with the highest bread level inclusion (650 g/kg).

The results also showed a significant treatment by period interaction effect in egg output (Figure 3.5). Interactions were particularly evident during the first two periods and involved most treatments. Over the nine month period the interactions were dominated by the bread inclusion level of 390 and 520 g/kg diet, without any clearly identifiable trend. The regression analysis revealed a highly significant ($P>0.01$) inverse linear relationship between egg output and bread inclusion level (Figure 3.6).

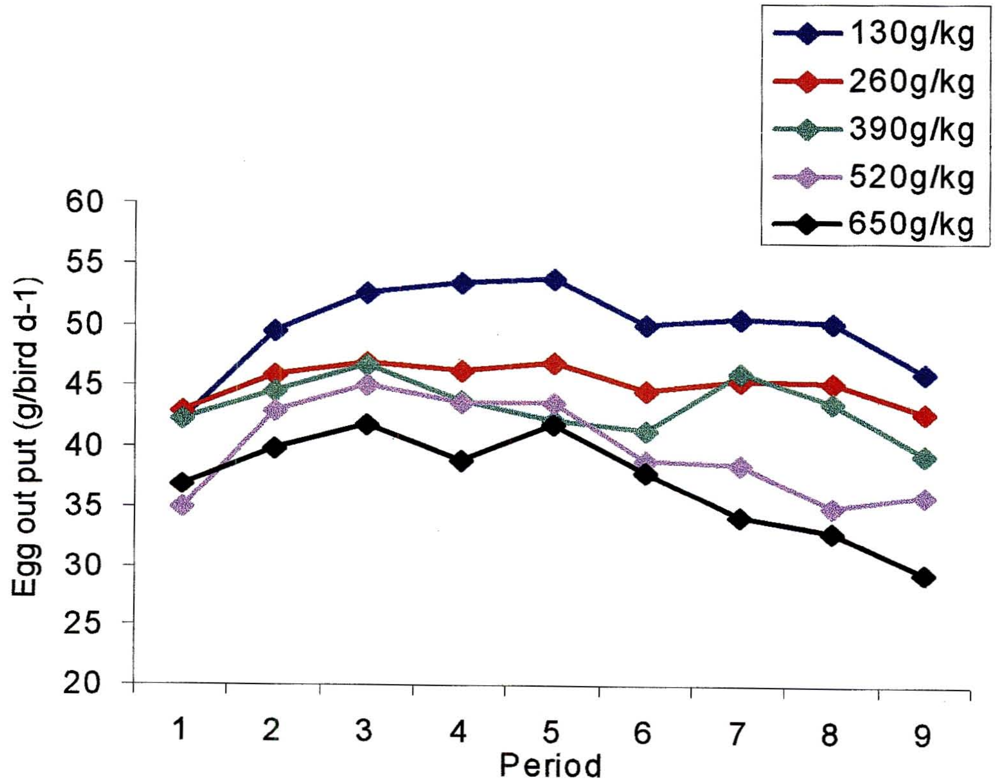

Figure 3.5 The egg output (g/ bird d) response of Amberlink laying hens fed graded levels of bread waste levels over a nine month period

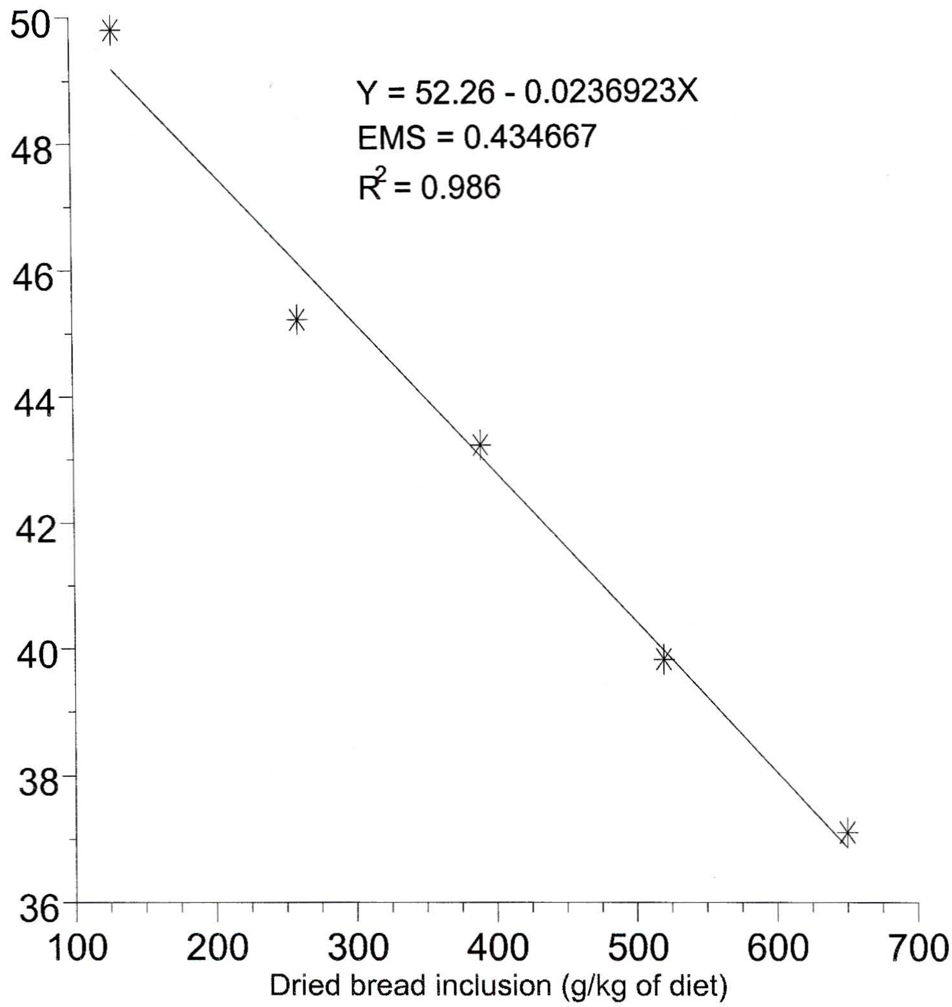

Figure 3.6 The egg output (g/bird d) response of Amberlink laying hens to increasing levels of bread waste in the diet

3.2.4 Feed Intake (g/bird d)

The feed intake of Amberlink laying hens fed restrictively on diets with varying levels of bread waste, ranging from a minimum of 130 to a maximum of 650 g/kg of diet, are presented in Table 3.5. Treatment had a significant effect on feed intake ($P<0.01$). The feed intake over the nine monthly experimental periods was not consistent within treatments and tended to increase and decrease over time. Feed intake was also not consistent between treatments, although at times similar trends were followed (Figure 3.7).

Most of the treatment by period interaction that affected feed intake occurred over the entire nine month experimental period. Feed intake of the treatments with higher bread inclusion levels (390 g/kg diet and above) tended to be more prone to flctuate up and down with treatment by period interaction than that of treatments with lower bread inclusion levels of 130 and 260 g/kg diet, which seem to be more stable during the entire experimental period.

By regressing the overall mean feed intake responses against the bread level, none of the linear, quadratic and cubic relationships were statistically significant. The linear model did not fit well, with only 5% of the variance accounted for.

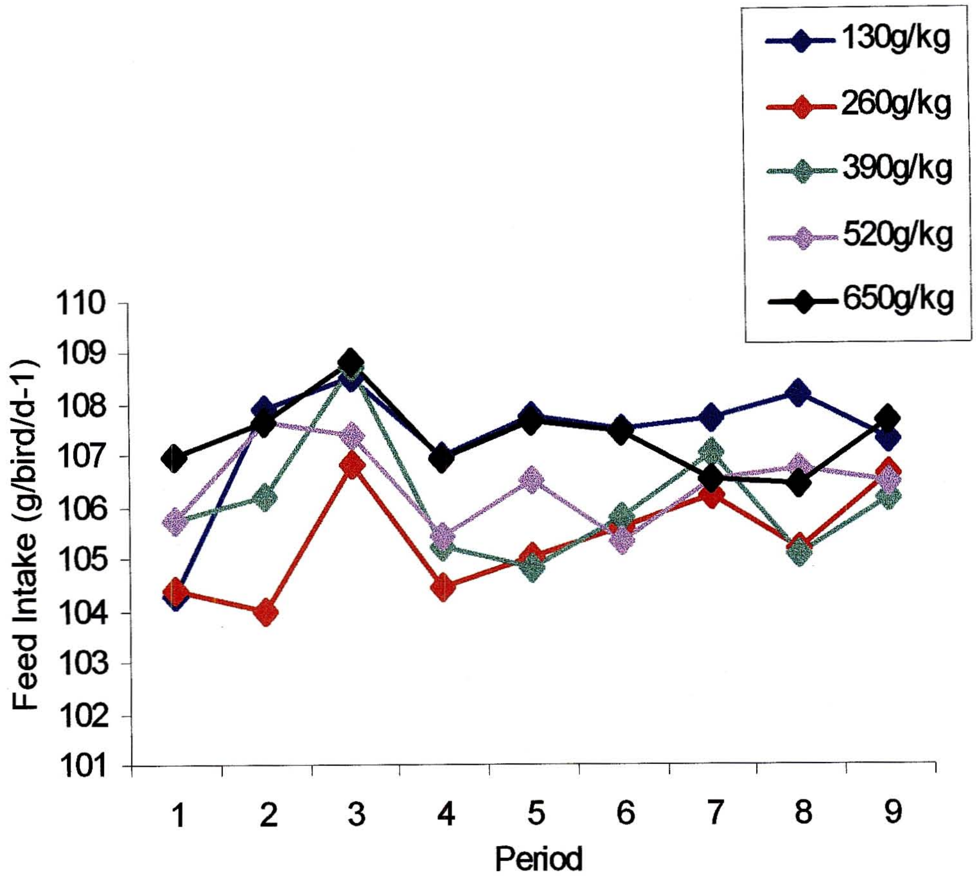

Figure 3.7 Feed intake (g/bird d) response of Amberlink laying hens fed graded levels of bread waste over the nine one-month periods

3.2.5 Egg shell thickness (mm)

Overall mean egg shell thickness for Amberlink laying hens fed ascending levels of bread waste, from 130 to 650 g/kg of diet, are shown in Table 3.5. Significant differences in egg shell thickness existed between the various treatments ($P<0.05$). The treatment by period interaction was also highly significant ($P<0.01$), but did not signify any particular trend (Figure 3.8). Regression of egg shell thickness on bread level depicted a highly significant ($P<0.01$) linear response, as presented in Figure 3.9. The model fitted moderately well with a percentage variance accounted for of 52.9%. The quadratic and cubic response terms were not significant.

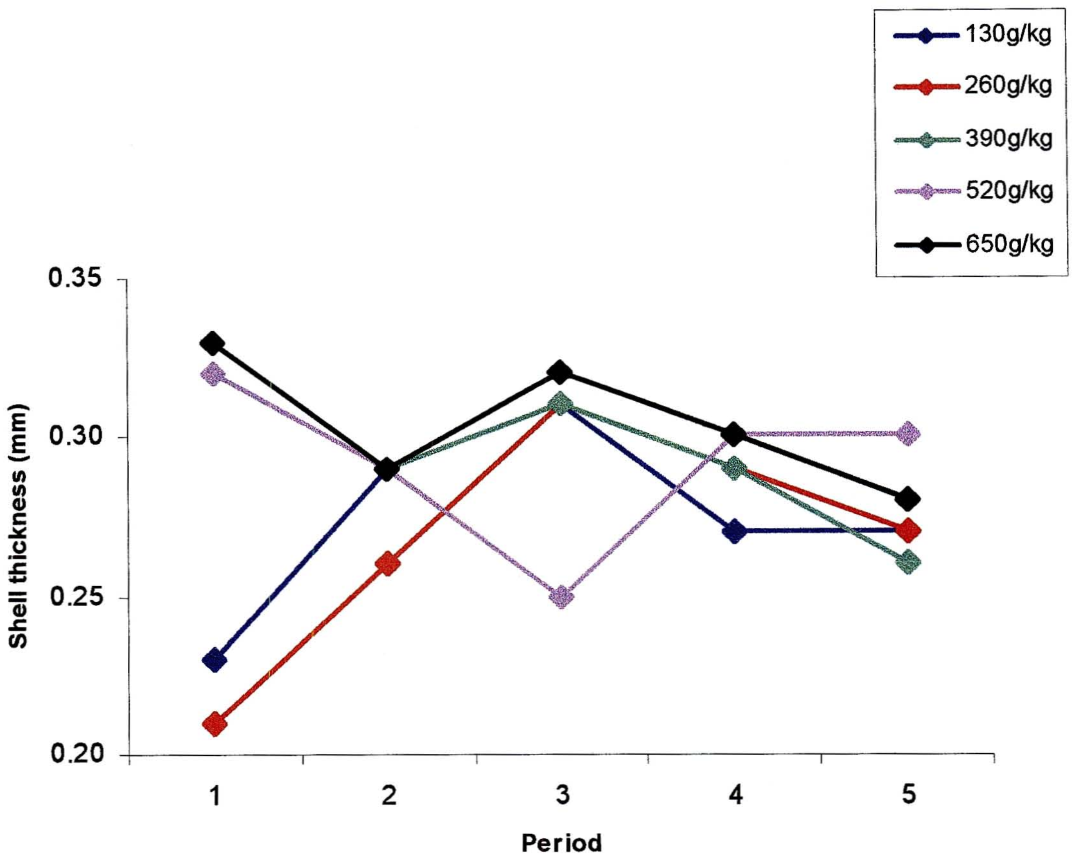

Figure 3.8 Shell thickness (mm) response of Amberlink laying hens fed graded bread levels of 130 to 650 g/kg diet as measured over a five month period

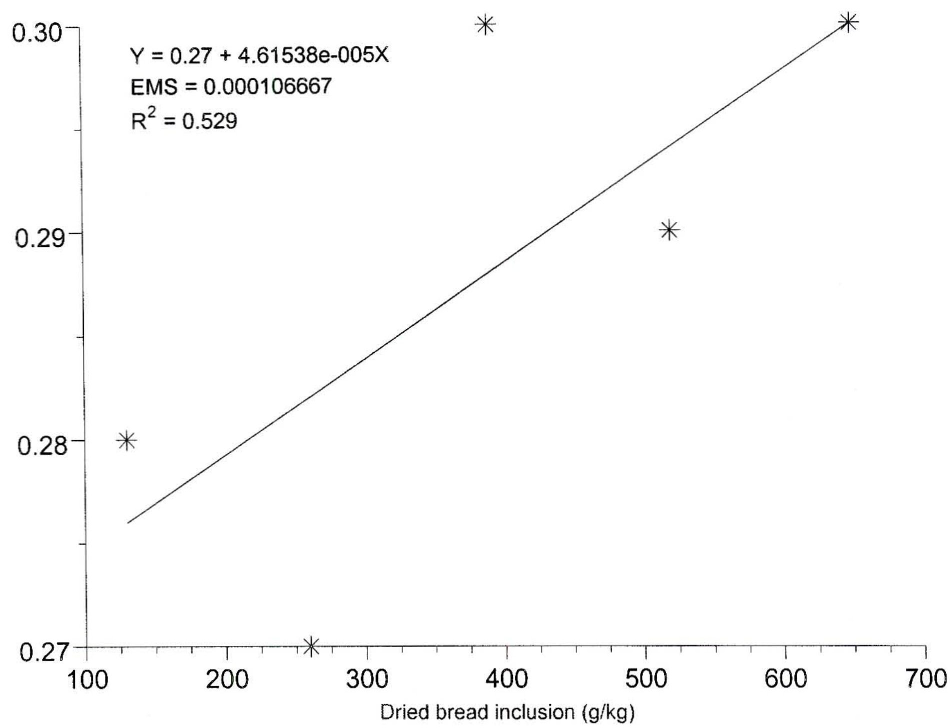

Figure 3.9 Egg shell thickness (mm) response in Ambelink laying hens to increasing levels of bread waste in the diet

3.2.6 Feed conversion efficiency (FCE)

The mean feed conversion efficiency (g egg/ g feed) of Amberlink laying hens fed increasing levels of bread waste are summarized in Table 3.5. There were significant differences between treatments in feed conversion efficiency ($P<0.01$). The feed conversion efficiency for high bread contents of 520 and 650 g/kg of diet was poor in comparison to lower bread levels of 130, 260, and 390. The regression of feed conversion efficiency on bread inclusion level indicated a significant negative linear trend ($P<0.01$)(Figure 3.10), with neither the quadratic nor the cubic relationship being significant ($P>0.05$).The linear model fitted well, with 96.5% of the variation accounted for.

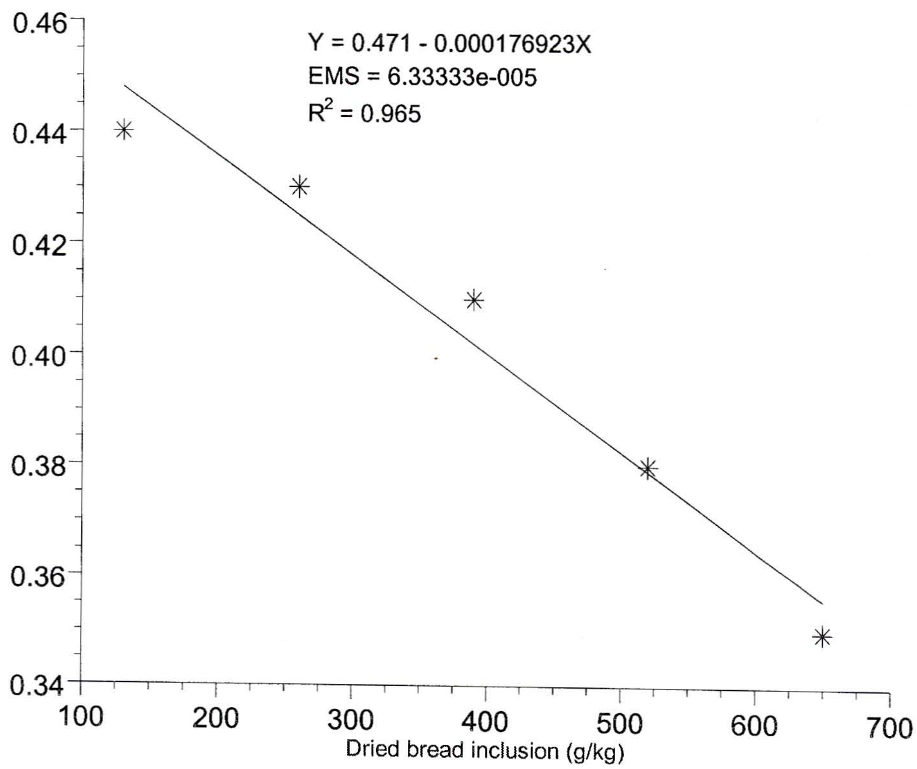

Figure 3.10 The feed conversion efficiency (g egg/ g feed) response of Amberlink layers to ascending levels of bread waste in the diet

3.2.7 Simulated rate of lay using the Wood model

The parameter estimates a, b and c of the Wood model, fitted to rate of lay data, are shown in Table 3.6, while the fitted curve is shown in Figure 3.11.

Table 3.6 Parameter estimates of the Wood model fitted to rate of lay data for each of the bread levels in the diet.

Bread inclusion level	Model parameter		
(g/kg of diet)	a	b	c
130	94.51	0.18	-0.07
260	91.11	0.05	-0.04
390	90.71	0	-0.03
520	87.12	0.3	-0.12
650	87.26	0.24	-0.07
Sed*	1.37	0.05	0.02

*Standard error of differences

The mean scaling factor explaining the initial rate of lay (eggs/100 birds d) for the Amberlink laying hens showed a declining trend to increased dried bread inclusion levels ($P<0.01$). The mean b-values describing the rate of increase in rate of lay (eggs/100 birds d) to peak differed ($P<0.01$) between the different bread inclusion levels. However, no consistent trend was evident. The highest rate of increase was obtained with the diet containing 520 and the lowest rate was of the diet having 390g/kg of diet. The mean c-value, representing the rate of decline in rate of lay after peak production differed between treatments ($P<0.05$). The highest decrease in rate of lay (eggs/100 birds d) was realized with the diets containing highest levels of dried bread, being -0.12 and -0.07, corresponding to 520 and 650 g/kg of diet respectively.

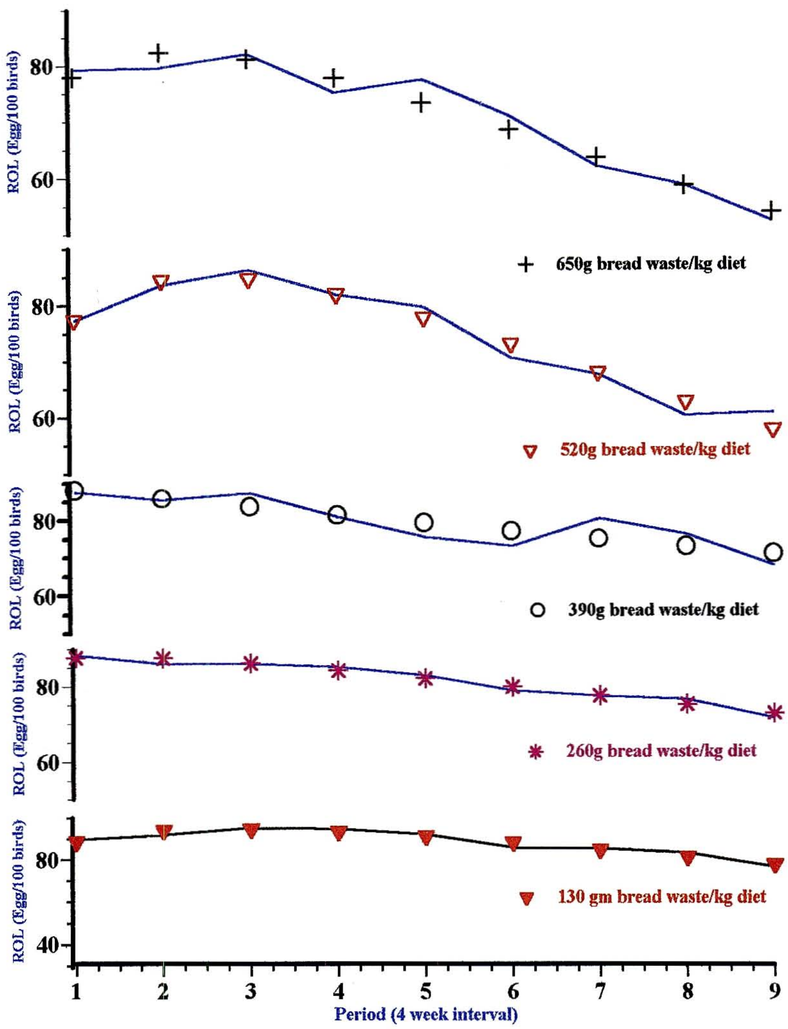

Figure 3.11 The predicted response in rate of lay for Amberlink hens fed ascending dietary levels of bread waste. (Solid line denotes the predicted values while the points depict the actual values).

3.2.8 Simulated egg output using the Wood model

The parameter estimates a, b and c of the Wood model, fitted to egg output data, are shown in Table 3.7, while the curve fit is graphically presented in Figure 3.12.

Table 3.7 Parameter estimates of the Wood model fitted to egg output data for each of the bread levels in the diet.

Bread inclusion levels	Model parameter		
(g/kg of diet)	a	b	c
130	45.92	0.34	-0.08
260	44.72	0.14	-0.04
390	44.04	0.1	-0.03
520	40.25	0.41	-0.12
650	40.59	0.33	-0.11
Sed*	0.6	0.03	-0.01

*Standard error of differences

The mean a-value, for the scaling factor describing the initial egg output (g/bird d), was significantly different (P<0.01) between treatments. The a-value depicted a negative linear trend. The b-value, representing the rate of increase in egg output (g/bird d), except that it was low and different (P<0.01) with diets containing dried bread inclusion levels 260 and 390g/kg of diet showing 0.14 and 0.10 g/bird d respectively in rate of decline after peak.

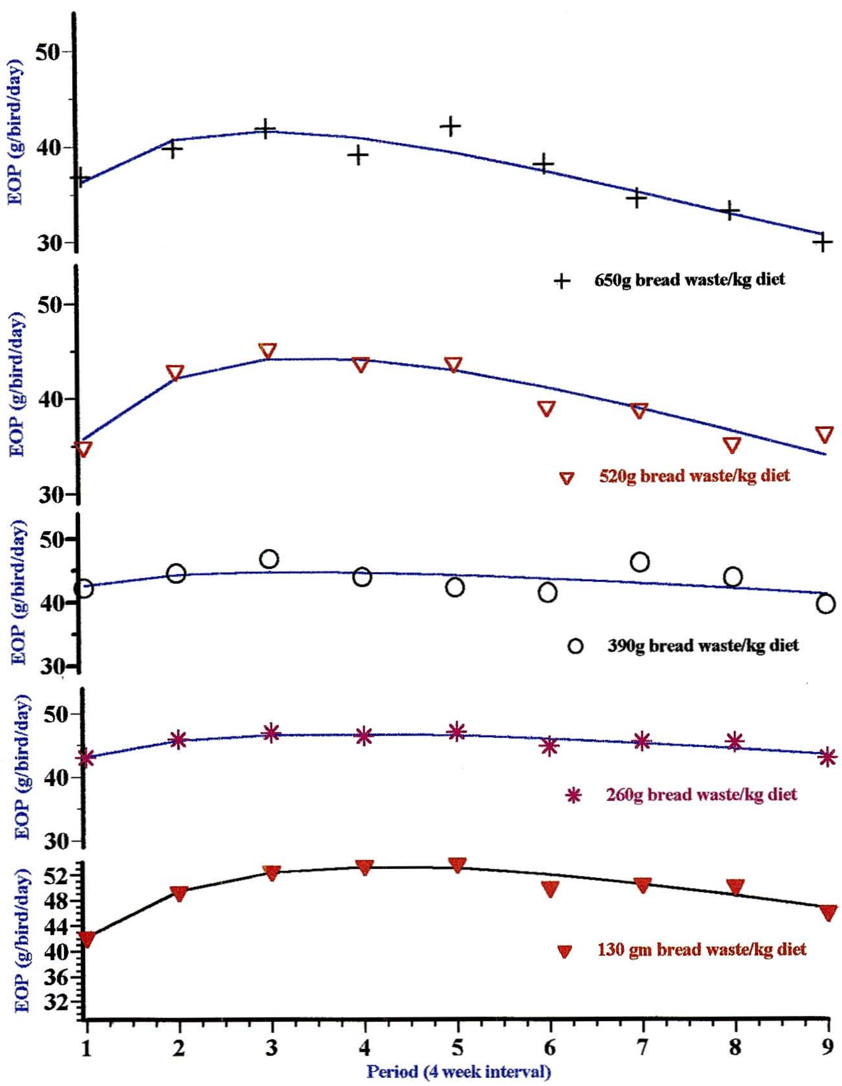

Figure 3.12 The predicted response in egg output (g/bird d) for Ambelink laying hens to ascending dietary levels of bread waste. (Solid lines denotes the predicted values while the points indicate actual values).

3.3 Economic Analysis

For the control treatment (zero bread inclusion), linear extrapolation was used in order to determine the egg numbers, egg weight, feed intake per period and their marginal returns. The extrapolated production of the control treatment (248.1 eggs per hen housed, and mean egg weight of 57.1 g) conformed closely to potential productivity of Amberlink hens (235.5 eggs per hen housed, and cumulative egg weight per hen housed of 58.4 g) under commercial management regimes when fed conventional laying diets up to 60 weeks of age (DEKALB, 1998). The economic analysis attempted to reveal the economic optimum by period, and subsequently the overall economic optimum by treatment.

3.3.1 Economic optimum by period

The economic optimum for each diet over the nine periods is shown in Table 3.8 at a price scenario of R 700 and R 350 per tonne respectively for maize and bread waste. The data indicate variation in marginal return over the periods, but the cumulative mean marginal returns are higher with lower bread inclusion levels, and a consistent linear trend was observed from lowest levels to highest level of bread inclusion, for the cumulative mean marginal return.

Table 3.8 Means of marginal return (Rand/hen/month), broken down by one month period and cumulatively over the experiment

Bread level (g/kg)	Mean Marginal Return by period 1	2	3	4	5	6	7	8	9	Cumulative Mean Marginal Return
0	5.70	6.10	7.80	9.14	9.04	8.60	**9.20**	9.10	8.10	**8.09**
130	6.70	7.80	8.30	**9.03**	9.02	8.00	8.20	8.00	7.20	8.02
260	6.70	7.40	**7.80**	7.55	**7.80**	7.10	6.80	6.80	6.20	7.13
390	6.90	**7.60**	7.30	6.18	5.86	5.10	5.30	4.90	3.90	5.90
520	5.60	7.20	**7.50**	6.87	6.68	5.70	5.70	4.90	5.20	6.16
650	5.90	6.60	7.10	6.13	**7.29**	6.30	5.50	5.40	4.60	6.08

Bold figures in the table indicate economic optima by period and cumulatively

The cumulative mean marginal returns recorded for the bread inclusion levels ranging from 130 to 650 g/kg diet were not statistically different from one another. Whilst the cumulative mean marginal return (R 8.09) for the zero-level of bread inclusion was derived by linear extrapolation, the small difference between that and the cumulative mean marginal return for the bread level of 130 g/kg diet (R 8.02) suggests a non-significant difference, since such differences between bread levels above 130 g/kg (which were numerically larger) were not significant. However, this inference is based on an extrapolated mean marginal return value for the zero bread level, and would have to be verified experimentally. The cumulative means of various economic margins (Rand/hen/month) over the range of bread inclusion levels are illustrated in Table 3.9.

The regression of cumulative mean egg income (Rand/hen/month) on bread inclusion level indicated a significant negative linear trend ($P<0.04$). The dependent variable, Y (cumulative mean marginal egg income) can be computed as follows: $Y = 11.542 - 0.00474X$, with X representing the dietary level (g/kg) of bread waste that is of interest. Neither the quadratic nor the cubic relationship was significant. The linear model fitted well, with an R^2-value of 0.803 (i.e. 80.3% of the variation accounted for).

The regression of cumulative mean marginal feed cost (Rand/hen/month) on bread inclusion level also indicated a significant negative linear trend ($P<0.01$). The dependent variable, Y (cumulative mean marginal feed cost) can be computed as follows: $Y = 3.437 - 0.00102X$, with X indicating the dietary level (g/kg) of bread waste that is of interest. Neither the quadratic nor the cubic relationship was significant. The linear model fitted well, with 96.1% of the variation accounted for ($R^2 = 0.961$).

The regression of cumulative mean marginal return (Rand/hen/month) on bread inclusion yielded a negative linear trend line, that was tending towards significance ($P<0.066$). Cumulative mean marginal return (Y) can be computed as follows: $Y = 8.113 - 0.00373X$, with X representing the dietary level (g/kg) of bread waste that is under scrutiny. The quadratic and cubic relationships were not statistically significant. The linear model fitted well, with 72.7% of the variation accounted for ($R^2 = 0.727$).

Table 3.9 Cumulative means of marginal income, cost and return ((Rand/hen/month) for varying dietary levels of bread waste over the experimental period of nine months

Bread inclusion level (g/kg) of diet	Cumulative mean marginal egg income		Cumulative mean marginal feed cost		Cumulative mean marginal return	
	Mean	SE*	Mean	SE	Mean	SE
0	11.51	-	3.42	-	8.09	-
130	11.35	0.34	3.34	0.00	8.02	0.34
260	10.26	0.76	3.13	0.10	7.13	0.70
390	8.93	0.76	3.03	0.00	5.90	0.74
520	9.06	0.82	2.9	0.00	6.16	0.82
650	8.87	0.40	2.79	0.00	6.08	0.40
Significance of F-value	0.05		0.00		0.12	

* SE = standard error.

- Not reported, since the mean values were extrapolated.

3.3.2 Economic analysis with the bread price as a proportion of the maize price

In order to determine the economic optimum dietary inclusion of bread waste, when the price of bread waste fluctuates proportionally to the price of maize, price ratios of 10, 20, 30, 40, 50, 60, 70, 80, 90, 100% relative to a current maize price of R 700 per tonne for the year 2000 are used in the economic model and the response is depicted in Figure 3.13. The line depicts the optimum inclusion level of bread waste in the diet, which did not move from 20% bread waste inclusion, irrespective of the wide range of price ratios of bread waste to maize used in the comparison.

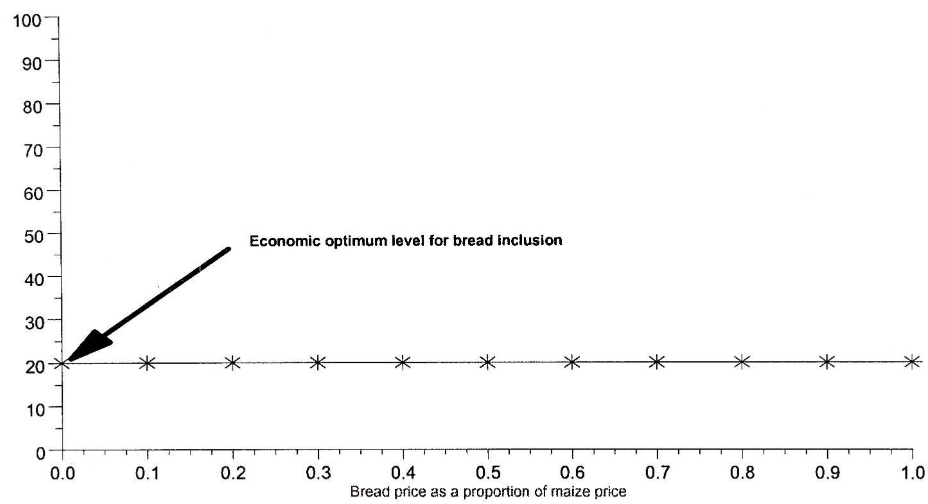

Figure 3.13 The economic optimum line for dietary inclusion level of bread waste, when the price of bread waste fluctuates in proportion to the maize price over the price ratio range of 10 to 100% of a maize price of R 700/tonne (year 2000).

4.0 DISCUSSION

Cereal feed resources, such as maize, considerably influence the production cost of broiler and layer enterprises, since these energy sources constitute the largest single fraction of typical commercial diets for poultry, and feed cost is the single most important aspect of the variable cost of these enterprises. The escalating cost of commercial poultry diets in South Africa in recent years can largely be traced back to escalating cereal grain prices, particularly maize. Furthermore, it is common knowledge that maize is a staple food for African communities, particularly in rural areas. Hence, both price considerations and potential human-animal consumption conflicts with regard to cereal grains (particularly maize) is prompting attempts to explore alternative feed resources for animal diets in many developing countries. Work by Damron *et al.* (1965) and Cheeke (1999) identified optimum levels of dried bread for maize replacement in monogastric diets, which was 25% or less. Such low levels of maize replacement by bakery by-products in monogastric diets produce positive results, both in terms of the biological responses measured and the cost-effectiveness (Okai, 1999; Zavon, 2000). An inference drawn from related findings by Saleh *et al.* (1996) on broiler chickens indicated that at least 25% of maize grain can be replaced by dried bakery product without any adverse effects on bird performance, whereas Okai (1999) reported that at least 30% maize replacement by dried bakery waste product was possible in pig diets without any deleterious effect on performance, whilst diets were slightly cheaper. Such findings reflect the general potential of a partial maize replacement by dried bakery product in monogastric feeds.

This study investigated the biological and economic responses of Amberlink hens fed graded levels of dried bread waste in replacement of maize in layer diets. The range of bread levels assessed was intended to offset the cost of the conventional layer diet and subsequently be a cost-effective substitute for maize in layer diets. In this study the majority of egg production variables measured with Amberlink layer hens (including rate of lay, egg output, egg weight, feed conversion efficiency, but not egg shell thickness nor feed intake), have revealed an inverse response to ascending bread inclusion levels.

In laying hens Harms *et al.* (1966) reported that a 12% bread inclusion was the maximum level without significant adverse biological and economic effects, measured over a 10 month period. However, the present work on Amberlink laying hens fed diets containing high bread levels (from 20 to 60% of the diet) indicated a consistent linear decline in egg production parameters with increasing levels of bread inclusion. One of the factors that may have contributed to the declining biological responses in this study may be the very high levels of bread inclusion that were studied.

In most other studies, the general tendency was to adopt much lower maximum bread inclusion levels (30% replacement of maize, in the study by Okai (1999)). Besides the reduced biological performance measurements, it was also observed that the litter under the battery cage system was rather watery, which required frequent disposal. This can probably be attributed to the high salt content of the bread in the experimental diets. High levels of salt in poultry diets have previously been implicated in wet litter problems (Damron *et al.,* 1965; Julian, 1990).

There appears to be nutrient deficiency or imbalance in bread waste that limits layer performance, when high levels of bread waste replace maize as energy source in layer diets. This nutritional limitation of bread waste may be associated with the quality of protein, and elevated levels of ash and NDF content in (wheat-based) bread waste versus that of maize. The nutritional quality of the protein contained in wheat and maize differs significantly. The chemical composition of wheat shows that this feed resource tends to be higher in crude protein and quite similar in energy content to maize. Although the diets in the study were formulated on the basis of available nutrients and blending was purposely used to ensure a nutritionally consistent diet across the six experimental feeds, layer performance declined linearly with increasing dietary level of bread waste, for all but two response variables measured.

The crude protein and energy content of a feed ingredient such as bread waste is not necessarily a good indicator of the nutritional quality of the protein content. Wheat is the primary constituent of bread, and wheat has generally been regarded as a relatively poor source of protein, due to poor digestibility (Leeson and Summers, 1997). The poor nutrient digestibility and, hence, relative unavailability of a limiting amino acid such as lysine in wheat compared to maize (Leeson and Summers, 1997) is a case in point. This applies to almost all nutrients in maize versus wheat. Moreover, further differences are associated with the high mineral content (ash; including salt) of bread waste.

The ash content may have had a significant detrimental effect on the nutrient digestibility in those layer diets which contained higher bread inclusion levels. The neutral detergent fibre (NDF) is a measure of the total cellulose, hemicellulose, lignin, silica, and heat-damaged protein. Bread has higher NDF figures than those found in maize and the NDF is another anti-nutritional factor (Leeson and Summers, 1997) which might have contributed to the negative linear response in the measured egg production variables. Furthermore, NDF and ash content of any feed ingredient are known for their inverse relationship with digestibility. This may help to explain the observed decline in the feed conversion efficiency with ascending dietary inclusion levels of bread waste.

The chemical composition of the diets has shown ascending levels of ash with an increase in dietary bread content. Therefore, digestibility of nutrients seem to have had a major effect on biological performance. The digestibility of lysine, in particular, is dependent on the extent of Maillard reactions and lysine is one of the first limiting amino acids in monogastrics. The extent to which lysine combines with carbohydrates during the baking process governs the lysine availability (Saleh *et al.,* 1996). Leeson and Summers (1997) observed that heating effects appear to contribute to Maillard reactions, which are also prevalent with maize, especially when maize is undergoing the drying process. The low digestibility of lysine in both white and brown bread by comparison with the other amino acids is the most outstanding observation (Saleh *et al.*, 1996). Therefore, the different ways in preparation and heating processes for maize and bread (wheat) may have a bearing on the extent of Maillard reactions and the associated negative effects on nutrient digestibility, which explains better the protein quality of a feed ingredient. Although lysine deficiency symptoms have not been observed in the study, it is possible that lysine requirements have not been met (despite formulating diets on the basis of available nutrients).Therefore, a number of negative nutritional influences associated with increasing levels of bread may have combined to impair biological performance.

The present investigation was not able to identify a biological optimum level of maize replacement. This was largely due to the forced omission of the control treatment (zero-inclusion of bread waste from comparisons, due to compromised data resulting from a mixing error (omitting salt) during the first batch mixing of feed. However, the biological response variables did indicate a clear negative trend with increasing dietary inclusion levels of bread waste. Furthermore, the economic impact in terms of cumulative mean marginal egg income (Rand/hen/month) versus the cumulative mean marginal feed cost (Rand/hen month), with a resultant cumulative mean marginal return (Rand/hen month). The economic response, as revealed by the cumulative mean marginal return, has consistently indicated that 130 g bread waste/kg of diet (20% maize replacement) was the economic optimum level of replacing maize with dried bread waste in laying hen diets. The economic optimum in this study is slightly lower than the economic optimum at 30% replacement level observed by Okai (1999) and Zavon (2000). Economically, these data imply that the decline in biological performance, particularly in egg numbers and egg weight, resulted in a poor egg income, which offset the corresponding feed cost reduction as the bread waste levels were increased above 130 g/kg diet. Therefore, the decline in biological performance appears to negatively affect the economic performance, in terms of marginal returns , even though a declining trend was observed in marginal feed cost.

These findings indicate that high levels of bread waste inclusion (above 130 g/kg diet) as a replacement for maize in layer diets leads to a declining trend in financial gain, which was not statistically significant. Therefore, the study has revealed that a nutritionally deficient and poorly regarded resource like dried bread waste from bakeries can be biologically recycled by monogastric animals (laying hens), to yield protein (eggs) for human use. Further research, to investigate the nutritional limitations of dried bread waste should be conducted. More specifically, digestibility of nutrients needs to be ascertained, in order to enhance the development of energy feed ingredients appropriate for use in small-scale poultry production systems.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The use of dried bread waste as a replacement for maize has been shown to be economical in terms of reducing marginal feed cost. Although dried bread waste is not equivalent to maize as an energy source in the diet of caged layer hens in terms of biological performance, the resultant marginal return was not reduced by replacing maize with bread waste at replacement levels ranging from 130 to 650 g/kg diet. This work revealed that bread waste can replace up to 100% of the maize in layer diets (containing 65% maize) on an economic basis, as there was no statistically significant reduction in the marginal return. Since extrapolated performance of control hens and potential performance of commercially kept Amberlink hens corresponded fairly closely, this conclusion is considered valid. The maize needs to be relatively cheap compared to bread waste in order to offset the marginal feed cost advantage of bread waste, even though a reduction in biological performance should be expected when bread waste replaces maize. Moreover, the use of high levels of dried bread waste for maize replacement has indicated that there is potential for use of this relatively cheap industrial by-product to be recycled via layer feed, thus contributing to small-scale animal protein (egg) production systems for human use, as also observed for pig production systems in Ghana by Okai (1999). Further investigations need to be conducted, focussing on the nutritional limitations of bread waste as feed resource in monogastric animal diets.

GENERAL DISCUSSION

Research strategies that have the potential to improve the small-scale poultry production system are likely to make a contribution to household animal protein production endeavours for many rural households of South Africa. One common reasoning about rural households has been the association of household food production system and improvement in family nutrition (Kirsten *et al.*, 1998). Such reasoning has led many people, particularly researchers, in motivating programmes or studies that would contribute to the improvement of agricultural productivity in less-developed and poverty-stricken areas. Agricultural activities includes the small-scale poultry farming and therefore this poultry production system cannot be ignored in view of the poverty and malnutrition prevailing in rural areas of South Africa. Small-scale poultry production has positively contributed to household nutrition in many Asian and some African countries, through improvement on the subsistence egg and meat production strategies.

Like in most African countries poultry farming in South Africa can be divided into two distinct types of production namely large-scale and small-scale poultry farming. Large-scale poultry farming is invariably commercially oriented. Generally, small-scale poultry production includes both commercial and scavenging or traditional poultry production systems. The small-scale poultry production systems are important for animal protein production, and contributes to subsistence egg and meat protein consumption for rural people. Guèye (2000) observed that the commercial poultry farming system across most of Africa tends to be found mainly in and around towns. Therefore, large-scale commercial poultry farming systems are more likely to directly contribute considerable quantities of protein and income for those who have migrated to the peri-urban and urban areas. Although the large-scale commercial poultry farming operations are recognized for providing jobs for many people living in and around towns. The large-scale poultry operation also contributes to protein production for meat and egg to many of the urban and rural dwellers.

The small-scale poultry production system has long been seen by researchers (Msane, 1995; Guèye, 2000) as a vibrant agricultural activity, with the potential to contribute to household food security. Furthermore, Sonaiya *et al.* (1998) and Guèye (2000) pointed out that small-scale poultry production could be a good strategy towards empowering the disadvantaged sectors of the African community. Dhladhla (1995) pointed out that small-scale poultry farming in South Africa was undergoing development, and called for initiatives to encourage and promote this small-scale poultry industry. There should be a specific emphasis to stimulate small-scale poultry production at household level, as a strategy to provide animal protein for subsistence consumption or as a sideline venture to generate subsistence income.

The small-scale traditional poultry production system has not been adequately studied in South Africa, and yet it forms an important component in the subsistence farming of poor rural people. The first part of this dissertation was intended to investigate the traditional management, feeding, constraints and socio-cultural and economic factors influencing family poultry production in eight households. This could contribute to development of an appropriate traditional knowledge base about the family poultry production system. It was envisaged that some of the traditional family poultry practices could be used towards improving human nutrition at household level, through increased poultry meat and egg production and consumption. This poultry farming sector is sustainable and could contribute to food security, poverty alleviation and ecological sound management of natural resources for the resource-poor people of Africa (Guèye, 2001).

In the eight households evaluated in this study, family poultry were found to have some potential to positively contribute to household food security. Family poultry rearing in those households was the most prevalent animal production practice, and was kept by even the poorest amongst the households. Therefore, family poultry like in most African countries is popular in rural, peri-urban and urban areas. Family poultry was found to be not only important for family nutrition, socio-cultural, religious and medicinal functions but also made significant contribution to the generation of cash income for subsistence households. The principal route by which family poultry rearing directly contributed to family poultry nutrition is through the occasional slaughtering and consumption of these chickens as meat, and more rarely in the form of consumption of eggs. Some traditional poultry production strategies have shown some positive impact on the size of family poultry flocks, which could potentially translate to a higher off-take (slaughter for meat consumption). Though not a common feature in most households, family poultry makes an important contribution to poverty alleviation through the sale of some of the birds, and thus subsistence income for family use was being generated. However, selling of birds was quite rare and only occurred in times of desperation. In this context, family poultry represent a form of investment that enables the households to cope with times of great adversity by selling poultry, money is generated that can be used to pay for other commodities, including other food types. Household farming practices are diverse and range from inter-cropping of many crops such as dry beans, maize, pumpkins, often integrated with animal production, including family poultry and cattle. The integration of the family poultry production system within household farming activities enhances the ecological management of natural resources. Family poultry relies on scavenging, which is a process that serves as bio-conversion of human reject food and naturally occurring feed resources that cannot be directly consumed by humans. In the household surroundings family poultry thus bio-convert cheap, low value materials such as grain harvest waste, kitchen scraps, vegetable waste, grass material and invertebrates, like insects into a valuable animal protein in the form of eggs and meat, which would otherwise be beyond the means of many subsistence households.

This work has revealed information about similar and diverse family poultry practices that could enhance this small-scale poultry production system. This involved practices like early chick separation, hen tethering (holding) and indoor hen laying. The impact of these practices has been through management of the principal family poultry production constraints particularly predations and infectious diseases, thus leading to larger family poultry flocks in households practising these innovations. The general technological advancement enjoyed by the commercial poultry farming sector include improved breeds, advanced nutrition and management strategies. However, the global principal constraint to commercial poultry production system relates to feed resources and feeding aspects. Feed costs in South Africa represent approximately 80% of the economic inputs required for broiler production, irrespective of the scale of operation (Swatson, 1997). The situation of high feed costs is more complex and pronounced for the small-scale poultry producer situated away from the central feed suppliers who are mostly found in and urban centres. The extent of effects of feed cost on the small-scale poultry production system is illustrated by the problems encountered in the household egg production units introduced by MacGregor and Abrams (1996) in the Northern Province of South Africa.

Cereal grains, especially maize, is used as the main energy component in most commercial poultry diets in South Africa. The problem is that direct human consumption of cereal grains as a staple food receive priority in most African countries and most of these countries have not reached self-sufficiency in cereal grain production for human consumption. This situation of insufficient grain maize production leads to the emergence of cereal grain shortages, which is a common problem amongst the developing countries. In practice, therefore, cereal grains only become available for use in poultry feeding when there is some surplus production. Principal environmental factors like rainfall and temperature considerably and adversely affect the production extent of maize in most African countries, and thus cereal grain scarcity for use in animal feeds is likely to be a persistent problem. Importation of cereal grains from the developed countries is one of the possible alternatives, but is not an economically feasible solution, because of the poor state of currencies of most developing countries. Interestingly, many African countries, including South Africa, produce an assortment of both conventional and alternative feed resources and ingredients that can be used in poultry feeds (Guèye, 2000).

The second part of this work was therefore, intended to investigate one such alternative energy feed resource, suitable for use in the small-scale commercial poultry farming system, particularly the household egg laying units in South Africa. The household egg laying units were purposely designed to assist in improvement of human nutrition by providing high quality protein and micronutrients and thus ameliorate human malnutrition problems amongst African families living in rural areas in South Africa.

The existence of one of the small-scale commercial poultry production sectors (household egg laying units) has been under constant threat over the past few years. This mainly been due to the increasing feeding cost, particularly the maize price, which is a major component in laying diets. Damaged and stale bread was identified as a suitable and locally available feed resource, found in large quantities in bakeries. Therefore, damaged or stale bread has the potential to contribute to alleviate this problem of escalating feed costs. After the on-station investigations, it was concluded that maize can be partially or fully replaced by bread waste, in diets where maize constituted up to 65% of the total layer diet, without any significant detrimental effects on the economic gain as determined by the marginal returns.

From the biological and economic evaluations, maize replacement in layer diets by damaged or stale bread apparently has some nutritional limitations, which require further investigation. However, this work has revealed that bakery by-product, as a reject material consisting mainly of damaged or stale bread, can be formulated into a layer diet, which enable the laying hen to produce eggs, albeit below her genetic potential. The protein, vitamin A and micronutrients generated under this small-scale egg production system can make an important contribution to solving deficiency problems in human nutrition at household level for these nutrients, which are causally involved in most of the malnutrition problems in young children of South Africa.

In conclusion, parts of this study have revealed the potential of the small-scale poultry production system, family poultry and household egg laying units towards making a positive contribution to animal protein production in the form of eggs and meat.

REFERENCES

ABALU, G. I. (1999). Food security, rural economic linkages and the creation of employment in rural areas of Southern Africa. *Agrekon*, **38** (special issue May) : 20 - 41.

ABSA BANK. (1993). Economic spotlight - The structure of the South African Economy, No.7 July.

AGANGA, A.A., OMPHILE, U.J., MALOPE, P., CHABANGA, C. H., MOTSAMAI, G.M. AND MOTSUMI, L.G. (2000). Traditional poultry production and commercial broiler alternatives for small-holder farmers in Botswana. *Livestock Research for Rural Development*, **12(4).** http://www.cipav.org.co/lrrd/lrrd12/4/aga124a.htm

AINI, I. (1990). Indigenous chicken production in South-east Asia. *World's Poultry Science Journal*, **46** : 51- 57.

ALDERS, R.G., FRINGE, R. AND MATA, B. (1997). Village chicken practices in Bilene District, Mozambique: current practices and problems. Proceedings INFPD Workshop, M'Bour, Senegal, December 9 -13. pp.167-171

ARDINGTON, E. AND LUND, F. (1996). Questioning rural livelihoods, In: Land, labour and livelihoods in rural South Africa, Vol 2: KwaZulu-Natal and Northern Province. Eds. M. Lipton, F. Ellis and M. Lipton. Indicator Press, Durban, South Africa. pp. 31-41.

ARENAS, M.A. (1997). Home poultry-raising (a project organized by peasant women in Chile). Hoja a Hoja, 10 Centro Catev, 1 Oriente 978, Casilla Postal 429, Talca, Chile. pp. 217-224.

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS. (1998). Official Methods of Analysis, 16th edition. Association of Official Analytical Chemists, Washington, DC.

BARUA, A. AND YOSHIMURA, Y. (1997). Rural poultry keeping in Bangladesh. *World's Poultry Science Journal*, **53** : 337-394.

BECKMAN INSTRUMENTS (1983). Applications data A6300-AN-002. Beckman Instruments Incorporated, Spinco Division, Palo Alto, California, U.S.A.

BILLET, R. (2000). Starting chickens from scratch. *Farmer's Weekly*, Durban, South Africa. April. pp. 26-38.

BOGDAN, R.C. AND BIKLEN, S.K. (1992). Qualitative research for education: An introduction to theory and methods. 2nd Edition. Simon and Schuster Inc., Needham, U.S.A. pp.88-94.

BRANCKAERT, R. (1995). FAO and rural poultry. In: Sustainable rural poultry production in Africa. Ed. E.B. Sonaiya. Proceedings of an International Workshop, June 13-16, Addis Abeba, Ethiopia. pp. 24-29.

BRANCKAERT, R.D.S. (1996). From backyard to commercial production. The keys of success. Proceedings of International Workshop on Newcastle Disease, University of Pretoria. South Africa.

BRANCKAERT, R.D.S. AND GUÈYE , E.F. (1999). FAO's Programme for support to family poultry production. Poultry as a tool in poverty eradication and promotion of gender equality - Proceedings of Workshop, Tune Landboskole, Denmark. http://www.husdyr.kvl.dk/htm/php/tune99/24-Branckaert.htm

BRINGHAM, S. (1987). Food and Nutrition. JM Dent and Sons Limited, London, Melbourne. pp. 90-91.

BRINK, H.I.L. (1987). Statistics for nurses. Academica, Pretoria, South Africa. pp. 100-112.

BUDLENDER, D. (1999). Patterns of poverty in South Africa. *Development Southern Africa,* **16** : 197-220.

BURGESS, R.G. (1988). Studies in qualitative methodology. JAI Press Ltd, 3 Henrietta Street, London WC2E 8LU. pp.1-16.

BURGESS, R.G. (1994). Field research, a source book and field manual. Routledge, a Division of Routledge, Chapman and Hall, Incorporated, New York. pp.191-194.

CALLENS, S.K. AND PHIRI, E. C. (1998). Household food security and nutrition in the Laupula valley, Zambia. In: FAO, food nutrition and agriculture. FAO, Rome. pp. 191-194.

CAMP, K. (1999). Guide to the use of Bioresource Programme. Cedara Report number N/A/99/11, KwaZulu-Natal Department Agriculture, South Africa. p.1-59.

CENSUS STATISTICS (1996). Statistics for Sub-ward Area: Amakhuze Sr4 T/4. http://innerweb.indrc.gov.za/CENSUS96/Zresult.asp

CENTRAL STATISTICAL SERVICE (1995). October household survey 1994: KwaZulu-Natal. Statistical Release P0317.5, 8 May. Central Statistical Service, Pretoria, South Africa.

CHAMBERS, R. (1998). Whose reality counts? Intermediate Technology Publications, 103-105 Southampton Row, London WCIB 4HH, United Kingdom. pp.15-50.

CHAVUNDUKA, D.M. (1976). Plants regarded by Africans as being of medicinal value to animals. *Rhodesian Veterinary Journal,* **7** : 6-12.

CHEEKE, P.R. (1999). Feeds and Feeding. Prentice Hall, New York. pp.73.

DAMRON, B.L., WALDROUP, P.W. AND HARMS, R.H. (1965). Evaluation of dried bakery products for use in broiler diets. *Poultry Science Journal,* **44** : 1122-1126.

DE BOER, A.J. AND SINGH, C.B. (1995). The farming systems research approach to agricultural research and development - an international perspective. In: Farming systems research for improving livestock production and crop residue utilisation.Eds. C.B. Singh, S.V.N. Rao and D.K. Jain. Indo-Dutch Project on Bioconversion of Crop Residues, New Delhi and Wageningen. pp. 1 - 7.

DEKALB (1998). DEKALB Amber management guide (4th Ed.). DEKALB Poultry Research, Inc., P.O. Box 926, DeKalb, IL60115-0926, U.S.A.

DHLADHLA, V. (1995). The RDP in the poultry industry. *Poultry Bulletin*, Pretoria, South Africa. January. pp. 3-5.

DU PREEZ, C. (2000). Rural household livelihoods and tourism. M.Sc. Thesis. Wageningen University, The Netherlands. pp.67-103.

ECKMAN, K. (1999). Linkages between participatory rural appraisal (PRA) and technological intervention. Poultry as a tool in poverty eradication and promotion of gender equality - Proceedings of Workshop, Tune Lanboskole, Denmark. http://www.husdyr.kvl.dk/htmphp/tune99/22-Eckman.htm

ETCHES, R.J. (1996). Reproduction in poultry. CAB International, Wallingford. pp. 29 - 37.

FAO. (1992a). Better nutrition at home. Improving household food security. Proceedings of International Conference on Nutrition, 5 -11 December 1992, Rome pp.9 -11.

FAO. (1992b). Hidden hunger. Preventing micro-nutrient deficiencies. Proceedings of International Conference on Nutrition, 5 -11 December 1992, Rome. pp.12-15.

FAO. (1997). Agriculture, food and nutrition for Africa. A resource book for teachers of Agriculture. Food and Nutrition Division, Food and Agriculture Organization of the United Nations, Rome, Italy. p. 12, pp. 160-161.

FAO. (1999). The state of food insecurity in the world. Food and Agriculture Organization of the United Nations, Viale Delle Terme di Caracalla, 00100 Rome, Italy. pp. 4.

FAO. (2000). Food supplies set to grow faster than population, but undernourishment will remain widespread, according to New FAO report. FAO press release 00/43. http://www.fao.org/waicent/ois/press_NE/presseng/2000/pren0043.htm

FISHER, C. AND MACNAB, J.M. (1988). Modified assay for true and apparent metabolizable energy based on tube feeding. *British Poultry Science*, **29** : 697-707.

FOURIE, C. (2000). Small-scale poultry production in South Africa. *Poultry Bulletin*, Pretoria, South Africa. September. pp. 414-420.

FRANKENBERGER, R.T., AND McCASTEN, M.K. (1998). The household livelihood security concept. Food, Nutrition and Agriculture, Food and Nutrition Division. The Technical Editor, FAO, Viale Delle Terme di Caracalla, 00100 Rome, Italy. pp. 280 -290.

GITTENS, C. (1998). A new lease of life for old poultry breeds. *Farmer's Weekly*, Durban, South Africa. October. pp. 21-22.

GUÈYE, E.F. (1998). Village egg and fowl meat production in Africa. *World's Poultry Science Journal*, **54** : 73-83.

GUÈYE, E.F. (1999). Ethno-veterinary medicine against poultry diseases in African villages. *World's Poultry Science Journal*, **55** : 187-198.

GUÈYE, E.F. (2000). Uncertain future for Africa's commercial poultry industry. *World Poultry*, **16** : 23-36.

GUÈYE, E.F. (2001). Marketing of family poultry products in Africa to be improved. *World Poultry*, **17** : 12-15.

GUIJT, I. (1998). Participatory monitoring and impact assessment of sustainable agriculture initiatives. International Institute for Environment and Development, 3 Endsleigh Street, London, United Kingdom. pp.3-111.

GUIJT, I., AND PRETTY, J.N. (1993). Rural people's knowledge. Agricultural Research Programme Overview Papers. International Institute for Environment and Sustainable Agricultural Development Programme. 3 Endsleigh Street, London. pp. 21-59.

HADDARD, L. (1997). Achieving Food Security in Southern Africa. International Food Policy Research Institute, Washington, D.C. U.S.A. pp. 3-153.

HANEKOM, T. (1997). Poultry development (initiatives to encourage small-scale production and indeed micro production). *Poultry Bulletin,* Pretoria, South Africa. November. p. 539.

HARMS, R.H., DAMRON, B.L. AND WALDROUP, P.W. (1966). Dried bakery products as an ingredient for poultry feeds. *Feedstuffs*, **38** : 42-43.

HATCH, G. (1996). Livestock and rural livelihoods in KwaZulu-Natal. In: Land, labour and livelihoods in rural South Africa, Vol 2: KwaZulu-Natal and Northern Province. Eds. M. Lipton, F. Ellis and M. Lipton. Indicator Press, Durban. pp. 77-86.

HONEYBORNE, N. (2000). Poultry farming systems. *Poultry Bulletin,* Pretoria, South Africa. September. p. 422.

HUCHZERMEYER, F.W. (1973). Free-ranging hybrid chickens under African tribal conditions. *The Rhodesia Agricultural Journal*, **70** : 73-75.

JOACHIM, T. AND HEATHER, M.G. (1991). Participatory rapid appraisal for community development. International Institute for Environment and Development, 3 Endsleigh street, London WCIH ODD, United Kingdom. pp.1-98.

JOB, T.A., OLUYEMI, J.A AND ENTOU, S. (1979). Replacement of maize with sweet potato in diets for chicks. *Poultry Science*, **20** : 515-519.

JULIAN, R.J. (1990). Chapter 3 - Cardiovascular diseases. In: Poultry diseases (3rd Ed). Ed. F.T.W. Jordan. Baillière Tindall, London. pp.333-334.

KHIEU, B. (1999). Chicken production, food security and renovative extension methodology in the SPFS Cambodia. Poultry as a tool in poverty eradication and promotion of gender equality - Proceedings of Workshop, Tune Landboskole, Denmark. http://www.husdyr.kvl.dk/htm/php/tune99/-khiu.htm

KIRSTEN, J.F., PARKER, A. N. AND VAN ZYL, J. (1996). Poverty, household food security and agricultural production: evidence from KwaZulu-Natal. *Agrekon*, **35**: 313-318.

KIRSTEN, J., TOWNSEND, R. AND GIBSON, C. (1998). Determining the contribution of agricultural production to household nutritional status in KwaZulu-Natal, South Africa. *Development Southern Africa,* **15** : 573-588.

KITALYI, A.J. (1998). Village chicken production systems in rural Africa: household food security and gender issues. FAO Animal Production and Health Paper No. 142. FAO, Rome, Italy.

KUMTAKAR, V.A. (1999). Backyard poultry system in the tribal areas of Shahpura block in Jabalpur District, Madhya Pradesh, India. Poultry as a tool in poverty eradication and promotion of gender equality - Proceedings of Workshop, Tune Landboskole, Denmark. http://www.husdyr.kvl.dk/htm/php/tune99/-kumtakar.htm

LEEDY, P.D. (1997). Practical research: Planning and design (6th Ed). Merill, An Imprint of Prentice Hall, Upper Saddle River, New Jersey/Columbus, Ohio. pp. 204-220.

LEONG, E. AND JALALUDIN, S. (1983). The poultry industries of South East Asia. The need for an integrated farming system for small poultry producers. *World's Poultry Science Journal*, **38** : 213-219.

LEESON, S. AND SUMMERS, J.D. (1997). Commercial poultry nutrition (2^{nd} Ed). University Books, P.O. Box 1326, Guelph, Ontario, Canada. pp. 12-85.

LEVIN, R. (1994). Transformation: Participatory Research and Democratic Agrarian Transformation: The case of the Eastern Transvaal Central Lowveld. pp. 35-40.

MACGREGOR, R.G. AND ABRAMS, L. (1996). Sustainable household egg production to enhance household food security. *South African Journal of Animal Science,* **26** : 85-87.

MAKARECHIAN, M., FARID, A., NIK-KHAH, A. AND SIMHAEE, E. (1983). Productive characteristics and genetic potentials of indigenous poultry of Southern Iran for meat production. *World Review of Animal Production*, **xix** : 45-57.

MALEPFANE, A.H., NGHATSANE, J., MACGREGOR, R.G. AND ABRAMS, L. (1993). Medunsa poultry outreach scheme: A Gazankulu case study. *Proc. Annual Symp. S. Afr. Soc. Anim. Sci. Dev. Areas Branch*, 11 - 14 October, Eiland Overvaal Resort. pp. 148-149.

MAY, J. (1998). Poverty and inequality in South Africa: poverty and inequality report to the office of the Deputy President. Praxis Publishing, 212 Evans Road, Glenwood, Durban 4001,South Africa. pp.1-21.

MAY, J. (2000). The structure and composition of rural poverty and livelihoods in South Africa, In: At the cross roads: Land and Agrarian reform in South Africa into the 21^{st} century. Ed. B. Cousins. PLAAS, Bellville. pp.1-78.

MAY, J., CARTER, M. AND POSEL, D. (1996). The composition and persistence of poverty in rural South Africa. An Entitlement approach to poverty. LAPC 21^{st} Floor, Sable Centre, 41 Dekorte Street, Braamfontein, Johannesburg. pp. 4 -117.

McCRAKEN, J.A., PRETTY, J.N. AND CONWAY, G.R. (1988). An introduction to rapid rural appraisal for agricultural development. International Institute for Environment and Development, London, United Kingdom. pp. 1-25.

MEKURIA, M. AND MOLETSANE, N.P. (1996). Initial findings of rural household food security in selected districts of the Northern Province. *Agrekon*, **35** : 309-312.

MIDNET PRA INTEREST GROUP. (1994). Sharing participatory rural appraisal (PRA) in Southern Africa. Pietermaritzburg, South Africa. pp.11- 41.

MINITAB (1998). Minitab Version 12.1. Minitab, Incorporated, State College, Pennsylvania, U.S.A.

MOORE, S. AND STEIN, W.H. (1948). Photometric ninhydrin method for use in the chromatography of amino acids. *Journal of Biological Chemistry*, **176** : 367-388.

MOPATE, L.Y. AND LONY, M. (1999). Survey on family chicken farms in the rural area of N'Djamena, Chad. *Livestock Research for Rural Development*, **11(2).** http://www.cipav.org.co/lrrd11/2/Chad112.htm

MOREKI, J.C., PETHERAM, R.J. AND TYLER, L. (1997). A study of Small-scale poultry production systems in Serowe-Palapye sub-district of Botswana. Proceedings INFPD Workshop, M'Bour, Senegal, December 9 -13. pp.185-197.

MORRISON, F.B. (1957). Feeds and Feeding (22nd Ed). The Morrison Publishing Company, Ithaca, New York. p. 552.

MSANE, T. (1995). Poultry and egg production in the New South Africa. *Poultry Bulletin*, Pretoria, South Africa. July. p. 302.

MTAMBO, M.M. (1999). Improving the health and productivity of the rural chickens in Africa. Poultry as a tool in poverty eradication and promotion of gender equality - Proceedings of Workshop, Tune Landboskole, Denmark. http://www.husdyr.kvl.dk/htm/php/tune99/-Mtambo.htm

MUSHI, E. Z., BINTA, M.G., CHABO, R.G., NDEBELE, R.T. AND RAMATHODI, T. (2000). Diseases and management of indigenous chickens in Oodi, Kgathleng, Botswana. *World's Poultry Science Journal*, **56** : 153-156.

NAIDOO, M. (2000). Merging different worlds in Agricultural education. M.Sc. Thesis Wageningen University, The Netherlands.

NARAYAN, D. (1996). Toward participatory research. World Bank Technical Paper number 307. The International Bank for Reconstruction and Development / The World Bank, 1818H Street, New York, Washington, D.C. 20433, U.S.A. pp. 3-112.

NATIONAL DEPARTMENT OF AGRICULTURE (1995). White paper on agriculture. Government Printer, Pretoria, South Africa.

NATIONAL RESEARCH COUNCIL (1994). Nutrient requirements of poultry (9th Ed). National Academy Press, Washington. p. 32.

NFCS. (2001a). The National Food Consumption Survey in children aged 1-9 years, part 1: Methodology, socio-demographic and anthropometric data. Stellenbosch, South Africa.

NFCS. (2001b).The National Food Consumption Survey in children aged 1-9 years, part 2: Nutrient intake, food requirement and household inventory, hunger and recommendations. Stellenbosch, South Africa.

NHLEKO, M.J. AND SLIPPERS, S.C. (1996). External quality traits of eggs from indigenous fowls by comparison with eggs from commercial Amberlink layers. *Proc. Joint Symp.S. Afr. Soc. Anim. Sci. Dev. Anim. Agric. Branch, Rare Breeds International and Association for the Conservation of Early Domesticated Animals*, 30 September to 3 October 1996, Pilanesberg, South Africa. (Abstract).

NHLEKO, M.J., SLIPPERS, S.C. AND LUBOUT, P.C. (1996). Poultry Production amongst subsistence farm households in Paulpietersburg, Northern KwaZulu-Natal. *Proc. Joint Symp.S. Afr. Soc. Anim. Sci. Dev. Anim. Agric. Branch, Rare Breeds International and Association for the Conservation of Early Domesticated Animals*, 30 September to 3 October 1996, Pilanesberg, South Africa. (Abstract).

NKOSI, N.N. AND JONES, M.W. (1993). "A warrior against malnutrition": Results of the mini-layer units established in Mahlabatini district of KwaZulu. *Proc. Annual Symp. S. Afr. Soc. Anim. Sci. Dev. Areas Branch*, 11 - 14 October, Eiland Overvaal Resort. p. 150 - 157.

OKAI, D.B. (1999). Alternative feed resources for pigs in Ghana. Book work by O.A. degraft Johnson, Accra. Ghana. pp. 1-6.

PAYNE, W.J. A. AND WILSON, T. R. (1999). An Introduction to animal husbandry in the tropics (5^{TH} Ed). Blackwell Science, Oxford. p. 526.

PRESTON, T.R. (1992). Alternative non-cereal diets for poultry. *Livestock Research for Rural Development*, **14(3)**. http://www.cipav.org.co/lrrd4/3/preston.htm

PRETTY, J., GUIJT, I., SCOONES, I. AND CHAMBERS, R. (1991). Participatory rural appraisal. Proceedings of the February, Banglore PRA Trainers Workshop. Rapid Rural Appraisal notes number 13. Rapid Appraisal Notes on Sustainable Agriculture Programme, Internation. pp. 3-37.

RANGNEKAR, D.V. AND RANGNEKAR, S. (1999). Traditional poultry production systems and the role of women in parts of Western India. Baif Development Research Foundation, P.B. No. 2030, Asarwa, Ahmedabad-380016, India.

REUTLINGER, R. (1987). Food security and poverty in developing countries, food policy. The Johns Hopkins University Press, Baltimore.

SALEH, E.A., WATKINS, S.E. AND WALDROUP, P.W. (1996). High-level usage of dried bakery product in broiler diets. *Journal of Applied Poultry Research*, **5** : 33-38.

SALEQUE, MD. A. AND MUSTAFA, S. (1996). Landless women and poultry: The BRAC Model in Bangladesh. Development Worker's Course: Integrated farming in human development, Tune Landboskole, Greve, Denmark, 25-29 March.

SAS/STAT SOFTWARE. (1999). Statistical Analysis Systems Institute (SAS), Reslease 6.11. Statistical Systems Institute. Inc, Cary, North Carolina, U.S.A.

SHAH, D.R. (1990). Alternatives in Rural Development. Sterling Publishers Private Limited L-10, Green Park Extension, New Delhi, India. pp. 40-89.

SINYANGWE, P.G. (1999).Poultry farming in Africa. *Poultry Bulletin*, Pretoria, South Africa. June, p. 382.

SMITH, A. (1990). Poultry. CTA/MACMILLAN, WAGENINGEN/LONDON.

SONAIYA, E. B. (1999). International Network for Family Poultry Development: origins, activities, objectives and visions. Poultry as a tool in poverty eradication and promotion of gender equality. Proceedings of Workshop, Tune Landboskole, Denmark. http://www.husdyr.kvl.dk/htm/php/tune99/-Snaiya.htm

SONAIYA, E. B., BRANCKAERT, R.D.S. AND GUÈYE, E.F. (1998). Research and development options for family poultry. Introductory Paper to the First INFPD/FAO Electronic Conference on Family Poultry. http://www.fao.org/ag/aga/agap/lpa/fampo1/fampo.htm

SOTSHONGAYE, A. AND MOLLER, V. (2000). 'we want to live a better life like other people': self assessed development needs of rural women in Ndwedwe, KwaZulu-Natal. *Development Southern Africa*, **17** : 117-133.

SWATSON, H. K. (1997). The use of choice feeding and mixture experiments to evaluate protein sources used in broiler feeds. M.Sc. Thesis, University of Natal, Pietermaritzburg, South Africa. pp. 1-3.

TADELLE, D. (1996). The role of scavenging poultry in integrated farming systems in Ethiopia. Second FAO Electronic Conference on Tropical Feeds. http://www.fao.org/waicent/faoinfo/agricult/AGA/AGAP/AGAP/FRG/conf96.htm/tadelle.htm

TADELLE, D. AND OGLE, B. (1997). Effect of maize (*Zea mays*) and Noug (*Guizotia abyssinica)* cake supplementation on egg production performance of local birds under scavenging conditions in the Central Highlands of Ethiopia. Proceedings INFPD Workshop, M'Bour, Senegal, December 9 -13. pp. 132-145.

TADELLE, D., ALEMU, Y., AND PETERS, K.J. (2000). Indigenous chickens in Ethiopia: genetic potential and attempts at improvement. *World's Poultry Science Journal*, **56** : 44-53.

THOMPSON, D.N. (1997). Bringing communal farmland into production. *In Focus Forum*, **4** : 67-71.

WORLD POULTRY SCIENCE ASSOCIATION. (1992). U.K. tables of feed co mposition. European amino-acid table (1st Ed). WPSA, Spelderholt Centre for Poultry Research, Beekbergen, The Netherlands. pp. 2-35.

VAN ROOYEN, C.J. (1998). Food security in the Southern African Development Community (SADC) region. *Farmer's Weekly*, Durban, South Africa. July. p. 33.

VAN ROOYEN, C.J., NGQANGWENI, S. AND FROST, D. (1996). Some considerations for South African food policy. *Agrekon*, **35** : 301-308.

VAN ROOYEN, J. (2000).Regional food security and agricultural policy in southern Africa: a challenge of policy conversion in diverse settings. *Development Southern Africa*, **17** : 1-22.

VAN SOEST, P. J. AND MASON, V.C. (1991). The influence of Maillard reaction upon nutritive value of fibrous feeds. *Animal Feed Science and Technology*, **32** : 45-53.

VERWOERD, D. (1998). Newcastle disease (NDV): A national strategy for South Africa. *Poultry Bulletin*, Pretoria, South Africa. April. pp. 182-185.

VON BRAUN, J., MSUYA, J. AND WOLF, S. (1999). On the 'how to' of agricultural growth promotion and improved food security: Implications for Southern Africa in a regional and international context. *Agrekon,* **38** (special issue, May) : 1-19.

WETHLI, E. (1999). The Southern African chicken book: how to start a small business keeping chickens. Juta and Company, Ltd., Kenwyn, South Africa. p. 103.

WINFEED. (1995). Winfeed Version 1.1 User's Guide. EFG Software (Natal), P.O. Box 101476, Scottsville, 3092, South Africa. p. 141.

WOOD, P.D.P. (1967). Algebraic model of the lactation curve in cattle. *Nature*, **216** : 164-165.

ZAVON, J. (2000). Bakery byproducts: Challenge and opportunity. *Feed International*, **21(5)** : 19-20. A Watt Publication, http://www.wattnet.com.

ZOUGRANA, B. AND SLENDERS, G. (1992). Poultry in the backyard, *Ileia Newsletter*, **8** : 17.

APPENDIX 1

Source of Variation	Degree of freedom	Rate of lay	Egg weight	Egg output	Feed intake	Shell thickness	Feed Conversion Efficiency
Treatment	4	0.0065	0.0006	0.0001	0.5892	0.1314	0.0032
Linear	1	0.0003	0.0001	0.0001	0.7195	0.0288	0.0001
Quadratic	1	0.7481	0.7908	0.6976	0.1812	0.1528	0.2713
Cubic	1	0.7585	0.7549	0.6875	0.4762	0.9535	0.5631
Deviation	1	-	-	-	-	-	-
Pen (treat) Error (a)	25	-	-	-	-	-	-
Period	35	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Treatment X Period (Error b)	905	0.0352	0.0248	0.0012	0.5340	0.0018	0.0023
Total	1109						